The Shadow Cost of Bank Capital Requirements

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Abstract

How much would an increase in regulatory capital requirements cost banks? We estimate the shadow cost of capital requirements for banks using data on their participation in a costly regulatory loophole. The extent to which banks bypassed capital requirements, by providing liquidity guarantees to asset-backed commercial paper conduits, reveals their private compliance costs. We estimate that a ten percentage point increase in capital requirements would cost \$2.2 billion a year for all banks that exploited the loophole combined, and no more than \$3.7 billion for all US banks. The average cost per bank is \$143 million, or 4 percent of annual profits. Lending interest rates would increase by 3 basis points and quantities would decrease by 1.5 percent.

JEL classification: G21, G28, L51

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1 Introduction

The severity of the financial crisis of 2007-2010 restarted an important debate on the regulation of financial intermediaries. Prominent economists and policy-makers have called for a substantial increase in capital requirements for financial intermediaries, as a way to rein in their leverage. Leverage amplifies small shocks to the value of an intermediary's assets into large swings in the value of its equity, increasing the chance of distress and insolvency. In an interconnected financial system, individual distress affects other intermediaries, and may lead to a financial crisis. Fearing the failure of the financial system, governments often rescue distressed intermediaries viewed as systemically important, thereby imposing the cost of distress on taxpayers.[1]

Nevertheless, proposals to increase capital requirements face fierce and successful opposition from financial intermediaries, apparently driven by their *private costs* of capital requirements. Despite the central role of these costs in shaping the regulation, they have not been measured empirically.[2] We address this gap by using banks' own actions to infer their perceived compliance costs. Prior to the crisis, banks had access to a costly loophole that helped them bypass capital requirements. Since, according to the banking industry, higher regulatory ratios decrease profitability, a profit maximizing bank would trade off the cost of the loophole against the benefit of reduced capital. Therefore, data on loophole use, together with information on its direct costs, reveal the shadow costs of capital requirements. This approach, first used by Anderson and Sallee (2011) to study fuel-economy standards, allows estimating the shadow costs of regulation without the need to estimate demand elasticities and other unobservables.

We formalize this intuition in a banking model and take it to data on banks' provision of liquidity guarantees to asset-backed commercial paper (ABCP) conduits. As documented by Acharya, Schnabl, and Suarez (2013), banks that provided liquidity guarantees to ABCP conduits effectively held the risks of the underlying assets. However, instead of treating such

[1] For a detailed analysis of the recent crisis, see, among others, The Squam Lake Report (French et al., 2010) and Admati, DeMarzo, Hellwig, and Pfleiderer (2011). Admati et al. (2010) – an open letter published in Financial Times – exemplifies recent calls of leading researchers to increase capital requirements of financial institutions. Similar proposals resurface following historical crises as well (Simons, 1948; Bryan, 1988).

[2] The costs of capital requirements are high according to banks (see, e.g., American Bankers Association, 2012). Theoretically, these costs could be large if the fragile capital structure of banks is necessary for their operation (Calomiris and Kahn, 1991; Diamond and Rajan, 2001). For opposing arguments see, e.g., Admati, DeMarzo, Hellwig, and Pfleiderer (2011) and Admati and Hellwig (2013). In their open letter, Admati et al. (2010) accept that higher capital requirements may reduce profits, but maintain that this cost would be mostly borne by banks' shareholders and managers. Some recent theories suggest that higher equity may increase bank value by improving incentives (e.g., Holmstrom and Tirole, 1997; Allen, Carletti, and Marquez, 2009; Mehran and Thakor, 2011). As we discuss below, the latest revision of US bank regulation increases capital requirements by at most two percentage points.

guarantees as risky assets, banks were allowed to include only ten percent (zero before 2004) of these guarantees in the calculation of regulatory capital ratios. Therefore, this loophole allowed banks to decrease their true capital ratios while keeping their regulatory ratios within the guidelines.

While the loophole benefited banks by relaxing their regulatory constraints, using it was costly, as banks had to pay an incremental cost for using ABCP conduits. Therefore, for constrained banks that use the loophole, the ratio of the marginal cost of using the loophole to the marginal benefit reveals the shadow cost of the regulatory capital constraint. The shadow cost for unconstrained banks is zero.

We derive the marginal benefit of exploiting the loophole for each of the three regulatory capital ratios: tier 1 risk-based capital ratio, total risk-based capital ratio, and tier 1 leverage ratio. The benefits can be calculated using our data; they are higher for banks with higher regulatory ratios and for banks that can achieve a larger reduction in the asset base by using the loophole. The marginal cost – the incremental increase in the cost of capital due to asset financing through the loophole – is harder to quantify since we do not have bank-level interest rate data. We measure the marginal cost at each point in time using the 30 day ABCP spread over financial commercial paper, which is positive and stable during the studied 2002-2007 pre-crisis period.

Our approach allows us to estimate the shadow costs of capital regulation for constrained banks that used the ABCP loophole, and provides an upper bound for other banks.[3] We identify 18 US bank holding companies that sponsored and provided liquidity guarantees to ABCP conduits in the pre-crisis period, using detailed data on ABCP conduits from Moody's Investor Service and banks' quarterly reports.[4] Although few in numbers, these institutions account for about half of all US bank assets. Consistent with the model, we show that these banks tend to be much more constrained by capital regulations than the rest of the banking universe. Moreover, these institutions play a central role in the current debate on capital requirements; these large, heavily levered banks were at the epicenter of the recent financial crisis, and are still the subjects of and active participants in the policy debate.

We find that contrary to claims by the financial sector, the shadow costs of capital requirements during the pre-crisis period were modest. We estimate that a 10 percentage point increase in the required tier 1 risk-based ratio (e.g., from 6% to 16%), would cost all

[3] As we discuss in detail in the model section below, to obtain a point estimate of the shadow cost of regulation we need to observe constrained banks that use, but do not exhaust the loophole (i.e., do not concentrate their entire asset portfolio in ABCP conduits). We verify these conditions empirically in Section 3. For the rest of the banking universe, our methodology identifies an upper bound for the costs.

[4] For brevity, we use the terms "ABCP sponsors" and "Liquidity providers to ABCP conduits" interchangeably. We explain the distinction between the two terms below. Also, while our analysis is done at the bank holding company level, we use the terms "Bank" and "Bank Holding Company" interchangeably.

participating banks in our sample *combined* about $2.22 billion a year in the pre-crisis period. The cost to an average bank is about $143 million, which corresponds to 4 percent of its annual profits. A similar increase in the tier 1 leverage and the total risk-based requirements would cost banks an aggregate amount of $2.2 billion and $1.6 billion, respectively. For *all* US banks combined, we estimate that such an increase would cost no more than $3.7 billion, $3.58 billion, and $2.68 billion for tier 1 risk-based, tier 1 leverage and total risk-based ratios, respectively. We perform a series of robustness tests, and verify the stability of our estimates under alternative assumptions.

The modest cost estimates may appear puzzling, especially given banks' strong resistance to higher capital requirements. Note, however, that we estimate the shadow cost of capital requirements for banking profits, rather than the cost of issuing additional equity (Kashyap, Stein, and Hanson, 2010; Baker and Wurgler, 2013) or the effect of deleveraging due to distress (Peek and Rosengren, 1997). We estimate the effect of capital regulation on profits during an economic expansion after banks utilized all available tools to mitigate the impact of the constraints. Therefore, a small shadow cost means that banks either significantly overstate the effect on the cost of capital, or that they can neutralize the effects of higher costs on profits.[5] Under both interpretations, our results show that increasing capital requirements while holding other rules constant would not significantly affect banking profitability, while achieving the benefits of increased equity. Regulators might still worry that because of tighter capital requirements banks would restrict or bias their provision of credit. However, our calculations indicate that the effects on lending quantities and interest rates, are also likely to be small. Finally, while banks' lobbying efforts may appear surprising given the low estimated costs, we note that lobbying expenses are not paid every year, whereas the costs we estimate are incurred annually.[6]

Our study is most closely related to the literature on the impact of increased capital requirements on lending and the cost of loans. Kashyap, Stein, and Hanson (2010) estimate that a 10 percentage point increase in capital ratios would raise banks' weighted average cost of capital by 25-45 basis points, while Baker and Wurgler (2013) estimate the same policy change would result in a 60-90 basis points higher cost of capital. Other papers focus on the benefits of higher capital requirements by examining the performance and survival of banks

[5]Banks could, for example, tilt their loan portfolio towards assets with lower risk weights or pass the increase in costs to borrowers. Thakor (1996) indicates that changes in risk-weighting schemes could result in a portfolio rebalancing by banks, at least in the short term. More recently, Brun, Fraisse, and Thesmar (2013) report a large effect on corporate lending in France following Basel II changes in risk-weighting rules. We leave the treatment of the effect of a change in risk-weighting schemes for future research. Note, however, that even if new regulations result in changes in risk-weighting schemes, our methodology would still be applicable.

[6]See, also, Thakor (forthcoming) for a discussion of the political economy of bank capital regulation.

during banking crises (e.g., Berger and Bouwman, 2013). Van den Heuvel (2008) measures the welfare loss from increasing bank capital requirements beyond their socially optimal level in a competitive banking environment. Our approach differs from the rest of the literature in that we focus on the effect of the regulation on the net *producer surplus*, which includes the parts of expected costs and benefits internalized by banks.

We view our approach as complementary to this literature in several ways. First, both consumer and producer surpluses are obviously important in quantifying the social costs of higher capital requirements (with the latter gaining importance in an oligopolistic environment). While the effect of capital requirements on producer surplus plays a central role in the current regulatory debates, to the best of our knowledge ours is the first paper to provide a direct estimate of this effect. Our estimates can directly inform policy-makers and the academic literature on the magnitude of the preferences of the banking sector towards leverage and help us better understand the forces opposing regulatory capital reform.

Second, we do not impose a Modigliani and Miller (1958) capital structure irrelevance assumption to estimate the shadow costs; banks in our framework rationally maximize profits, and may perceive equity to be costlier than debt. Instead, our estimates are inferred from banks' revealed preference for capital structure.

Third, we can estimate the effect of capital requirements during an economic expansion (2002-2007), without relying on negative economic shocks for identification.[7] This feature increases the relevance of our estimates for the current regulatory debate, since the implementation of new rules is not done in a crisis period, allowing banks a sufficient transition period and access to well-functioning equity markets. Moreover, our estimates can help regulators assess the potential effects of macroprudential regulation, which relies on increasing required capital ratios during economic expansions.

More broadly, our paper is related to a literature in microeconomics that studies the effect of regulation on industry participants and market outcomes. Most closely related is Anderson and Sallee (2011), who study the effect of regulatory fuel-economy standards on automakers. Their approach greatly influenced the development of our model and estimation. We show how bank capital regulation loopholes can be used to produce estimates of its shadow cost. Our estimates could be used to calibrate macroeconomic models with financial frictions (He and Krishnamurthy, 2013, 2012; Brunnermeier and Sannikov, forthcoming).[8]

We also contribute to a burgeoning macro-finance literature studying the costs of financial constraints for financial intermediaries. Most related is Koijen and Yogo (2013), which

[7]Much of the related literature study periods of economic downturns (see, e.g., Peek and Rosengren, 1997; Brun, Fraisse, and Thesmar, 2013).

[8]See Gertler and Kiyotaki (2010) and Brunnermeier, Eisenbach, and Sannikov (2013) for recent surveys.

estimates the shadow cost of statutory reserve regulation for life insurers. The main advantage in adapting the Anderson and Sallee (2011) loophole approach to banking is that it avoids fully specifying the competitive equilibrium, as well as estimating demand elasticities, markups, and other unobservables. Due to the complexity of the banking industry this would involve multiple limiting assumptions and significantly increase the data requirements.

The paper proceeds as follows. Section 2 describes the model and derives the shadow costs of capital regulation. Section 3 describes the data and verifies some necessary conditions for estimation. Section 4 presents the main results for US banks. Section 5 verifies the robustness of our estimates and considers European banks. Section 6 calculates effects on lending. Section 7 concludes.

2 Institutional Setting and Model

We begin by describing the regulatory environment in which banks operate and the regulatory treatment of ABCP liquidity guarantees. Given this context, we then model a bank maximizing its profits subject to a regulatory capital constraint and derive the marginal benefit from using the ABCP loophole to relax the capital constraint. We then derive the optimal use of the loophole and provide a simple expression for the shadow costs of the regulatory capital constraints in terms of observable variables.

Of course, the shadow cost is equalized across different margins and could potentially be revealed by other optimal choices. The main advantage of the present approach is that it avoids estimation of a large number of demand elasticities, markups, and production cost parameters. At an interior solution (that is, when the fraction of assets in the ABCP conduits is strictly between 0 and 1), the ratio of the marginal cost to the marginal benefit of exploiting the loophole reveals the shadow cost of regulatory capital requirements, and we can remain agnostic about the details of the equilibrium and key parameters that we do not observe (Anderson and Sallee, 2011).

2.1 Regulatory Environment

2.1.1 Capital Ratios and Risk-Weighted Assets

A bank holding company in the United States reports three separate capital ratios to the regulatory authorities. Upon observing the ratios and other banking characteristics, the regulators decide whether the bank is considered well-capitalized, adequately capitalized, or under-capitalized. A bank is considered *well-capitalized* if all of the following are true:[9]

[9] See 12 CFR Part 225.

