Financial Stability Paper No. 16 – May 2012

Precautionary contingent capital

Gareth Murphy, Mark Walsh and Matthew Willison

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The authors are grateful to Niki Anderson, Peter Brierley, Patrik Edsparr, Rob Edwards, Simon Hall, Marius Jurgilas, Colin Miles, Victoria Saporta, George Speight and Chris Yeates for very useful comments and Clare Rogowski and Harshil Shah for excellent research assistance.

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The views expressed in this paper are those of the authors, and are not necessarily those of the Bank of England. This paper was finalised on 30 May 2012.

ISSN 1754–4262

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Gareth Murphy, Mark Walsh and Matthew Willison

The financial crisis showed that levels and quality of bank capital were too low for banks to be able to absorb the losses they faced. Policymakers have responded by increasing the amount of equity all banks are required to have in their capital structures and imposing additional equity requirements on those banks considered to be globally systemically important. Contingent capital has been put forward by some as another way of potentially enhancing the resilience of banks. Several contingent capital instruments have been issued and some authorities have proposed that banks could issue such instruments to meet certain regulatory requirements. This paper takes stock of the current debate about contingent capital. The various possible designs of contingent capital are described and the key potential systemic risk implications of these instruments are highlighted. The paper suggests the considerations any policymaker would need to make if considering in future whether contingent capital is an appropriate means of ensuring banks' resilience.

1 Introduction

During the recent financial crisis, it became evident that banks globally held insufficiently high levels of capital to absorb losses on a 'going concern' basis. Equity constituted a small proportion of regulatory requirements and the going concern loss absorption achieved by many debt instruments during the financial crisis was revealed to be weak (see Collazos (2011)).

As a consequence, policymakers internationally have been discussing what is the appropriate level and composition of banks' capital. In 2010, the Group of Governors and Heads of Supervision (GHOS), the oversight body of the Basel Committee on Banking Supervision, announced that minimum capital requirements would be increased and that the definition of capital instruments eligible for meeting these requirements would be changed to ensure eligible instruments would be truly loss-absorbing (Basel Committee on Banking Supervision (2010)). In June 2011, GHOS announced that banks assessed to be globally systemically important would be required to hold minimum additional common equity Tier 1 capital to counter the negative externalities and moral hazard posed by globally systemically important banks (Basel Committee on Banking Supervision (2011b)). Their proposal was endorsed at the Group of Twenty (G20) summit in November 2011 (see Basel Committee on Banking Supervision (2011c) and G20 (2011)) and formed part of a package of policies for mitigating the risks posed by systemically important financial institutions announced by the Financial Stability Board (see Financial Stability Board (2011)).

The decision to require globally systemically important banks to use common equity, rather than other capital instruments, to meet additional capital requirements was taken because policymakers wanted to be fully confident that the resilience of these banks would be increased by the requirements. Policymakers were concerned that other instruments, such as contingent capital instruments, would be less loss-absorbing than equity and that they were hard to design. GHOS did, however, announce that the Basel Committee would continue to monitor contingent capital instruments and would support the decision of any national authority to allow banks to use contingent capital to meet capital requirements for its globally systemically important banks set higher than the agreed minimum requirements.

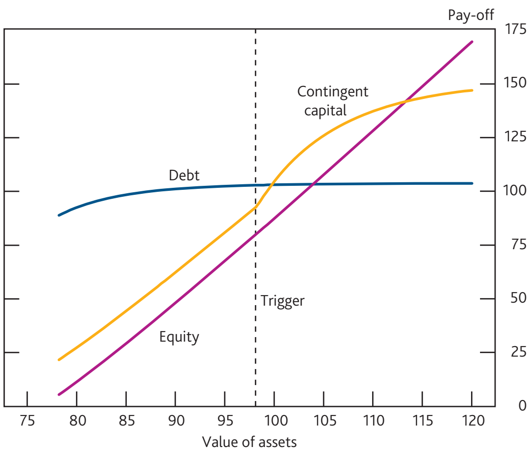
Certain authorities have announced that banks could issue contingent capital instruments to meet particular prudential requirements or have announced that they are considering whether or not such instruments would be eligible to meet capital requirements. The authorities in Switzerland have proposed that the largest Swiss banks should be subject to higher capital requirements that could be in part met by issues of contingent capital (FINMA (2010)). In the EU, the European Banking Authority has announced that contingent capital instruments that satisfy specified criteria might be used to meet the capital buffers banks are required to build up by the end of June 2012 (European Banking Authority (2011)). In the United States, the Dodd-Frank Act commissioned the US Financial Stability Oversight Council to prepare a study of contingent capital for systemically important financial institutions (Library of Congress (2010)).

The purpose of this paper is to take stock of existing work on contingent capital. It outlines the considerations a policymaker would need to make if assessing whether or not a contingent capital instrument could be suitable as an instrument for meeting capital requirements. The focus is on the potential systemic risks associated with contingent capital instruments. The paper is intended to contribute to ongoing debate about contingent capital.

What is meant by contingent capital?

To fix ideas, **Chart 1** shows how the value of a contingent capital instrument in the form of convertible debt differs from those of equity and debt.[1] All values are plotted against the value of a bank's assets. The conversion of contingent capital from debt to equity occurs when the value of assets falls below a 'trigger value', which is above the value of assets at which a bank could be considered a 'gone concern' and require the authorities to resolve it. Taking the face value of instruments as fixed and assuming no change in the composition of a bank's assets, a fall in the value of assets increases the likelihood that the value of assets will hit the trigger value. In this example, the value of the contingent capital instrument falls as the value of assets falls towards the trigger value. The difference between the values of contingent capital and equity at the trigger reflects the contractual terms on which contingent capital converts into equity.

Chart 1 Pay-offs to equity, debt and contingent capital holders



Source: Bank calculations.

(1) Debt that converts to equity has been a form of contingent capital that has received much attention and, unless stated otherwise, we are referring to this form of instrument when we refer to contingent capital. But it is not the only possible type of contingent capital. Different types of contingent capital are described in Section 4.

