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Contingent capital to strengthen the private safety net for financial institutions: Cocos to the rescue?

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Abstract:

This study examines the promise of reducing expected resolution costs of financial institutions through either voluntary or mandated addition of contingently convertible debt securities to their long-term financing mix. I model the stochastic process by which an initially very well capitalized banking firm may come to violate its minimum capital maintenance requirement. Conversion of cocos then provides a second chance because the firm's initial capitalization is restored. Although regulatory insolvency remains a distant threat, the expected reductions in the cost of bankruptcy and hence the cost of capital are such that cocos may win a place in the liability structure of financial institutions without the need for mandates.

Keywords: financial reforms, regulatory insolvency, contingent capital, bank regulations, cocos

JEL-Classification: E44, G33, G38

Non technical summary

The economic costs of bunched insolvencies by big, highly interconnected or numerous financial firms are many times greater than those borne by the entities directly affected. Society has a stake in reforms that reduce the frequency and severity of financial crises and their negative spillovers. For both investors and taxpayers, avoiding much of the deadweight losses of bankruptcy or other forms of resolution of financial institutions has become of particular concern. One reform idea is to strengthen the industry's own defenses against an incipient crisis at its own cost. This is to be done by inducing banks and other financial institutions to add cocos, which are debt securities that are contingently convertible to common equity, to their financing mix. Conversion is triggered when regulatory capital approaches a critical minimum so that the ample initial level of capitalization is restored. This can be done just once in a good while since cocos cannot be reissued soon after their conversion.

How much the introduction of cocos could reduce the deadweight losses of bankruptcy is estimated under controlled conditions: Applying a binomial diffusion process to the gross rate of return, the model follows a firm that is initially very well capitalized into a possible brush with bankruptcy 10 or more years later. With cocos in the financing mix, this low-probability event can be averted by cocos conversion so that it would now take two adverse developments in succession, rather than just one such event, to bring down the firm. For this reason cocos greatly reduce the expected economic costs of bankruptcy for the benefit of all debt and equity holders: Depending on the model's parameters, for programs of at least 30 years, reductions in the cost of long-term capital of between 0.4 and 1.5 percentage point can be achieved. Hence cocos may win a place in the long-term financing structure of firms without the need for mandates.

Nicht technische Zusammenfassung

Die volkswirtschaftlichen Kosten einer gleichzeitigen Insolvenz großer und stark vernetzter Finanzunternehmen bzw. einer großen Anzahl von Finanzunternehmen sind um ein Vielfaches höher als die Kosten, die von den direkt betroffenen Instituten selbst getragen werden müssen. Die Gesellschaft hat ein Interesse an Reformen, die die Häufigkeit und Schwere von Finanzkrisen sowie deren negative Ansteckungseffekte reduzieren. So ist es Investoren und auch Steuerzahlern mittlerweile ein besonders wichtiges Anliegen, Wohlfahrtsverluste aufgrund von Insolvenzen oder anderen Arten der Liquidierung von Finanzinstituten weitgehend zu vermeiden. Ein Reformvorschlag sieht die Stärkung der Schutzmechanismen des Bankensektors gegen eine beginnende Krise auf dessen eigene Kosten vor. Hierbei sollen Banken und andere Finanzinstitute dazu bewogen werden, ihre Finanzierung um Coco-Bonds (Contingent Convertible Bonds, also Schuldverschreibungen, die unter bestimmten Bedingungen in Eigenkapital umgewandelt werden) zu erweitern. Die Umwandlung erfolgt, sobald sich das regulatorische Eigenkapital einer kritischen Untergrenze nähert, womit die Eigenkapitalausstattung wieder auf ein großzügiges Ausgangsniveau angehoben wird. Dies ist jedoch nicht immer möglich, da nach einer Umwandlung Coco-Bonds nicht sofort neu emittiert werden können.

Das Ausmaß, in dem die Einführung von Coco-Bonds die Wohlfahrtsverluste von Insolvenzen reduzieren könnte, wird unter kontrollierten Bedingungen geschätzt. In dem Modell wird ein Unternehmen beobachtet, das anfangs über eine sehr gute Eigenkapitalausstattung verfügt und nach zehn oder mehr Jahren vor einer möglichen Insolvenz steht. Dabei wird ein binomialer Diffusionsprozess auf die Bruttorendite angewendet. Bei einer teilweisen Finanzierung über Coco-Bonds kann dieses Ereignis mit geringer Eintrittswahrscheinlichkeit durch die Umwandlung der Coco-Bonds abgewendet werden. Damit wären also zwei negative Entwicklungen in Folge erforderlich (und nicht nur eine), damit das Unternehmen in Konkurs geht. Die Coco-Bonds führen demnach zu einem erheblichen Rückgang der erwarteten volkswirtschaftlichen Kosten von Insolvenzen, wovon alle Gläubiger und Aktionäre profitieren. Auf diese Weise können bei Programmen mit einer Laufzeit von mindestens 30 Jahren die Kosten des langfristigen Kapitals in Abhängigkeit von den Parametern des Modells um 0,4 bis 1,5 Prozentpunkte verringert werden. Somit könnten sich Coco-Bonds innerhalb der langfristigen Finanzierungsstruktur durchsetzen, ohne dass hierfür eine entsprechende Vorschrift erforderlich wäre.

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1 Introduction

This paper examines whether it is privately profitable to add contingently convertible debt – debt that converts to common equity when a specified capital-maintenance requirement has been breached – to the liability structure of financial firms. Such debt, known as ***cocos***, could prove to be an efficient financial instrument if it lowers the cost of capital by reducing the expected frequency and costs of bankruptcy or of banks' regulatory insolvency and resolution. Firms may then choose to issue cocos unless doing so individually sends a negative signal.

Should there be a case for financial firms to issue an appreciable amount of contingent-capital debt voluntarily, issuing even more may well be desirable socially. The reason is that there are external benefits to reducing widespread bankruptcies and the disruptions they cause throughout the financial system and the entire economy. However, benefits that are not appropriable by, or attributable to, individual private parties are not going to be assessed here. That keeps the searchlight on how much going-concern insurance and expected savings of bankruptcy costs adding cocos to the financing mix may provide.

Although the focus is on private costs and benefits, any of them that do not also represent corresponding social costs or benefits are excluded from consideration. Thus it is the "union," or area of overlap, of private and social cost savings that is to be measured. By disregarding taxes

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and subsidies, -- including safety-net subsidies which will be reduced by the introduction of cocos, -- and by assuming risk neutrality, this study captures social costs and benefits as what private costs and benefits would be if transfers through the tax and subsidy system and the excess private cost of risk over expected loss, along with externalities, were set aside. For instance, one private advantage of cocos over requiring permanent increases in the strength of the common equity shield is that the interest on them is deductible from taxable income while returns on common equity are taxable. But the fact that cocos are "tax-efficient" does not add social value and thus is ignored: Someone else must make up the loss in taxes sooner or later according to the intertemporal government budget constraint. Hence "tax-efficiency," a euphemism for non-neutrality in the tax system, does not enter the subsequent calculations of how the various components of the cost of capital would be affected by adding cocos to the financing mix. The capital-cost components to be considered are for (i) cocos, (ii) otherwise comparable *not* contingently convertible long-term debt, ***nocos***, and (iii) common equity outstanding prior, and subsequent to, the conversion of cocos.

Likewise, the fact that the resolution costs of bankruptcies in the financial sector are borne in part by taxpayers – for instance, through underpriced deposit insurance, other "emergency" bank-liability and debt guarantees, government-orchestrated capital infusions, troubled asset purchases – does not reduce the total direct resolution costs caused by a failing financial institution in the private sector. These costs should be attributed entirely to that institution, and no credit should be given for any safety-net subsidies it may enjoy.[1] On the other hand, external costs of one firm's distress pulling down others or resulting in fire sales that cause

[1] Economically, private bankruptcy costs consist of (i) financial transfers which are not counted as social costs and (ii) losses of future productivity and the destruction of value of tangible and intangible capital assets which are indicative of both private and social costs. On average, bankruptcy costs considered here are assumed to be at least equal to (ii). See Geanakoplos ((2010), esp. p. 118) for a description and estimates of the resource cost of losses associated with bankruptcy and mortgage default and foreclosure.

loss of value to others are not within our purview. The question then is whether, with these estimated jointly private and social costs and benefits, a private market for cocos could develop even without regulatory mandates or official suasion.

A quantitative, model-based answer to at least that central part of the question that deals with the expected reduction in the frequency and cost of bankruptcies that cocos will bring, and at what price, is important. For it would indicate how large an excess of external benefits over costs would be required to justify a cocos mandate should private issuance appear unprofitable.

1.1 Definitions, forms and functions from contingent capital to cocos

Although cocos are often meant when contingent capital is discussed in the current literature, contingent capital is as heterogeneous as the contingencies – both positive and negative – to which it can be linked. Appendix 2 provides an impression of the history and breadth of the concept and its diverse current applications. Contingent capital can be likened to a genus that has contingently convertible securities as one of its species, which in turn have cocos with their distinctive trigger as a subspecies. The genus can be defined as the increase in common equity capital that would be provided if holders of rights to subscribe or convert to common stock, and of contingently triggered conversion obligations attached to convertible bonds or to preferred stock -- and of warrants on bonds with warrants -- exercised their options, warrants, conversion rights, and contingently-triggered obligations. For the underlying instrument to be recognized in whole or in part as supplying capital due to a positive contingency such as a rise in stock price there must be a reasonable expectation that such exercise will occur soon, such as within a maximum of three to five years from the date of accounting. The same does not apply if the conversion is triggered by a *negative* contingency, such as an acute threat of regulatory

insolvency. For insurance against catastrophic contingencies to be feasible which could otherwise pose a bankruptcy risk,[2] these contingencies would have to be judged remote.

To strengthen self-insurance mechanisms in this regard, the Group of Central Bank Governors and Heads of Supervision have agreed at the BIS (2010b) that banks will be required to hold a conservation buffer. This is on top of a minimum common equity equal to 4.5% of risk weighted assets they must maintain from the start of 2015 on. Drawing down this buffer in periods of stress, hopefully only temporarily, activates capital distribution constraints intended to conserve capital. As now envisioned, the conservation buffer is to be filled by common equity. However, depending on forthcoming regulatory determination, a subspecies of the species of debt instruments that are contingently convertible to common equity might be counted as part of the conservation buffer, at least for Systemically Important Financial Institutions, SIFIs. For this to happen their triggers will have to be set to specified levels of some preferred regulatory capital ratio, as it is for subspecies cocos. With the buffer scheduled to be built up to 2.5% of risk-weighted assets by the start of 2019, total common equity equal to 7% of risk-weighted assets would then be required. This is equivalent to 3% to 4% of total assets.

Although cocos might get credit for helping to satisfy the conservation buffer, that buffer and cocos operate differently. A conservation buffer is pre-positioned to absorb losses should they happen to the firm. Maintaining the capital buffer in all but the worst of times, when it may

[2] Kashyap, Rajan, and Stein (2008) offer a plan for explicit capital insurance on a prepayment basis as an alternative to the insurance provided by cocos holders on a current basis. They explain that the insurance policy in their plan would resemble a contingently forgiven catastrophe bond acquired by the insurer, who might be a sovereign wealth fund or private-equity firm. Rajan (2009b) tweaks the 2008 plan further. Collender, Pafenberg, and Seiler (2010) give several reasons why Contingent Capital Notes or cocos hold more immediate promise than capital insurance. Other non-governmental capital insurance devices, such as catastrophe equity put options, allow their buyers for a specified tenor to sell common shares at a predetermined price in the event of a catastrophic loss as defined in the put agreement (Culp (2002), p. 48 cites actual cases). There are also contingent debt-issuance facilities, which, unlike lines of credit which may be withdrawn when the firm to which they were granted experiences a material adverse change in its circumstances, may be triggered by just such a change and require the insurer to lend to the firm on pre-loss terms. For proposals of fee-based contingent capital insurance commitment schemes offered by government, e.g. the central bank rather than the private sector, see Caballero and Kurlat (2009).

be used, is costly for it. Since the buffer requirement is non-contingent, it differs from the ex post equity injection provided by cocos when a conversion claim has been triggered by a major loss event for the firm and its consequences for regulatory capital. Cocos conversion alone then provides for automatic deleveraging without balance-sheet contraction beyond that associated with capital ratios declining to the trigger point.

Cocos are hybrid securities whose conversion from notes or bonds to common equity capital becomes mandatory when regulatory capital threatens to become insufficient. The trigger level of that capital ratio may be set somewhat above the regulatory minimum say of core tier-1 capital divided by risk-weighted assets or of the supplementary *leverage ratio* defined as tier-1 capital divided by total assets. Conversion may then be triggered by a negative contingency that drives the chosen capital ratio below the mark that has been set for it in the cocos instrument issued. Investors in cocos will help signal through the yield they require where the trigger should optimally be set to ward off impending disasters but also false alarms and unnecessary conversions.[3] When the trigger event has materialized, no new funds are raised but the debt involved in the conversion is cancelled. Paraphrasing Culp (2002), this type of contingent capital combines the functions of raising common equity capital and bankruptcy risk management. Investors may view it as an option on paid-in capital that contains "barriers" or second triggers. These would be activated only by losses resulting in pre-specified deterioration of equity capital in relation to assets on the balance sheet. Conversion would occur when the financial institution, barring sudden meltdowns, still has substantial net worth and can be made whole by conversion.

Market-based instruments other than cocos that can provide core tier-1 capital, in particular common equity, counter-cyclically in times of stress are described in Appendix 2. All

[3] There is some ambiguity because after a conversion that is seen to have been unnecessary to save the firm, equity holders might do quite well. Glasserman and Nouri (2010) have drawn attention to the potential upside of the equity that cocos investors obtain.

these instruments can provide alternatives to the direct issuance of common shares through a public offering when such an offering might fail or be excessively dilutive. As the Squam Lake Working Group (2009) explains, when a troubled bank issues new equity, the act amounts to a transfer of wealth from existing shareholders, whose claims on the firm are diluted, to bondholders who gain some of the protection of a greater equity buffer. Thus shareholders will be looking for alternatives, such as those highlighted in Appendix 2, that can provide an increase in the equity cushion and lower expected bankruptcy costs without stock dilution.

2 Cocos instrument, trigger, and an actual issue: detailed specifications

Cocos are dated securities. They provide a financial firm with a call option on its debt of this type that it linked to a put option on its own equity, where joint exercise of the options is automatic when the barrier level of a specified regulatory capital ratio has been breached. It may be determined that ownership of cocos needs to be restricted to prevent cross-gearing within the banking sector that could defeat their purpose. SIFIs definitely may not have cocos, or derivatives linked to cocos, as investments to hold on the asset side of their balance sheet. However, they must be allowed to hold cocos in their trading book if a secondary market for cocos is to develop. In that case cocos would have to be sold to other institutions and investors such as hedge funds, groups of private-equity investors, or sovereign wealth funds possibly with a prohibition against concentrated ownership that could convey control through cocos conversion. Initially at least, cocos would therefore be likely to have a narrow market although that market, as for the LBG issue described below, may be international. Pension-fund covenants may preclude holding hybrid instruments that may be classified as equity-like or which fail to attract an adequate bond rating. On the other hand, cocos are mandatory-pay securities, and the

interest payment is tax deductible. Firms do not count the shares that may yet be issued in conversion of cocos in calculating diluted earnings.

Cocos may go into default for non-payment of interest and principal unless and until conversion has been triggered. But any prudentially well-designed trigger level of capitalization is likely to be breached before any of the most junior debt goes into default and cross-default clauses kick in. Hence the addition to tier-1 capital comes just in time to make the prospect of default and bankruptcy much more remote. How much more depends on the strength of the cocos shield in percent of a company's total assets on (and off) the balance sheet and on whether all its cocos outstanding, once triggered, are to be converted at one time or in several steps.[4]

Conversion terms may be specified in such a way that the share of the common stock owned by the former cocos holders after the conversion must be equal to the share of regulatory tier-1 capital contributed by them to the company in distress. Then conversion of all the company's cocos at one time could convey effective control to its new shareholders if acting as a group. Flannery (2005; 2009) proposes conversion to a variable number of shares whose market value is to be equal to the face value of the debt that is being converted, using the stock price recorded on the trigger activation date. Doing so would provide full payment of the face value of the debt converted unless the price of the stock is at or below its selling costs.

For insurance, cocos function as a precautionary instrument that authorizes a certain block of common shares to be issued for injection into companies in emergencies under specified conditions. As explained below, that number of shares here is to amount to a fixed fraction of the total number of common shares outstanding just after the conversion, and that fraction, unlike in

[4] Glasserman and Nouri (2010) base their simulations on a conversion process that converts just enough debt to meet the capital requirement each time a bank's capital ratio reaches the minimum threshold so long as the stock of contingent capital has not been depleted. Though this process is not adopted here, their work is exemplary in other respects. Most notably, it adopts a stochastic process that may lead an initially adequately capitalized bank to become undercapitalized and does not just pick up the story once a crisis is at hand.