1. Core capital (leverage) ratio ≡ Tier 1 (core) capital as a percent of average total assets - ineligible intangibles ≥ 3% to 5% depending on its composite CAMELS rating;

2. Tier 1 risk-based capital ratio ≡ Tier 1 (core) capital as a percent of risk-weighted assets ≥ 6%; and

3. Total risk-based capital ratio ≡ Total risk-based capital as a percent of risk-weighted assets ≥ 10%.

Banks that are not well-capitalized face greater regulatory scrutiny, are less likely to get regulatory approval for acquisitions, and cannot accept brokered deposits without an explicit approval from the regulator. If a bank fails to be *adequately-capitalized*,[10] it faces stronger regulatory sanctions, such as the need to submit a plan to the regulator detailing the ways the bank would increase its capital. Failure to submit, receive an approval, and execute such a plan would trigger further sanctions. Further deterioration in the ratios can change the status of the bank to *significantly under-capitalized* or *critically under-capitalized*, and may eventually result in a takeover by the federal deposit insurance corporation.

A central feature of bank capital regulation that plays an important role in our analysis is the risk-weighting of banks' assets for the purposes of calculating capital ratios. To calculate risk-weighted assets, the bank applies a risk weight w_j to each asset of a risk group j on its balance sheet. There are four major risk weights: 0%, 20%, 50%, and 100%.[11] For example, cash holdings get a risk-weight of zero, claims conditionally guaranteed by OECD central governments 20 percent, residential mortgages 50 percent, and standard assets 100 percent. Off-balance sheet items are converted into balance sheet equivalents by further multiplying their risk-weighted value by a conversion factor β smaller than 1.[12]

2.1.2 Regulatory Treatment of Liquidity Guarantees to ABCP Conduits

Here, we briefly describe the structure of ABCP conduits and the regulatory treatment of their liquidity guarantees, highlighting the issues most relevant for our analysis. We refer interested readers to Acharya, Schnabl, and Suarez (2013) and the follow-up literature, as well as industry publications (e.g., Bate, Bushweller, and Rutan, 2003) for a detailed discussion of conduit structure and relevant regulation.

Liquidity guarantees to ABCP programs were given a special regulatory treatment. In particular, for such guarantees, the conversion factor was $\beta_{ABCP} = 0\%$ until September

[10] Tier 1 risk-based ratio falls below 4%, total risk-based ratio below 8%, or tier 1 leverage ratio below 4%.

[11] Some assets, such as securitized assets get weights between 20% and 200% depending on credit ratings.

[12] To simplify notation, we omit the asset-specific subscript on β except when we describe the conversion factor for ABCP assets.

2004, and 10% until January 2010 when this loophole was closed. In other words, before September 2004 banks could completely ignore these guarantees when calculating their risk-based capital ratios. After June 2004, the risk-weights were applied to 10% of these assets.[13]

Acharya, Schnabl, and Suarez (2013) show that this special treatment of liquidity guarantees to ABCP conduits is equivalent to securitization without risk transfer. That is, the bank providing the guarantee (usually 102% of asset value) is effectively assuming all of the risk in the loans made by the conduit, even though the guarantees are conditioned on the assets performing well.[14] The reason is that investors in the short term ABCP (mostly money-market mutual funds) provide only short-term financing to the conduit and would stop rolling over the debt long before the assets stop performing. At this point the liquidity provider would be required to step in, repay the maturing debt and take possession of the assets. Therefore, for all practical purposes, conduit assets were equivalent to on-balance sheet loans. In fact, the role of ABCP conduits in bypassing the regulation was widely recognized at the time.[15] Had the regulation recognized this fact, the conversion factor for ABCP liquidity guarantees would have been $\beta_{ABCP} = 100\%$, as it has been since 2010. We next turn to modeling the bank's behavior given the regulatory requirements and the presence of the ABCP loophole.

2.2 Banks

We assume that banks operate in an oligopolistic environment and maximize profits by choosing the interest rate r_j they charge on loans of risk class j, capital ratio k, and share

[13]See Final Rule issued July 20, 2004 by the federal banking and thrift regulatory agencies on Capital Requirements for Asset-Backed Commercial Paper Programs, which became effective September 30, 2004. For the 2010 revision, see Federal Register Vol. 75 No. 18 dated January 28, 2010.

[14]On top of liquidity guarantees, some conduits have "credit enhancements" — arrangements designed to protect investors from the default risk of the underlying assets. As we discuss in section (3), however, credit enhancements have little relevance for our analysis; they cover a small part of the assets, and tend to be provided by the sponsors themselves.

[15]Consider these quotes from Moody's description of the conduits (Bate, Bushweller, and Rutan, 2003):

"The programs are typically structured and accounted for by the banks as an off-balance sheet activity. If the bank were to provide a direct corporate loan, even one secured by the same assets, it would appear on the bank's balance sheet as an asset and the bank would be obligated to maintain regulatory capital for it. An ABCP program permits the Sponsor (i.e., the commercial bank) to offer receivable financing services to its customers without using the Sponsor's balance sheet or holding incremental regulatory capital."

"The rise of bank risk-based capital standards around the world in 1988 imposed significant costs on Support Providers in fully-supported ABCP programs. Risk-based capital standards required Support Providers to hold regulatory capital for the entire face amount of ABCP outstanding under certain ABCP programs because the support facility has been viewed as a "direct credit substitute" and not merely as a loan commitment. The increased costs associated with providing direct credit substitutes motivated banks to find a more cost effective way to structure ABCP programs. The result was the creation of partially-supported ABCP programs, which were eligible for more advantageous treatment under the risk-based capital standards, and could continue to offer funding at attractive rates to Sellers."

of assets they move off the books using liquidity guarantees to ABCP conduits θ

$$\max_{\mathbf{r},k,\theta} \Pi = \sum_j \left[r_j - c(k) - \alpha\theta\right] q_j(\boldsymbol{r}) - I(\theta > 0) \times F, \tag{1}$$

subject to a regulatory capital constraint

$$K(\boldsymbol{q}, k, \theta) \geq \sigma. \tag{2}$$

Banks are constrained to have a regulatory capital ratio K at least as large as the capital requirement(s) σ.[16] The bank must pay a fixed cost F to set-up an off-balance sheet ABCP conduit before it can exploit the loophole. Once set-up, an ABCP conduit can contain assets of any kind, thus fixed-costs are shared among assets of different risk classes. We therefore assume the fraction of loaned capital used to fund ABCP conduits $\theta \in [0, 1]$ is constant across risk classes (we relax this assumption in the robustness section).

The bank faces a residual demand function $q_j(\mathbf{r})$, and its total assets are denoted by $Q = \sum_j q_j$. Total assets of each risk class, q_j, include on and off balance sheet assets, as well as the liquidity guarantees:

$$q_j = a_j + \beta_j b_j + l_j$$

where a_j are on-balance sheet assets, b_j are off-balance sheet assets (other than ABCP liquidity facilities) converted into on-balance sheet equivalent amounts by the conversion factors β_j. Liquidity guarantees for ABCP conduits l_j are assumed to be a fixed proportion of total actual assets, i.e. $l_j = \theta q_j$ for all j.

The marginal cost of bank capital $c(k)$ is increasing in its capital ratio k. This assumption is consistent with bankers beliefs, and captures frictions that make equity capital costly relative to debt financing from the bank's perspective, such as taxes, underpriced deposit insurance, a demand for money-like securities, or market segmentation (Gorton and Pennacchi, 1990; Dang, Gorton, and Holmstrom, 2012; Stein, 2012; DeAngelo and Stulz, 2013).

The capital ratio k is the true capital ratio of the bank, which is potentially different from the regulatory ratio K. The wedge between k and K is meant to capture ways banks can change their risk profiles while holding constant their regulatory ratios. The exact ways in which k and K differ plays no role in our analysis, since, as we show below, k does not enter our shadow cost expressions. We find it useful, however, to think of k as the ratio that matters for bank investors and other market participants (as opposed to regulators). A difference between k and K, then, means that the market is not misled by the different

[16] Here, for clarity of exposition, we ignore the fact that there are three different capital ratios, and address them in detail below.

regulatory loopholes that the bank may be using.

The incremental cost per dollar of assets financed through the ABCP loophole is α. It is positive, reflecting the assumption the banks would face a lower marginal cost of financing were they to absorb these assets on their balance sheets. In other words, while ABCP conduits do not change the bank's true leverage ratio k, moving assets into shadow banking is costly. Measuring α empirically requires an estimate of the bank's marginal cost of capital. In the empirical section, we validate the assumption that α is positive and examine the sensitivity of our results to various alternatives assumptions about α.

Summing over risk classes, we get total balance-sheet assets $A = \sum_j a_j$, off-balance sheet converted assets $B = \sum_j \beta_j b_j$, and total liquidity guarantees $L = \sum_j l_j$. Differently from total actual bank assets Q, risk-weighted assets are

$$Q^r = \sum_j w_j \left(a_j + \beta_j b_j + \beta_{ABCP} l_j\right) = \left[1 - \left(1 - \beta_{ABCP}\right)\theta\right] \sum_j w_j q_j. \tag{3}$$

Denoting by $E1(k)$, $E2(k)$, and $E3(k)$ the tier 1, tier 2, and tier 3 capital raised by the bank, the leverage ratio is

$$K^{T1Lev}(\mathbf{q}, k, \theta) = \frac{E1(k)}{A} = \frac{E1(k)}{Q(1-\theta) - B}, \tag{4}$$

tier 1 risk-based capital ratio is

$$K^{T1RB}(\boldsymbol{q}, k, \theta) = \frac{E1(k)}{Q^r} = \frac{E1(k)}{\left[1 - \left(1 - \beta_{ABCP}\right)\theta\right] \sum_j w_j q_j}, \tag{5}$$

and total risk-based capital ratio is

$$K^{TotRB}(\boldsymbol{q}, k, \theta) = \frac{E1(k) + E2(k) + E3(k)}{\left[1 - \left(1 - \beta_{ABCP}\right)\theta\right] \sum_j w_j q_j}. \tag{6}$$

Equations (4), (5), and (6), substituted into equation (2), provide expressions for the regulatory capital constraints faced by banks. These expressions determine the marginal benefit of exploiting the loophole to relax the constraint.

Having defined the competitive and regulatory environment for banks, we can now solve for optimal usage of the ABCP loophole and derive the shadow costs of banking regulation.

2.3 Optimal ABCP Shares Reveal the Shadow Cost

Banks choose the share of assets to hold in ABCP conduits. Focusing only on this decision, the Lagrangian for the maximization problem is

$$\mathcal{L} = \sum_j \left[r_j - c\left(k\right) - \alpha\theta\right] q_j\left(\boldsymbol{r}\right) - I\left(\theta > 0\right) \times F + \lambda Q\left[K\left(\boldsymbol{q}, k, \theta\right) - \sigma\right] \tag{7}$$

where λ is the shadow price per dollar of the capital constraint. By the envelope theorem, the effect of a marginal increase in σ on profits is simply this Lagrangian multiplier. The first-order condition for banks with an interior ABCP share of assets $\theta \in (0, 1)$ can be solved for the Lagrangian multiplier. Therefore the shadow cost per dollar of the regulatory capital constraint as revealed by optimal use of the loophole is simply

$$-\frac{\partial \mathcal{L}^*}{\partial \sigma}\frac{1}{Q} = \lambda \leq \frac{\alpha}{K_\theta}, \text{ with equality if } \theta > 0. \tag{8}$$

Intuitively, given a bank's optimal capital structure, interest rates and the use of the loophole, a higher marginal cost of exploiting the loophole (α) or a smaller marginal benefit (K_θ) imply the bank faces a higher cost of complying with the capital constraint.

Note that our analysis for each constraint is valid only if it binds. Expression (8) still holds, however, even if banks' capital ratios are not exactly equal to the constraint, but rather they keep a constant cushion from σ, which, as we show below, is supported by the data. If a bank does not use the loophole to relax the constraint ($\theta = 0$), then α/K_θ is an upper-bound on the shadow cost faced by the bank.

For each binding constraint, we can calculate its shadow cost from (8). Specifically, from the leverage ratio constraint our estimate of the shadow cost per dollar of assets is

$$\lambda^{T1Lev} = \frac{\alpha}{K^{T1Lev}} \times \frac{A}{Q}, \tag{9}$$

from the tier 1 risk-based capital ratio constraint it is

$$\lambda^{T1RB} = \frac{\alpha}{K^{T1RB}} \times \frac{Q^r}{\left(1 - \beta_{ABCP}\right)\sum_j w_j q_j}, \tag{10}$$

and similarly the shadow cost implied by the bank's total risk-based capital ratio is

$$\lambda^{TotRB} = \frac{\alpha}{K^{TotRB}} \times \frac{Q^r}{\left(1 - \beta_{ABCP}\right)\sum_j w_j q_j}. \tag{11}$$

The shadow costs of binding constraints are positive, and zero for non-binding constraints.