Bail-in debt and resolution

It should be made clear at the outset that the contingent capital instruments discussed in this paper are completely distinct from debt instruments or other creditor claims that are written down or converted to equity, in whole or in part, by a country's resolution authority at the point a failing bank enters resolution. This power exercised by the authorities is generally referred to as 'statutory bail-in' or 'bail-in within resolution'. Sometimes the relevant debt instruments are referred to as 'bail-in debt', although that is somewhat misleading since, depending on the statutory regime, any debt can take losses in a resolution.

The Financial Stability Board's *Key Attributes of Effective Resolution Regimes for Financial Institutions*, endorsed as an international standard at the G20 Summit in November 2011, include bail-in as one amongst other tools that Resolution Authorities should have at their disposal in order to resolve failing firms in an orderly manner, maintaining continuity of their critical economic functions without taxpayer exposure to loss from solvency support, and so avoiding the destruction of value and disorder entailed by standard corporate liquidation procedures.

The Financial Stability Board Standard provides that authorities should have power to write down the principal value of debt and effect a debt-for equity conversion, within a special resolution regime for failing banks. This is designed to ensure that holders of debt instruments face a credible threat of incurring losses when a bank is doomed to failure. That is equivalent to the point at which it no longer meets the statutory criteria for authorisation as a bank or dealer, and has no reasonable prospect of once again meeting those criteria (absent entry into resolution).

The European Commission published a consultation paper on crisis management in early 2011 that included a proposal that authorities have a statutory bail-in tool as part of a special resolution toolkit (European Commission (2011)). More recently, the Commission has issued a Discussion Paper on the design features of such a tool (European Commission (2012)), as a precursor to the publication of a proposal for a Directive on bank recovery and resolution.

In the UK the Independent Commission on Banking recommended that the United Kingdom's special resolution regime toolkit be augmented with an explicit bail-in power (Independent Commission on Banking (2011)) and the UK Government has supported this recommendation.

Other policy announcements have been made that are related to the broad issues covered in this paper. For example, the Basel Committee has specified that for non-common equity instruments to count as Tier 1 and Tier 2 capital instruments, they must include a provision that, at the discretion of the authorities, these instruments can be written down or converted to equity if a trigger event occurs, unless a jurisdiction already has in place laws that require them to do this, for example via resolution (Basel Committee on Banking Supervision (2011a)). The trigger is the earlier of an assessment by the authorities that a bank is otherwise no longer viable as a going concern or the point at which an injection of capital into a bank has been made by the public sector.

In summary, in this paper we discuss *only* contingent capital instruments that provide additional loss-absorbing capacity before a bank has reached the point where it needs to go into resolution. We are not, therefore, discussing bail-in able debt. We refer to the instruments we discuss as 'precautionary contingent capital'.[1]

2 Capital structure, frictions and precautionary contingent capital

In a frictionless, arbitrage-free economy the required return on precautionary contingent capital should be lower in equilibrium than the return on equity since the correlation of the value of contingent capital with the value of underlying assets would be lower than that of equity and the volatility of contingent capital lower than that of equity. Precautionary contingent capital would thus have a lower covariance, and hence beta, with the market and therefore would require a lower equilibrium return (see Duffie (2001)). But overall (taking into account the required returns on equity and debt) a bank's overall cost of capital would be independent of its capital structure in a frictionless economy (Modigliani and Miller (1958)).

Frictions most likely do exist in reality, as evidenced by banks being financed by debt that is multiples of their equity capital. The remainder of this section discusses the frictions that could drive decisions about bank capital structures and considers whether these frictions imply that precautionary contingent capital might play a role in banks' capital structures and why banks may not have issued these sorts of instruments in the past.[2]

Moral hazard

One important friction in the banking system is that bank debt can be insured. This insurance is explicit in the case of retail deposits (up to some limit). It could be implicit as in the case of debt issued by a bank perceived to be 'too important to fail'. In a crisis, a policymaker may be concerned that the failure of such a bank will generate negative externalities in the financial system and wider economy. For instance, a bank may be an

(1) Other phrases that have been used to describe these instruments include high-trigger contingent capital and going concern contingent capital.
(2) See Harris and Raviv (1991) for a survey of the factors that could drive a firm's choice of capital structure.

important provider of payment, settlement, or custody services and the supply of these services could be disrupted when a bank nears failure. Or a policymaker may consider that support should be provided because selling a failing large bank's assets could force market prices for these assets down, which could cause losses for other banks if they mark-to-market their holdings of these assets.(1)

But insured debt combined with limited liability for equity could give equity holders an incentive to choose risky investments because they enjoy the upside benefits when the investments successfully pay off but only incur some of the downside costs when investments fail to pay off (Jensen and Meckling (1976)). This *risk-shifting* behaviour would be tempered in the absence of insured debt because debt holders would demand higher interest rates to compensate them for the risk of losses they are exposed to.(2)

One way of reducing risk-shifting incentives in the presence of insured debt is to increase the amount of equity in a bank's capital structure. That way, equity holders would absorb a greater fraction of any falls in the value of a bank's assets. Issuing precautionary contingent capital instead of equity might also reduce risk-shifting incentives as long as holders of contingent capital face a credible threat of suffering losses. This credibility would derive from contingent capital being able to absorb losses before a bank becomes so distressed that it risks generating negative externalities in the financial system and wider economy. Contingent capital holders would then have an incentive to pay attention to downside risk and, prior to conversion, demand compensation for risk.(3)

Of course, and as noted above, as a mechanism for ensuring debt holders face a credible threat of losses, the capacity for authorities to use a statutory bail-in power to convert debt to equity or write down the value of debt at the point of entry into the resolution regime would also be a way of reducing risk-shifting incentives.

Discipline on banks' risk-taking could also be imposed by supervisors. Market prices of precautionary contingent capital could provide useful information about the riskiness of banks to supervisors if investors have private information about banks' assets, highlighting which banks require supervisory action (Calomiris (2010)). This argument is very similar to one made about subordinated debt in the past (see Evanoff and Wall (2000)).