Flannery (2009), is known beforehand. Cocos should be issued when times are good for the company or at least solidly improving, and not when a major crisis has just set in. Rajan (2009a) has noted that because these contingent-capital arrangements will be entered into when the chances of a downturn seem remote, they will be cheap compared with raising new capital in the midst of a recession and less burdensome for the industry. Because the contingent equity infusion is an unlikely possibility, Rajan sees firms unable to raise their risk profile appreciably by issuing cocos in good times. Hence, he expects that they would not be inclined to take on more risk by immediately counting the contingently available future capital as backing. Applying this expectation of *ceteris paribus* to risk taking by the firm is critical to support this study's subsequent adoption of the same potentially loss generating diffusion process whether or not the firm has cocos on its balance sheet.

2.1 When markets shut down in a crisis: accounting- versus market-based triggers

A characteristic distinguishing the cocos here considered from the reverse convertible securities discussed in the last subsection of Appendix 2 is that their trigger is pulled by the firm's regulatory capital ratio declining below some critical level, and not its share price and/or a stock price index for financial institutions (see McDonald (2010); Sundaresan and Wang (2010)). Losses in all these respects are positively, but far from perfectly, correlated. Thus there is a choice to be made between triggers based on market values and the stochastic processes to which they are subjected and triggers based on regulatory accounting measures and what disturbs them.

Flannery ((2009), pp. 10, 16) argues that "capital measures for large firms must be expressed in market value terms" and that "market pricing errors should be random" while regulatory accounting or book-value measures are lagging measures likely to overstate the

market value of a distressed firms' equity. In fact, market pricing errors measured against a conservative valuation model based on fundamentals are not randomly distributed over firms or over time in a major financial and liquidity crisis. Instead they are positively correlated across financial firms and time on account of a surge in counterparty risk and growing illiquidity. If a crisis deviation from moving equilibrium were random at an annual frequency, it could not be expected to last long and hence probably would not be deep: "Great Moderation" for ever.

It also is an empirical question whether capital ratios based on regulatory accounting lag market-value based measures. First of all, accounting measures are adjusting and becoming more forward looking, for instance in the recognition of impairment. This process is ongoing as the convergence of FASB and IASB accounting standards proceeds, and GAAP is harmonized with International Financial Reporting Standards, IFRS.[5] Secondly it is likely that market valuations react strongly to quarterly earnings announcements and reports that highlight a financial firm's end-of-quarter regulatory capital ratios because priors become highly diffuse in a financial crisis. Then announcements of accounting measures can have great information and confirmation value even if they do not differ from "expected" value or the average earnings forecast.

In addition, the derivation and appropriate recognition of market values or fair values and selective application of mark-to-market rules themselves require an extensive set of accounting regulations and inferences from approved models. Constructing a financial firm's balance-sheet entries for non-par-value items simply, or even largely, by use of an uninterrupted and "thick" flow of auction-market prices is rarely an option, least of all in a financial crisis. Indeed, use of market values in public accounting is least feasible and most pro-cyclical in a crisis when

[5] For instance, the International Accounting Standards Board, IASB, requires expected credit losses to be reassessed each period and the effects of any changes in expectations to be recognized in net income immediately. The U.S. Financial ASB, FASB, meanwhile is still based on an incurred-loss model, and not an expected-loss model like IASB. In general, IFRS-based impairment models may require impairments to be recognized earlier than would be required under US GAAP. For a systematic comparison see PriceWaterhouseCoopers ((2010), pp. 95-106).

markets for some financial instruments shut down, liquidity dries up and market data have to be inferred from past data and valuation models for lack of usable current data, especially for smaller financial firms. Hence market-value accounting is as exposed to accounting gimmicks as regulatory accounting. It requires just as much policing, updating and effective oversight to prevent it from being used to defer recognition of developing problems. In reality that policing is done, if at all, for regulatory compliance and bank supervision, thereby providing a high degree of measurement certainty for investors in instruments whose conversion may be triggered.

2.2 The pioneering LBG issue of cocos

As a practical matter, in periods of financial turmoil and steeply declining stock prices of financials, cocos become difficult to issue on acceptable terms. One of the reasons is that the premiums for at-the-money puts which investors in cocos might use to hedge the conversion risk may quickly become unaffordable in a downdraft, if such puts continue to be offered at all. Short sales also might be difficult to arrange or be restricted. When Lloyds Banking Group plc (LBG) pioneered the issuance of cocos, it managed to defy the rule that cocos are to be issued in good times for conversion in very bad times. The Group emerged from the UK-government arranged and heavily subsidized acquisition of HBOS, the holding company for Bank of Scotland (BOS), at the beginning of 2009. This is the same year in which LBG later managed to launch a greatly oversubscribed cocos issue of "Enhanced Capital Notes" (ECNs), for almost £9 billion (worth $15 billion). These cocos-type ECNs are classified under Basle II as subordinated debt (lower tier-2 capital). While they have fixed maturities of 10 to 15 years, if LBG's consolidated core Tier 1 capital ratio under the Basle II definition falls below 5% during their term, they will all promptly and completely be converted to common shares in LBG.

The minimum core tier-1 capital ratio (equal to common equity after deductions -- i.e., retained earnings and proceeds from the issue of common shares minus goodwill and other intangible assets -- divided by risk-weighted assets), which was 2% under Basle II and will remain 2% through 2012, is scheduled to rise in three steps to 4.5% by the start of 2015 under Basle III. This means that after 2014, when the ECNs still have 5 to 10 years to run unless their conversion is triggered earlier, the new minimum will be close to LBG's trigger for its ECNs. The initial conversion price of 89.7246 pence was set at the volume-weighted average price of Ordinary Shares on the London Stock Exchange for each of the 5 consecutive trading dates included in the period from November 11 to November 17, 2009. This price was adjusted to 59.2093 pence to compensate for dilution from a massive rights issue processed later that month. The £9 billion raised from the issuance of cocos in a few weeks toward the end of 2009 amounted to almost 2% of the Group's risk-weighted assets of £493 billion and to almost 1% of its total assets of £1,027 billion at yearend 2009 according to LBG's *Annual Report and Accounts 2009* (pp. 22, 83). Conversion of all of LBG's cocos would push its conventional tier-1 capital ratio from under the 5% trigger point to over 6.5%.

Perhaps paradoxically, the 43% ownership acquired by the UK government in the course of its bailout operations in January 2009 was partly responsible for the cocos issue finding such eager buyers. For when HM Treasury negotiated the bank's state-led restructuring plan with the European Commission (EC), the Commission, in return for allowing state aid, required Lloyds to suspend dividends and all optional (i.e., suspendable and non-cumulative) payments to subordinated bondholders and also to refrain from exercising any capital call options on hybrids within the two-year period commencing January 31, 2010.[6] As a result of this suspension of interest and dividends and uncertainty about its possible extension, legacy perpetual preferred

[6] See http://crossborder.practicallaw.com/7-501-5719, p. 11 and *passim* for further links and details.

and undated subordinated notes, issued prior to the formation of LBG, that could be exchanged for cocos in the U.S. exchange offer were trading at between 50% and 75% of par. A total of 35 of the recent prices of 52 existing securities in the non-U.S. exchange offer fell into this range, while for 17 the percentage of par was above it.[7] Exchanging the securities in the exchange offer at par for lower-ranking cocos that had a fixed maturity and mandatory interest payments provided an escape from the EC's two-year restrictions on "optional" interest payments.

In addition, investors, in return for accepting the cocos, received a coupon rate that was 250 basis points (150 - 250 bps in the non-US exchange offer) higher than on the existing securities issued by HBOS, BOS, and Lloyds TSB Bank plc (LTSB) for which they were exchanged. The ECNs were issued by LBG Capital No. 1 when existing securities of HBOS were exchanged, and by LBG Capital No. 2 otherwise, in a minimum aggregate amount of $100,000 per holder according to the U.S. Exchange Offer. That offer provided for conversion into one floating-rate (3-month USDLIBOR + 2.75%) and two fixed-rate (7.875% and 8.571%) ECNs. The 52 series of ECNs in the non-U.S. exchange offer were denominated mostly in GBP but also in EUR, USD, and JPY. The fixed coupon rates in the various currencies ranged from 6 to 16.25%. LBG accepted the increased interest burden on an instrument meant to provide a capital buffer in order to escape from the massive dilution that would have resulted from coming under the (U.K.) Government Asset Protection Scheme which it earlier had planned to join. Hence very special conditions created by the government bailout contributed to the success of the offering of cocos by a company then still in difficulties.

[7] See p. 195 of the U.S. (pp. 326-328 of the non-U.S.) Exchange Offer for "Recent Prices of Existing Securities" and pp. 187-192 of the U.S. (pp. 213-322 of the non-U.S.) Offer for the ECNs' "Pricing Schedule." http://www.lloydsbankinggroup.com/media/pdfs/investors/2009/2009Nov3_LBG_US_Exchange_Offer_Memo.pdf . http://www.lloydsbankinggroup.com/media/pdfs/investors/2009/2009Nov3_LBG_Non_US_Exchange_Offer_Memo.pdf .

Pursuant to Rule 144A[8], the ECNs may only be sold to, or traded by, Qualified Institutional Buyers (QIBs) presumably over the counter and without the use of clearing houses at least until a substantial volume of trading has developed. Hence transaction prices, quantities, and positions initially may remain opaque. Although the LBG ECNs eventually were rated, the marketability of cocos generally also stands to be curtailed by the major credit rating agencies' reluctance to rate them. Difficulties have centered on estimating changes in the probability of conversion and how such changes depend on rating changes of the issuers and guarantors (see Merriman (2010)). Also, cocos are not included in bond indexes thereby excluding them from index-based financial products.

3 Official support for cocos and cocos mandates

During the financial crisis of 2007-2009 and its aftermath, a reform idea for reducing the moral hazard created by the government's safety net has been to include cocos in the financing mix of financial institutions. Active counter-cyclically, cocos would shore up the core capital of financial institutions through their own devices just when such a crisis threatens. Having this form of contingent capital on their books also would provide a measure of self-insurance against a regulatory-capital deficiency triggering Prompt Corrective Action by government agencies. Such Action may include costly seizure of the institution and its resolution. As a result, the prospect of suffering the deadweight losses of reorganization under bankruptcy may be greatly diminished without tying up additional equity capital permanently to achieve the same effect.

Most of those who have advocated the introduction of contingent-capital mandates in the wake of the recent financial crisis have cocos bonds in mind. They thus refer to them by the

[8] Rule 144A of the Securities Act of 1933 as amended provides a safe harbor from the SEC registration requirement for QIBs. Foreign companies rely on its provisions when accessing the U.S. market.

name of the group to which they belong. One prominent example of this advocacy and usage is Greenspan ((2010), p. 11) who testified: "The solution ... that has at least a reasonable chance of reversing the extraordinarily large 'moral hazard' that has arisen over the past year is to require banks and possibly all financial intermediaries to hold contingent capital bonds ─ that is, debt which is automatically converted to equity when equity capital falls below a certain threshold. Such debt will, of course, be more costly on issuance than simple debentures,[9] but its existence could materially reduce moral hazard."

Mandatory debt-to-equity conversion that may be triggered for cocos is not to be equated with cram-downs of equity in exchange for long-term debt of financial institutions as advocated by Buiter (2008) and Zingales (2009) for dealing with the recent crisis. These cram-downs would be arranged on discretionary terms set only after the seizure of these institutions or during receivership; they are part of the government's resolution regime which this study does not consider. Buiter grants that the mandatory debt-for-equity swap he proposes for all US financial institutions amounts to a compulsory re-assignment of property rights - a form of expropriation. Such improvised emergency measures are not part of the regulation- and market-disciplined contingent-finance and insurance regime that is specified and evaluated here. That regime attempts to cover bankruptcy risks through timely recapitalization provided by investors in cocos who know the terms and triggers in advance and are not subject to collective directives.

Voluntary or mandatory issuance of contingent capital in the form of cocos has been commended by officials in the Federal Reserve System,[10] the European Central Bank (Tumpel-

[9] This statement needs to be qualified since it may not hold if "simple debentures" refers to debt previously issued when there were no cocos in the financing mix. When cocos then are introduced, the yield required on them may be lower than on such prior debt according to findings presented later. Even with cocos already in the picture, Glasserman and Nouri ((2010), p. 26) deduce from an illustrative calibration of their structural valuation model that the yield required on cocos would be less than on senior debt provided cocos amount to at least 6% of the total debt.

[10] In Andrews (2009), Bernanke is quoted as saying that giant financial players might be forced to adopt "contingent" capital – selling bonds that would automatically convert into common stock if a company had trouble.

Gugerell (2010)), the Bank of England (King (2009) and Tucker (2009)), and the Swiss National Bank (Hildebrand (2009)). Regulatory or supervisory bodies such as the (U.K.) Financial Services Authority (Huertas (2010)) and Canada's Office of the Superintendent of Financial Institutions (Dixon (2010)) and various international committees, boards, and multilateral financial institutions have urged further study of the instrument and its possible applications. Among the latter are the Basel Committee on Banking Supervision (see BIS (2010a)), the FSB (2009) also based at the BIS, and the IMF (2010). Wider use of cocos, and even a mandate that would require at least a small percentage of the long-term liabilities of large and interconnected financial institution's to be held in the form of cocos, thus have been endorsed by several central bankers and regulators of financial institutions and markets. Others, such as Weber (2010), have suggested that it might prove rewarding to have this bail-in, as an alternative or supplement to increasing capital requirements, explored further. In addition, a few academics have started to provide substantive support, with Flannery (2005; 2009) a pioneer in that regard.

Thus far there has been very little analysis of why cocos have found scant acceptance in the private sector. Are individual issuers discouraged by the market's presumption that any financial institution that chooses to issue this still rare instrument must have private knowledge of its approaching the "vicinity of insolvency" (Coffee (2010), p. 36)? Then a cocos mandate applicable to an entire class of financial institutions could readily be justified because it would eliminate that adverse signal and solve the coordination problem. But any such problem cannot explain why a cocos mandate has not generally been supported even as a group by the very institutions whom it is designed to help issue these types of instruments. Is preparing for the

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Federal Reserve Presidents Dudley (2010), Plosser (2010a), and Rosengren (2010) and, as reported in Paletta (2009), Daniel K. Tarullo, then a Governor of the Federal Reserve System, also have endorsed the contingent-capital *idea*, though not necessarily contingent-capital *mandates*. Rosengren "strongly endorses" the idea and finds that "contingent capital is an important part of the solution" to moral hazard problems and bailouts by taxpayers.

worst viewed as a public relations disaster for the industry? Ultimately, some strong institutions which are above suspicion may decide to offer cocos, but the industry may still be split on this.

The purposes which cocos are meant to serve may vary depending on whether the interests of existing shareholders and bondholders, the survival of the financial institution and the preservation of going-concern value, or contributions to financial stability of the economic system as a whole are considered. Starting from the latter perspective, the BIS ((2010b), p. 2). has reported agreement on a counter-cyclical buffer on top of the conservation buffer which can absorb losses during periods of financial and economic stress. As mentioned in the introduction, cocos could be part of any of these, at least incidentally, countercyclical buffers, although that does not appear to be as yet officially intended. What cocos and the countercyclical buffer have in common is that both are to be built up in good times for use in times of stress. However, cocos, upon conversion, provide common equity and deleveraging while the countercyclical buffer provides an equity cushion front-up for use when times are very bad even though leverage thereby may be raised.[11] Cocos thus may come to be seen as an essential component of a contingency funding plan (Tucker (2009)) and as superior to the government-orchestrated countercyclical buffer proposed at the BIS.

The distinguishing feature of cocos, which is that their trigger references a regulatory capital ratio, makes it difficult for firms to dodge or game conversions because all the accounting relating to regulatory capital ratios is under the close scrutiny of regulators and supervisors in any event. Cocos are also superior to a type of convertible debt advocated by Krahnen and Siekmann ((2010), p. 11-12) that would be triggered individually but with the conversion trigger

[11] BIS ((2010b), pp. 14-16) explains the integration of the countercyclical capital buffer and the capital conservation buffer as envisaged at mid-year. Other supplemental countercyclical reserving mechanisms either already in use (e.g., in Spain) or proposed by official bodies are identified in Scott ((2009), p. 88).

activated at the discretion of government supervisors or risk managers. This type of debt would belong to another subspecies, gocos (government-convertible securities).