All else equal, the shadow cost is larger for banks with smaller ratios K, and smaller discounts from loophole usage applied to its asset base in each regulatory ratio. To gain some intuition, consider two hypothetical banks with the same leverage ratio K^{T1Lev} and the same marginal cost α: a "simple" bank with all its assets on the balance sheet, and a "complex" bank with only a small fraction of its true assets on the books. The marginal benefit that increasing θ has on the leverage ratio is just $K^{T1Lev} \times 1$ for the simple bank, while, for the complex bank, the marginal benefit would be the larger $K^{T1Lev} \times \frac{Q}{A}$. Since the simple bank pays the same incremental cost α, *despite* the fact that its marginal benefit at the optimum is small, its perceived shadow cost of the capital constraint must be larger.

2.4 Discussion

Before applying the model to data, we pause to discuss two features of our approach not explicitly mentioned above. First, λ measures each bank's marginal compliance costs in equilibrium. This may appear limiting, since regulatory changes are likely to apply to the whole industry. We note, however, that if regulatory tightening of capital requirements substantially change the interest rates or capital structure for competing banks, then the marginal loss in profits the bank would suffer would likely be *smaller* than we estimate. Intuitively, it would harm competitors and weaken the effect on the individual bank.[17]

Second, the envelope theorem argument holds constant the endogenous choice variables (interest rates, capital structure, ABCP share), to estimate the first-order effect on profits of a small increase in capital requirements. The effect of a substantial tightening would include second-order effects from choice variable adjustments. Since these choices would be made to mitigate the loss in profits, our estimates, again, would likely overstate the total effect.

3 Empirical Analysis

We next describe the data used and verify some necessary conditions for estimation. While relatively few in number, ABCP sponsors are a significant part of the banking sector. We find that large constrained banks exploit but do not exhaust the ABCP loophole, which facilitates estimation of the shadow cost.

[17] See Anderson and Sallee (2011) for an extensive discussion of this issue.

3.1 Data

3.1.1 ABCP Conduits

Our data on ABCP programs was provided to us by Moody's Investor Service. It includes information on the asset composition, ratings, and liquidity guarantees of most programs from 2002 to 2012. The data consists of distinct datasets. The first dataset contains monthly data on bank-sponsored multi-seller, security arbitrage, and hybrid programs. It includes information on the total amount of assets in the conduit and the composition of assets over time, such as industry, credit rating, and deal size (but not the identity of the seller). It also provides information about the sponsoring institution and the list of entities that provide liquidity guarantees to the conduit, as well as their relative share in the provision of the guarantees. Finally, the data covers other contractual features of the conduit, such as credit enhancements and the limit on the size of conduit assets.

The second dataset provided to us by Moody's has quarterly coverage of the ABCP universe, and includes (in addition to the conduits described above) single-seller conduits, Structured Investment Vehicles (SIV), and loan-backed conduits. While this dataset covers a larger part of the ABCP universe and has complementary information, such as the type of support given to the conduit (full vs. partial), it does not provide an asset-level breakdown or the list of liquidity providers.[18] We match these datasets by conduit name and date to create an exhaustive database of ABCP conduits, their sponsors, and liquidity providers.

Figure 1 tracks the size of the ABCP market and compares the coverage of our data with the aggregate numbers provided by the Federal Reserve. The figure shows that our conduit-level data tracks well and exceeds in coverage the publicly-available aggregate numbers. Also, as has been well-documented elsewhere (e.g., Covitz, Liang, and Suarez, forthcoming), the figure shows the increase of the ABCP market prior to the crisis, as well as its eventual collapse. The decline is likely due to both the recession and the diminished incentive to use ABCP financing after the liquidity guarantees loophole was closed in the aftermath of the financial crisis. We focus on the pre-crisis period to estimate the shadow cost of capital regulation in normal times.

Table 1 provides summary statistics on ABCP sponsors and the underlying conduit assets. Panel (a) shows the number of sponsors, liquidity providers, total assets and total liquidity provisions. The entries "Liquidity Providers" and "Total Liquidity Provisions" focus on conduits relevant for the loophole – ABCP programs covered by liquidity guarantees. This category excludes conduits whose paper was covered by weaker guarantees, such as SIVs, CDOs, and ABCP with extendible guarantees. The table shows these statistics separately

[18] See Acharya, Schnabl, and Suarez (2013) for a detailed description of this second dataset.

for three categories of sponsors: US Banks, Non-US Banks, and Non-banks ("Other").

Consistent with the predominant use of liquidity guarantees to bypass capital requirements, the table shows that while non-banks were active participants in the ABCP market as a whole, they provided only about five percent of the total dollar value of liquidity guarantees.

Panel (b) of Table 1 takes a closer look at the quality of assets held by the conduits covered by liquidity guarantees. ABCP conduits held securitized and unsecuritized assets. For unsecuritized assets, our data includes the credit ratings of the sellers of these assets. For securitized assets, the table shows the credit ratings of these assets. The table shows that ABCP conduits were comprised predominantly of assets that would be considered high quality at the time.

While liquidity guarantees covered, on average, 102% of assets, some conduits also had conduit-level "credit enhancements." We find (untabulated) that these credit enhancements covered 6.8% of the assets on average. Moreover, for an average (median) conduit 71% (100%) of these credit enhancements were letters of credit provided by the *sponsor itself*.[19] This supports the premise that for the conduits in our analysis banks that provided liquidity guarantees to ABCP conduits bore the risks of conduit assets.

3.1.2 Bank Holding Companies

After correcting Moody's identification of sponsoring banks for mergers, owner-subsidiary links, name changes, and other such issues, we merge Moody's data with the financial information on bank holding companies from the Consolidated Financial Statements (FR Y-9C) filed quarterly with the Fed.

We find 18 bank holding companies that provided liquidity guarantees to ABCP programs during our sample period (2002Q4 - 2007Q2). While few in numbers, as we discuss in detail below, these institutions hold about half of aggregate US bank assets in our sample. Table 2 compares these bank holding companies with the rest of the banking universe. ABCP sponsoring banks are on average much larger than non-sponsors, and all three of their regulatory capital ratios are smaller.

3.2 Preliminary Analysis: Empirical Relevance of the Model

Two important observations about the empirical applicability and relevance of our model are in order. First, we have derived the shadow costs of capital requirements from the first-order

[19]See Bate, Bushweller, and Rutan (2003) for a detailed discussion of these arrangements. Major categories of credit enhancements are: Credit Asset Purchase Agreements, Cash Collateral Account, Letter of Credit, and Surety Bond.

condition for the share of ABCP assets of a profit-maximizing bank. For these first-order conditions to hold with equality, the bank cannot be in a corner solution – that is, we cannot identify the shadow costs using our methodology for banks that do not exploit the loophole, or for banks that shift all of their portfolio of assets to ABCP conduits. For banks that do not exploit the ABCP loophole, the ratio of the marginal cost of reducing capital ratios using the loophole to its marginal benefit α/K_θ gives an upper bound on the compliance costs for such banks (see (8)). Second, we assume that the quantities demanded $q_j(\boldsymbol{r})$ do not depend directly on the share of assets placed in conduits. That is, borrowers care about the interest rates charged by the bank, but do not care about the way banks finance their loans.

The above discussion suggests that before calculating the estimates of shadow costs, we need to provide two important pieces of evidence. First, since there are relatively few banks that choose to exploit the ABCP loophole, we need to examine the relevance of these banks for the banking sector, and, in particular, for the debate on tightening the capital constraints regulation.

Second, in order to use equations (9), (10), and (11) to calculate the shadow costs of capital requirements, we need to verify that the following sufficient conditions are satisfied in our data:

- C1 Constrained banks must exploit the liquidity guarantee loophole to comply with capital regulation (i.e. $K \approx \sigma$ implies $\theta > 0$).
- C2 Constrained banks must not finance their entire operation with ABCP conduits (i.e. $\theta \in (0, 1)$).
- C3 Marginal borrowers must not value loans financed with traditional deposits differently from those financed with ABCP conduits.

In the following subsection, we verify C1 and C2 empirically. Although our data does not allow us to verify C3 directly, the assumption seems plausible since the value of a dollar to the borrower is the same regardless of whether the loan is held by an ABCP conduit or by the bank itself. In Section 5.4 we show that if conduits created value in addition to their regulation-avoidance role, our results *overestimate* the the shadow cost of regulation. Our results would still hold if in practice, for whatever reason, some borrowers prefer that their loan would be held by the bank itself, or, alternatively by an ABCP conduit, as long as many marginal borrowers are indifferent between the source of financing.

3.2.1 Economic Significance of ABCP-sponsoring Banks

Figures 2a and 2b examine the relevance to the economy and the capital regulation debate of the banks captured by our methodology. Figure 2a shows the fraction of the total banking assets held by these banks.[20] Domestic sponsors held on average 50 percent of all banking assets in the United States. Adding the assets of banks owned by foreign ABCP-sponsoring banks (and thus also provide liquidity to conduits) increases this number to 63 percent. Therefore, while relatively few in number, ABCP sponsors appear to be a significant part of the banking sector.

Further evidence that ABCP sponsors are central to the current regulatory debate is provided in Figure 2b, which takes a closer look at the differences in the distribution of bank size between the ABCP sponsors and other banks. The difference in the size distributions is striking. There appears to be little overlap in the size distribution between domestic ABCP sponsors and other banks.[21] As policy-makers focus their attention to the correlation between the size of assets of individual banks and the risks they pose, it appears that our sample of liquidity guarantors represents well the banks currently at the epicenter of the regulatory debate: large banks that capture a significant share of the industry. As discussed above, however, in order to apply our methodology, it is still important to verify that these banks are constrained by capital regulation.

3.2.2 Constrained Banks Exploit but Do Not Exhaust the Loophole

Figure 3 contrasts the distribution of capital ratios for banks that use the loophole with the distribution for banks that do not. Consistent with condition C1, ABCP sponsors are bunched up much closer to the regulatory "well-capitalized" threshold. While they appear more constrained than the rest, these banks seem to keep a cushion of about 2% from the threshold. This behavior is most apparent in the case of the tier 1 risk-based capital – a constraint usually considered the most binding of the three.

A closer look into specific cases further confirms and clarifies the evidence from aggregate distributions. Figure 4 shows for the four most active ABCP sponsors (by dollar exposure), their regulatory ratios with and without ABCP assets. In the case of tier 1 risk-based ratio, three banks appear to target an 8% mark, i.e., the minimum requirement for being "well-capitalized," plus a stable cushion of 2 percentage points. The fourth bank, State Street,

[20] This number is calculated each quarter for banks that actively provided liquidity guarantees to ABCP conduits (a bank that participated in the ABCP market, but had not provided liquidity guarantees would not be included in the calculation).

[21] While the sample of US banks that do not sponsor ABCP conduits includes some extremely large banks, we find that most of them are banks owned by foreign ABCP sponsors.

holds a larger (but stable) cushion relative to the tier 1 risk-based capital constraint. This bank, however, appears to have been constrained by the leverage ratio requirement and its usage of the ABCP loophole appears to have allowed it to relax that constraint.

Overall, figures 3 and 4 are consistent with Berger, DeYoung, Flannery, Lee, and Oztekin (2008) who suggest these capital cushions could be due to precautionary motives in volatile environments. More importantly, the cushions appear to be remarkably stable over time. As discussed above, a fixed capital cushion does not alter the shadow cost expression (8).[22]

Finally, condition C2 requires that banks would not exhaust the loophole. In line with this condition, Figure 5 shows that the average ratio of total assets financed with ABCP with liquidity guarantees θ is about 3 percent. This fraction is quite stable over the pre-crisis period and across banks with a standard deviation of 0.26 percentage points.[23]

To further verify condition C2, we perform a detailed analysis of the composition of assets held in the ABCP conduits. Moody's data includes a detailed information about the types (and industry affiliation) of assets held in the conduits. This allows comparing dollar amounts of various types of assets held in the conduits with the amounts reported in FR-Y9C forms. If the fraction of assets of each type held in the ABCP conduits is between zero and one, this would imply that condition C2 holds both on the bank and the asset type level.

We aggregate Moody's data to broad asset type categories in order to compare ABCP assets to the bank data in the FR-Y9C forms. These categories (and their percent of total ABCP assets) are: Consumer Loans (18.9%), Commercial Loans (18.8%), Residential Mortgages (14.2%), Trade Receivables (11.2%), CBO&CLO (11.7%), Credit Card Receivables (10.7%), Other (14%).[24]

Panel (b) of figure shows the average and the median shares of ABCP assets for the asset types that we could match to the numbers in the FR-Y9C forms: credit cards, consumer loans, commercial loans, and residential mortgages. Consistent with C2, the shares are well below one. In unreported test, we verified that with the exception of State Street, this holds for each individual bank throughout our sample.

To summarize the evidence presented in figures 2a, 2b and 3, US banks that provided liquidity to ABCP conduits represent a significant part of the banking universe. Since these banks are also constrained by regulatory capital requirements (more so than the rest of the

[22]Further evidence that commercial banks target a fixed leverage ratio is provided by Adrian and Shin (2010) who find that leverage growth is insensitive to asset growth.

[23]Unreported in the figure, the maximum share over the whole sample was 13 percent.

[24]Commercial Loans include the following Moody's asset type classifications (with the percentage of the total in the parentheses): Commercial Loans (47.5%), Equipment Loans and Leases (24%) and Commercial Mortgage Loans (20%), Floorplan Finance (6.1%) and Commercial Paper (1.9%). Within Consumer Loans, the subcategories are Auto Loans and Leases (56%), General Consumer Loans (26%), and Student Loans (17%).

banking industry), and exploit the ABCP loophole to relax the constraints, they represent a tenable sample for measurement of the shadow costs of capital regulation.