Bank cost of capital

In the presence of certain frictions, equity could be more socially expensive to issue than straight debt. One reason given for this is that equity generates agency problems when there is a lot of free cash in a firm. Managers of a firm could have an incentive to use the cash to make investments that yield them private benefits but the costs of which are incurred by equity holders (Jensen and Meckling (1976)). Having more debt in a firm's capital structure mitigates this agency problem by reducing the amount of cash that is freely available to invest in inefficient activities. Managers must make payments to debt holders to avoid insolvency whereas they could defer dividend payments to equity holders and not trigger insolvency (Jensen (1986)).(4)

Another reason why it might also be relatively more expensive to issue equity than debt is that a bank could face an adverse selection problem when issuing capital instruments (Myers and Majluf (1984)). Investors could demand a discount if they are concerned that bank management and existing equity holders have private information about the quality of a bank's assets.(5) A lower-risk firm can reduce any adverse selection discount by issuing securities whose values are less sensitive to its private information, which could be debt.

Would precautionary contingent capital face the same problems as equity that could make equity relatively more costly than debt or might it mitigate these problems? In theory at least, precautionary contingent capital could alleviate any free cash flow problems because prior to converting to equity it could reduce the amount of free cash flow available.(6) But it seems unlikely that precautionary contingent capital could be less costly than equity because it would be less sensitive to private information (ie less affected by adverse selection problems) if there is a credible threat of it converting. For example, if the private information is primarily about the downside risk faced by a bank, the values of equity and precautionary contingent capital could be similarly affected by this private information.

Another reason that is sometimes put forward for a firm's equity being more expensive than debt is that interest payments on debt instruments are deducted from profits before corporate tax is levied, but dividend payments are not similarly tax deductible. So more debt in a firm's corporate

(1) The Basel Committee's methodology for assessing the global systemic importance of banks is comprised of a range of indicators of bank characteristics that are associated with the systemic impact a bank would have was it to get into distress (Basel Committee on Banking Supervision (2011c)).
(2) There is mixed evidence for risk-shifting behaviour; eg Eisdorfer (2008) finds evidence supporting such behaviour in distressed firms but Graham and Harvey (2001), in a survey of chief finance officers, do not find evidence consistent with risk-shifting considerations influencing capital structure choices.
(3) But if debt was *not* insured, replacing debt with contingent capital could encourage risk-shifting behaviour (see Koziol and Lawrenz (2012)). This is because contingent capital, by providing more loss-absorbing capacity, reduces the risk that equity holders lose control of a firm in a bankruptcy, which may increase their incentives to invest in risky assets.
(4) There is mixed evidence suggesting free-cash considerations affect firms' capital structures. There is empirical evidence of free cash flow problems influencing firms' capital structures in the oil industry (Griffin (1988)), life insurance sector (Wells, Cox and Gaver (1995)), non-financial firms (De Jong and Van Dijk (2007)), and in decisions to take firms private (Lehn and Poulsen (1989)). But there is also evidence that suggests it is not a determinant of firms' capital structure decisions (Graham and Harvey (2001)).
(5) But this effect may be smaller if a bank raises equity at the same time as other banks in response to an increase in regulatory capital requirements.
(6) Of course, as Hart (2001) argues, there may be ways of alleviating such agency problems other than through the design of a firm's capital structure (eg by putting the management on an appropriately designed incentive scheme).

structure could reduce the amount of tax a firm pays (Modigliani and Miller (1963)); although the effect of taxes on the relative costs of equity and debt would also depend on the way returns to investors in equity and debt are taxed. If interest payments on precautionary contingent capital were tax deductible, then some might conclude that it would be less costly than equity. But this cost represents a *private* cost rather than a *social* cost. Admati *et al* (2011) point out that the tax deductibility of interest payments is not a valid reason for favouring other instruments over equity because, while a bank might gain from deductibility, the public could lose. And Miles (2010) shows that taking account of the extra tax revenue generated by a switch from debt to equity can reduce estimates of the cost of higher equity requirements on banks.

Why was precautionary contingent capital not issued in the past?

Another set of factors might explain why precautionary contingent capital was not present in banks' capital structures in the past.(1) One factor lies with capital regulation, which defines the instruments that banks can issue to meet capital requirements. If these did not include precautionary contingent capital of the type currently being considered, banks could have been deterred from issuing such instruments.

Another factor is that there could have been a co-ordination failure among issuers. A bank might not have had an incentive to issue precautionary contingent capital instruments if other banks did not issue similar instruments because it would perceive the market for such an instrument to be illiquid. If all banks behaved in the same way, then none would issue precautionary contingent capital.

A third factor is that devising and designing new capital instruments is not costless. The crisis demonstrated the benefits of banks holding sufficient buffers of capital and induced banks, academics and policymakers to think of ways for banks to increase going concern loss-absorbing capacity.(2)

3 Assessing precautionary contingent capital

In this section, a set of considerations is outlined that can be used to assess various features of precautionary contingent capital instruments.

Would precautionary contingent capital ensure the same level of resilience as common equity?

To ascertain whether precautionary contingent capital could mean banks have the same level of going concern loss-absorbing capacity as they would if they issued common equity or less going concern loss-absorbing capacity, two key considerations could be borne in mind.

Rollover risk

In order for a bank to have sufficient loss-absorbing capital at all times, it should not be possible for holders of precautionary contingent capital to run, especially if they perceive that conversion of contingent capital is imminent. The shorter the maturity of precautionary contingent capital, the greater could be the risk of failing to roll over these instruments. The opportunity to run before conversion could also reduce the incentives of precautionary contingent capital holders to monitor a bank's risk-taking and impose market discipline.

Timeliness of conversion of precautionary contingent capital

Contingent capital would only generate the same loss-absorbing capacity as equity if the trigger was designed so that conversion *always* happens prior to the time equity is needed. That is, conversion should occur *for sure* ahead of banks having to write down assets and well ahead of the triggering of resolution measures. If conversion is not timely because it occurs only with a lag, there is a risk that a bank would have insufficient capital to absorb losses. McDonald (2010) discusses the problem of false positives and false negatives with the triggering of contingent capital by drawing an analogy with type I and type II errors in statistics. A policymaker might have a greater tolerance of the risk of unnecessary conversions (type I errors) being triggered than of the risk of not triggering necessary conversions (type II errors).