Having cocos to convert can help financial institutions at times of system-wide distress avoid some the downward price pressures and ensuing collateral calls from collectively having to sell equity or engage in fire sales of assets in vanishing markets. Yet any such conversion would be prompted by the circumstances of individual institutions and follow their covenants. As Blanchard ((2009), p. 14) has pointed out, counter-cyclically active, i.e., pro-cyclical, capital ratios can dampen the build-up of risk on the way up, and the amplification mechanism on the way down. Since cocos can normally be issued only in good times and can get converted only in very bad times for individual financial institutions, pro-cyclical build-up of leverage could be automatically reversed through cocos conversion that deleverages by cutting debt and raising equity in the same step (see FSB (2009), pp. 4-5; Lockhart (2010)). To the extent many firms try to deleverage simultaneously in a crisis, the resulting contagion, or adverse deleveraging externality (Tressel, 2010), may be reduced. But even if financial institutions act as a herd, they do not run off equally far in the same direction nor make themselves equally vulnerable to cycles. To foster good management, deliberate differentiation in the pricing and provision for self-insurance by such institutions should be encouraged.

If the initial cocos shield was adequate for absorbing shocks to the initial capital position, "[o]n conversion the market would [get] the message that the bank had been solidly recapitalized with common equity, and not that it was still in trouble and its common equity had been bolstered only modestly" (Dixon (2010)). Indeed, according to her, "embedded contingent capital provides a means to address many of the problems related to moral hazard and market discipline... It forces the costs of excessive risk taking on to the right people – the shareholders

and subordinated debt holders. The reward for its implementation would be a much safer global financial system." In addition, the yield spread of cocos over zero-coupon-rate Treasuries of similar maturity "is a much more effective message of discipline from the debt markets than that provided by subordinated debt without the conversion feature" (Huertas (2010)). "[I]nstruments, such as subordinated debt, which banks have been permitted to count as capital under the Basel regime, ... do not provide a reliable capital buffer until after the bank has failed" (King (2009)).

There is evidence that investors in subordinated debt believe supervisory discipline to be more effective than what the market itself can supply (DeYoung *et al.* (2001)).[12] In addition, Plosser (2010a) states, perhaps somewhat wishfully, that the market price of cocos, if they were actively and transparently traded, could provide regulators with a valuable signal about the financial health of the firm and about the market's perception of systemic risk. Finally, investors in a financial firm that had a cocos capital buffer on its balance sheet would have anticipated that common equity would be replenished automatically if the firm came under stress, and this knowledge might have tempered anxieties about counterparty risk and given that firm a funding advantage (Dudley (2010), p. 4).

The purpose of the remainder of this study is not to evaluate such often glowing assessments against alternative ways of providing contingent capital or of making its provision less needed. Nor is there space to debate the logical consistency or factual accuracy in official endorsements of cocos. The critical overview recently prepared for the European Commission by Maes and Schoutens (2010) has already taken on part of such a challenging task. Goodhart (2010) has expressed summary reservations. Admati, DeMarzo, Hellwig, and Pfleiderer ((2010),

[12] Subordinated debt is widely regarded as having failed in its ability to absorb losses as a buffer against reorganization and bankruptcy and to provide early warning of trouble ahead. According to Kaufman (2010), wholesale government guarantees of bank debt and uninsured deposit liabilities in a crisis as well as cross-default clauses in debt contracts are among the reasons. For an earlier analysis of the market discipline expected in vain from subordinated debt compared with cocos, see Raviv (2004).

pp. 45-48) have declared that approaches based on equity dominate alternatives, including contingent capital. Their constructions related to the working of "contingent capital" do not match specifications and trigger for subspecies cocos and leave unclear what forms of contingent capital they seek to address.[13]

Rather than debate judgments which are often lacking in specificity and evidence, the objective here is to enrich the pool of transparent model-based assessments of the merits of subspecies cocos. Specifically, the sole purpose is to estimate what having cocos on the books of a financial firm would be worth in terms of reducing the probability that an initially very well capitalized firm would fall into receivership and incur the deadweight losses of bankruptcy and resolution. The resulting reduction of the expected cost of bankruptcy benefits existing shareholders and holders of debt that is senior to cocos, as well as the cocos holders themselves, to different degrees. As discussed at length at the outset, the private-social overlap value of these benefits is to be estimated to determine the cost effectiveness of cocos in the financing mix.

4 A model of cocos and how their conversion may get triggered

The model presented in this section specifies how an initially very well capitalized financial firm can see its fortunes decline over the years to the point where it faces imminent bankruptcy. It calculates to what extent this prospect is averted through cocos conversion if there are cocos in the firm's financing mix. The goal is to assess how the availability of cocos lowers the expected

[13] They ask rhetorically , "If we want to enhance the bank's equity cushion, why not just require the cushion to come in the form of simple equity?" (p. 46). They then state, "One can in fact think of equity as contingent capital that is converted *ab initio*" (p. 48). But cocos, unless converted, are not a regulatory substitute for core tier-1 capital. They are issued in good or improving times and triggered, if at all, much later to avert regulatory insolvency. This counter-insolvency effect which, if banks herd, is also counter-cyclical, provides for automatic deleveraging and recapitalization in a crisis. Plosser ((2010b), p. 47) has provided a fitting analogy when he likened cocos conversion to prompt corrective action before a crisis gets started and thus helping to avert a crisis.

cost of bankruptcy for the various components of the cost of capital and hence the economic fallout and expected size of the government's safety-net subsidies.

Cocos contain (a) a conversion trigger which needs to be defined and set together with (b) a firm's initial level of capitalization. Next (c) the amount of cocos to be issued and outstanding needs to be expressed in percent of total balance-sheet assets, and a decision has to be made whether the cocos outstanding, if triggered, are all to be converted to common equity at one time. Then (d) the conversion terms must be set that determine in advance what percentage of the equity claims outstanding after conversion is added by the new issues from conversion of cocos, potentially conferring control on the new shareholders as a group. Finally, (e) the stochastic process must be specified which, jointly with (f) endogenous reactions to conditions generated by that process, explains how the capital position of a company that starts out very well capitalized could with some low probability deteriorate so much as to trigger conversion.

In this and the following section, only the parameters for the base case will be given and their choice explained. Alternative parameter values are applied for sensitivity testing in the penultimate section of this study.

4.1 The ABCs of the cocos conversions to be modeled

(a) The conversion trigger actually encountered in the first cocos issue, by Lloyds Banking Group (LBG), was a particular capital ratio falling below 5%, where that ratio was defined as core tier-1 capital divided by risk-weighted assets. For LBG at the end of 2009 core tier-1 capital was £39.94 billion or 84% of its tier-1 capital of £47.53 billion. Because our simplified model contains only equity from common-share issues and retained earnings, its core tier-1 capital is no less than its tier-1

capital without distinction. For LBG, the denominator, risk-weighted assets, was £493 billion, which was 48% of its total assets of £1,027 billion at the end of 2009. Our model provides only for total balance-sheet assets and lacks the detail required to compute risk-weighted assets or their evolution. Hence the capital ratio used in it as the trigger is best understood as a so-called *leverage ratio*, a counter-intuitively named accounting measure that goes down when leverage goes up. It is defined as tier-1 capital divided by average adjusted on-balance sheet assets in regulatory and solvency directives focusing on the avoidance of excessive leverage. For instance, the minimum leverage ratio imposed on J P Morgan Chase & Co. (JPM (2010), p. 229), one of the large U.S. financial groups least damaged by the 2007-2009 financial crisis, was 3%, and falling below 3% to any degree is the trigger used in this study. JPM's actual leverage ratio at the end of 2009 was 6.9% while that calculated for LBG with the data given above was 4.6%.

The choice of 3% as the trigger level is consistent with conditions expected to prevail from 2015 on if the higher global minimum capital standards announced September 12, 2010 (see BIS (2010a)) are ratified and implemented. The announced 6% minimum ratio of tier-1 capital to risk-weighted assets would translate into a minimum leverage ratio of 3% if risk-weighted assets continue to be represented by a number that is about half as large as that for the total assets of financial institutions. To discourage "gaming" of the 6% risk-based tier-1 ratio that is to prevail from 2015 on, this minimum ratio is officially backstopped by a non-risk-based leverage ratio

which is required to be no less than 3% (BIS (2010a), p. 2).[14] The agreed period for testing this minimum tier 1 leverage ratio of 3% is 2013-2016 with disclosure of that ratio and its components by banks starting January 1, 2015. When used as a trigger in future, that ratio ideally should contain only core tier-1 capital, common equity plus retained earnings, in the numerator, to make sure that there remains a substantial loss-absorbing cushion to build on when conversion is triggered.[15]

(b) JPM's Annual Report for 2009 (JPM (2010), p. 229) shows 3% as the regulatory minimum of the leverage ratio and 5% as the least level for it to be declared "well capitalized." I added 7% as the minimum for a company to be regarded as "very well capitalized," and start the evolution of the financial firm in our model from this initial condition. JPM's actual leverage ratio of 6.9% at the end of 2009 fell just short of this very well capitalized level. In Appendix 1, Table A2, whose "actual" levels are taken from Table A1 for J P Morgan Chase as a real-world example, can help determine which of the regulatory capital ratios shown is closest to being the binding constraint on asset expansion. It appears to be the leverage ratio, LEV, here expressed as tier-1 capital in percent of the company's total assets (minus goodwill).

(c) To start over once conversion has been triggered by LEV falling below 3%, the amount of cocos outstanding is maintained at 4% of total balance-sheet assets prior to

[14] The Issing Committee (see Center for Financial Studies (2009), p. 4) had recommended "introduction of an additional overall leverage ratio in addition to the risk-weighted Basel ratio" already earlier. The FSA ((2009), p. 68) pronounced itself "convinced that the arguments for imposing a gross leverage ratio are compelling".

[15] Still using the rule of thumb that risk-weighted assets amount to about half as much as total assets for financial institutions, the Basle III standard of 4.5% for core tier-1 capital in relation to risk-weighted assets would translate into 2.25% in relation to total assets. Hence a 3% trigger by the latter definition would meet the Shadow Financial Regulatory Committee's (2010) concern that "the 4.5% new minimum book value capital requirement is still too low, given that most of the financial institutions that required government assistance during the crisis had currently reported ratios in excess of that amount." Static pre-positioned defenses made of regulatory matter cannot and should not be so high as to preclude bankruptcy categorically: Yet the contingent ex post relief provided by cocos may lower bankruptcy risk more effectively. Regulatory accounting measures are monitored frequently and able to provide adequate legal certainty.

conversion. This ensures that the leverage ratio is reset from (just under) 3% to 7% as soon as conversion of cocos to common shares, all at one time, has been triggered.

(d) Because conversion in the base-case occurs when the leverage ratio first dips below 3% of total assets, and because the face amount of cocos to be converted is maintained at 4% of total assets, the former cocos holders will end up owning 4/7 of the total book equity in the firm after conversion in the base case. In all cases, cocos holders know already upon completion of the initial offering to what share of the firm's equity they will be entitled upon conversion. As a group, they then will be able to exercise control. Whether concentrated holding of cocos by institutional investors such as sovereign wealth funds or private equity investors could lead to perverse incentives to decapitalize the firm to force cocos conversion is not analyzed here.

(e) Combining annual macroeconomic forecasts for the decade from 2010:Q4 to 2020:Q4 from the CEA ((2010), p. 75) with structural financial data taken from the year-end 2009 balance sheet and 2009 income statement of JPM yields 8.2% as the prospective annual equilibrium rate of growth of nominal magnitudes such as the book values of equity and total assets. The data supporting the choice of a gross base rate of growth of 1.082 for these magnitudes are gathered in Appendix 1, Table A3. For total assets, this nominal rate of growth reflects average real GDP growth of 3.35% and GDP-price-index inflation of 1.72% over the next 10 years, and 2.9% financial deepening estimated as described in Table A3. Tier-1 capital will also grow at 8.2% yearly on average in equilibrium when retained earnings that produce 6.2% annual growth of tier-1 capital with data for JPM are supplemented by net stock issuance increasing tier-1 capital by a further 1.9% per annum. The expected equilibrium rate of return on

equity, including the 30% dividend payout inferred for JPM, would also be 8.2%, implying an equity premium of about 4.3% over the forecast of the average annual 91-day Treasury bill rate of 3.73% over the next 10 years. However, the actual annual 1.082 gross rate of growth of equity is modeled as a binomial expansion and subject to progressive annual bifurcations into up or down movements by the factor 1.10 or 1/1.10, respectively, on top or bottom of this trend growth.

(f) That expansion is slightly compressed or reined in by allowing for some degree of mean-reversion in the gross rate of return on equity capital; Semmler and Chappe (2011) cite at least 6 studies published since 2002 that specify stochastic returns with mean reverting. Although deleveraging by selling assets and/or reducing reliance on debt is a difficult and gradual process, particularly in a crisis, the growth of assets is taken to respond to the level of the preceding leverage ratio in relation to its comfort level. Thus assets grow somewhat faster when that ratio is high, i.e., above 7%, than when it is low and the institution is poorly capitalized.

A formal explanation of properties of the binomial expansion in the gross rates of growth of Tier-1 Capital (T1C) follows shortly. Subsequently the functional form of the firm's responses is specified to the financial disequilibrium levels of the leverage ratio, LEV, that may be reached as the binomial expansion of the gross rate of growth of T1C proceeds.

4.1.1 Starting equilibrium values

That gross rate of return as well as the rate of growth of T1C are $(1+g^{T1C})_0 = 1.082$ per annum. The equilibrium gross rate of growth of total assets (A), $(1+g^{A})_0$, is also 1.082 yearly as deduced in the ABCs above. The initial yearend level of the leverage ratio is $LEV_0 \equiv T1C_0/A_0 = 0.07$. Initial values are registered at t=N=0. The number of years (t) that elapses subsequently involves

an equal number of annual steps and outcomes added in the N steps of the expansion. Hence the total number of cross-sectional outcomes after N=t steps and years is N+1.

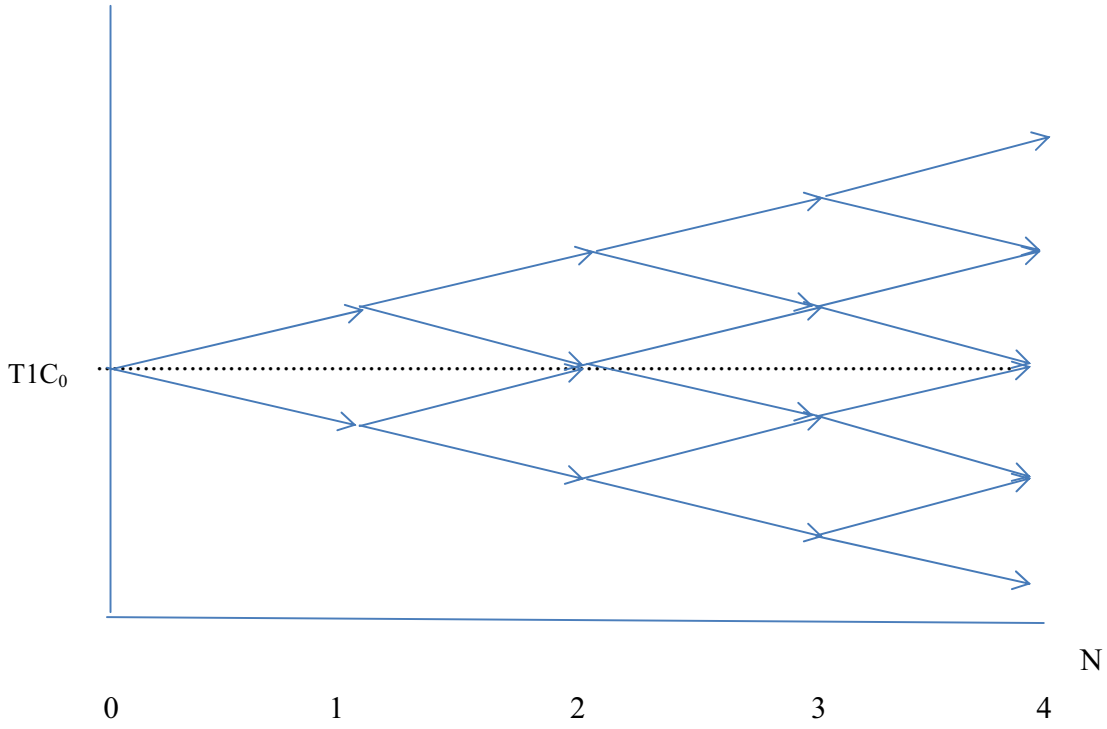
4.1.2 Specification of the binomial expansion process for T1C, the numerator of LEV

The expansion from each of the N+1 outcomes is by the factors 1.10, producing "up" moves, and 1/1.10, producing "down" moves, with equal probability of 50% each year. Each outcome can be reached by the *combinations* involving a fixed number of U_N "up" and D_N "down" moves, which lead to it in year $N = U_N+D_N$. For empirical relevance, the maximum number of steps and years considered is limited to N=50. The pattern of binomial expansion and some of its properties, given below, can be gleaned from Figure 1. The model of LEV's evolutionary dynamic in the last part of this main section allows for mean reversion in the rate of return on equity and adjustment in the rate of asset growth in response to changes in LEV.