4 Estimating the Shadow Cost of Capital Requirements

We use expressions (9), (10), and (11), to estimate the shadow costs of regulatory capital requirements. For risk-based ratios, which take a similar form, the empirical counterpart for the shadow cost of bank i in quarter t is

$$\lambda_{it} = \frac{\alpha_t}{K_{it}} \times \frac{Q^r_{it}}{(1-\beta_{ABCP})\sum_j w_j q_{ijt}}, \tag{12}$$

where K_{it} can be replaced by either the tier 1 or the total risk-based ratio. The shadow cost implied by the bank's leverage ratio when this constraint binds is

$$\lambda_{it} = \frac{\alpha_t}{K^{T1Lev}_{it}} \times \frac{A_{it}}{Q_{it}}. \tag{13}$$

Most inputs into these expressions are publicly reported by banks in their Consolidated Financial Statements. We take regulatory risk-weighted assets Q^r_{it} and capital ratio K_{it} as reported by the banks. The conversion factor β_{ABCP} applied to off-balance sheet guarantees to provide liquidity to ABCP facilities is zero prior to September 2004. After 2004 it is 10 percent until this loophole was closed in January 2010.

In order to construct the summation $\sum_j w_j q_{ijt}$ we need to apply risk weights to balance sheet and off-balance sheet assets, as well as to the liquidity guarantees. The first two are reported in schedule HC-R of the quarterly reports. Assigning risk weights to the ABCP assets is less straightforward because this information is not reported. We calculate our main estimates under the assumption that the distribution of risk weights in the conduits mirrors the distribution of risk weights of the rest of the assets, as reported by the bank. We show in the robustness section that our benchmark estimates are not sensitive to this assumption.

An important component of the shadow cost expression is α, which measures the incremental marginal cost of financing assets through ABCP conduits. Obviously, it is impossible to know exactly how the capital structure of each bank in our sample would change if it were to expand its balance sheet by absorbing these assets. Industry participants that we interviewed indicated that the financial commercial paper rate is commonly considered to be the alternative cost of financing that a bank would face if the assets were not held in the ABCP conduits. Although this argument resembles the ungrateful task of trying to assign specific financing costs to individual assets on the balance sheet, we take the standard 30 day AA financial CP rate as a conservative measure of the marginal cost of expanding the balance sheet with the conduit assets. Note that assuming higher marginal financing costs would *decrease* α, and therefore decrease the estimate of shadow cost. Moreover, this assumption goes in line with our goal of estimating the cost of compliance as perceived by the banks, regardless of whether we agree with their methodology.[25]

Since we do not observe individual bank-level ABCP rates, we take the market spread between the 30 day AA ABCP rate and the 30 day AA financial CP rate as reported by the Fed.[26] Figure 1 shows that this spread was quite stable before the crisis. Until the second quarter of 2007, the spread was 4 basis points on average with a standard deviation of 0.9bp, after which it widened substantially.

Finally, since interest payments are tax deductible, we subtract the corporate tax rate $\tau = 35\%$ to account for the debt-tax-shield.[27] Therefore the marginal cost of using the loophole at time t is proxied by

$$\alpha_t = \left(r_t^{ABCP,30d} - r_t^{CP,30d}\right)(1-\tau). \tag{14}$$

4.1 Results

Columns (1) through (3) of Table 3 report time-series averages for each of the ABCP sponsoring banks in our pre-crisis sample for each of the three regulatory capital ratios. The average shadow costs per dollar assets across all banks and over time are precisely estimated at $\lambda^{T1RB} = 0.003$, $\lambda^{TotRB} = 0.0022$, and $\lambda^{T1Lev} = 0.0025$.

To get a better idea of the economic magnitude of these costs, we can use each bank's total actual assets to compute its shadow cost of a $d\sigma$ increase in each regulatory capital requirement $s \in \{Tier1\,RB,\, Tier1\,Lev,\, Tot\,RB\}$ as

$$d\Pi_{it} = -\lambda_{it}^{s} \times Q_{it} \times d\sigma. \tag{15}$$

Columns (3) to (6) of Table 3 report the time-series averages of this estimate for each bank for a 1 percentage point increase in capital requirements. According to these estimates, a 10

[25] In the robustness section we examine the sensitivity of our results to alternative assumptions on α.

[26] Regulators, who have access to more detailed bank-level data, could obtain more precise bank-level estimates of the shadow cost. Using equations (12) and (13), this can be done by simply replacing our measure of alpha with a different number, without the need to replicate the rest of the analysis. Note, however, that since much of our empirical analysis deals with averages and aggregate estimates, much of this heterogeneity is averaged out.

[27] The tax treatment of ABCP conduits can potentially make a large difference. For example if the debt-tax-shield only applies to on-balance sheet CP but not to ABCP then the incremental cost would be larger. If the marginal tax the bank faces on both ABCP and CP is close to zero, then our estimates of the shadow costs, reported below, would increase by about half.

percentage point increase in the tier 1 risk-based ratio, say from 6 to 16 percent – that is commonly entertained in the policy discussions – would cost an average bank in our sample about $140 million, or 4 percent of its annual profits. For all banks in our sample combined, this 10 percentage point increase would cost about $2 billion annually in aggregate. A similar increase in the other two ratios would cost about 3 percent of annual profits.

Panel (a) of Figure 6 plots the aggregate annualized cost of a 1 percentage point increase in each capital ratio for all ABCP sponsoring bank holding companies combined. These quarterly estimates are rather stable over the pre-crisis sample, ranging from 0.8 and 3 billion dollars for a 10 percentage point increase, across all ratios.

Panel (b) of Figure 6 constructs a similar estimate for the upper bound of the aggregate effects on profits for the entire banking industry, which amounts to about $3.7 billion on average for tier 1 risk-based ratio. For the leverage ratio and total risk-based ratio the upper bounds are $3.57 billion and $2.68 billion, respectively. Recall, that our methodology allows estimating an upper bound for non-participating banks. This figure, therefore, includes all banks described in Table 2, regardless of how far away they are from the regulatory constraint. As we saw in Figure 3, the majority of non-participating banks had significantly more capital than required by law, which makes the estimated upper bound a significant over-estimation of the true costs of regulatory constraints. The small magnitude of this estimate may appear puzzling at first. Recall, however, that the effect on profit is a function of bank size, and as shown in Figure 2b and Table 2, an average participating bank was about seventy times larger than an average nonparticipating bank.[28]

We prefer to focus on the pre-crisis period because it reveals the shadow cost of capital regulation during normal times when adjustment costs play a minor role. During the crisis, banks would probably reduce their exposure to ABCP conduits quickly, if they could do so cheaply. Mid-crisis, adjustment costs play a larger role, which could be interesting to study, but beyond the scope of the current paper. With this qualification in mind, at the height of the crisis (fourth quarter of 2007), the aggregate shadow cost of a ten percentage point increase in the tier 1 risk based ratio was around $58 billion. Intuitively, relaxing capital constraints in times of stress is valuable because the shadow costs are relatively large.

5 Robustness

We next perform a series of robustness tests, and verify the stability of our estimates under alternative assumptions. The shadow cost estimates remain quite stable when we change the

[28]In the working paper version of this paper we document that the results for European banks are similar to the results for US banks and imply a modest effect of capital requirements on bank profits.

definition of the binding constraint. The estimates increase by a modest amount if banks only use low risk-weight assets in conduits, or under the extreme assumption that the alternative on-balance sheet funding cost to ABCP is the overnight fed funds rate. By contrast, if ABCP loans have an intrinsic value to borrowers, our benchmark estimates overestimate the shadow cost. Finally, we find that the results for European banks are similar to the results for US banks and imply a modest effect of capital requirements on bank profits.

5.1 Alternative Definitions of a "Binding Constraint"

Thus far, our estimates of the shadow costs have not distinguished between banks with different proximity to the regulatory threshold. Essentially, we have treated all banks that provided liquidity guarantees to ABCP conduits as constrained by the capital regulation. The evidence provided in Section 3 suggests that this is not a restrictive assumption. There is, however, some heterogeneity in the proximity of banks to the regulatory thresholds (Figure 3 and Table 2). Therefore, we would like to examine the behavior of our estimates as we limit our sample to bank-quarter observations that are closer to the constraint. That is, we are interested in the stability of our estimates when we omit observations that are further away from the constraint.

The estimates of shadow costs remain quite stable when we change the definition of the binding constraint. In Figure 7 we plot the mean, median, and the confidence intervals around the mean of the shadow costs for different subsamples, defined based on the proximity to the constraint. The estimates increase slightly as we shrink the sample, but overall remain stable and robust to alternative definitions of a constrained bank.

5.2 Risk Weighting of Conduit Assets

We do not observe the true risk weights of conduit assets, and our derivation of the shadow costs assumed, for simplicity, that the share of assets placed in the ABCP conduits is constant across risk weights. This assumption allows us to average out some uncertainty regarding the risk weights of conduit assets. We now examine the sensitivity of our results to alternative assumptions about risk weights.

The basic intuition on the potential importance of risk-weighting assumptions can be seen already in the benchmark model (equation 12). Smaller risk weights of ABCP assets in the denominator of the shadow cost expression would increase the estimated cost. Intuitively, if a bank places assets with low risk weights in the conduit, the constraint must be costly for it, since these assets contribute less to relaxing the constraint.[29]

[29] The estimates from the benchmark model (unreported) remain virtually identical even when we make

To properly explore the issue, we relax the assumption that all risk weights have the same fraction of assets placed in ABCP and derive the shadow cost equations for a model where each risk weight can get its own share. The Lagrangian for the bank's maximization problem in this extended model becomes:

$$\mathcal{L} = \sum_j [r_j - c(k) - \alpha\theta_j]\, q_j(\boldsymbol{r}) - I(\theta_j > 0 \,\text{for any } j) \times F + \lambda Q [K(\boldsymbol{q}, k, \theta) - \sigma] \tag{16}$$

where ABCP shares can vary across risk-weight classes j, and the rest of the model assumptions follow those in Section 2. The shadow cost becomes $\lambda = \frac{\alpha q_j}{Q K_{\theta_j}}$ when $\theta_j \in (0, 1)$. With this adjustment, the shadow cost estimated from loophole use of risk weight j assets is:

$$\lambda_j^{T1Lev} = \frac{\alpha}{K^{T1Lev}} \times \frac{A}{Q} \tag{17}$$

$$\lambda_j^{T1RB} = \frac{\alpha}{K^{T1RB}} \times \frac{Q^r}{(1 - \beta_{ABCP})\, w_j Q} \tag{18}$$

$$\lambda_j^{TotRB} = \frac{\alpha}{K^{TotRB}} \times \frac{Q^r}{(1 - \beta_{ABCP})\, w_j Q}. \tag{19}$$

Assuming that the fixed costs of an ABCP conduit are shared among j's (i.e. the bank only pays to set up a conduit once), the only reason to have assets of more than one type j in the conduit is if their incremental cost α_j is different. If banks use the same α for all j (as our empirical implementation effectively assumes), the model implies that banks would prefer to use ABCP conduits for asset classes that relax the constraint the most (highest K_{θ_j}). An asset class that provides the largest net benefit in terms of relaxing the constraint would be exhausted ($\theta_j = 1$), before the next most beneficial asset class is used, and so on. In this scenario, there is only one valid first-order condition per constraint, the one for an interior $\theta_j \in (0, 1)$. To take this extended model to data, we make a conservative assumption that all conduit assets get a particular weight, and then examine what happens to our estimates when we change this risk weight.

Figure 8 presents the results for tier 1 risk-based ratio (Panel a) and total risk-based ratio (Panel b). The shadow costs estimates for the leverage ratio remain the same as in the benchmark model, since its expression is identical. The solid black line in each panel is the estimated effect on profits from the extended model for a range of risk weighing assumptions. Adjacent to the line, for comparison, is the benchmark estimate from Table 3. Relative to the benchmark estimates, these estimates range between 50% smaller if most assets have

an extreme assumption that all ABCP assets carried the risk weight of 20%. This is not surprising since the fraction of assets in ABCP conduits relative to the rest of the bank's assets (θ) was about 3%, which mitigates the effect of risk weighting assumptions.

high risk-weights to 150% larger for the lowest risk-weight. Since the truth likely rests somewhere in between these extremes, we find it reassuring that our benchmark estimates do as well. In practice, the actual risk-weights are known to bank regulators, who could use our methodology to calculate the shadow costs more accurately.

5.3 Incremental Costs of ABCP Conduits

We do not observe the bank-level incremental cost of ABCP financing (α) – an important component of the shadow cost expressions. In our benchmark tests in Table 3, we used the tax-adjusted spread between the 30-day ABCP rate and the 30-day financial commercial paper rate.

To get alternative estimates of α we change the assumption on the rate of financing that the bank would face if ABCP assets were held on its balance sheet. We calculate an extreme upper bound for α by assuming that the funding rate alternative to ABCP is the overnight Fed Funds rate. While unrealistically high, this estimate of α is conservative in the sense that it results in the highest possible shadow cost of regulation.