Precautionary contingent capital might lead to wider systemic problems

The trigger metric should ideally be an accurate as possible measure of the soundness of a bank. But the trigger metric could be undermined if it could be manipulated. For instance, with a trigger metric based on a bank's equity price, there would be a risk that investors may short-sell a bank's equity to drive the equity price down in the absence of any change in the underlying value of a bank's assets and trigger a conversion event that results in a transfer of value from existing equity holders to precautionary contingent capital holders (Hillion and Vermaelen (2004); Pennacchi, Vermaelen and Wolff (2010)) (see the discussion in Section 4).

The fall in a bank's equity price due to short-selling could lead to wider disruption in the financial system. Investors might interpret the fall as a signal about the solvency position of other banks. This could also raise the borrowing costs of other banks in wholesale markets.

Another effect due to the presence of precautionary contingent capital in a bank's capital structure could be to the volatility in a bank's equity price (even if there is no investor

(1) Although a type of contingent capital did exist in the banking system in the United Kingdom prior to World War I (see Grossman and Imai (2011)).
(2) Although the idea of using contingent capital to recapitalise banks does predate the crisis (see Flannery (2005)).

manipulation). If investors hedge their positions in precautionary contingent capital with equity, the volatility of the equity price of the issuing bank could be increased or decreased due to the presence of precautionary contingent capital, depending on the terms on which precautionary contingent capital converts to equity (see Box 3 for a more detailed discussion).

The presence of precautionary contingent capital could also risk creating systemic problems in other ways if bank equity holders or managers seek to avoid the trigger event. Bank equity holders might have an incentive to do this to avoid the dilution of their claims while managers could have an incentive to do this if they fear that conversion could lead to their replacement. If the trigger metric depends on a bank's ratio of capital to assets or risk-weighted assets, incumbent equity holders or managers could try to reduce assets to push the ratio up and away from the trigger value. But a reduction in assets, via a sale of assets or decision not to replace maturing assets, could spill over on to the rest of the financial system and real economy. Asset sales could reduce asset prices, forcing other banks to mark down their holdings of the same assets. Not replacing maturing assets could reduce the supply of bank credit and have adverse macroeconomic effects. These risks might be lower if the trigger value is set at a high level so that if these actions are taken it is at a stage where other parts of the financial system might be more capable of absorbing assets and expanding the supply of credit.

Would there be a market for precautionary contingent capital?

Precautionary contingent capital could only be an effective capital instrument if there was demand from investors for these instruments. And banks would only have an incentive to issue contingent capital if they expected there to be adequate investor demand. The level of investor demand could depend on a number of interrelated considerations.

Transparency

Clarity about the conditions in which precautionary contingent capital converts to equity, over which contingent capital instruments are converted when a trigger event occurs, and the determination of the rate at which contingent capital converts into equity could support investor appetite.

Tractability

A tractable precautionary contingent capital instrument is one that can be modelled, priced and risk managed. This is closely linked to transparency because investors would find it less costly to value an instrument if its features are transparent. Even with a high level of transparency, tractability could also be affected by the complexity of the instrument or by difficulties in hedging some of the risks embedded in the instrument. Investors may find it less costly to value a simpler instrument with fewer contractual features (eg an instrument with a single conversion trigger as opposed to multiple triggers).

Liquidity

The risk premium that investors demand for holding precautionary contingent capital will depend on their perceptions of the liquidity of the instrument. An active and engaged investor base could support liquidity. Such investors are likely to seek transparency and tractability. Liquidity could also be supported by the fact that precautionary contingent capital instruments would sit towards the middle of a bank's capital structure, so some investors would trade them when they see relative value opportunities (see Box 3). These investors would provide price transparency to other investors with longer investment horizons and so might help ensure efficient pricing of all liability instruments issued by a bank.

Investor mandates

Investor appetite is affected by the constraints placed on the types of assets they can purchase by investment mandates. Some investors might be subject to mandates that preclude them from investing in equities. Mandates might also prevent them from investing in precautionary contingent capital. But this might only be a temporary issue. Mandates could adjust to allow investors to purchase precautionary contingent capital. Or new investment funds could emerge with mandates that allow them to invest in precautionary contingent capital instruments.

4 Different types of precautionary contingent capital

There is a range of possible types of precautionary contingent capital that banks could issue. These differ in terms of the definition of the trigger event and the rate at which contingent capital converts into equity. Box 1 outlines several precautionary contingent capital instruments that have already been issued, which illustrates the range of possible designs. A wide variety of academic proposals have also been developed, in particular in response to the financial crisis. These types of contingent capital are not mutually exclusive and it is possible to imagine them coexisting in a banking system. **Table A** summarises the different types of precautionary contingent capital and how each one would *in principle* enhance the loss-absorbing capacity of a bank.

Debt to equity conversion

This involves a mandatory conversion of precautionary contingent capital to equity at a level of capital significantly above the minimum regulatory capital requirement.(1) New

(1) Coffee (2011) suggests debt converts into preference shares with voting rights rather than equity. He argues that since preference share holders do not share in upside risk, they could use their voting rights to reduce a bank's risk-taking after a conversion.

Box 1
Contingent capital instruments in practice

Certain banks and building societies have issued or announced capital instruments that incorporate convertibility or write-down features, to address a varying range of prudential objectives.

Credit Suisse

In February 2011, Credit Suisse announced that it had agreed with two investors to issue contingent capital instruments for cash or in exchange for existing Tier 1 instruments in 2013. It also issued an additional series of contingent capital instruments.(1) The trigger for these instruments would be 7% of common equity Tier 1 to risk-weighted assets ratio but could also convert at the discretion of the Swiss regulatory authority. The conversion price would be the higher of the average equity price over the 30 days prior to the announcement of a conversion or a pre-specified floor. The final maturity of these instruments was 30 years. The issue was around eleven times oversubscribed.