4.1.3 Properties and implications of the binomial expansion

1) The cross-sectional distribution of the logarithm of future (N>0) gross-rate-of-return outcomes is symmetric around the logarithm of their mean, which is ln(1.082) = 0.0788.
2) The total number of distinct outcomes reached in a specified number of N steps or bifurcations grows by 1 when letting the expansion run 1 more year. Hence, as noted, N+1 different outcomes or nodes are encountered after N steps starting at N = 0. Here is the proof: Each outcome can be reached only in U_i "up" moves and $D_i = N-U_i$ "down" moves in any order. Hence the total number of outcomes is equal to the combinations of R=2 things taken N times, which is (N+R-1)!/[N!(R-1)!] = (N+1)!/N! = N+1.
3) It follows that the gross rates of return leading to any outcome characterized by given values of N and U are $1.082^N(1.1)^U(1/1.1)^{N-U} = 1.082^N(1.1)^{2U-N}$, U = 0, 1, ... N.

Figure 1: Illustration of binomial expansion of ln(T1C) over its first 4 steps



4) The number of *permutations* or distinct, not completely overlapping, pathways leading to the outcomes reached after N steps starting from N=0 is 2^N in the binomial expansion.

5) The number of permutations leading to an outcome involving U_i "up" moves and hence $D_i = N-U_i$ "down" moves is $N!/[U_i!(N-U_i)!]$, where $U_i = 0, 1 \ldots N$.

6) In view of 4) and 5), the probability, P, of reaching any of the N+1 outcomes is given by $P(U_i) = 2^{-N}\, N!/[U_i!(N-U_i)!]$, $U_i = 0, 1, \ldots N$, noting that 0! = 1, and that $P(U_i) = P(N - U_i)$ by symmetry. If N is an even number such as 20, $P(U_i = N/2)$ is unique and at a peak. For instance, if N=20 and U_i =10, this peak probability, of having expanded annually over 20 years by the equilibrium factor of 1.082 on average, is 0.1762. If N is an odd number, the peak probability attaches to each of the two integer U values that straddle N/2. Farthest away from the center of the distribution where U_i equals 20 or 0 the probability of the gross rate of return having more than doubled from 1.082 to 2.371 after 20 steps, or fallen by over half to 0.494, is only $2^{-N} = 0.000001$ or 1 in a million.

7) Except at the limit when N goes to infinity (N is here capped at 50), the binomial expansion is mildly platykurtic, with negative kurtosis revealing a flatter peak and stubbier tails than the normal distribution. For the binomial case with p=0.50 and N =20, the measure of kurtosis is $[1-6p(1-p)]/[Np(1-p)] = -0.10$. Distributions with fatter tails than the normal, such as a Pareto or even a Cauchy distribution, are often recommended to gauge the probability of default from a stationary distribution (e.g., Dowd and Hutchinson (2010), pp. 87-110). However, the binomial expansion provides ample default opportunities with growing unconditional probability for any fixed value of 2U-N such that dU=dD=0.5dN and dN is even (so that dU and dD are integers). As N runs on

by 2 at a time, the fixed trigger level of LEV moves from the lower edge closer to the center of the expanding distribution merely by staying below the center of that distribution of T1C, and hence of LEV to that extent, by a fixed percentage. That fixed percentage is a function merely of the number of D over U moves later found to be 10 at the biannual thresholds to bankruptcy in the base case. Hence D-U=N-2U=10, or U=0.5N-5, where N has to be an even number here. Substituting for U in the expression for the unconditional probability, P, then yields $P = 2^{-N}\ N!/[(0.5N - 5)!(0.5N+5)!]$. Solving this expression for N=10, 12, and 14 shows that P rises at first steeply with N, but at a decreasing rate, growing from 0.001 at N=10 to 0.042 when N=50. The probability, that is conditional on bankruptcy not having occurred earlier, peaks at a value of 0.027 at N=40. The unconditional probability peaks outside our range of interest equally at N=98 and N=100 at a value of 0.048474. At higher values of N, the diffusion effect of the expansion lowering the probability of the outcome just below the trigger value of LEV=0.03 surpasses the opposite effect of that outcome moving *relatively* closer to the center of the distribution as it spreads and flattens out.

4.2 Economic forces tempering the binomial expansion process

The trigger variable, LEV, has the gross rate of growth of T1C times the preceding level of T1C in the numerator and the gross rate of growth of assets, A, times the preceding level of assets in the denominator. Both rates respond to economic forces.

4.2.1 Mean reversion in the rate of return and growth of tier-1 capital

A representation of mean reversion is that $(1+g^{T1C})$, instead of taking on the fixed values 1.082(1.1) and 1.082/1.1 at each bifurcation, is sensitive to how far the succession of up and

down moves from the underlying uptrend already have moved T1C away from its long-run equilibrium. That value is represented by its growing expected value. Hence mean reversion is made to depend only on the current balance of positive and negative shocks experienced up to N. The advantage of choosing this specification is that the number of outcomes at each step N remains the same as previously specified and that all such outcomes can still be calculated independently so that the transparency of the binomial expansion scheme is retained. The straight outer edges of the wedge-like log linear binomial shown in Figure 1 now would appear inward-bent like a crab's open claw, yet there would be no increase in the number of outcomes that must be considered at any t = N. Thus the N+1 outcomes for T1C at time t from the start of the expansion at t=N=0 to its chosen end at t=N=50 are available by solving:

$$(\text{T1Capital})_{N,U} = 7(1.082)^{N}(1.10)^{2U-N}\, e^{0.001(N-2U)}\ ; \quad N= 0, 1 \ldots 50;\ U = 0, 1 \ldots N. \qquad (1)$$

This equation starts at the very well capitalized level of T1C of 7 relative to A=100 and then allows for normal growth at the gross rate of 1.082 per annum for N years. That growth will have been raised or lowered depending on whether N-2U is positive (D>U) or negative (U>D) in the exponent by that time. Mean reversion thus softens the progressive effects of binomial expansion in leading away from the center where N-2U=0. The size of the *Mean Reversion Coefficient, MRC*, is 0.001 in the exponent in the base case. If "down" shocks predominated so that N-2U is positive and LEV below its comfort level of 0.07, the firm's management will be pressed to cut dividends and costs. It will thereby seek to improve retained earnings and to raise T1C whether or not it is still meeting its conservation buffer requirement. For example, if N-2U

is 10 because N=10 and U=0, the mean reversion term as a whole would raise TIC by the factor exp[0.01] or by 1 percent, and in later sensitivity testing by ten times as much, or 10 percent.

4.2.2 Asset growth adjustment

The growth rate g^A of total assets adjusts to any deviation of LEV from its initial "very well capitalized" level of 7% in the base case. If LEV is above 0.07, the growth of the firm's assets rises above the normal pace of 8.2% because its level of T1C then is so high in relation to its assets that it can safely and profitably acquire more of them by expanding its deposit liabilities and debt. Some deleveraging occurs in the opposite case. The formula applied is:

$$(1+g^A)_{(N,U)t} = 1.082 \exp[0.1(LEV_{(N,U)t-1} - 0.07)];\ N = 1 \ldots 50;\ U = 0, 1 \ldots N. \qquad (2)$$

The factor 0.1 in the exponent above is the *Asset-growth Adjustment Coefficient, AAC*, for future reference. As Blanchard (2010, p. 7) points out, to maintain an adequate capital ratio either to satisfy regulatory requirements or to dissipate investors' concerns about bankruptcy risk, financial institutions have two choices. They can either get additional funds from outside investors or they can 'deleverage', i.e. decrease the growth of their balance sheets by selling some of their assets or reducing their lending. Either step is likely to be difficult in a general crisis to the extent stock offerings and asset sales are involved. Thus equation (2) allows for only a weak tendency to adjust g^A in response to LEV deviating from 0.07 in the base case. For instance, if the lagged value of LEV had fallen to 0.03 rather than staying at 0.07, the gross rate of growth of assets would be reduced by the factor exp(0.004) or about 0.996. In later sensitivity tests raising AAC ten times, the corresponding reduction factor applied to $(1+g^A)$ would be 0.96.

LEV, to this extent, would then be 4% higher, or 0.0312 rather than 0.03, still implying a very low rate of adjustment compared with the pre-crisis findings by Memmel and Raupach (2010).[16]

If both MRC and AAC were set to zero in equations (1) and (2), respectively, it would take at least N=9 years for an initially very well capitalized firm to find itself undercapitalized because LEV has fallen below 0.03, albeit with probability of only $2^{-9} = 1/512$. With MRC set equal to 0.001 and AAC to 0.1 in the base case, it takes one additional year for there to be any chance (of 1/1024) for the LEV trigger minimum to be violated. If that violation does not occur in year N=10 with U=0 and D=10, it may next occur in year 12 with U=1 and D=11, as Figure 2 shows, and every other year thereafter, each time adding 1 to both U and D so that N-2U is unchanged (at 10) and trigger-ready.

The fact that LEV is entered with a lag in equation (2) creates a more technical than substantive problem that must briefly be considered. The reason is that in a binomial expansion through time, all but the two current values at the upper and lower edge of the expansion do not have unique antecedents. Rather, all but these extreme values could have come from two different, though adjoining, lagged values with equal probability. Allowing for this splicing would lead to a proliferation of outcomes if both of the possible precursor values to a current outcome that depends on these lagged values were considered. The first chance of bankruptcy occurs on the lowest border of LEV where U=0; the lagged value for that outcome is unique.[17]

[16] Because their banks target a capital ratio with risk-weighted assets (RWA) in the denominator, their exemplary study also allows for changing the riskiness of assets, lowering RWA relative to A, without changing A.

[17] To derive the full set of subsequent results, as in Figure 2, with minimum loss of accuracy while preventing dimensional sprawl requires pairing each of the N+1 outcomes with just a single one of the N lagged value available for $LEV_{(N,U)t-1.}$ This can be done by using one of these N lagged values, at the center of the distribution, twice if N is even or by using an average of two adjoining lagged values near the center, as well as each of them separately, if N is odd. A glance at the pattern in Figure 1 that carries over to LEV shows why both rules have to be used alternately from step to step: Points on the center line, used twice as lags, materialize only every other step at which N is even-numbered. The two points nearest the center, which are each used separately and as their average of 0.07 as lagged values, straddle the center line when N is odd.

Figure 2. Binomial Expansion of LEV up to N=12, with LEV first below 0.03 in Years 10 and 12

						U = 0, 1 ... N							
0.5(2U-N)													
12													0.204
11												0.188	
10											0.173		0.173
9										0.159		0.159	
8									0.145		0.145		0.145
7								0.133		0.133		0.133	
6							0.122		0.122		0.122		0.122
5						0.111		0.111		0.111		0.111	
4					0.102		0.102		0.102		0.102		0.102
3				0.093		0.093		0.093		0.093		0.093	
2			0.084		0.084		0.084		0.084		0.084		0.084
1		0.077		0.077		0.077		0.077		0.077		0.077	
0	0.070		0.070		0.070		0.070		0.070		0.070		0.070
-1		0.064		0.064		0.064		0.064		0.064		0.064	
-2			0.058		0.058		0.058		0.058		0.058		0.058
-3				0.053		0.053		0.053		0.053		0.053	
-4					0.048		0.048		0.048		0.048		0.048
-5						0.044		0.044		0.044		0.044	
-6							0.040		0.040		0.040		0.040
-7								0.037		0.037		0.037	
-8									0.033		0.033		0.033
-9										0.031		0.031	
-10											**0.028**		**0.028**
-11												0.025	
-12													0.023
	0	1	2	3	4	5	6	7	8	9	10	11	12
													Year

4.2.3 Iterating LEV forward

T1C values can be calculated independently from eq. (1) for each N=t, but a recursive feature enters the solution of the model because LEV must be updated before the gross rate of growth of total assets, $(1 + g^A)$, can be calculated from eq. (2) for the next period and be used to iterate the estimates of A and hence LEV forward year-by-year until year 50. The initial value of total assets was set as $A_0 = A_{-1}(1+g^A)_0 = 100$, which, with $T1C_0 = 7$, is consistent with $LEV_0 = 0.07$. Then the following identity yields the updated values of $LEV_{(N,U)t}$ once $(1 + g^A)_{(N,U)t}$ has been calculated with use of the associated lagged value of LEV to update $A_{(N,U)t-1}$ to $A_{(N,U)t}$:

$$LEV_{(N,U)t} = T1C_{(N,U)t} / [A_{(N,U)t-1} (1+g^A)_{(N,U)t}] = T1C_{(N,U)t} / A_{(N,U)t}; \; N = 0, 1...50; \; U = 0, 1...N \quad (3)$$

Having generated the binomial expansion web of LEV values first without allowing for conversion of cocos, it can be determined when, and with what probability, such conversion would occur because the LEV would else be below its trigger level of 3%. Should conversion be precipitated, cocos would no longer be available to ward off receivership if LEV should again decline to less than 3% in the remaining years of our 50-year window. While some of the firms whose cocos have been converted may again be able to issue cocos if and when better times have returned, assuming that firms will always be able to do so would amount to ruling out, rather than just greatly diminishing, the possibility of bankruptcy. For valuation purposes it is clearer to focus on what a single addition of cocos to the financing mix might be worth. Since the cocos debt outstanding in the base case is required to be equal to 4% of total assets, its conversion raises the book value of the leverage ratio from 3% back to its initial value of 7%.

As the new shareholders from conversion will have contributed four-seventh of the book value of the equity outstanding after conversion, they know they are entitled to newly issued shares equal to 4/7 of the resulting total number of shares outstanding. Such capital injections of well over 50% are not unusually large. For instance, Kick, Koetter, and Poghosyan ((2010), pp. 8-9) report -- based on annual audit reports compiled by the Deutsche Bundesbank -- that the capital support measures conducted in Germany in 1994-2008 accounted for 83% of the gross equity of the supported institutions at the end of the year in which the injections occurred.

4.3 Cocos conversion: an even-money exchange or a loss operation?

Table 1 shows the value of the equity held by owners of existing shares and of new shares from cocos conversion under two alternative assumptions: (i) the market value of equity is always equal to its book value, and (ii) the market value of equity would have fallen to 0 in the absence of conversion so that only its prospect may give value to common shares. The sudden loss of value in (ii) might happen because a "jump", or rather "crash", process is involved that produces discontinuous price movements. Current book values, and the regulatory capital ratios based on them, could also be lagged indicators of current problems. This is frequently asserted, though generally without proof or tests against alternative methods of valuation and their timeliness. In both cases the financial firm starts out very well capitalized with LEV of 700/10,000 in the scale chosen for Table 1, or 7%. As the fortunes of the firm deteriorate, LEV falls to 3%, to the threshold of conversion. At that point (core) tier-1 capital, T1C, is down to 300 with a market value of 300 under assumption (1) and 0 in case (2) not yet considering the equity value of cocos. If cocos conversion then occurs because T1C dips either ever so slightly in (i) or drops massively in (ii) below 300, the post-conversion value of the equity of pre-existing shareholders

Table 1. Distributional Consequences of Cocos Conversion Under 2 Assumptions

Assumption:	(1) Market Value of Equity is Always Equal to its Book Value			(2) Market Value of Equity Falls to 0 Prior to Cocos Conversion		
	Value of Equity	No. of Shares	Value per Share	Value of Equity	No. of Shares	Value per Share
Column:	1	2	3	4	5	6
A. Existing Shareholders						
Initially Very Well Capitalized Level	700	100	7	700	100	7
After Deterioration up to Trigger Point	300	100	3	0	100	0
Dilution upon Pulling Trigger	-(4/7)300	100	-1.7143	0	100	0
Pro Rata Benefits from Cocos Debt Cancellat'n	(3/7)400	100	1.7143	(3/7)400	100	1.7143
Post-Conversion Value	300	100	3	171.43	100	1.7143
B. Value of Cocos Bonds or of New Shares from Cocos Conversion						
Initial and Pre-Convers. Value of Cocos	400			400		
Transfer from Existing Shareholders' Dilution	(4/7)300	133-1/3	1.2857	0	133-1/3	0
Pro Rata Benefits from Cocos Debt Cancellat'n	(4/7)400	133-1/3	1.7143	(4/7)400	133-1/3	1.7143
Post-Conversion Value	400	133-1/3	3	228.57	133-1/3	1.7143
C. Combined Value of all Equity and Cocos Debt Claims Outstanding						
Initially	1,100			1,100		
of which Equity	700	100	7	700	100	7
Equity after Conversion	700	233-1/3	3	400	233-1/3	1.7143

Note: The values shown in columns 1 and 4 are scaled to a total asset value of 10,000.

in (i) is still 300. As detailed in Table 1, it remains 300 because the dilution of the stake of pre-existing shareholders, who now do not own 4/7 of all shares outstanding, is fully compensated by their obtaining 3/7 of the benefit from cocos debt cancellation.