The dashed green line in Figure 8 reports the estimate under the assumption that the bank can borrow at the Fed Funds rate, for a range of ABCP asset risk-weights. Again, adjacent to this line is the estimate from our benchmark model that only changes the assumption on the incremental cost of ABCP financing.

Despite the fact that increasing the additional funding cost α has a first-order effect on the shadow cost estimates, this loose upper bound still results in modest estimates of the effect of tighter capital regulation. Figure 8 shows that increasing α to this extreme level increases our benchmark estimates by about 80 percent. The estimate of the average effect of increasing tier 1 risk-based capital requirement on profits by ten percentage points from –\$142 million to approximately –\$260 million. Together with the extreme assumption, that all the assets in the conduits are of the lowest risk weight, the estimate changes to about –\$360 million for the average participating bank.

5.4 Potential Value from ABCP Financing

So far in our analysis, regulatory constraints were the only reason for the use of ABCP conduits: the loophole allowed banks to decrease their costs by increasing leverage. It could be the case, however, that the ABCP arrangement created some additional value for banks and borrowers. Access to ABCP market could potentially have changed the supply curve as well as the demand curve. The supply-side effect could happen if banks could reduce their costs by using ABCP to finance loans. The demand could change if marginal borrowers valued the fact that their loans were warehoused in ABCP conduits.

Our conversations with the market participants revealed that, if anything, the supply-side effect was in play. While all market participants – including bankers – agreed that ABCP conduits were a way to circumvent the regulation, some have indicated that ABCP was sometimes viewed as a way to reduce banks' cost of lending.[30]

To model this, we assume that the ABCP financing reduces the banks' marginal cost by γ, and rewrite the Lagrangian as:

$$\mathcal{L} = \sum_j \left[r_j - \left(c\left(k\right) - \gamma\theta_j\right) - \alpha\theta_j\right] q_j\left(\mathbf{r}\right) - I\left(\theta_j > 0 \,\text{for any}\; j\right) \times F + \lambda Q\left[K\left(\boldsymbol{q}, k, \theta\right) - \sigma\right],$$

which leads to the following expression for the shadow costs of capital requirements:

$$\lambda = \frac{\alpha}{K_{\theta_j}} - \frac{\gamma}{K_{\theta_j}} \tag{20}$$

where the first term on the right is our benchmark estimate. Equation (20) shows that as long as $\gamma > 0$, our benchmark estimates *overestimate* the shadow costs of capital constraints.[31]

5.5 European Banks

Since the first Basel accord, the regulatory treatment of banks in different participating countries has been roughly comparable, making our methodology applicable to non-US banks as well. Of particular interest are European banks who have been very active in the ABCP market prior to the crisis (Acharya, Schnabl, and Suarez, 2013). Unfortunately, due to the low quality of the available international data, we excluded European banks from our main analysis.

We find it instructive, however, to examine the robustness of our methodology using the international data for two reasons. First, we would like to compare the magnitudes of our estimates using data from countries with a comparable regulatory regimes. Given the similarity of the regulation, similar estimates would be evidence for the reliability of our methodology. Second, as shown in Figure 2, these banks have a significant US presence.

We obtain annual data on European banks from Bankscope. After identifying bank holding companies in Bankscope, and tracing owner-subsidiary relationships, we match the

[30] See, also Bate, Bushweller, and Rutan (2003, p. 15) – Moody's description of the ABCP market – for a similar argument. In our interviews we learned that a potential source of these cost savings was that ABCP provided money market mutual funds with an opportunity to circumvent diversification requirements, which may have contributed to their willingness to accept a lower rate of return on their ABCP investments.

[31] It has to be the case that $\gamma < \alpha$, otherwise banks would opt for a corner solution of $\theta = 1$.

Bankscope data with the liquidity guarantors dataset from Moody's by bank holding company names. After dropping bank-year observations with missing or non-reconstructible capital ratios, we are left with 27 European bank holding companies (131 bank-year observations) that provided liquidity guarantees between the end of 2002 and the second quarter of 2007.

Table 4 presents summary statistics for ABCP sponsoring European banks. Compared to US ABCP sponsors described in Table 2, European ABCP Sponsors are larger and more levered, as measured by the debt-to-assets ratio. The tier 1 leverage ratio requirement does not apply to European banks in this period. They do, however, maintain a roughly comparable regulatory tier 1 risk-based capital ratio.

Table 5 reports estimates of shadow costs and changes in profits for each of the 27 banks in this sample. The average shadow cost estimate for the tier 1 risk-based ratio is 0.0038 (compared to 0.003 for the US). This, and the fact that these banks are larger in size, results in a higher average effect on profits of $35 million (compared to $14.3 million for the US). Overall, the results for the foreign sample are similar to the results for the United States and show a modest effect of capital constraints on bank profits.

6 Effects on Lending and Interest Rates

We can use our estimates to make a back-of-the-envelope calculation of the impact of increasing regulatory capital ratios on lending and interest rates faced by borrowers. For simplicity, focus on a special case of our model with a single asset class $q = Q$. We can see from the total derivative of profits with respect to σ,

$$\frac{d\Pi}{d\sigma} = -\lambda Q_0 = \frac{\partial \Pi}{\partial \theta}\frac{d\theta}{d\sigma} + \frac{\partial \Pi}{\partial Q}\frac{dQ}{d\sigma} + \frac{\partial \Pi}{\partial r}\frac{dr}{d\sigma} + \frac{\partial \Pi}{\partial c}\frac{dc}{d\sigma}, \tag{21}$$

that the effect of tighter capital requirements on profits emanates from four potential sources: a change in loophole use θ, credit demand Q, lending interest rates r, or funding costs c.

6.1 Interest Rates and Cost of Capital

To get an estimate of the effect of an increase in regulatory ratios on the cost of capital (c) and interest rates (r), we first examine the last term on the right-hand side of (21). Expanding the last term, we get $\frac{dc}{d\sigma} = c'(k)\frac{dk}{d\sigma}$. From the first-order condition with respect to k, we have $c'(k) = \lambda\frac{\partial K}{\partial k}$. We assume that the bank remains constrained under the new regulation, so that $\frac{dK}{d\sigma} = 1 = \frac{\partial K}{\partial k}\frac{dk}{d\sigma} + \frac{\partial K}{\partial r}\frac{dr}{d\sigma} + \frac{\partial K}{\partial \theta}\frac{d\theta}{d\sigma}$, where the last two terms are likely positive. Therefore, $1 \geq c'(k)\frac{1}{\lambda}\frac{dk}{d\sigma}$ and hence

$$\frac{dc}{d\sigma} \leq \lambda, \tag{22}$$

which implies that the effects on the cost of bank capital are bounded by the shadow cost. Intuitively, this upper bound would be reached if the bank was forced to raise equity to comply with tighter regulation, without changing its lending or loophole use.

Focusing, for brevity, on the tier 1 risk-based capital ratio, let $\lambda = 0.003$ as in Table 3. This implies that a ten percentage point increase in the regulatory ratio would increase the cost of capital for an average bank by at most 3 basis points. This calculation also places an upper bound on the increase in r, which is likely bounded from above by the increase in the cost of capital, i.e., $dr \leq dc \leq 3$ basis points.

6.2 Lending

Turning to the effect on the quantity of lending (dQ), we rearrange (21) to express the effect of increased capital requirements as a fraction of assets

$$\frac{dQ}{Q} = \frac{-\lambda_s - \left(\frac{dr}{d\sigma} - \frac{dc}{d\sigma}\right)}{r - c} \times d\sigma, \tag{23}$$

where we omit the effect of loophole use on the markup. As a rough proxy for the markup $r - c$ we can use the bank's annualized interest income minus interest expense divided by its assets, which, in our sample is on average around 0.02. Therefore, in order to calculate the total effect of increased regulatory ratios on lending, we need dc (for which we now have an upper bound), and dr, which captures the total increase in interest rates.

While estimation of demand elasticity is beyond the scope of this paper, we can estimate the change in lending dQ's implied by different assumptions about dr, for different estimates of dc. For example, given $dc \geq 0$, assuming that $dr = 0$ could underestimate the effect on lending, while assuming $dr = dc$ could overestimate the effect, since it would imply that the bank passed all of the increase in costs to borrowers. If we make the latter extreme assumption, equation (23) simplifies to $\frac{dQ}{Q} = -\frac{\lambda}{r-c} \times d\sigma$, which implies that a ten percentage point increase in the tier 1 risk-based regulatory capital ratio would lead to a decline of about $-\frac{0.003}{0.02} \times 0.1 = -1.5\%$ of bank assets.

6.3 Comparison with Prior Estimates

Prior literature provides estimates of the increase in the cost of capital (dc) due to an increase in regulatory capital ratios. Most closely related is Kashyap, Stein, and Hanson (2010) who estimate that a 10 percentage point increase in capital ratios would raise banks' cost of capital by 25-45 basis points.[32] These estimates are much larger than our upper bound of 3 basis points, and it is useful to understand the sources of the difference.

Kashyap et al. derive their estimates under the assumptions of the Modigliani-Miller model (with taxes). This approach relies on several important assumptions. In particular, two assumptions that are most relevant for our setting are: (i) the only reason for the increase in the cost of capital is the loss of the debt tax shield, and (ii) banks have to comply by increasing the equity ratio (i.e., they cannot avoid the capital charge).

The major difference between our approaches is that we avoid making these assumptions and infer the costs from banks' actions. While we view this as an important advantage of our approach, we cannot identify which one of these assumptions fails. It could be the case that higher capital ratios would have a positive effect, mitigating the effect of the lost tax shield, as implied by some banking theories.[33] Alternatively, as we mentioned in the introduction, banks could diminish the effect of regulation using other tools, such as shifting their assets toward lower regulatory risk weights or using other loopholes.

Regardless of whether the differences in our estimates stem from assumptions (i) or (ii), we view our results as complimentary to Kashyap et al. While their estimates provide an important benchmark of what would be the increase in the cost of capital if assumptions (i) and (ii) held in practice, our estimates show how much of this increase would persist once banks act to mitigate the costs and realize some additional benefits of equity financing.[34]

7 Conclusion

We calculate the shadow cost of capital requirements for banks' profitability using data on their participation in a costly loophole that helped them bypass the requirements by providing liquidity guarantees to asset-backed commercial paper conduits.

[32]Other estimates are available in the literature. Baker and Wurgler (2013) estimate the same policy change would increase the cost of capital by 60-90 basis points. See also a recent contribution by Gornall and Strebulaev, 2013, who calibrate a supply chain model of banking and find that such policy change would increase the cost of credit by 15 basis points.

[33]See, e.g., Allen, Carletti, and Marquez (2009); Mehran and Thakor (2011).

[34]By showing that even these conservative assumptions would result in a rather small effect on the cost of capital, Kashyap et al. alleviate some of the concerns of the banking industry. They note, however, that some of these concerns still remain, since even an increase in 25 basis point could potentially harm the competitiveness of the bank.

We considered throughout a 10 percentage point increase in regulatory capital ratios and found modest effects. However, the latest revision of US bank regulation increased capital requirements by much smaller amounts. Effective January 1, 2015, to be well-capitalized, a bank needs the same total risk-based capital ratio (10%) it needed during our sample; a 2 percentage point higher tier 1 risk-based capital ratio (8%); a 2 percentage point higher leverage ratio (5%); and a new requirement that common equity tier 1 capital ratio be 6.5 percent or more. Our estimates suggest its effect on bank profitability would be hardly noticeable. That said, several changes were made to the calculation of risk-weighted assets, and a counter-cyclical capital buffer was introduced.[35] Our model is quite general and could incorporate such changes, though a different loophole would be needed since the specific ABCP loophole we study is now closed. Since bank regulation provides multiple ways for relaxing capital constraints, it would be interesting to compare our estimates to those implied by other loopholes, such as structured investment vehicles and letters of credit.

Our approach builds on recent advances in the industrial organization literature, and could be applied more broadly to study the effects of regulation in banking, and financial intermediation in general. Moreover, our estimates could be used to calibrate structural macroeconomic models with financial frictions.