Bank of Ireland, AIB, and Irish Life and Permanent

In March 2011, the Central Bank of Ireland announced the findings of the Financial Measures Project which included a plan to restructure and recapitalise the domestic Irish banking system. As part of this exercise, the capital-raising programmes of three banks — Bank of Ireland, AIB, and Irish Life and Permanent — resulted in the issuance of contingent capital instruments in July 2011.(2) These instruments have a number of features that mirror the Credit Suisse issue. The trigger event can be a 'capital deficiency event': a bank's ratio of core Tier 1 equity (under Basel II) or common equity Tier 1 (under Basel III) to risk-weighted assets falling below 8.25% or the Central Bank determines the capital ratio would be below this trigger level in the short term. Or it can be a 'non-viability event': a bank is insolvent without state support. On conversion, the instruments convert into ordinary shares at either a price determined at the point of issue or at the higher of the average equity price over the 30 days prior to the announcement of a conversion, with a pre-specified floor. The conversion is also subject to adjustments during the life of the instrument for certain increases in the share capital, rights issues and scrip dividends. Instruments have maturities of five years.

Lloyds Banking Group

In November 2009, Lloyds Banking Group exchanged existing securities for a series of Enhanced Capital Notes (ECNs). ECNs are designed so that they convert into equity when the bank's core Tier 1 ratio falls below 5%. Each ECN differs as to maturity date and coupon — the maturity dates depends on the terms of the existing security it is being offered in exchange for. The coupon step-up is between 150 and 250 basis points above the initial coupon. The conversion price is established at the point where the ECNs are created. It is the higher of a volume-weighted average share price for the firm in the run-up to an exchange of existing securities for the ECNs or 90% of the share price on the final day of the run-up period. The conversion price would thereafter be adjusted for future corporate events.

Newcastle Building Society

In April 2010, Newcastle Building Society added a conversion feature to certain subordinated debt and permanent interest-bearing shares, in exchange for increases in coupons. These instruments would convert into profit participating deferred shares if the Society's core Tier 1 capital ratio fell below 5%. The addition of the conversion feature added £46 million of contingent core Tier 1 capital to the Society's existing £179 million of core Tier 1. A distinctive feature of these instruments is that they lose their conversion feature, and the increases in coupons, if the Society's core Tier 1 capital ratio exceeds 12%.

Rabobank

Rabobank has issued several contingent capital instruments. In March 2010 it issued €1.25 billion of ten-year Senior Contingent Notes that would be repurchased at 25% of their face value if Rabobank's equity capital ratio (which includes member certificates in addition to retained earnings and reserves) fell below 7%. Rabobank issued a further contingent capital instrument in January 2011. This instrument is perpetual and has a trigger of 8%. In the event of Rabobank's capital ratio falling below this trigger value, the instrument is written down by enough to ensure that its capital ratio recovers to 8%. The most recent issue was in November 2011 and the instrument is again perpetual (with a call after five and a half years) and has a trigger of 8%.

(1) The Credit Suisse instrument was issued on 24 February 2011 and admitted for trading on the Luxembourg EuroMFT Market.
(2) The Bank of Ireland instrument was approved under the EU Prospectus Directive, admitted for trading on the Irish Stock Exchange Main Securities Market, and issued on 29 July 2011. The AIB issue was admitted to the Irish Stock Exchange Global Exchange Market (which does not require approval under the EU Prospectus Directive) and issued on the 27 July 2011. The Irish Life and Permanent instrument was issued on 27 July 2011 by way of a direction order under the Credit Institutions (Stabilisation) Act 2010 after shareholders rejected the recapitalisation plan of the bank.

Table A Different types of precautionary contingent capital

Type	How it increases a bank's loss-absorbency capacity	Key features
Debt to equity conversion	Debt converts to equity	• Conversion occurs at a capital level significantly above the minimum capital requirement. • The trigger metric could be based on a regulatory, accounting or market-based measure of a bank's soundness.
Principal write-down	The value of the principal of the debt is written down	• Like a debt to equity conversion, except that debt principal is written down.
Systemic	Debt converts to equity	• The trigger event is defined in terms of the aggregate state of the banking system. • The conversion trigger could be defined in terms of an objective measure of the robustness of the banking system or depend on a policymaker's assessment of the state of the banking system.
Capital insurance	Insurer purchases new equity	• A bank pays premia to an insurer. • An insurer commits to purchasing new equity in the event that a bank needs a capital injection.
Mandatory rights offering	Incumbent equity holders purchase new equity	• Incumbent equity holders are offered new shares, issued on deeply discounted terms, in the event of a decline in a bank's capital position.

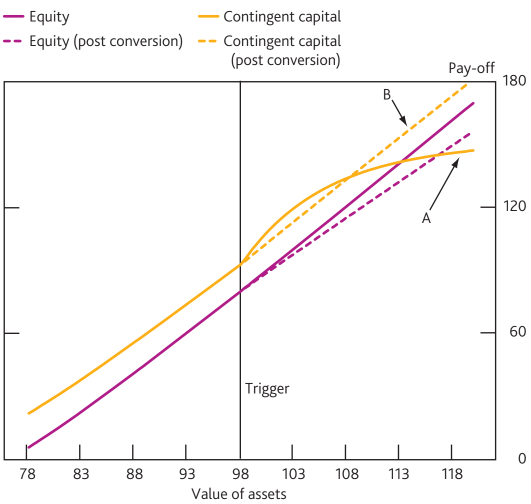
equity is injected into a bank before its capital level gets low enough that either it loses the confidence of creditors, loses access to funding markets, or to a level that equity holders are unwilling to issue new equity because of a debt overhang problem (Myers (1977)) or unable to do so at a fair price because of adverse selection problems (Myers and Majluf (1984)).

The trigger event is defined in terms of a capital ratio of a bank. The denominator of this ratio could be total assets, risk-weighted total assets, or the face value of debt. The numerator of the ratio could be regulatory capital (eg common equity Tier 1 capital), accounting capital (eg book value of common equity), or a market value of equity (eg market capitalisation). The key considerations when deciding which capital measure to use in the numerator are the timeliness of conversion and the risk of investors manipulating the trigger.