In case (i) the holders of new shares obtained from cocos conversion collect the transfer benefits from existing shareholders' dilution plus the pro-rata benefits obtained from cancellation of the cocos debt. The result is that their stake retains the same value of 400 after conversion which it had initially still in the form of cocos debt. In case (ii) new holders find only their share of the benefits from cocos debt cancellation reflected in the price of new shares. This price is 1.7143 for all shareholders in case (ii) compared with 3 in case (i).

This evaluation yields the following results:

(i) If the market value of equity is always equal to its book value so that bankruptcy is not imminent in the absence of cocos conversion, existing shareholders see the value of their equity fall in line with the decline in its book value as the fortunes of a financial firm deteriorate and LEV falls from 7% to 3%. However, the market value of their holdings is unaffected by the conversion of cocos per se, and the cocos holders receive the full face value of cocos in the form of new shares. Existing equity holder thus suffer no *value* dilution as the *stock* dilution implicit in having their equity stake fall from 100% to 43% (3/7) is fully compensated by their gaining 3/7 of the benefit from the transfer of value from the cocos debt converted to equity. New shareholders on the other hand would gain both from existing shareholders' dilution and from obtaining their 4/7 pro rata share of the benefit of cocos debt cancellation to achieve the same share price of 3. As Table 1 shows, existing shareholders as a group command 300 in total book value and cocos holders 400 in such value both before cocos conversion and immediately thereafter.

Hence there is no redistribution or dilution of value from cocos conversion as commonly claimed (e.g., by Maes and Schoutens ((2010), p. 7). There is also nothing in Table 1 that would support Goodhart's ((2010), p. 31) expectation that CoCos would incur a large loss by converting just when other assets are doing badly and so they could be sold only to a small clientele at a high yield, as if they were junk bonds.

(ii) If the market value of common equity would be 0 in the absence of conversion even though its book value is still 3% of total assets and the book value of cocos 4% of such assets, such conversion creates value for the holders of existing and new shares alike.[18] If there had been no cocos outstanding in this situation, the firm would inevitably be in receivership with all equity wiped out. The benefits then obtained from cocos conversion by the holders of both existing and newly-issued shares are equal to their pro rata shares of the present value of interest and principal on cocos debt that is no longer due. Again, cocos conversion produces no loss of value or redistribution between the holders of existing and new shares as it leaves them with value of 171.43 and 228.57. These numbers are 3/7 and 4/7 of their sum of 400. Hence this division is proportional to the book value of the equity of existing shareholders at the trigger point (300) and the face value of the original cocos debt (400). Existing holders of the financial firm's debts other than cocos (i.e., nocos) gain from the existence of cocos to the extent the probability of

[18] Goodhart ((2010), p. 30) regards capital ratios based on accounting, rather than market values of equity capital as adjusting far too slowly to support prompt corrective action, including through cocos conversion. Elsenburg and Jobst ((2010), p. 21) note that triggers based on market conditions are more forward-looking in flagging financial distress than financial soundness indicators based on a bank's balance sheet. Maes and Schoutens ((2010), pp. 2-3) remark that only core tier-1 capital, composed mostly of retained earnings and common shares, turned out to be loss-absorbing as all Tier 1 capital is supposed to be. They endorse the idea of imposing supplementary simple maximum leverage ratios (i.e., minimum levels of LEV in U.S. usage) that assess the size of a bank's total and non-risk-weighted on- and off-balance sheet exposures in relation to a high-quality measure of capital such as core tier-1. Valencia (2010) shows that such a supplementary ratio, which he defines as total equity divided by total assets, is positively related to the degree of uncertainty or volatility faced by U.S. banks, with banks wanting to increase leverage lowering LEV pro-cyclically in response to decreased uncertainty in good times.

bankruptcy, and the losses they would incur conditional on bankruptcy, are reduced. However, because the firm with cocos was not insolvent when the trigger point was reached, all cash flow freed by the conversion is available to bolster equity rather than to add to payments on any impaired nocos debt outstanding.

5. Additional specifications and simulation results

The private value of cocos here is evaluated by the contribution they can make to lowering the expected probability of bankruptcy and its costs given that resolution of distressed financial firms is expensive. Before laying out how this is done, there must be some acknowledgement that these private savings are only the most tangible part of the social value that can be attributed to measures reducing bankruptcy risk for financial firms in a crisis.

5.1 Systemic considerations and loss specification

The regulatory regime still prevailing, through Basel II at least, has three basic elements: "a minimum capital requirement (or leverage ratio), a risk-based capital requirement, and requirements that supervisory agencies take Prompt Corrective Action (PCA). [The latter take] the form of mandatory escalating supervisory restrictions, as a financial firm's capital position deteriorates relative to established triggers. [A shortcoming of this] regime is that it fails to protect the financial system or the economy from spillover effects related to the distress of financial firms" (Collender, Pafenberg, and Seiler (2010), pp. 3, 5). Hence any cost savings resulting from a reduction in the expected deadweight losses from bankruptcy for debt and equity investors in these firms represent only a part of the social cost savings from lowering the probability of bankruptcy for these firms.

For instance, financial crises associated with falling asset prices decrease risk capital, increase financial institutions' risk aversion, and further reduce asset prices. Fire-sale externalities and credit-crunch externalities can link up in a vicious circle freezing up economic activity. According to Kashyap ((2010), p. 10), and others cited by him, there are other feedbacks, relevant for this paper, that are indicative of externalities: A given firm will see a lower benefit of selling equity to increase its risk capital, relative to the benefit for the whole financial sector, because of the external effects that the firm's risk capital has on other firms' risk capital. But, Krishnamurthy ((2010), p. 26) continues, if the financial sector does not internalize this risk, it may undervalue risk capital for yet another reason: The government is set up to rectify the situation by injecting capital into the financial sector in a crisis. The ensuing safety-net subsidies perpetuate moral hazard. In the event of a bailout, there is a sense of social injustice in that those who stand to earn the most by recklessly courting danger get to extort the most from the taxpayer because they need to be saved "at all cost" when calamity strikes.

"A primary challenge for capital regulation is that it amounts to forcing banks to hold more equity than they would like" to reduce taxpayers' exposure to bailout risk (Kashyap (2010), pp. 2-3). Contingent capital mandates belong to the class of measures that attempt to bring the cost of negative externalities arising from a crisis home to those who might cause it.[19] While pre-positioning relief supplies of capital for a crisis event helps reduce the likelihood of financial

[19] The provision of contingent capital is designed not only to make socialization of losses less likely. It is also intended to counteract the undermining of bankruptcy protections that is implicit in financial innovations. For instance, holders of collateralized derivative contracts are entitled to make off with collateral in a bankruptcy that would otherwise have been subject to "automatic stay ... to ensure an orderly liquidation or to preserve going concern value" (Brunnermeier (2010), Part II, Section 4). Unsecured or non-collateralized derivative obligations can also in effect be terminated early through the use of other derivative obligations so that bankruptcy protections are partially undermined. A struggling firm is more likely to go through an expensive bankruptcy procedure because what Brunnermeier calls the "run externality" on the firm's remaining assets is no longer effectively contained by the bankruptcy code's "automatic stay" in resolution.

institutions' losing going concern value and suffering other deadweight losses from bankruptcy, there are thus additional, social, benefits attached to cocos not further detailed.

Turning to the results for the base case, the very well capitalized financial firm first faces a possibility of bankruptcy after 10 years of binomial diffusion at time N=10. That possibility is remote because it results from an unbroken succession of "down" (D) moves by the factor 1/1.1 whose probability is 2^{-10} or 0.000977. These 10 D and 0 U moves then are just sufficient to cause LEV to fall below the trigger point of 0.03 (to 0.028). So would 11 D and 1 U moves for N=12, as shown in Figure 2, and so forth for higher even values of N through N=50. Only the difference between D and U, the number of down and up moves, or, equivalently, only the size of N-2U, matters for triggering cocos conversion. Conversion cannot occur at any odd value of N, such as N=11, in this line-up, since the only time series of outcomes that could trigger bankruptcy due to LEV dropping below 0.03 at N=11 (to 0.025 in Figure 2) already did so at N = 10.

Since, by assumption, cocos equal to 4% of a financial firm's total assets are issued when a financial institution is very well capitalized, it takes 10 years for bankruptcy risk first to arise. In the absence of cocos, the risk on all other and more senior non-cocos debt, for short *nocos*, then persists for up to another 40 years until N = 50 in the longest window chosen. To make sure that the firm maintains cocos equal to 4% of total assets when its deteriorated condition is on the verge of triggering conversion, cocos must grow at the same nominal rate as the firm's assets. Cocos financing instruments with initial maturities ranging from 10 to 50 years thus are assumed to add to their initial principal on the run, as through reopening or a process like capitalizing interest. Their growth rate falls below its average gross level of 1.082 to $(1+g^A) = 1.0777$ in the solution of the model for the point where LEV has sunk to just below the trigger point. This level of 1.0777 is almost the same as that of the gross discount rate, 1.0775, deduced before. The

present value of the growing amounts of assets, and of bankruptcy losses on liabilities to investors, thus can conveniently be treated as approximately constant through time in an internally consistent manner because growth factor and discount factor are so similar.

In Table 2, financing programs from 10 to 50 years are considered. Any nocos issued for less than 10 years would be safe even without there being any cocos in the financing mix for the same term. Starting with the 10-year program, and assuming that interest is still paid in the year in which bankruptcy would occur and that debt is not amortized, only the principal repayment could be at risk in the tenth year without cocos. While that probability of bankruptcy here is very small, only $2^{-10} = 0.000977$, it would have been eliminated entirely if cocos had been issued. Hence Table 2 shows that 10-year debt requires practically no risk premium over the assumed base rate of 7.75% on long-term securities that are taken to be free of expected bankruptcy costs.

An evaluation of FDIC loss experience for the period 1986 to 2007 by Bennett and Unal ((2009), p. 3) found a mean discounted total resolution cost to asset ratio of 33.6%.[20] Bankruptcy costs to be borne by private investors could be less if the government's safety net is made less available and private pressure for prompt corrective action increases. Such an assumption is necessary since the model did not contain deposit or other short-term liabilities which could help bear some of the cost of bankruptcy. Equity and long-term debt together are equal only to around one-sixth of the value of the assets of financial institutions even in good times. Long-term nocos debt is equal to about 12% of total assets and common equity amounts to only 3% when bankruptcy is imminent.

[20] No allowance for loss of going-concern or charter value of a bankrupt institution is included because FDIC intervention, takeover, and arranged merger procedures minimize losses from these sources. The *deposit payoff* method of resolution, under which the FDIC liquidates the failed bank's assets and pays off depositors could involve such losses. However, Bennett and Unal (2009) found that this method imposes no higher resolution costs than resolution by means of *purchase and assumption agreements* which leave most or all of the failed bank's assets in the private sector and transfer some or all of the deposits to an acquirer. The FDIC thus appears to have optimized choice of the two methods so that, at the margin, there would be no cost saving from switching methods.

Table 2. Yield (IR) Differences on Non-Contingent Debt (Nocos) due to Expected Bankruptcy Costs without or with Cocos for an Initially Very Well Capitalized Firm

	10-Year Nocos		**20-Year Nocos**		**30-Year Nocos**	
Cocos:	**without**	**with**	**without**	**with**	**without**	**with**
Present Value of Bankruptcy Costs per 100	0.0489	0	2.1859	0.0001	7.4566	0.0183
Remaining Asset Value	99.9511	100	97.8141	99.9999	92.5434	99.9817
IR	7.7553%	7.75%	7.8691%	7.75%	8.0287%	7.7507%
Difference	0.0053%		0.1191%		0.278%	

	40-Year Nocos		**50-Year Nocos**	
Cocos:	**without**	**with**	**without**	**with**
Present Value of Bankruptcy Costs per 100	14.1158	0.2118	20.7351	0.9007
Remaining Asset Value	85.8842	99.7882	79.2649	99.0993
IR	8.1607%	7.7557%	8.2519%	7.7695%
Difference	0.405%		0.4824%	

Note: The method for calculating 1+ IR=X applied in this and the following table is illustrated using 40-year nocos, when there are no cocos in the financing mix, as an example given that underlying nominal growth and the interest rate free of bankruptcy risk are 7.75% per year:

$85.8842 = 100(1.0775/X)^{40}$, $X = 0.858842^{-0.025}(1.0775)$, $X = 1.081607$.

This leaves two choices: One option is to spread bankruptcy costs over shorter-term bank borrowing and (uninsured) deposit liabilities because forfeiture of the long-term nocos debt plus equity alone cannot cover these costs. In this case nocos would still lose all value, being junior to the claims of depositors. The other option is drastically to reduce the total loss from bankruptcy in percent of the firm's assets. Perhaps, without government backstops, the threat of bank runs could serve as a compelling disciplining device that ensures prompt corrective action before prospective losses mount. In choosing the latter option, it is also desirable to stop short of wiping out the claims of long-term nocos holders in a bankruptcy resolution entirely. Otherwise the functioning of these instruments in distress would become indistinguishable from that of common equity. Cutting the aggregate loss realization from one-third to 9% means choosing the latter option. Then extinction of the equity claims absorbs bankruptcy costs equal to 3% of assets and a 50% loss in realizable value on nocos absorbs the remainder equal to 6% of assets. Thus when bankruptcy or receivership occurs, an amount equal to 9% -- consisting of 100% of the equity and 50% on the long-term debt, in relation to the growing assets and liabilities of constant present value (=100) is lost. Multiplying 0.000977 by 50 then yields the present value of the loss equal to 0.0489 shown for 10-year nocos without cocos in Table 2.

5.2 Results for long-term financing of up to 50 years

While the concerns of the 10-year debt holder end here, in the 20-year program the investor in 20-year debt has to start considering that cocos are available for conversion only once. They therefore do not banish the prospect of bankruptcy entirely for debt that has 20 or more years from the start of the simulation to run. The reason is that cocos conversion, when it occurs, re-

establishes the very well capitalized LEV position of 0.07 and thus the status quo ante with bankruptcy then occurring 10 years after the conversion, i.e., at N=20, at the earliest. Thus LEV may fall below 0.03 again by year 20 at the earliest, again with probability of 0.000977, this time precipitating bankruptcy. Hence even with cocos in the financing mix, there is an expected bankruptcy cost, equal to $50(0.000977)^2$ which is rounded inconsequentially to 0.0001 in Table 2 without causing the discount rate to budge from 7.75%: The composite probability of conversion followed by bankruptcy within a total of 20 years is less than one in a million.

Without cocos, bankruptcy on 20-year debt can occur every other year from N=10 to 20 in the binomial expansion with conditional probability that rises from 0.000977 at N=10 (U=0, D=10) to 0.014352 at N=20 (U=5, D=15). Taking the conditional probabilities of encountering bankruptcy in each of the 6 even-numbered years in this interval, summing them (to 0.043716), and multiplying by 50 then yields 2.1859 in relation to 100 as the loss from bankruptcy in the absence of cocos. Conditional probabilities are composed of the probability of reaching a LEV ratio just below the trigger level in the cross-section of possible outcomes for given N, multiplied by the probabilities that bankruptcy has not already occurred in any of the prior years. The present-value sums get longer as the program horizon is extended by decades to nocos with maturity of up to 50 years – with expected bankruptcy costs rising from 2.1859 for N=20 to 20.7351 for N = 50 in the absence of cocos. However, the extension to the longer programs is straightforward.

With cocos, calculation of the present value of bankruptcy costs is more difficult. Having cocos in the financing mix fully protects against the possibility of bankruptcy only through year N=19. The procedure adopted to allow for bankruptcy costs from that year on is best illustrated with the longest debt considered. On 50-year debt, cocos conversion may occur as early as

N=10, with the earliest bankruptcy at N=20 and the latest at N=50. Conversion that leaves open any possibility of bankruptcy within the 50-year horizon may occur as late as N=40, with the only possible year of bankruptcy then being N=50. Hence the probability of cocos conversion at year 10 is multiplied by a sum consisting of 16 even-numbered terms each representing the product of the conditional probability of bankruptcy 10 to 40 years after the reset of LEV to 0.07 at time N=10. When cocos conversion occurs at N = 12, the earliest bankruptcy is at N=22 and the latest at N=50 reducing the number of terms in the sums from 16 to 15, and so on, until there is only 1 such component when cocos conversion occurs at N = 40. Each of these 16 sums is multiplied by 50 and the respective conditional probability of cocos conversion. Then these intermediate results are summed to yield a present value of bankruptcy costs after cocos conversion. The result is 0.9007 per 100 which causes the discount rate over these 50 years to rise by about 2 basis points. The number of intermediate results to add is 11 for 40-year debt, 6 for 30-year debt, and 1 for 20-year debt where the end result becomes almost infinitesimally small, as already explained. Hence the bankruptcy costs that are left for investors in nocos to bear even over the longest time frame of 50 years covered here are negligible when cocos are available without replacement for conversion at one time during this term.