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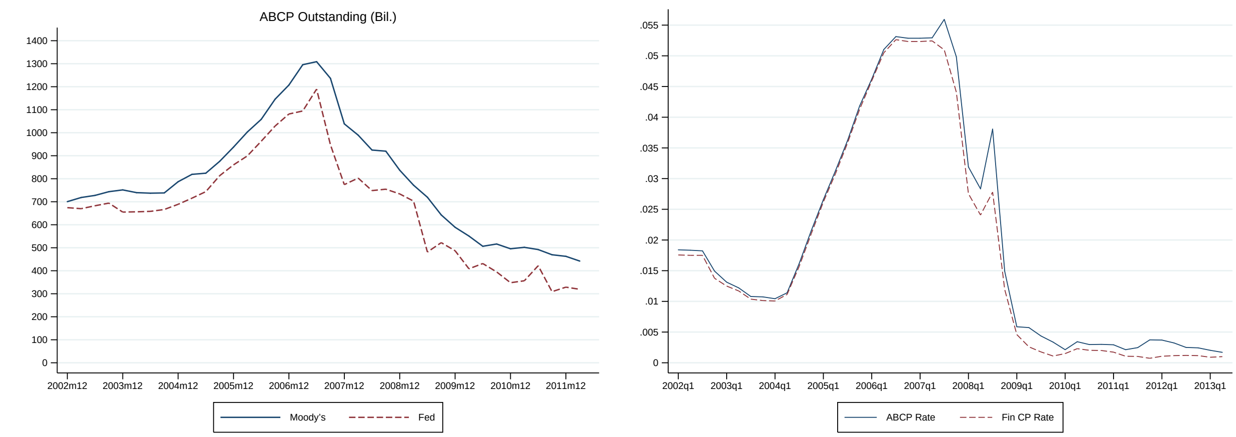
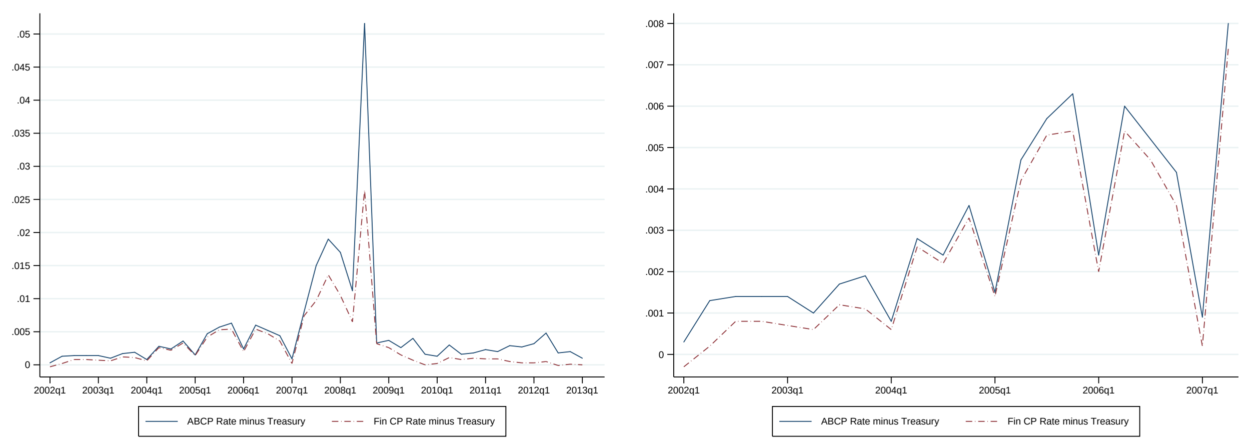
Figure 1: ABCP Market Over Time



(a) Market Size and Rates Over Time

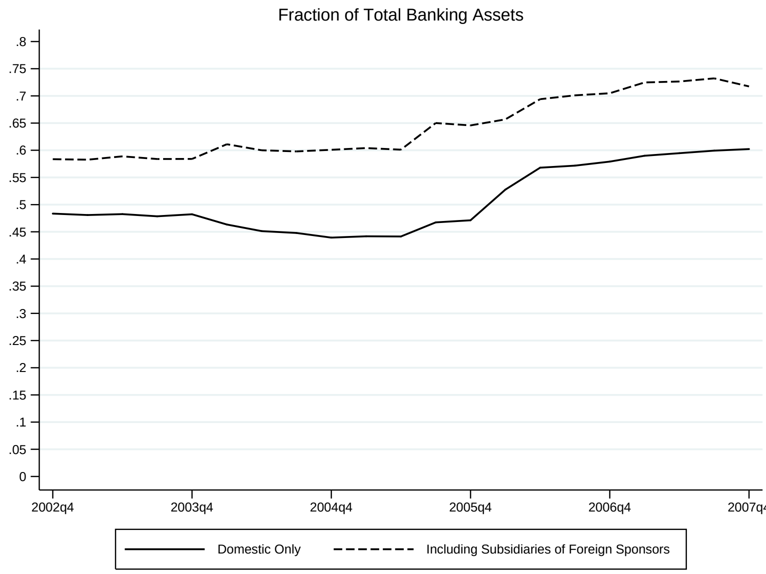


(b) ABCP and Financial CP Rates Net of Treasury

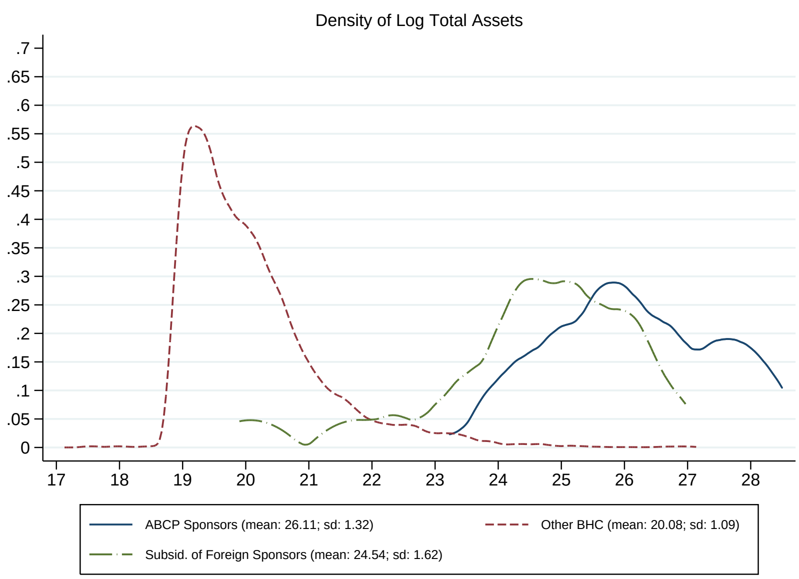
Notes: Left hand-side figure of Panel (a) shows total asset-backed commercial paper outstanding (excluding SIV) from quarterly and monthly reports by Moody's Investor Service (solid line) and reported weekly by the Fed (dashed line). Right hand-side figure pf Panel (a) shows the quarterly averages of top rated 30-day ABCP rates compared to the 30-day top-rated financial commercial paper rates. Panel (b) shows same ABCP and financial commercial paper rates spread over same maturity treasuries for the period 2002-2013 (on the left) and for the sample period studied in this paper (2002-2007Q2) (on the right).

Figure 2: Total Assets Held by ABCP Sponsors vs. Other Banks

(a) Fraction of Total Banking Assets Held by Participating Banks

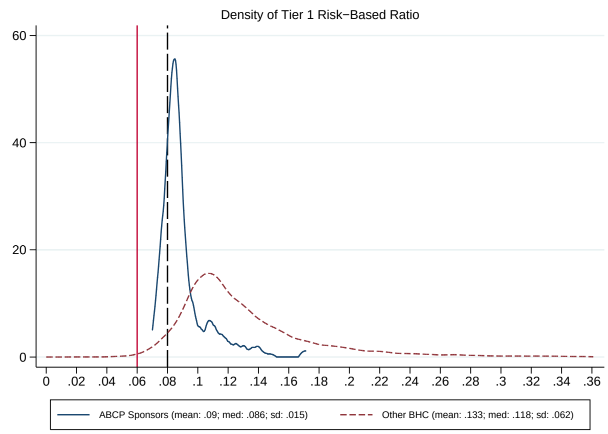


(b) Distribution of Log Total Assets

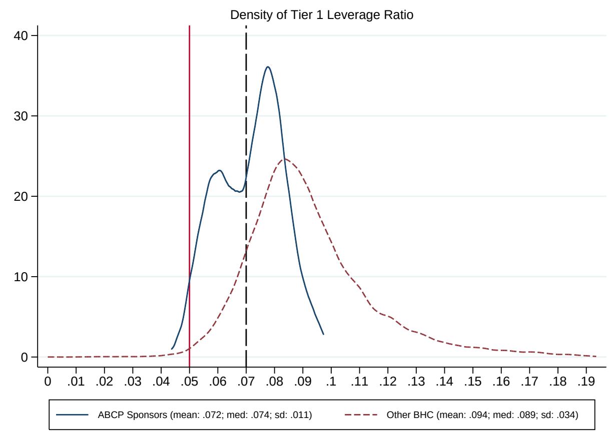


Notes: Figure 2a shows the fraction of total banking assets in the US held by bank holding companies ("BHC") that provided liquidity guarantees to ABCP conduits with (dashed line) and without (solid line) subsidiaries of foreign ABCP sponsors. Figure 2b reports kernel density estimates of the log assets for bank holding companies that provided liquidity guarantees to ABCP conduits (solid line), BHCs that were subsidiaries of foreign banks that provided such guarantees (long dashed line), and BHCs that did not participate in the ABCP market (dashed line). Only bank-quarters with non-zero liquidity guarantees were included in the sample of BHCs that provided liquidity guarantees. That is, observations for banks that participated in the ABCP market, but did not provide liquidity guarantees in a particular quarters were designated as "Other BHC." Sample period: 2002Q4-2007Q4. Kernel: Epanechnikov.

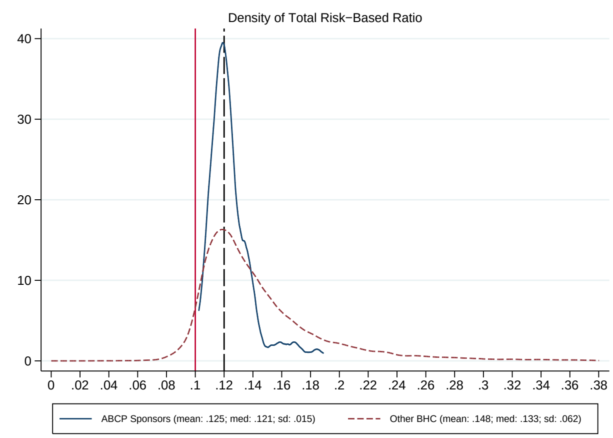
Figure 3: Distribution of Capital Ratios: ABCP Sponsors vs. Other Banks



(a) Tier 1 Risk-Based Ratio



(b) Tier 1 Leverage Ratio



(c) Total Risk-Based Ratio

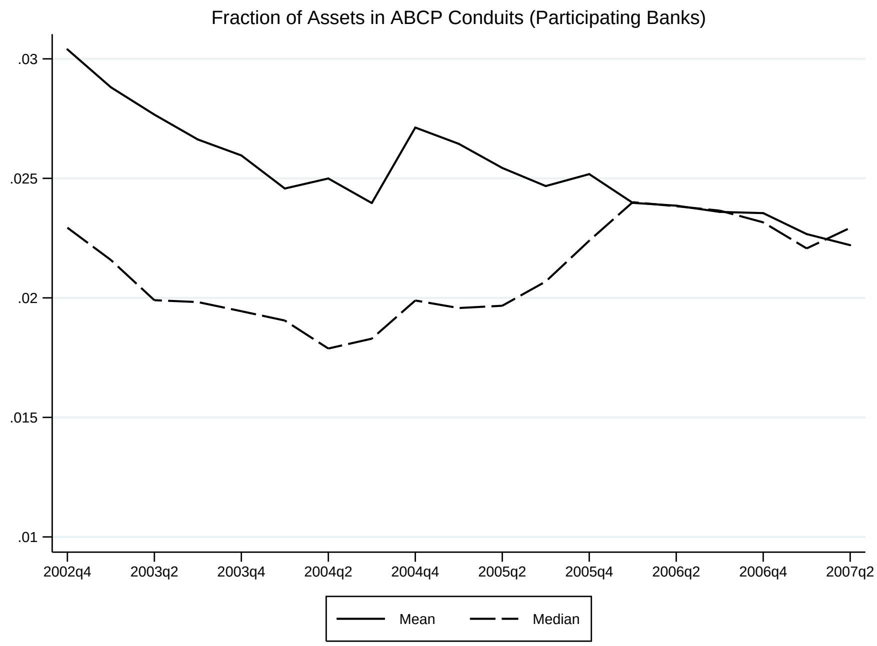
Notes: All figures report kernel density estimates of the corresponding capital ratios. “ABCP Sponsors” (solid line) are bank holding companies that provide liquidity guarantees to ABCP conduits. For each ratio, the solid vertical line denotes the well-capitalized regulatory threshold, and the dashed vertical line shows the well-capitalized threshold plus a 2% cushion. Sample period: 2002Q4-2007Q2. Kernel: Epanechnikov.

Figure 4: Examples of Reported and Adjusted Capital Ratios Relative to the Constraint

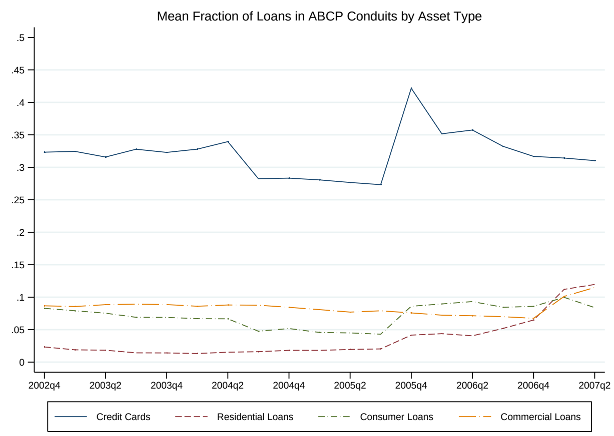
Notes: The figure presents time series of reported capital ratios (solid line) vs adjusted capital ratios for for four major US participants in the provision of liquidity guarantees to ABCP conduits. The adjusted value for each ratio (dashed line) shows what the ratio would be were the liquidity guarantees reported on the books. Horizontal lines show the regulatory requirement for each of the three capital constraints. Regulatory capital ratios: total risk-based ratio (green); tier 1 risk-based ratio (black); tier 1 leverage ratio (blue). Sample period: 2002Q4-2007Q2.