Some have argued that market capitalisation could be a more forward-looking measure of a bank's capital position than regulatory and accounting capital (Flannery (2009a); Claessens, Herring and Schoenmaker (2010); Haldane (2011); Herring (2011)).(1) There may also be a risk that banks might have incentives to delay the recognition of losses (Flannery (2009a)). The argument that a trigger based on market capitalisation could generate a more timely conversion could be assessed by observing the past behaviour of banks' capital ratios based on market capitalisation, Tier 1 capital, and book equity as the numerator. In the period up to the crisis there is some evidence suggesting that conversion would have occurred earlier if the trigger event was based on a capital ratio with market capitalisation as the numerator (see Box 2).

While it might be timelier, the risk of using market capitalisation to define the trigger event is that it could give investors an incentive to manipulate the equity price to trigger a conversion. **Chart 2** illustrates why this might happen. Above the point where conversion is triggered, the post-conversion value of contingent capital (dashed orange line) lies above the value of contingent capital (orange line). Manipulation of the equity price does not change the value of the bank's assets. Therefore, if the value of the bank's assets is above the trigger but the equity price is driven low enough to trigger conversion, contingent capital holders effectively receive a windfall denoted by the gap between A and B. The greater is the number of shares which contingent capital converts into (ie the lower the conversion price) the greater the gap between A and B. Thus, the incentive for contingent capital holders to manipulate the equity price will be greater

Chart 2 Contingent capital holders' incentives to manipulate a bank's equity price



Source: Bank calculations.

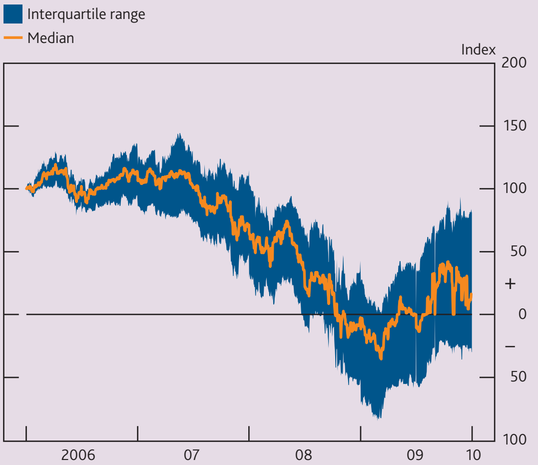
(1) The use of market capitalisation rather than the equity price would be to avoid giving a bank an incentive to undertake reverse share splits to avoid a trigger event occurring.

Box 2
Regulatory triggers and market-based triggers

A key part of the design of a precautionary contingent capital instrument is the trigger for conversion because contingent capital could only provide loss-absorbing capacity if it converts ahead of additional equity being needed. Two broad types of bank-specific triggers that have been discussed are market values and accounting or regulatory values. Comparing historic time series of these different metrics could help answer the question of which of the metrics would produce a more timely injection of equity.

Chart A shows the evolution of the difference between a ratio of market capitalisation to risk-weighted assets and the regulatory ratio of Tier 1 capital to risk-weighted assets for the largest 50 banks by total assets in 2006.(1) Observations of ratios for a bank are normalised by the values of its ratio at the start of 2006 to calculate an index of the difference. The index fell from 2007 onwards as market capitalisation declined relative to Tier 1 capital. The index continued to fall as the crisis continued. The experience of the crisis appears to suggest basing the conversion on market capitalisation (given an appropriate trigger value) could mean that an injection of equity could happen sooner than if the trigger was based *solely* on a regulatory measure of capital adequacy.

Chart A Difference between the ratios of market capitalisation to risk-weighted assets and Tier 1 capital to risk-weighted assets(a)(b)



Sources: Capital IQ and Bank calculations.

(a) Value of the difference between the ratios for each bank at the start of 2006 where each is normalised to 100.
(b) Based on a sample of the largest 50 banks globally by total assets.

Other studies

Hindlian, Lawson and Strongin (2009a, b) perform back tests for seven large US banks. They show that contingent capital with a value equal to 6% of risk-weighted assets could have been effective in delivering capital injections that avoided the failure of a bank and they argue that the existence of contingent capital may in fact induce bank management to raise new equity in advance of a trigger event. They also argue that a monitored capital ratio could be based on the stress test of the 2009 US Supervisory Capital Assessment Program, because this framework compares all banks on a similar basis and takes into account possible expected losses over the subsequent two years (ie it is forward looking). This has the virtue of dealing with the criticism that regulatory triggers might not be sufficiently timely to affect a write-down or conversion at a point well in advance of a trigger for resolution.

Claessens, Herring and Schoenmaker (2010) consider a trigger based on a bank's market capitalisation but with the trigger depending on the change in the price rather than a bank solvency measure. Contingent capital is assumed to convert if there is a 40% or more fall in a bank's market capitalisation over a period of say, three months. They show that for six major US financial institutions that failed or faced severe problems during the crisis, three of them would have hit the conversion trigger in December 2007, two more in March 2008, and the last one in June 2008. For example, Lehman would have breached the trigger value six months before it failed. They find similar results for European institutions. For instance, RBS and UBS would have hit the trigger in January 2008.

(1) **Chart A** is drawn for the current definition of Tier 1 capital and not the revised definition that will be introduced under Basel III.

for contingent capital instruments that entail higher levels of dilution of incumbent equity holders.(1)

One potential way to reduce incentives to short-sell is to use a moving average of market capitalisation, calculated over a period so that the cost of holding the short stock position outweighs the incentives to manipulate the equity price (Flannery and Perotti (2011)). The longer this period, however, the less timely the injection of capital may be. Another way to remove such incentive could be to only allow investors that are prevented from short-selling to hold precautionary contingent capital issued by banks (Calomiris and Herring (2011)). Multiple trigger metrics might reduce these incentives because it might be harder for investors to manipulate several triggers than it would be to manipulate a single trigger (Coffee (2011)). A further possible way of reducing short-selling incentives could be to prohibit the use of equities created as a part of the conversion to cover short positions, assuming it was possible to monitor effectively the equities a contingent capital holder delivers to close their short-sale position.