How the cocos themselves are to be valued depends on what is to be assumed about the value of the stock prior to conversion as already explained. If a financial institution's stock trades at book value per share and continues to do so after the conversion as in case (1) of Table 1 before, then converting cocos equal to 4% of the book value of total assets to equity which can be sold immediately would preserve and cash out their value, in effect shortening their maturity. Indeed, according to the results in Tables 2 and 3, an investment in 50-year nocos with cocos would require an annual yield to cover expected bankruptcy costs that is only 2 basis points

lower than on an investment in 50-year cocos: 7.77% compared with 7.79%, all relative to the bankruptcy-free rate of 7.75%. The difference is due to investors, in the quite unlikely event that they went through a succession of conversion into equity followed later by bankruptcy which made that equity worthless, losing 100% on cocos. They would have only a partial, i.e., 50%, loss from bankruptcy had they invested in nocos with cocos for the same horizon instead.

At the other extreme, where equity would have been worthless in the absence of cocos as in case (2) of Table 1, the holders of equity from the conversion of cocos would be exposed to higher losses from bankruptcy. Investors in cocos would receive interest until their debt is converted, but since the interest is taken to be capitalized, i.e., added to the face value of cocos, it too would be lost in any eventual bankruptcy. Furthermore the results in Figure 2 suggest that bankruptcy could now first occur in 4 rather than 10 years after conversion, because conversion would raise LEV only from 0 to 0.04, not from 0.03 to 0.07. Obviously the cocos program may well fail if it is managed so badly that conversion and bankruptcy could almost coincide. A well-capitalized, let alone a very-well-capitalized, position can not be restored by the firm in a death-bed conversion of cocos that comes too late. While one cannot rule out such futility, there is no analytical interest in pursuing it: It would mean viewing cocos as little better than equity without cocos in their exposure to bankruptcy costs. The high cost of such equity unaccompanied by cocos is reflected in the large excess of the required yield, IR, over 7.75% in Table 3. That excess amounts to 1.16 (8.91-7.75) percentage point on the longest program maturity.

6. Are cocos worth adding to the financing mix?

According to JPM's yearend 2009 balance sheet compressed in Table A1 of Appendix 1, the amount of its long-term debt was equal to 11% of total assets, and a little more, 12%, appears to

Table 3. Yield (IR) Differences on Equity Due to Expected Bankruptcy Costs without or with Cocos for an Initially *Very Well* Capitalized Firm

	10-Year Horizon		**20-Year Horizon**		**30-Year Horizon**	
Cocos:	**without**	**with**	**without**	**with**	**without**	**with**
Present Value of Bankruptcy Costs per 100	0.0977	0	4.3717	0.0001	14.9132	0.0366
Remaining Asset Value	99.9023	100	95.6283	999.9999	85.0868	99.9634
IR	7.7605%	7.75%	7.9911%	7.75%	8.3316%	7.7513%
Difference	0.0105%		0.2411%		0.5803%	

	40-Year Horizon		**50-Year Horizon**	
Cocos:	**without**	**with**	**without**	**with**
Present Value of Bankruptcy Costs per 100	28.2316	0.4237	41.4702	1.8014
Remaining Asset Value	71.7684	99.5763	58.5298	98.1986
IR	8.6473%	7.7614%	8.9105%	7.7892%
Difference	0.8859%		1.1213%	

Note: Expected bankruptcy costs on cocos, and their effect on the required yield above the bankruptcy-free rate of 7.75%, are the same on cocos as on equity with cocos because cocos are converted to equity before there is a possibility of bankruptcy in the model.

be a good assumption.[21] Adding cocos equal to 4% and the initial common equity equal to 7% of total assets to the financing mix raises the combined long-term debt and equity total to 23% of assets. The normalized exponential weights applied to the 2 or 3 components of the cost of capital are given below. These weights are subsequently applied to the gross rate of return on each instrument before multiplying the resulting factors to estimate the effect of cocos on the overall cost of capital. This leads to contrasting two financing programs whose length ranges from N = 10 to N = 50 years. One is for nocos (12/19) and equity (7/19) without cocos and the other for cocos (4/23) together with nocos (12/23) and equity (7/23). Should the automatic deleveraging implied in cocos conversion be triggered, the second financing program would reduce to the first program of nocos and equity without cocos.

6.1 Results for the base case and an application

Considering only the gross yield (1+IR) on long-term debt and equity to be affected by cocos, the financing program with cocos will be more efficient than the one without cocos for the chosen value of N if it costs less. The solutions of each of the parts of inequality (4) below (after subtracting 1 from each result and reconverting IR from a fraction to a percentage) are shown in bold type on the top line of the first 2 of 3 panels in Tables 4.

$$(1+\text{IR nocos w/o cocos})^{12/19}(1+\text{IR equity w/o cocos})^{7/19} > (1+\text{IR cocos})^{4/23}(1+\text{IR nocos w. cocos})^{12/23}(\text{equity w. cocos})^{7/23} \quad (4)$$

[21] Flannery ((2009), p. 8) reports that, about one year earlier, unsecured long-term debt, including subordinated debt, averaged 12.2% of the risk-weighted assets of a representative group of U.S. bank holding companies.

Table 4 summarizes the base-case results for the required yield, IR, from Tables 2 and 3 for a financial firm's long-term financing, consisting of nocos and equity plus, in the second of two financing programs, cocos. The *rate spread* or difference in the third panel of Table 4 shows that the excess cost of long-term debt and equity in the program without cocos over that with nocos rises from near zero at the 10-year horizon, to 39 basis points at the 30-year and to 72 bps at the 50-year horizon. Looking at the individual financing components of the cost of capital contributing to this result, the difference in the cost of equity without vs. with cocos is always about twice as high as the difference cocos make for the required yield on nocos. For equity the spread rises to over 1 percentage point at N=50. Like in all the other cost comparisons here, it indicates only the expected savings in bankruptcy costs that would accrue to stockholders from adding cocos to the financing mix. Bankruptcy or regulatory insolvency that is accompanied by a loss of value equal to 9% of total balance-sheet assets causes a 100% loss on equity when down to 3% of assets and a 50% loss on nocos which are equal to 12 % of assets as previously laid out.

Being exposed to the total loss of the equity received from cocos conversion in the event of a subsequent bankruptcy, expected bankruptcy costs are the same for cocos as for the original or "existing" shareholders when cocos are present in the financing mix. In both cases, the probability calculations and the 100% loss rate should bankruptcy occur are precisely the same. For nocos without cocos, receivership, rather than conversion of cocos to common equity that returns the firm to being very well capitalized, is the consequence of common equity first falling to a value (just below) 3% of total assets. Receivership of a financial firm is here taken to be final so that there is no possibility of emerging from bankruptcy or playing for redemption. To remind, cocos are available for conversion only once and conversion must precede any possible bankruptcy by at least 10 years in the base case.

Table 4: Cost-of-capital comparisons based on equity and long-term debt subject to bankruptcy risk, without and with cocos, for an initially *very well* capitalized firm

	10-year	**20-year**	**30-year**	**40-year**	**50-year**	**Weights**
Without cocos	**7.7572%**	**7.914%**	**8.1402%**	**8.3397%**	**8.4941%**	1
--nocos	7.7553%	7.8691%	8.0287%	8.1607%	8.2519%	0.6316
--equity	7.7605%	7.9911%	8.3316%	8.6473%	8.9105%	0.3684
With cocos	**7.75%**	**7.75%**	**7.751%**	**7.7584%**	**7.7789%**	1
--nocos	7.75%	7.75%	7.7507%	7.7557%	7.7695%	0.5217
--cocos	7.75%	7.75%	7.7513%	7.7614%	7.7892%	0.1739
--equity	7.75%	7.75%	7.7513%	7.7614%	7.7892%	0.3044
Rate Spread	**0.0072%**	**0.164%**	**0.3892%**	**0.5813%**	**0.7152%**	without
-- for nocos	0.0053%	0.1191%	0.278%	0.405%	0.4824%	vs. with
--for equity	0.0105%	0.2411%	0.5803%	0.8859%	1.1213%	cocos

Note: The cost of capital for long-term debt and equity financing combined is derived from an exponentially weighted average of the gross rates of return where the weights sum to one. The nocos without cocos financing programs over 10 to 50 years consist of noncos with weight 12/19 and common equity of 7/19 for the very well capitalized firm, where 19 is the sum of long-term debt and equity in percent of total assets. The corresponding programs with cocos involve an initial weight of 12/23 for nocos, 4/23 for cocos, and 7/23 for common equity. However, all cocos outstanding have to have been converted to common equity before there is any possibility of decapitalization proceeding to the point of triggering bankruptcy. Immediately after any such conversion, the weight on nocos would again be 12/19 and the weight on equity 7/19. Cocos conversion thus provides for automatic deleveraging when capital ratios have declined to the trigger point. Expected bankruptcy costs alone are reflected in any excess over 7.75% in the estimates of required rates of return. Regulatory insolvency occurs when the value of the common equity outstanding has fallen to (just below) 3% of total assets. When that trigger point has been reached, the entire value of equity and half the value of nocos is lost, for a total loss equal to 9 percent of assets. Differences in the cost of long-term debt and equity capital without, versus with, cocos thus indicate how much in expected bankruptcy costs could be saved by adding cocos equal to 4% of total assets to the financing mix.

Having found that the rate spread that covers bankruptcy costs expected without vs. with cocos is about 100 times as large at the 50-year than at the 10-year horizon has implications for the optimal length of financing with cocos. If LBG when very well capitalized had issued enough cocos to restore it, when in distress, to again being very well capitalized, the base case would apply. From that perspective it would appear that the cocos or "enhanced capital notes" issued by LBG with fixed maturities of 10 to 15 years would be unlikely to perform any useful function. Given the strength of the pair of impact factors 1.1 and 1/1.1 chosen for the binomial expansion that determines how quickly decapitalization from a very well capitalized level may occur, cocos would not bring any appreciable reduction in expected bankruptcy costs. The reason is that hardly any such costs would be anticipated even without them over such a short horizon.

Considering cocos by themselves, before cocos could be involved in any bankruptcy, capital would first have to be running down rather quickly so as to trigger conversion before the cocos are paid off at maturity. Then capital would have to run down again to trigger bankruptcy, so that two independent low-probability or "tail" events would have to happen in succession. This is highly improbable in the base case: Table 4 shows that even for a 20-year program, cocos would be essentially free of bankruptcy risk. Nor could a yield that was 1.5 - 2.5 percentage point higher on cocos than on the nocos for which they were exchanged by LBG possibly be justified on financial grounds unless LBG was far from very well capitalized when the cocos were issued. The nocos in the exchange offer which eventually became senior to cocos consisted of subordinated debt and hybrid securities that were issued long before cocos appeared on the planning horizon of any of the firms involved so that their initial yield reflected that required on nocos without cocos. Such a discrepancy between base-case results and empirical observation

motivates specification changes that have the financial firm start out not *very* well but only well capitalized with an initial cocos buffer that is only half as large as in the base case.

6.2 Sensitivity tests

To test sensitivity in these regards, the base case is supplemented first by cutting the cocos issue from 4% to 2% of total assets. In addition, the initial level of capitalization is LEV_0 =0.05 for a *well* capitalized firm, instead of LEV_0=0.07 for the *very well* capitalized firm of the base case. In both the base case and the present Case A, as well as in Case B described later, dipping below LEV of 0.03 triggers conversion if cocos are available and bankruptcy otherwise. In all cases, cocos conversion will be sufficient to restore the firm's LEV to its respective initial value. But because the LEV ratio starts out lower in cases A and B, the firm reaches the trigger point sooner, i.e., in less than N=10 years, unless some countervailing change is made. Lowering the strength of the disturbance factor from 1.10 to 1.06 up or down at each step would be such a change. Making these two changes jointly would keep N at the critical value of N=10 at which bankruptcy first becomes possible in the absence of cocos, thereby replicating the results of Table 4. However, cutting the initial LEV value from 0.07 to 0.05 without at the same time weakening the disturbance factor causes the firm to face the possibility of bankruptcy already at N=6 years from its now merely *well* capitalized start. Details are given in Panel (A) of Table 5.

Without cocos in the financing mix, the increase in the combined cost of long-term debt and equity capital over the 7.75% baseline is much more dramatic in Case A than in the base case. The cost of capital (in bold type) is elevated appreciably already at the 10-year horizon to 8.39%. The increase is to 9.62% at the 50-year horizon without cocos. Comparing the cost of capital without cocos against those in a financing program with cocos shows a maximum rate

Table 5. Cost-of-Capital Comparison based on Equity and Long-Term Debt subject to Bankruptcy Risk, without and with Cocos, for an Initially Well Capitalized Firm Calculated over Horizons from 10 to 50 Years

Panel (A)	**10-year**	**20-year**	**30-year**	**40-year**	**50-year**	**Weight**
Without cocos	**8.3882%**	**9.1707%**	**9.4992%**	**9.6098%**	**9.6228%**	1
--nocos	8.2376%	8.7895%	8.9575%	8.9524%	8.8803%	0.7059
--equity	8.7506%	10.0912%	10.8103%	11.2038%	11.4254%	0.2941
With cocos	**7.75%**	**7.8018%**	**7.9703%**	**8.1808%**	**8.3745%**	1
--nocos	7.75%	7.7878%	7.909%	8.0542%	8.1774%	0.6316
--cocos	7.75%	7.8259%	8.0756%	8.3981%	8.7133%	0.1053
--equity	7.75%	7.8259%	8.0756%	8.3981%	8.7133%	0.2631
Rate Spread	**0.6382%**	**1.3689%**	**1.5289%**	**1.429%**	**1.2482%**	without
-- for nocos	0.4876%	1.0017%	1.0485%	0.8982%	0.7029%	vs. with
--for equity	1.0006%	2.2653%	2.7347%	2.8057%	2.7121%	cocos
Panel (B)						
Without cocos	**7.9279%**	**8.5373%**	**8.928%**	**9.1311%**	**9.2246%**	1
--nocos	7.887%	8.3413%	8.599%	8.6965%	8.7056%	0.7059
--equity	8.026%	9.0093%	9.7217%	10.1814%	10.4805%	0.2941
With cocos	**7.75%**	**7.7592%**	**7.8231%**	**7.9415%**	**8.0804%**	1
--nocos	7.75%	7.7567%	7.8032%	7.8879%	7.9837%	0.6316
--cocos	7.75%	7.7634%	7.8573%	8.0335%	8.2465%	0.1053
--equity	7.75%	7.7634%	7.8573%	8.0335%	8.2465%	0.2631
Rate Spread	**0.1779%**	**0.7782%**	**1.1049%**	**1.1896%**	**1.1442%**	without
-- for nocos	0.137%	0.5846%	0.7958%	0.8086%	0.7219%	vs. with
--for equity	0.276%	1.2459%	1.8644%	2.1479%	2.234%	cocos

Note: The initial leverage ratio for the *well* capitalized firm is 0.05, compared with 0.07 for the *very well* capitalized firm in the previous table. As before, either conversion, or lacking cocos, bankruptcy, is triggered as soon as LEV dips below 0.03. This can happen as early as N=6 in Panel (A) and N=7 in Panel (B) compared with N=10 in the base case. Hence conversion of a cocos shield of 2% of total asset, rather than 4% as in the base case, restores the firm's leverage ratio to its initial level. The weights for noncos and equity without cocos are now 12/17 and 5/17, respectively, while for nococ, cocos, and equity they are 12/19, 2/19/ and 5/19. For the results in Panel (B) above, both MRC and AAC are 10 times their base values, i.e., 0.01 rather than 0.001, and 1 rather than 0.1. Bankruptcy costs on cocos are the same as those on equity with cocos.

spread of 1.53 percentage point at the 30-year horizon. For comparison, the maximum spread in the base case was 0.72 percentage point at the 50-year horizon. This finding indicates that the lower the level of tier-1 capital, T1C, in relation to total assets, A, to start with, the greater the risk of encountering bankruptcy sooner and the greater the benefit from having cocos in the financing mix. This in a spite of the fact that the strength of the cocos shield in percent of assets is only half as large in Case A as in the base case and the yield required on cocos is now almost 1 percentage point above what it was in the base case, or 8.71% rather than 7.79% at N=50.