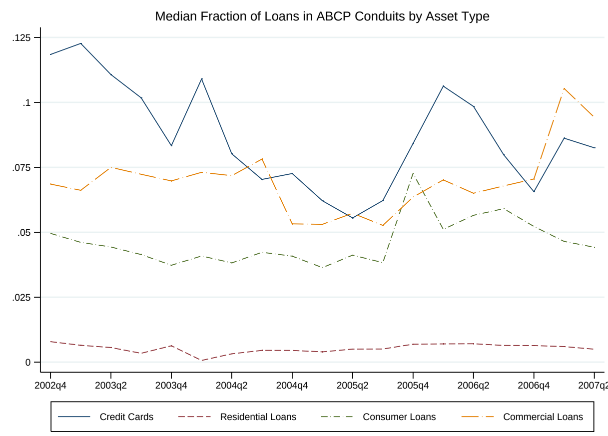
Figure 5: Constrained Banks Did Not Exhaust the ABCP Loophole

(a) Fraction of Assets in ABCP Conduits



(b) Fraction of Assets in ABCP Conduits by Asset Type

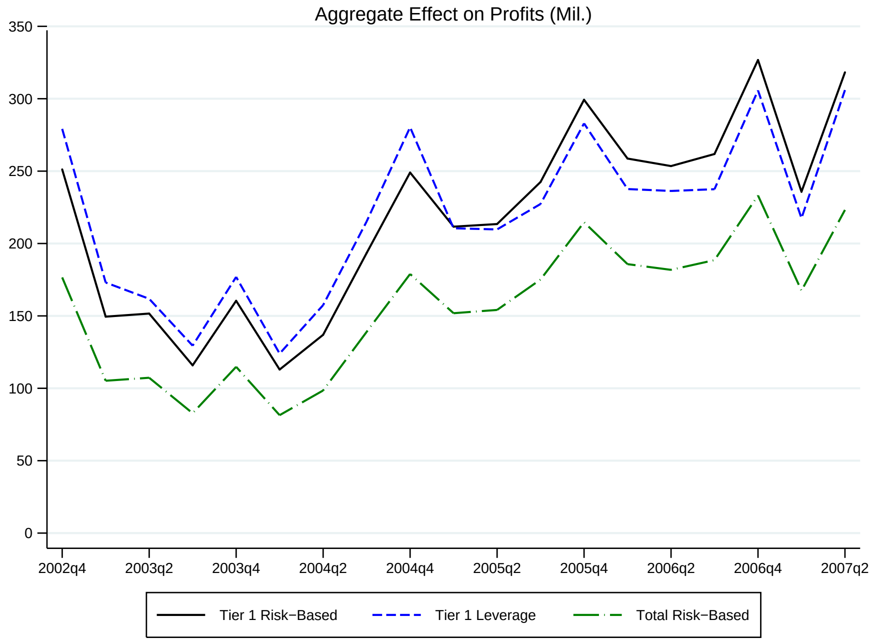




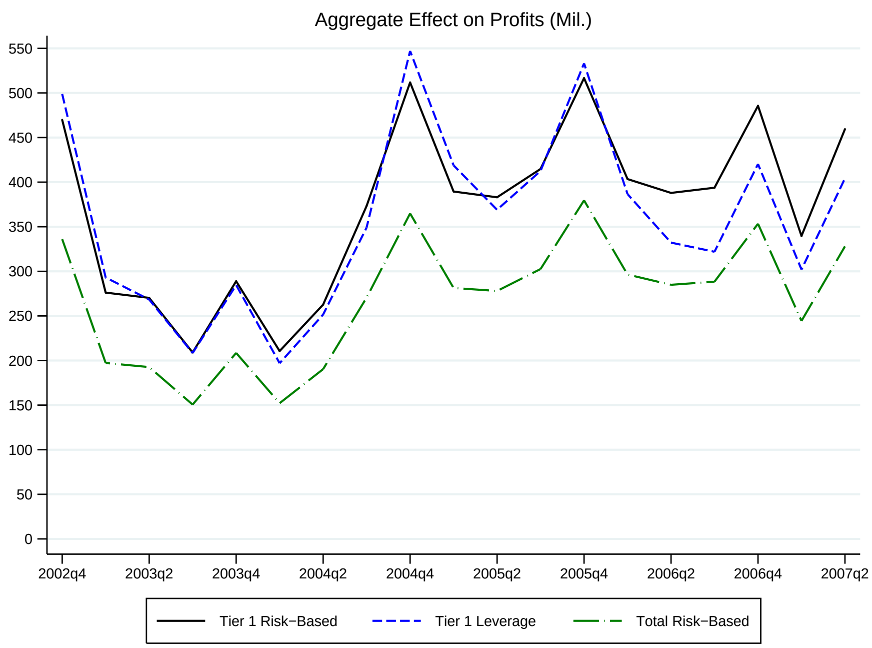
Notes: Panel (a) shows the aggregate fraction of assets in ABCP conduits over time. The mean (solid line) and the median (dashed line) of the fraction of total assets financed via ABCP conduits with liquidity guarantees (θ in the model) by US bank holding companies that provided liquidity guarantees to ABCP conduits in the period 2002Q4-2007Q2. Panel (b) shows the mean (left) and the median (right) of the fraction of assets in ABCP conduits for major asset types over time. Each point is the fraction of assets of the particular type that were financed through ABCP out of all assets of that type financed by the bank.

Figure 6: Aggregate Cost of a One Percentage Point Increase in Regulatory Ratios

(a) ABCP-participating Banks

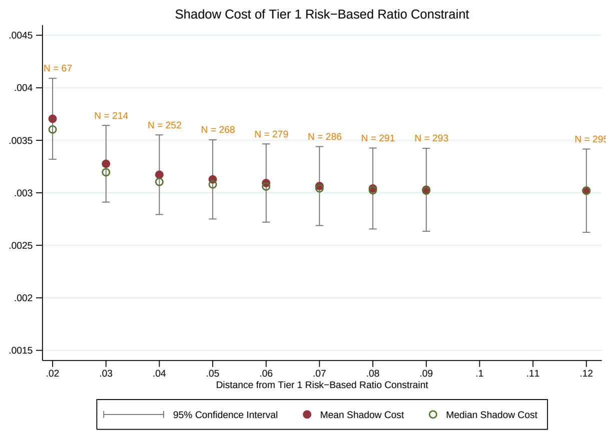


(b) All US Banks, Upper Bound Estimate

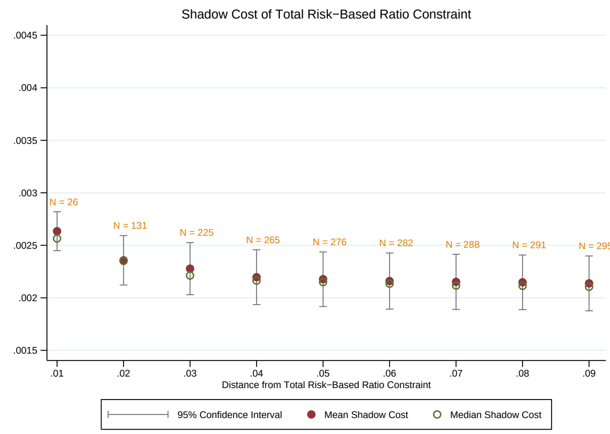


Notes: Aggregate cost (in terms of banks' profits) of a one percentage point increase in each regulatory ratio. Panel (a): banks that participated in the ABCP market. Panel (b): the upper bound of the effect for the universe of US banks. The aggregate change in profit is calculated as $\Sigma_i d\Pi_{ist} = \lambda^s_{it} \times Q_{it} \times d\sigma_s$, where λ^s_{it} is the shadow cost of constraint s for bank i, $s \in \{Tier1\,RB, Tier1\,Lev, Tot\,RB\}$, $d\sigma_s$ is set to be a one percentage point increase in the regulatory requirements of each ratio s (e.g., from 6% to 7% for the tier 1 risk-based ratio) and Q_{it} is the total assets of bank i in quarter t. The numbers are in millions of US dollars.

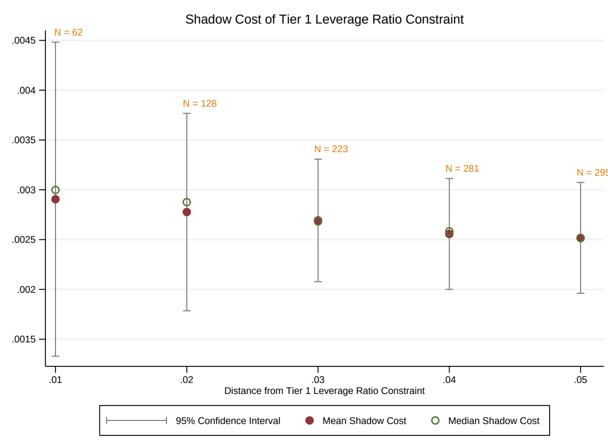
Figure 7: Shadow Cost Estimates vs. the Distance from the Constraint



(a) Tier 1 Risk-Based Ratio



(b) Total Risk-Based Ratio

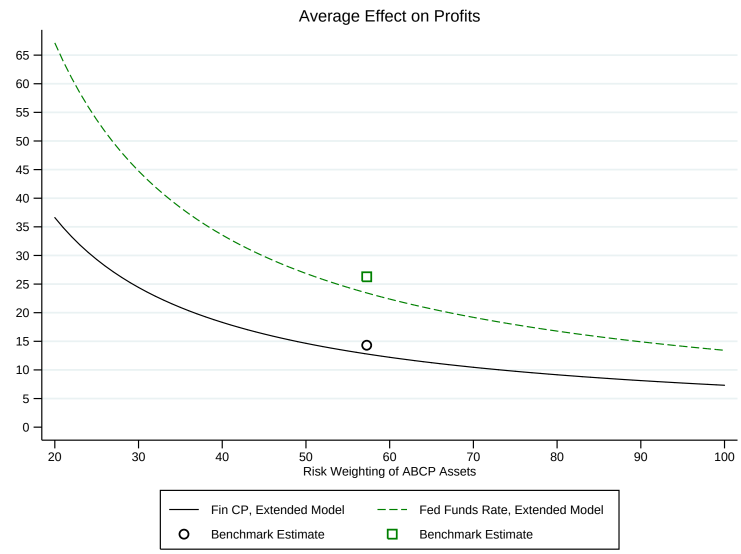


(c) Tier 1 Leverage Ratio

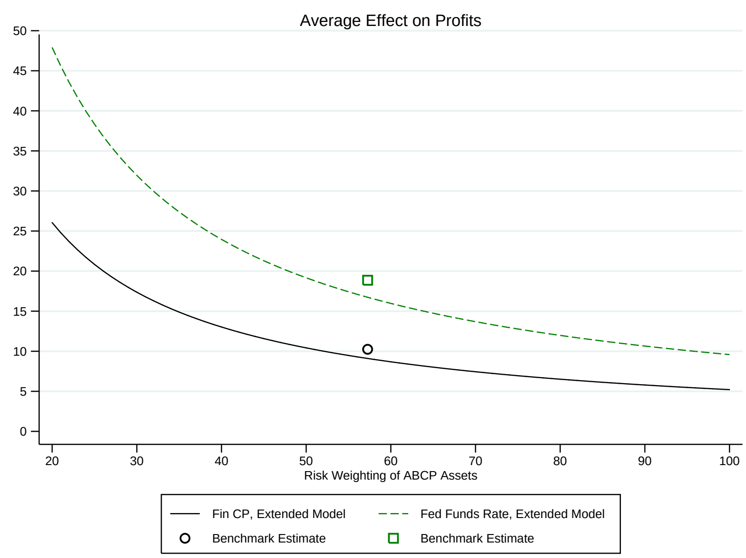
Notes: On the horizontal axis is the distance from the constraint. Each dot represents the mean or the median shadow cost of all bank-quarters whose reported ratio is at or below the distance on the horizontal axis. The estimates for the rightmost group on each plot include the full sample. N is the number of bank-quarters in each group. Standard errors for confidence intervals are adjusted for two-way clustering on a bank and year-quarter level. Sample: US bank holding companies that provided liquidity guarantees to ABCP conduits in the period 2002Q4-2007Q2.

Figure 8: Sensitivity of the Estimated Average Cost ($ Mil.) to Risk-Weighting and Cost of Capital Assumptions

(a) Cost of a 1 Percentage Point Increase in Tier 1 Risk-Based Ratio



(b) Cost of a 1 Percentage Point Increase in Total Risk-Based Ratio



Notes: Average cost (in terms of banks' profits) of a one percentage point increase in each regulatory ratio. For each bank i, the change in profit is $d\Pi_{ist} = \lambda^s_{it} \times Q_{it} \times d\sigma_s$, where λ^s_{it} is the shadow cost of constraint s for bank i, σ is the required ratio, Q_{it} is the total assets. Lines represent estimates from the extended model (equations 18 and 19) that allows for differential risk weighting of ABCP assets, for a range of risk weighting assumptions. Solid black lines use the benchmark incremental cost of ABCP financing, calculated as the difference between the ABCP rate and financial commercial paper rate. Dashed green lines use the upper bound incremental cost for ABCP financing, calculated as the difference between the ABCP rate and the overnight Fed Funds rate. Adjacent to each line is the estimate from the benchmark model given the corresponding assumption about the incremental cost (black circle is the estimate in table 3 and green square is the estimate from the same model, using Fed Funds rate as an alternative cost of capital).