An issue related to the risk of investor manipulation is the possibility that precautionary contingent capital leads to multiple equilibrium equity prices if the conversion trigger depends on the market value of equity *and* the conversion price is set so that conversion dilutes incumbent equity holders' claims (Prescott (2011) and Sundaresan and Wang (2010)).(2) There can be multiple (rational expectations) equilibria because expectations that the equity price next period is such that market capitalisation is below (above) the trigger value leads to an equity price this period such that market capitalisation is below (above) the trigger value. Manipulation could then select the equilibrium with the lower equity price.

Calomiris and Herring (2011) argue incumbent equity holders would, however, have an incentive to issue new equity to avoid a dilutive conversion and if investors would anticipate this, the low equity price scenario could not occur in equilibrium (see Box 2 for more discussion of equity holders' incentives to issue new equity to avoid a conversion of contingent capital). Calomiris and Herring suggest that the trigger be based on a 90-day moving average of market capitalisation so as to give banks sufficient time to carry out pre-emptive equity issuances.

Pennacchi, Vermaelen and Wolff (2010) propose giving incumbent equity holders the option to purchase any equities issued to converted contingent capital holders as a way of dealing with the multiple equilibrium and manipulation problem. By exercising this option, incumbent equity holders can undo any transfer from them to contingent capital holders. With no value transfer there are no incentives to manipulate the conversion trigger and multiple equilibria are not possible.

Prescott (2011) outlines a couple of other possible ways the risk of multiple equilibrium equity prices might be eliminated. Creating a market for a security that pays one if the convertible debt converts and zero otherwise and basing the conversion trigger on the market capitalisation and the price of this security means that equity prices that can arise are only those for which there can be a unique equilibrium (see Bond, Goldstein and Prescott (2010)). Another way is to design a conversion price that is a specific function of the equity prices designed so that there is always a unique equity price for a given fundamental value of the bank's assets.

Principal write-down

The design of precautionary capital instruments is flexible and can be made relevant for non joint stock firms. While mutuals and co-operatives do not have common stock that contingent debt instruments can be converted into, a similar increase in highly loss-absorbing capital can be achieved via a permanent write-down on the trigger event. When an instrument is fully and permanently written off the instrument ceases to exist.(3) Such a write-off extinguishes a liability or a non common equity instrument of a bank, and thereby increases core capital as a percentage of risk-weighted assets and debt liabilities. In such circumstances, a write-off ensures that precautionary contingent instrument holders participate in the recapitalisation of the non joint stock bank.

Systemic contingent capital

The trigger event could be defined in terms of the aggregate state of the banking system as an alternative to or in addition to the state of an individual bank itself. In states of the world in which the banking system is weaker overall, there is a higher risk of contagious defaults and a systemic crisis if a bank fails. In these states of the world, precautionary contingent capital could convert to boost equity. In other states of the world in which the banking system is stronger and the risk of contagion consequently lower, precautionary contingent capital could remain as debt and any beneficial incentive effects associated with debt there are, as discussed in Section 2, would be maintained.

To achieve this state-dependency, the conversion trigger would need to depend on the aggregate state of the banking system. The measure of the aggregate state could be an equity index for the banking system (McDonald (2010)). Or a

(1) Flannery (2009b) suggests setting a conversion price above the equity price when conversion is triggered (ie convert at a price that is anti-dilutive towards incumbent equity holders) to deter contingent capital holders from short-selling. But this would not necessarily eliminate incentives to manipulate a conversion trigger because an anti-dilutive conversion price could give incumbent equity holders an incentive to short-sell a bank's stock to trigger a conversion (see Albul, Jaffee and Tchistyi (2010)). A further problem with an anti-dilutive conversion price is that no equilibrium equity price may exist (see Sundaresan and Wang (2010)).
(2) Sundaresan and Wang assume that the conversion is based on the equity price rather than market capitalisation but their multiple equilibrium results would still apply if the conversion trigger is based on market capitalisation.
(3) It is possible to have an instrument for which the principal is partially written down (see Box 1).

policymaker could take the decision to declare that there is a significant risk of a systemic crisis (Squam Lake (2009)).

Capital insurance

This type of precautionary contingent capital would not be in the form of a convertible debt instrument that sits on a bank's balance sheet but instead take the form of an insurance contract with a private investor. The investor would be mandated to purchase equity or simply provide cash under certain pre-specified circumstances in return for a stream of premia (Kashyap, Rajan and Stein (2008)).

Capital insurance like convertible debt could be designed so that banks' equity increases ahead of when it might be needed to absorb losses. The insurance provider could commit to providing new capital by investing premia in safe assets. But a policymaker might still have to monitor an insurance provider to ensure that they do invest premia in this way.(1) If an insurance provider's investment in safe assets cannot be monitored perfectly there is a risk that capital insurance shifts moral hazard problems onto the insurance providers.

Mandatory rights offerings

Duffie (2011) presents a proposal for contingent recapitalisation via mandatory rights issues on deeply discounted terms. Under this proposal, the trigger event would be a decline in the bank's capital position. At this point, incumbent equity holders would be offered new shares in a bank at a price below the current equity price. If incumbent equity holders do not have the cash to purchase new shares they could sell their shares, and the accompanying right to purchase additional shares, to investors that do have sufficient cash. As well as being a way of supporting the solvency position of a bank, another potential benefit of this proposal is that the equity issuance generates cash liquidity for the bank. This could help reduce any liquidity problems a bank is also suffering. A possible drawback with this proposal is that an underwriting bank would be needed to ensure that the rights were fully taken up. Such a back-stop may not be available at the time when the trigger event occurs and the bank's equity price is more volatile.

Other forms of precautionary contingent capital could also help to alleviate a bank's funding liquidity problems. Precautionary contingent capital in the form of convertible debt could reduce liquidity problems on conversion because a bank no longer has to make interest payments to holders of these instruments and also, by raising the level of capital, a bank might be more able to borrow in wholesale funding markets.