Moving from Case A to Case B, the two economic and financial response parameters, MRC and AAC, are both increased by a factor of 10. Hence the mean reversion coefficient, MRC, rises from 0.001 to 0.01 in equation (1) where the lead factor 7 (in relation to assets of 100) was lowered to 5 already for Case A. At the same time the Asset Adjustment Coefficient, AAC, of 0.1 in the exponent in equation (2) is raised to 1 and asset growth now reacts to deviations of LEV from 0.05 rather than 0.07, as already in Case A. With only MRC and AAC changing from Case A to B, the binomial diffusion map now is tugged inward more strongly toward the center line of LEV = 0.05 than in Case A. Hence the first possible trigger point cannot be reached quite as soon as in that case: It now takes a critical value of N=7 rather than N=6 years for the possibility of bankruptcy to arise for the initially *well* capitalized firm. Bankruptcy risk that first arises later must also have lower probability by the rules of binomial expansion.

Conversely, every possibility of bankruptcy that arises every other year thereafter must also have higher probability the lower the critical first-trigger value of N to start with. For instance, the cumulative conditional probability of bankruptcy of 0.8131 at N=50 in Case A -- with just over four-fifth of financial institutions not surviving for more than half a century -- is appreciably greater than 0.7139 at N=49 (persisting through N=50) in Case B. On the other hand,

both values are much higher than in the base case where the cumulative conditional probability of bankruptcy at N=50 is 0.4147, suggesting a half-life of the financial firm of well over 50 years from the date it was *very well* capitalized. Not surprisingly, the results in Panel (B) of Table 5 lie between those in Panel (A) and in the base case portrayed in Table 4. Maximum savings in the cost of (long-term) capital from having cocos in the financing mix now occur at a 40-year time horizon, compared with 30 years in Case A, and 50 years in the base case. At 1.19 percentage point off the required rate of return without cocos, they are still considerable.

At the 30- to 50-year horizons just identified for each of the three cases, cocos contain a rate premium over 7.75%, to cover expected bankruptcy costs, that is at most 1/3 of one percent. It is 4 basis points at N=50 in the base case, 33 bps at N=30 in Case A, and 28 bps at N=40 in Case B. In the last two Cases, the rate premium for the longest maturity (N=50) would be 2 to 3 times higher: 96 bps in Case A and 50 bps in case B. If financial firms could sell cocos with such low premiums to cover the expected costs of bankruptcy remaining after cocos conversion, cocos would be highly cost-effective hedges for their shareholders and holders of long-term debt. The reason is that, with cocos, two low probability adverse tail events would have to occur successively in no more than 50 years, while the occurrence of just a single such event would precipitate bankruptcy without cocos.

To take the middle instance, Case B, as an example, paying a premium of 28 basis points on 40-year cocos equal to 2% of total assets, reduces the premium on nocos, equal to 12% of assets, by 81 bps and that on equity, equal to 5% of assets, by 215 bps. These results, reported under *Rate Spread* in Panel (B) of Table 5, are of course model-specific and relate only to the savings in bankruptcy costs. They do not account for risk aversion, illiquidity risk, term premiums, market-acceptance risk or other factors that determine required yields and may affect

yield comparisons. But it is bankruptcy-risk generating conditions, insolvencies, and the resulting disruptions of the financial intermediation and investment systems, in addition to resolution costs assumed by the government, that concern regulators and taxpayers the most.

7 Summary of main results, and conclusions

If "[a]n edifice of debt contracted to finance risky ventures is inherently unstable" (Kindleberger and Aliber ((2005), p. 63), choosing a cocos buffer may help financial firms reduce this vulnerability and provide greater counter-cyclical resilience. To be of much help, financial firms should issue cocos equal to 2-4% of total assets in good times with a maturity of no less than 30 years. A rule of thumb for the desired size of the issue could be to let it cover the difference between the firm's comfort level of the relevant regulatory capital ratio, which could be close to its current actual level, and the regulatory minimum of that capital ratio. Conversion of all cocos outstanding at one time could then restore the firm's comfort level of capitalization if the trigger is set close to, but perhaps up to 1/2 percentage point above, the minimum capital ratio as in this study. Cocos then could come to play a major role in increasing financial stability and reducing government safety-net subsidies and taxpayer exposures to otherwise failing banks.

Due solely to a reduction in the estimated frequency and costs of bankruptcy, in the 30-50 year program range, the exponentially weighted net-of-depreciation cost of long-term capital (the cost of equity alone) falls through the inclusion of cocos by:

- 0.39-0.72 (0.58-1.12) percentage point in the base case of LEV_0 =0.07,
- 1.25-1.53 (2.71-2.81) percentage point in Case A of LEV_0 =0.05,
- 1.10-1.19 (1.86-2.23) percentage point in Case B of LEV_0 =0.05 and with MRC=0.01 and AAC=1 both 10-times higher than in the base case and Case A.

For cocos alone in the 30-50 year range the excess over the risk free reference rate of 7.75% is at most 4 basis points in the base case, 33-96 bps in Case A, and 11-50 bps in Case B. Investors in cocos even in initially only well, rather than very well, capitalized firms thus face low bankruptcy risk exposure. This is a risk which by their investment in cocos they themselves have reduced. At the same time, they drastically lower the expected costs of bankruptcy for investors in long-term non-contingent debt, nocos, and in equity. Therefore holders of nocos and existing equity would have reason to strongly welcome the addition of cocos to the financing mix under the conditions modeled in this paper.

Unfamiliarity and illiquidity of the new instrument and the limitation of trading to Qualifying Financial Institutions (QFIs)[22] may well delay wide issuance for years unless some large institutions, like LBG in the United Kingdom, lead the way. However, the expected private savings in bankruptcy costs in the absence of government bailouts that may be expected from the introduction of cocos (at unchanged exposure to binomial diffusion in the gross rate of return) are impressive. They are likely to be more than sufficient to cover the instrument design and introduction costs if the vow of "no more bailouts" can be made credible. If financial firms become responsible for paying for their own insurance against regulatory insolvency, they may find that cocos are highly cost-effective in providing a substantial amount of that insurance coverage. Having cocos in the financing mix could eventually be given credit toward the conservation buffer equal to 2.5% of risk-weighted assets proposed under Basel III[23] although rebuilding the cocos shield, once used, might prove slow and difficult.

[22] The membership of QFIs is never self-explanatory and its application must be specified from case to case. For instance, top-tier Bank Holding Companies belong to the set of QFIs in many contexts but they should not be qualified to invest in cocos here though some holdings must be permitted by their trading departments.

[23] The Basel Committee (on Banking Supervision) and the Financial Stability Board (FSB (2010)) are considering combinations of capital surcharges, contingent capital, and bail-in debt, but so far only for financial institutions that are systemically important individually. This assessment of steps to achieve higher loss absorbency for SIFIs was scheduled to be completed by mid-2011.

If the advantages of cocos deduced in this study turn out to be robust under a greater variety of parameters, reaction functions, and conditions than here considered, cocos mandates will prove unnecessary for getting cocos issued. A number of different bankruptcy-risk generating or abating statistical and economic processes, among them "jump" processes that can cause rapid meltdowns, may have to be included in extended sensitivity testing.

Although data reported by JPM have provided some guidance for calibrations used in this study, detailed event studies based on the experience of major financial firms during the last financial crisis could provide a useful contrast to the crisis-generation process adopted in the model. Such studies may also provide a better fix on response parameters, such as the asset adjustment coefficient, AAC, of the financial firm when caught up in a general financial crisis. Rating agencies have had difficulties rating cocos, but they should have no difficulty giving credit for the extra safety margin provided by a substantial cushion of cocos when rating nocos. Finally, there remains room for official and industry-organization encouragement and technical support to reduce the costs of pioneering the new and largely untested instrument. Bringing cocos to the market not only in London but also in New York and other major financial centers remains a major challenge. In this area, an ounce of prevention really is worth a pound of cure.

Appendices

Appendix 1. Three Tables

Table A1. Adjusted Yearend 2009 Balance Sheet, J P Morgan Chase & Co
Billions of US dollars and in percent of total assets minus goodwill

	Assets		
(1)	Cash Assets: Cash and due from banks, deposits with banks, Federal Funds sold and securities borrowed or purchased under repo agreements	404.5	20.39%
(2)	Trading assets	411.1	20.73%
(3)	Securities	360.4	18.17%
(4)	Loans net of allowance for loan loss	601.9	30.34%
(5)	Accounts receivable and other assets	194.7	9.81%
(6)	Premises and equipment	11.1	0.56%
(7)	**Total assets excluding goodwill**	**1, 983.7**	**100.00%**
	Liabilities		
(1)	Deposits and Federal Funds	1,199.8	60.48%
(2)	Commercial Paper and other borrowed funds	97.5	4.92%
(3)	Trading liabilities	125.1	6.31%
(4)	Accounts payable and other liabilities adjusted for those included in (-) and excluded from (+) total qualified capital	166.4	8.39%
(5)	Long-term debt adjusted for components included in total qualified capital	217.8	10.98%
(6)	Total qualified capital: Tier 1	133.0	6.70%
	Tier 2	44.1	2.22%
(7)	**Total liabilities and qualified capital**	**1,983.7**	**100.00%**

Source: Based on J P Morgan Chase & Co Form 10-K, *Annual Report for Period ending 12/31/09*, pp.76, 83, with adjustments to show Tier 1 and Tier 2 capital.
Memo: Net income was $11.7 billion, or equal to 0.59% of total assets, in 2009.

Table A2. Actual and Regulatory Capital Ratios and their Uses in the Model

Capital Ratios:	Actual 12/31/2009	Very Well Capitalized	Well Capitalized[a]	Minimum Capital[a]
Tier 1 capital[b]	11.1%	8%	6%	4%
Total[c] capital[b]	14.8%	12%	10%	8%
Tier 1 leverage[d]	6.9%	7%	5%[e]	3%[f]

Source: J P Morgan Chase & Co., *Annual Report for Period Ending 12/31/09*, p. 229 except for "very well capitalized" ratios which were added here.

Uses of these ratios and related assumptions: The 7% Tier 1 leverage ratio, almost achieved by the company at the end of 2009, is used as a starting base of the binomial diffusion process that could eventually activate contingencies in the debt contract under prolonged adversity. It is assumed that two-thirds of all dividends (including all common-stock dividends and half of preferred-stock dividends which are non-cumulative) or more will no longer be paid or owed and common stock issuance will cease and remain suspended when the leverage ratio has fallen to 4% or less. This assumption assures that the net effect of the firm's defensive measures, the simultaneous partial or total elimination of dividends and of new common-stock issue, on the growth of Tier 1 capital nets out to zero. Finally, all contingent-capital debt outstanding will be converted to common equity at the end of the first year in which the leverage ratio otherwise falls to less than 3%. This conversion is to prevent the minimum capital maintenance requirement to be violated in that year. The contingent-capital debt percentage will be rebuilt, all at once, to 2% of assets in the year in which the leverage ratio recovers to 5% or more. The interest rate required on contingent-capital debt issued when the leverage ratio is 5% will, of course, be higher than when it is 7%, but not prohibitive.

[a] As defined by the regulations issued by the Federal Reserve, OCC and FDIC. However, there is no Tier 1 leverage component in the definition of a well-capitalized bank holding company.
[b] The denominator is yearend risk-weighted capital of $1,198 billion calculated in accordance with U.S. federal regulatory capital standards.
[c] The numerator is the sum of yearend Tier 1 and Tier 2 capital of $133.0 and $44.1 billion, respectively, for a total of $177.1 billion.
[d] The denominator is adjusted average assets of $1,934 which is close to yearend 2009 total assets excluding goodwill of $1,984. The actual leverage ratio calculated with the yearend data would be 6.7% as previously shown in the "Adjusted Yearend 2009 Balance Sheet" table.
[e] Represents requirements for banking subsidiaries pursuant to regulations issued under the FDIC Improvement Act. There is no Tier 1 leverage component in the definition of a well-capitalized bank holding company.
[f] The minimum Tier 1 leverage ratio for bank holding companies and banks is 3% or 4%, depending on factors specified in regulations issued by the Federal Reserve and OCC.

Table A3. Earnings and Growth Parameters for a Sustainable Equilibrium of the Financial Firm

(1) Assumed annual rate of return on total assets excluding goodwill: 0.6%

Implications: The implied return on qualified capital of $177.1, from the previous table, is 6.7% (11.9/177.1) nominal and 6.0% real given the 0.68% increase in the chained price index for GDP from Q4 2008-2009.
Reasons for choice of rate of return on assets: Internal consistency and guidance from the memo entry in Table A1.

(2) Common (weight 1/3) and Preferred (2/3) dividend pay-out rate of net income: 30%

Implications: This leaves retained net income applicable to common stockholders of $8.3 billion which is 6.2% of tier 1 capital of $133 billion. In addition common stockholders receive dividends of $1.2 billion, for a total expected return on tier 1 capital of 7.1% nominal and 6.4% real.
Reasons for choice of pay-out rate: This pay-out ratio is close to J P MorganChase's 2007 ratio of 34% at the beginning of the financial crisis.

(3) Annual rate of growth of real GDP over the next 10 years: 3.35%
Annual rate of GDP price index inflation over the next 10 years: 1.72%
Annual interest rate on 91-day Treasury bills over next 10 years: 3.73%

Implications: The real (GDP-based) interest rate is forecast as 1.98% per annum. The nominal return that would then produce a real return of 6.4% on tier 1 capital as in (2) above, is 8.2%.
Source: Calculated from annual forecasts for 2010:Q4 to 2020:Q4 provided in CEA ((2010), p. 75).

(4) The equity premium over rolling future contemporaneous 3-month T-bills: 5%

Implications: The expected nominal return on Tier 1 capital then is 8.73%, because the equity figure was to be estimated "casually" as the equity return minus the risk free rate in the survey of finance professors referenced below. The average nominal stock return of 8.2% in (3) above is compatible with a somewhat lower prospective equity premium of 4.3%, well within the Q1 to Q3 range of survey results of 4%-6% in Welch (2009). See also the surveys on the expected equity premium presented and compared in Fernandez and del Campo ((2010), pp. 7-9).

(5) Expected annual rate of financial deepening: 2.9%

Implications: Reflecting expected financial deepening (2.9% per annum), Real growth (3.35%), and inflation (1.72%), balance-sheet expansion of the representative financial institution over the next 10 years will proceed at an annual nominal rate of 8.2% and a real rate of 6.4%. Because it was deduced in (2) that retained earnings will produce growth of 6.2% in tier 1 capital, net stock issuance increasing the number of shares outstanding by almost 2% (1.88%) per annum is necessary to achieve 8.2% growth in tier 1 capital.
Reasons for choice of the rate of deepening: The average annual rate of growth of the total financial assets of Commercial Banking, including U.S. bank holding companies was 8.60% for 1997-2007 while nominal GDP grew by 5.38%, implying financial deepening of 3.06%, slightly above the 2.9% annual rate assumed for 2011-2020.
Source: Federal Reserve Statistical Release Z.1, *Flow of Funds Accounts of the United States*, March 11, 2010 (for 2007 data), p. 71 and March 10, 2000 (for 1997 data), p. 69.

(6) Interest Rate on Corporate Debt Rated Baa by Moody's: 7.75%

About equal to 3.73% rate on 91-day T-bills projected above plus 4%. The latter is the exact average of the difference between Baa and T-bill rates for 1990-2009.

Appendix 2. History and Varieties of Contingent Capital Activated in Distress

Outside creditors and debt holders have always been reluctant to finance a business venture without the security of owners putting up a substantial amount of equity capital. Before publicly-traded shares were introduced, owners tended to have "unlimited" liability so that they would have to keep debt holders whole in adversities with whatever assets they possessed. Partnership shares originally would often be assessable for the same purpose. Thus not only actual capital paid in, but also "contingent" capital could be called upon to hold harmless debt holders and to stave off bankruptcy and the deadweight loss of going-concern value which it might entail.

While such arrangements lasted for millennia, they largely restricted access to financing of enterprises to those who had substantial wealth that could serve as implicit collateral for the otherwise unsecured loans they received or debt they issued. The introduction of limited liability in the mid-19th century first in the UK and then in most of Europe and North America was a socially beneficial innovation that greatly aided entry into business by eliminating the recourse of debt holders to the personal wealth of stockholders and "limited" partners and proprietors. This change, together with the growing separation of (professional) management from ownership of businesses, brought two interconnected problems to the fore that concerned debt holders: (1) A principal/agent problem that gave rise to doubts that management would put the interests of the principals (stockholders, and by extension debt holders) first when they clashed with management's own financial interests, and (2) a moral hazard problem that tempted management to go for short-term rewards and take excessive risks because it stood to participate in any gains to a much greater extent than in any losses either because of asymmetries in the structure of executive compensation or because of the government's safety net.