Table 1: Summary Statistics, ABCP Sponsors and Assets

(a) ABCP Sponsors and Liquidity Providers

	U.S. BHC	Non-U.S. BHC	Non-Banks
N of Sponsors	22	59	124
N of Liquidity Providers	18	52	33
Total ABCP (bil.)	236	524	197
Total Liquidity Guarantees (bil.)	150	431	32

(b) Assets in ABCP Conduits Covered by Liquidity Guarantees

	Percent of Deals	Percent of Assets
Seller Rating		
AAA – A3	24.49	33.97
BAA1 – BAA3	18.51	15.80
BA1 – BA3	7.75	4.89
B1 – B3	2.74	1.41
CAA1 – CA	0.37	0.13
Not Rated	20.87	21.56
Security Rating		
AAA – A3	21.44	20.86
BAA1 – BAA3	1.45	0.64
BA1 – BA3	0.31	0.06
B1 – B3	0.17	0.02
CAA1 – CA	0.01	0.00
Not Rated	1.88	0.65

Notes: First two rows of Panel (a) show the number of sponsors and the number of liquidity providers, for each category described in the column header. Total ABCP is the total monthly amount (in billion of US dollars) of ABCP outstanding for each category, averaged over time. Total Liquidity Provisions is the total monthly amount of liquidity provisions for each category, averaged over time.

Panel (b) shows the breakdown of assets by credit ratings in conduits that had liquidity guarantees from US banks. The first part, under *"Seller Rating,"* shows the breakdown by the credit rating of the sellers behind the unsecuritized underlying assets. The category *Not Rated* refers to sellers for which Moody's did not provide credit ratings. The second part, under *"Security Rating,"* provides a similar breakdown for securitized assets held by these conduits.

Table 2: Summary Statistics: ABCP Sponsors and the Rest of the Banking System

	ABCP Sponsors	Other BHC	Diff in Means	All
Total Balance Sheet Assets (bil.)	331.8	3.40	328.4***	6.31
	(475.44)	(27.15)	[3.01]	(60.67)
Total Assets, Including Off-BS (bil.)	444.8	3.75	441.0***	7.67
	(545.07)	(30.55)	[3.43]	(72.57)
Total Risk-Weighted Assets (bil.)	230.2	2.33	227.9***	4.36
	(302.28)	(18.62)	[1.95]	(40.12)
Quarterly Net Income (bil.)	1.06	0.0096	1.05***	0.019
	(1.55)	(0.10)	[0.01]	(0.20)
Tier 1 Risk-Based Ratio (%)	8.90	13.1	-4.23***	13.1
	(1.51)	(4.95)	[0.28]	(4.95)
Tier 1 Leverage Ratio (%)	7.14	9.27	-2.12***	9.25
	(1.13)	(2.48)	[0.14]	(2.48)
Total Risk-Based Ratio (%)	12.4	14.6	-2.22***	14.6
	(1.52)	(4.87)	[0.28]	(4.86)
Balance Sheet Debt to Assets (%)	90.7	90.7	0.064	90.7
	(1.52)	(2.84)	[0.16]	(2.83)
Observations	305	34039		34344
Banks	18	2537		2553

Notes: Column "ABCP Sponsors" shows the means and standard deviations of variables for bank holding companies ("BHC") that provided liquidity guarantees to ABCP conduits. Column "Other BHC" shows the means and standard deviations for the rest of the sample. Column "All" shows the statistics for the whole sample. Column "Diff in Means" shows the differences in means between the subsamples and the corresponding standard errors. Standard deviations are in parentheses and standard errors are in brackets. Statistical significance of the differences in means: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Sample period: 2002Q4-2007Q2. Variable Definitions: Total assets BHCK2170. Total risk-weighted assets BHCKA223. Total assets by risk-weight BHCKB696-BHCKB699. Net Income BHCK4340. Tier 1 capital BHCK8274. Tier 2 capital BHCK5311. Tier 3 capital BHCK1395. Total risk-based capital BHCK3792. Tier 1 risk-based ratio BHCK7206. Tier 1 leverage ratio BHCK7204. Total risk-based ratio BHCK7205. Total debt BHCK2948. Balance sheet debt to assets BHCK2948/BHCK2170.

Table 3: Shadow Costs of Regulatory Ratios and Change in Profits due to a One Percentage Point Increase in Required Ratios

	Shadow Cost			Change in Profit (Mil.)			Change in Profit/Profit			N
	T1 RB (1)	Tot RB (2)	T1 Lev (3)	T1 RB (4)	Tot RB (5)	T1 Lev (6)	T1 RB (7)	Tot RB (8)	T1 Lev (9)	(10)
BANK OF AMERICA	0.0032	0.0023	0.0038	-40.9	-29.2	-47.6	-0.0025	-0.0018	-0.0030	19
BANK OF NEW YORK	0.0034	0.0022	0.0010	-13.4	-8.81	-3.83	-0.0097	-0.0063	-0.0030	19
BANK ONE	0.0023	0.0016	0.0021	-8.66	-6.30	-7.87	-0.0024	-0.0017	-0.0021	7
CITIBANK	0.0031	0.0023	0.0044	-50.7	-37.1	-71.9	-0.0028	-0.0021	-0.0041	19
COMPASS BANK	0.0030	0.0022	0.0029	-1.01	-0.76	-0.97	-0.0025	-0.0019	-0.0024	19
FIFTH THIRD BANK	0.0028	0.0023	0.0024	-3.36	-2.71	-2.83	-0.0031	-0.0025	-0.0025	19
FLEET	0.0029	0.0021	0.0023	-7.11	-5.15	-5.68	-0.0039	-0.0028	-0.0031	6
FNB OMAHA	0.0030	0.0023	0.0028	-0.39	-0.30	-0.36	-0.0037	-0.0028	-0.0035	8
JPMORGAN CHASE	0.0032	0.0022	0.0031	-48.1	-34.2	-45.2	-0.0067	-0.0047	-0.0068	19
KEYBANK	0.0031	0.0020	0.0021	-3.63	-2.37	-2.47	-0.0038	-0.0025	-0.0026	8
MARSHALL-ILSLEY	0.0034	0.0023	0.0029	-1.78	-1.21	-1.46	-0.0025	-0.0017	-0.0021	19
MELLON BANK	0.0027	0.0017	0.00071	-4.66	-3.02	-1.10	-0.0058	-0.0037	-0.0014	19
PNC BANK	0.0030	0.0021	0.0024	-3.41	-2.42	-2.65	-0.0026	-0.0018	-0.0020	19
STATE STREET	0.0021	0.0018	0.0010	-10.4	-9.10	-4.39	-0.011	-0.0096	-0.0048	19
SUNTRUST	0.0036	0.0024	0.0029	-6.62	-4.49	-5.36	-0.0037	-0.0025	-0.0030	19
US BANK	0.0031	0.0021	0.0025	-7.97	-5.28	-6.29	-0.0019	-0.0012	-0.0015	19
WACHOVIA	0.0034	0.0024	0.0031	-21.4	-14.8	-18.9	-0.0034	-0.0024	-0.0031	19
ZIONS	0.0028	0.0019	0.0024	-1.36	-0.90	-1.11	-0.0028	-0.0019	-0.0024	19
Mean	0.0030	0.0022	0.0025	-14.3	-10.2	-14.1	-0.0043	-0.0031	-0.0030	
Std. Error	[0.00020]	[0.00013]	[0.00028]	[4.39]	[3.16]	[5.42]	[0.00073]	[0.00058]	[0.00041]	

Notes: Time-series averages for ABCP sponsoring US bank holding companies, 2002Q4-2007Q2. The shadow costs (λ) per dollar of a unit change in the regulatory capital requirement for tier 1 risk-based ("T1 RB") and for the total risk-based capital ratio ("Tot RB") are calculated using equation (12). The shadow cost for the tier 1 Leverage ratio ("T1 Lev") is calculated using equation (13). Change in Profit is calculated as $d\Pi_{is} = -\lambda_s \times Q_i \times d\sigma_s$, where $d\sigma_s$ is a one percentage point increase in the regulatory requirements a ratio $s \in \{Tier1\ RB,\ Tier1\ Lev,\ Tot\ RB\}$ and λ_s is a corresponding shadow cost, and Q_i is the total assets of bank i. The column "Change in Profit/Profit" scales the change in profits by the annualized quarterly net income. "N" is the number of quarterly observations of each bank with non-zero liquidity guarantees. Standard errors are adjusted for two-way clustering on a bank and year-quarter level.

Table 4: Summary Statistics: European Bank Holding Companies Providing Liquidity Guarantees to ABCP Conduits

	Mean	St. Dev.
Total Balance Sheet Assets (bil.)	802.2	558.5
Total Assets, Including Off-BS (bil.)	969.9	678.9
Total Risk-Weighted Assets (bil.)	311.8	211.6
Quarterly Net Income (bil).	3.80	4.27
Tier 1 Risk-Based Ratio (%)	8.15	1.47
Total Risk-Based Ratio (%)	15.2	3.87
Balance Sheet Debt to Assets (%)	96.1	1.48
Observations	131	
Banks	27	

Notes: Sample: Annual data on European bank holding companies available in Bankscope database that provided liquidity guarantees to ABCP conduits in the period 2002Q4-2007Q2. Variable Definitions: Total assets DATA2025. Net Income DATA2115. Off-Balance Sheet Items DATA2065. Tier 1 capital DATA2140. Total risk-based capital DATA2055+DATA2160+DATA2165. Total debt DATA2060-DATA2055. Tier 1 risk-based ratio DATA2130. Balance sheet debt to assets (DATA2060-DATA2055)/DATA2025.

Table 5: Shadow Costs of Regulatory Ratios and Change in Profits due to a One Percentage Point Increase in Ratios (European Banks)

	Shadow Cost		Change in Profit (Mil.)		N
	T1 RB	Tot RB	T1 RB	Tot RB	
	(1)	(2)	(3)	(4)	(5)
ABN AMRO	0.0033	0.0019	-40.3	-23.4	6
BARCLAYS	0.0040	0.0021	-69.4	-37.1	6
BAYERISCHE L-B	0.0038	0.0021	-22.3	-12.0	3
BNP	0.0039	0.0019	-80.9	-39.0	3
CALYON	0.0038	0.0019	-68.4	-33.8	3
COMMERZBANK AG	0.0043	0.0025	-30.3	-17.8	6
CREDIT SUISSE	0.0024	0.00099	-24.2	-10.1	5
DANSKE BANK	0.0041	0.0025	-18.7	-11.2	6
DEUTSCHE BANK	0.0033	0.0016	-54.3	-26.5	6
DRESDNER BANK	0.0037	0.0016	-25.9	-11.2	6
DZ BANK	0.0036	0.0022	-21.0	-12.7	3
HBOS	0.0039	0.0022	-41.0	-23.0	6
HSBC	0.0035	0.0018	-57.0	-30.7	6
HSH NORDBANK	0.0047	0.0028	-12.7	-7.58	6
ING BANK	0.0041	0.0025	-40.9	-25.3	6
INTESA	0.0043	0.0022	-63.8	-34.3	4
KBC	0.0037	0.0021	-13.2	-7.48	4
LLOYDS BANK	0.0036	0.0019	-23.3	-12.4	6
NATIONWIDE	0.0026	0.0020	-5.76	-4.47	4
NATIXIS	0.0033	0.0013	-23.1	-9.30	3
NORDDEUTSCHE L-B	0.0048	0.0027	-13.2	-7.54	3
RABOBANK	0.0027	0.0023	-17.8	-14.9	6
RBS	0.0042	0.0018	-80.2	-31.9	6
SOCIETE GENERALE	0.0038	0.0019	-62.5	-30.9	3
STANDARD CHARTERED	0.0040	0.0019	-7.79	-3.63	4
UNICREDIT	0.0050	0.0022	-43.3	-18.7	6
WESTLB AG	0.0041	0.0023	-17.0	-9.78	6
Mean	0.0038	0.0021	-36.3	-18.9	
Std. Error	[0.00033]	[0.00020]	[4.97]	[2.31]	

Notes: Time-series averages for each ABCP-sponsoring European bank holding company. The shadow costs (λ) per dollar of a unit change in the regulatory capital requirement for tier 1 risk-based capital ratio in columns "T1 RB" and for the total risk-based capital ratio ("Tot RB") are calculated using equation (12). Change in Profit is calculated (in millions of dollars) as $d\Pi_{is} = -\lambda_s \times Q_i \times d\sigma_s$, where $d\sigma_s$ is a one percentage point increase in the regulatory requirements a ratio $s \in \{Tier1\ RB,\ Tier1\ Lev,\ Tot\ RB\}$ and λ_s is a corresponding shadow cost, and Q_i is the total assets of bank i. "N" is the number of annual observations of each bank with non-zero liquidity guarantees and nonmissing data. Standard errors are adjusted for two-way clustering on a bank and year-quarter level. Sample: European bank holding companies that provided liquidity guarantees to ABCP conduits in the period 2002Q4-2007Q2.