2.1 The Return of "Contingent" Capital as Part of the Current Reform Agenda

Some of the oldest mechanisms of "contingent" capital provision still find occasional use. For instance, the U.S. Treasury issued an "unlimited" guarantee in the latest financial crisis not to let the capital of certain loss-making government-sponsored enterprises, Fannie Mae and Freddie Mac, fall below regulatory minima that would trigger bankruptcy. Relating or indexing the principal of debt to the world-market price of natural resources, such as silver, is another traditional way to build contingencies into the debt contract that would kick in to help a resource company in adverse circumstances. It too has contemporary, if imprecise and ex post, analogues from the financial crisis. For instance the 2009-2010 government-sponsored home foreclosure mitigation programs endeavored to get at the problem of insufficient capital or negative owner's equity more or less by formula by forgiving some part of the mortgage debt, but with a catch. In the U.S. Department of the Treasury's ((2010), p. 5) Home Affordable Modification Program, debt forgiveness on homes in which the owners have negative equities can be coupled with a partially compensating equity sharing arrangement by which the lender can be entitled to up to 50% of any increase in property value, after credit for capital improvements, between the date of the permanent mortgage-loan modification and the date the loan is fully satisfied.

Such government-orchestrated ad hoc and uncertain mortgage modifications are not, of course, comparable to cocos with their preset, legally certain, automatically triggered, observable and transparent conversion terms. Yet they attempt to accomplish some of the objectives of cocos by

converting a slice of debt into equity, in a home rather than a company, when foreclosure threatens. Like the bankruptcies of a few major, or many smaller, financial firms, high rates of foreclosures have negative externalities of their own. These affect not only the areas surrounding where they are bunched, but also the economy at large by placing stress on the interconnected financial system and the balance sheets of financial institutions.

As another example, cumulative preferred stock is often treated as closer to subordinated debt than to common equity which would neither pay nor owe dividends in a crisis. In a series of steps, such preferred equity has been converted into common equity under the TARP program for distressed companies like Citigroup. The result has been to raise its common stock outstanding from 5.5 billion shares at the end of the second quarter of 2009 to 28.5 billion at that year's end, with 7.7 billion of these shares held by the U.S. Treasury.[24] These transactions lowered Citi's subordinated-debt-like liabilities and created some transfer of value to holders of other (i.e., non-contingent) debt and to stockholders in the process. At the same time they greatly diluted common equity and provided no new funds even though "tier 1" capital (essentially the regulatory accounting value of common equity) was raised. Several of the modifications involved in this supplementation of tier 1 capital were improvised as the crisis mounted. They did not provide for the orderly deployment of "contingent" capital that is conditional on the occurrence of pre-specified events whose probabilities can be gauged in advance.

2.2 Varieties of Instruments Other than Cocos Providing Common Equity in Distress

It is useful to go beyond cocos in identifying features, comparable to those of contingent capital, that would allow common equity to be issued in bad times for the firm under prior arrangements that would minimize the dilution of its stock. What the 5 instruments featured in Table A4 have in common is that they may provide an alternative to the direct issuance of common shares through a public offering when such an offering may fail or be excessively dilutive. The four instruments in addition to the cocos already described are rights issues, capital calls, and mandatory and reverse convertible securities.

Rights Issues

Rights issues need not be dilutive as they preserve the ownership shares of existing stockholders of record. Since the intention of the issuer is that these rights be exercised to increase core capital, there will be pressure to underprice them. This is done to protect their exercise against all but extreme shocks that could render the call option, which these rights represent, worthless before they expire, usually after a few weeks from the time of issue.

The principal features of rights offerings by distressed companies may be inferred from a recent issue by the Bank of Ireland Group. BKIR raised additional capital of €1.73 billion through the issuance of rights to its qualifying stockholders to acquire 3 units of new ordinary (i.e., common) shares per every 2 units of ordinary shares that they held on May 17, 2010, the "record" date. The exercise price of €0.55 represented a discount of 41.7% from the theoretical ex-rights price of €0.9436. That price was calculated from €1.534 -- which was the closing quotation on May 14, 2010, the last business day before the announcement of the rights issue -- by adjusting it for

[24] See Citi, Annual Report 2009, p.9 (conveniently available from www.citigroup.com). The Treasury sold its holdings in 2010 at an accounting "profit", i.e., a nominal capital gain not counting interest, risk taking, and Treasury's administrative costs.

Table A4. Means of Augmenting Tier-1 Capital in Distress without Primary-Market Issuance of Common Shares

	Interest Rate (IR)	Maturity or Expiration	Trigger for Conversion or Exercise	Option Equivalent in Exercise or Conversion	Frequent Purpose
Column:	**1**	**2**	**3**	**4**	**5**
(1) Rights Issue in Lieu of Traditional Stock Issue	N.A.	Short-term	Market price > exercize price at maturity	Call Option	Shield existing shareholders from dilution
(2) Partly Paid-Up Share Capital: Call the Balance	N.A.	Balance due when triggered	Insolvency or threat of bankruptcy	None	Raise liquid assets for pay-out to creditors
(3) Issue Reverse Convertible Securities	Higher than for comparable straight debt	Short-term notes with rollover	Share Price ≤ specified fraction of its reference price	Company put option of shares for its notes	Debt relief and new equity issue in adversity
(4) Mandatory Convertible Bonds, MCBs	Above rate on plain convertible bonds	Generally 5 years or less	Prespecified conversion date and No. of shares	None: mandatory exchangeables	Issue new equity for debt by date certain
(5) Contingent Convertible Bonds, CoCos	Higher than for comparable straight debt	Varies, could be perpetual	Violating regulatory capital maintenance requirement	Company put option of shares for its bonds	Raise new equity required to stave off bankruptcy

Notes: When triggered, both (1) and (2) are sources of capital and equity as new funds are provided. Under equity-related debts (3), (4) and (5), the book value of equity is raised by that of the debt converted to common shares when conditions have deteriorated. Under (4), the number of shares per bond sometimes may be adjusted to provide a guaranteed minimum redemption value; under (3) and (5), the number of shares in the conversion tends to be prespecified and fixed in total (3) or as a share of all common stock outstanding at maturity (5).

the 150% increase in the number of shares outstanding and also allowing for the cash raised. The right to new common stock lapsed at 11a.m. on June 8, 2010, and the new units started trading fully paid on June 14, 2010. They closed at €0.8 on that date and then touched a low of €0.6 at the start of July, barely above the exercise price, before recovering to €0.8 by the end of that month. One interesting feature of this offering was that lapsed rights would not simply be left to expire but could be sold to others, with any premium obtained over the issue price and the expenses of sale paid to the qualifying stockholders who had not exercised their rights. In this way BKIR could ensure that the rights would be fully exercised.

Capital Calls

A capital call may be issued under stress because the liability of partners and stockholders, while limited, extends to the full original subscription price of their common or partnership shares. A call may ensue upon reaching unfavorable conditions requiring that (i) these shares have to be fully paid up or (ii) new shares have to be accepted in full payment for subordinated debt or preferred shares outstanding. Under (i), the unpaid balance will and must be called when needed to protect the interests of debt holders, usually in a bankruptcy proceeding. While such a capital call is activated by bankruptcy and comes too late to prevent it, the ever present threat of it being issued can help encourage less risky behavior, making bankruptcy less likely. Under (ii) the intention is to strengthen core capital and to provide debt relief to avoid receivership.

Particularly in the 19th century, partly paid-up capital was viewed as coming with a buffer of contingent capital. Its credibility depended on the security of the independent wealth of the partners or shareholders obligated to provide the unpaid balance in emergencies.[25] To be classified as tier-1 capital under current regulations, capital instruments must be fully paid up. The use of older forms of partly-paid-up equity capital thus has become rare.[26] Still, the exposure to adverse contingencies triggering claims on investors is in some ways similar to that of the cocos. Goodhart (2010) judges that the double liability imposed by wind-up rules on shareholders for many decades up until the 1930s had some considerable success in dampening the appetite for excessive risk. Wilson and Kane ((1996), pp. 6, 16) found that extended liability delivered positive transfers to stockholders of large U.S. national banks in the late 1920s, but the windfalls declined and reversed themselves in the early 1930s until double liability was abandoned. These transfers, which at the optimum should be zero, are the difference between the capitalized reduction in funding costs that stockholders enjoy under double liability and the capitalized opportunity costs marginal stockholders expect to face in covering the resulting extra obligations to creditors.

Capital calls are still commonly included in partnership, venture-firm and investment-fund contracts. Furthermore, hybrid capital securities may contain capital call options which management can exercise on specified conditions or occasions to raise common equity. The

[25] Dowd and Hutchinson ((2010), p. 50) provide a vivid account of the principal partner in a failing British bank converting the partnership to a limited company and floating its shares with the help of the then "dodgiest" promoter in the City. As customary around 1865, payment of only 30% of the stock subscription was demanded up front. When the shareholders were asked within the same year by the liquidators to pony up the unpaid 70% of the issue amount, their fury was intense but their money ensured that that the creditors were eventually paid in full.

[26] One major, and to some extent still on-going, exception are privatizations of government enterprises with popularly offered subscriptions which can be paid in installments. However, no contingencies or calls are involved.

hybrids also may carry coupon payments that are subject to suspension and non-cumulative or can be satisfied by equity issuance or from its proceeds.

Mandatory Convertible Bonds (MCB) and Notes (MCN)

MCBs and MCNs shift the risk that a company's common shares may perform poorly for any reason to the bondholders. Only the coupon payments are made in cash while the principal must be converted into equity at maturity. For this reason the major rating agencies count between 70% and 90% of newly issued MCBs as additions to equity capital even before they are converted. If these instruments can be sold with a conversion premium even when they are set to mature in just 2 to 3 years, the market must expect the stock price to rise during this time. Because this type of bond guarantees equity infusion through conversion from debt even when this market expectation turns out to have been mistaken, it has some, albeit imprecise and limited, insurance value against any unexpected and quickly developing bankruptcy risk. As a practical matter, MCBs offered with a conversion discount, like those contemplated by UBS in 2010 before they were made convertible into the stock of another bank (BBVA), rarely are encountered since they signal more trouble ahead. According to a study by Chemmanur, Nandy, and Yan (2003), the types of firms that issue MCDs face less information asymmetry and a larger probability of distress than those issuing ordinary convertibles. On average, abnormal returns are experienced by the stockholders of such firms upon announcement of an MCD issue. Hence issuing MCBs is most practical and affordable when they are seen to support a company's path to recovery and increased earnings and not just its struggles to avoid bankruptcy.

Because MCBs, unlike regular convertible bonds, require conversion regardless, and not just in the good states that would make conversion profitable, they require a higher interest rate than regular convertible bonds. However, they would tend to command a lower interest rate than straight bonds of the same credit quality to the extent the distribution of expected gains on the equity from conversion at maturity dominates that of losses by enough to cover the added risk.

To illustrate actual features of an MCB, Banco Santander S.A. issued €7 billion of 5-year MCBs in October 2007 at par at an interest rate of 7.30% until October 4, 2008 and 3-month Euribor plus 2.75% thereafter. (The 3-month Euribor future is the only such contract that offered a 5-year quotation horizon.) The bonds, whose face value is €5,000 per unit, can be voluntarily exchanged for common shares of Banco Santander on October 4, 2010 and 2011, and must be mandatorily exchanged on October 4, 2012. By prior announcement, in October 2009, when the 5-year MCB had come within three years of its mandatory conversion, Standard & Poor's (2009) started to include it in its adjusted total equity measure. The reference price per unit, initially €16.04, or 311.76 shares per unit of MCB, implied a conversion premium of 16% over the share price of €13.82 at the close of October 4, 2007. This price subsequently was adjusted downwards on several occasions, in accordance with anti-dilution provisions in the prospectus. By May 2010 it had been lowered to €14.48 per share and the conversion ratio was 345.30 shares per unit of MCB while the stock closed at €8.32 at the end of that month. If the percentage shortfall of the actual price from the reference price per share were the same at maturity, then, given the modest risk premium in the interest rates payable by this bank, investors in its MCBs would stand to lose almost 30% of the original investment value relative to investing for 5 years at 3-month Euribor.

Reverse Convertible Securities (RCS) and Debentures (RCD) [27]

RCSs or RCDs, when issued by a company that uses its own shares as the reference asset, rather than by a broker, could be designed to provide debt relief and respite from having to roll over short-term notes. Such relief would become available when a company has experienced difficulties and the price of its stock has declined by at least some significant pre-specified percentage, such as 20 or 30 %, from its reference level. For a recent example, Resti and Sironi ((2010), p. 4), have suggested, "As a way to improve capital quality, regulators may also consider the introduction of 'reverse convertible' subordinated bonds, which could/should be converted into common equity upon occurrence of some trigger which cannot be controlled by the bank (say, a large drop in the share price or in the stock market index)." But because share prices can fall appreciably with the market even when the fortunes of the company are stable, securities of this kind are a fairly blunt instrument to ward off bankruptcy.

RCSs may contribute to unhelpful dilution in some instances, particularly if the stock price of a company is characterized by high volatility, such as a beta value well above 1. Triggers based on the market value of equity in relation to the book value (or market value) of assets, such as those proposed by Flannery (2005; 2009), may tend to be pulled early in a financial crisis and fairly indiscriminately. For instance, assume the trigger to conversion is activated when the market value of a firm's equity has declined by just over 20% on monthly average in relation to the firm's assets, or from 5% to below the regulatory minimum of 4% as in Flannery ((2009), pp. 5-6). Flannery suggests using daily data for the trigger, with conversion the day after it was pulled. Conversion is then set to restore the ratio to 5%. Be it granted also that the percentage decline in the market value of a firm's common equity is roughly equal to the percentage decline in its stock price over short periods and that the book value of assets remains roughly constant in the short run. Then judging by the exchange-traded iShares Dow Jones US Financial Sector, ticker symbol IYF, and assuming a May 2007 starting point at IYF = 120.94, conversion would first have been triggered in December 2007, as IYF fell to 94.14. It would then have been triggered again in June 2008 (IYF = 67.89), October 2008 (IYF = 53.87), and January 2009 (IYF = 34.48). This assumes first that reissuing cocos again and again in a declining market had been possible so that there would have been some cocos left and secondly that the evolution of the IYF price would have been unaffected by the successive conversions in the representative firm included in that index share.

Flannery ((2009), p. 10) requires that converted debt must be replaced promptly in the capital structure. But if firms are reluctant to issue new equity and regulators are reluctant to demand prompt equity sales for reasons such as debt overhang,[28] as he well explains (pp. 2-3), it is

[27] The RCDs proposed by Flannery (2005) in a paper written in 2002 would now be called cocos. Indeed, Kashyap, Rajan, and Stein ((2008), pp. 30, 35) give him full credit as does Raviv ((2004), p. 2) who made the first important additions to this literature. Stanton's (1991) recommendation, that the U.S. government-sponsored enterprises Fannie Mae and Freddie Mac be required to issue subordinated debt that would automatically convert to equity when these GSEs get into a specified level of difficulty, was an isolated precursor. Later contributors, among them several members of the Squam Lake Working Group on Financial Regulation, are recognized in Shiller (2009) and Flannery ((2009), Appendix B). Culp (2009) still classifies cocos as contingent reverse convertibles that are not, strictly speaking, providing contingent capital in his view because they involve a rearrangement of a firm's liabilities without providing new funds from the issuance of new securities.

[28] Bulow and Rogoff (1988) have argued that the marginal value of both sovereign and domestic corporate debt is below its average value or buyback price when any of the existing debt is impaired. Swapping part of that

unclear why there is a market on affordable terms for debt that may be converted to common equity within a few months from issue when a financial crisis rolls on. Especially in Flannery's proposed conversion scheme in which the market value of the equity acquired through conversion must be equal to the face value of the debt converted on the day of conversion so that the amount of new shares issued is not limited, the dilution of existing shareholders could be very severe. The prospect of serial conversion occurring in a firm over the course of a major financial crisis that makes new shareholders quickly suffer the fate of existing shareholders at the next conversion would render it quite unattractive to risk being put into that firm's stock by any route.

Returning to regular RCSs whose holders suffer losses at conversion, interest rates on RCSs are higher than on otherwise comparable straight debt. There is no possibility of a return above that rate. However, potential losses are equal to the percentage decline in the stock price beyond the initial reference price if the stock price has ever dipped below the knock-in level during the term of the note. That level commonly is set at 70 or 80% of the reference price. If conversion has not been triggered, or the stock price ends up *above* the reference price at maturity so that the issuer will not choose to exercise the European option of paying in stocks, the RCS note or bond is simply paid in full. But if the stock price were equal to 70% of the initial reference price at maturity and the reference price had not previously been lowered, 30% of the value of the principal of an RCS would be lost. To cover such high risks, coupons averaged about 12% on U.S. RCSs issues in 2010 when money-market interest rates were near 0.

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debt for equity at that price then can raise the market value of the remaining debt at the limit so much as to leave the debt-equity ratio, evaluated at market prices, very nearly unchanged. In other words, the intended transfer of market value from debt to equity through conversion may not (fully) succeed on account of the "debt overhang" problem.

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