5 A model for analysing and monitoring precautionary contingent capital instruments

The behaviour of prices of the contingent capital instruments that have been already issued could provide useful information for a policymaker monitoring precautionary contingent capital. For instance, price data could indicate whether investors in these instruments price the risk of conversion efficiently or underprice this risk. The behaviour of prices could also indicate whether these instruments are in practice susceptible to attempts by investors to manipulate the conversion trigger.

To interpret market prices in this way, a policymaker might find it useful to be able to compare observed price behaviour with model-based estimates of the value of a precautionary contingent instrument that depend on the value of a bank's assets and on the contractual features of the instrument in an efficient market.

This section introduces a model that could be used in this way. It is an extension of Leland's (1994) approach to pricing a firm's equity and debt (Appendix A1 gives the details). Other, more complex, models could be used for modelling the prices of contingent capital instruments (eg an extension of Leland and Toft (1996), Glasserman and Nouri (2010), Koziol and Lawrenz (2012), or Pennacchi (2010)).(2)(3) But we have used a simpler model to expose how some of the key features of a precautionary contingent capital instrument could affect the price of such an instrument in an intuitive and parsimonious way.

In the model, a precautionary contingent capital instrument has the following design features.

- A single conversion trigger.

- The conversion trigger is defined in terms of market capitalisation of a bank relative to the (most recently announced) book value of assets.

In an efficient market, with the value of assets observable, book equity and market capitalisation would be consistent with the value of a bank's assets at all times. Thus, the trigger can equivalently be defined in terms of market capitalisation instead of book equity.(4)

- The value of the trigger is set to a level significantly higher than a level at which bank resolution measures would come into effect.

(1) There is an analogy between capital insurance and extended liability of equity holders. Under extended liability and in the absence of insurance, individual equity holders have to undertake costly monitoring of the wealth of other equity holders to assess the value of their own claims (Easterbrook and Fischel (1985); Halpern, Trebilcock and Turnbull (1980)).
(2) The Leland and Toft model allows for debt with a finite maturity, whereas debt is assumed to be perpetual in the Leland model. Glasserman and Nouri model partial conversions of debt and determine coupons on convertible debt endogenously within their model — we allow for only a single conversion of debt to equity and assume values of the coupons on contingent capital and debt. Koziol and Lawrenz model a bank's choice of how risky its assets are if it has or has not got convertible debt in its capital structure. Pennacchi allows for the possibility that the value of a firm's assets jumps whereas Leland (1994) assumes the value of assets evolves smoothly.
(3) The model abstracts from any principal-agent problems within banks by assuming that the value of a bank's asset does not depend on its capital structure.
(4) The book value of equity is in reality observed at discrete times and the equivalence between book equity and market capitalisation may not hold at all times.

This implies that bank capital is meant to be increased well ahead of the triggering of resolution measures.

- The conversion price is set at the point of issue.

- The instrument is perpetual.

Precautionary contingent capital may not provide a bank with going concern loss-absorbing capacity if holders of instruments run as the trigger value is approached. Rollover risk can be eliminated by making precautionary contingent capital instruments perpetual.(1)

- The coupons paid to holders of the instrument in its unconverted state are tax deductible.

Coupon payments to contingent capital holders paid prior to conversion might be tax deductible. To reflect this feature, we assume they are (as in the Leland model). But as discussed in Section 2, deductibility represents a private benefit to the bank.

The effects of the change in the value of a bank's assets on the values of this precautionary contingent capital and equity, and how these effects depend on the contractual features of the contingent capital instrument, are analysed, using the model, in Box 3.

Using experiments to analyse contingent capital

Another potential way to analyse the behaviour of and assess the risk associated with precautionary contingent capital instruments is to run experiments that simulate markets for such instruments. Davis, Korenok and Prescott (2011) conduct experiments where the conversion decision is given to the regulator or is based on a market price. They find evidence of inefficient market prices and conversion decisions in their experiments, supporting the concerns about precautionary contingent capital that have been raised.

6 Summary

This paper has taken stock of existing work on precautionary contingent capital. It has set out the range of ways these instruments could be designed. And it has highlighted the key potential systemic risks associated with precautionary contingent capital and considerations any policymaker should take into account. In particular, policymakers should consider the risk that it would be possible for holders of precautionary contingent capital to run before a conversion occurs, and whether the conversion trigger is designed so that instruments would convert to equity prior to the time equity was needed. Policymakers should also consider the possibility that precautionary contingent capital instruments lead to wider systemic problems because investors have incentives to manipulate the conversion trigger to generate a conversion or bank equity holders or management have incentives to take actions (such as fire-selling assets) to try to avoid a conversion occurring.

(1) Another way of reducing rollover risk would be to have contingent capital with a fixed maturity but stagger the maturity dates so that only a small proportion of holders could run at any one time.

Box 3
Modelling a precautionary contingent capital instrument

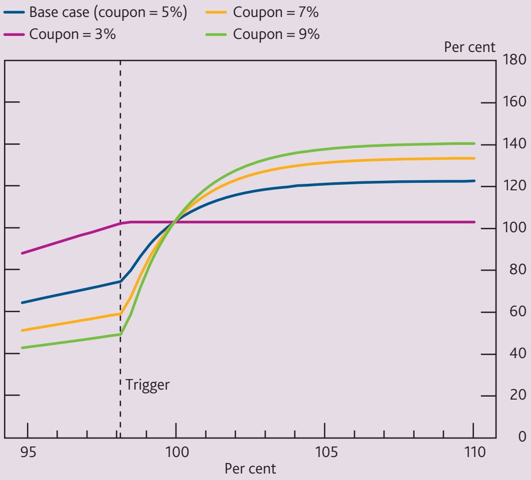
We use a stylised balance sheet as a base case (see Appendix A2 for details) and variations from this base case to explore, in the model, the impact of changes to contractual features of a precautionary contingent capital instrument and the notional value of precautionary contingent capital in a bank's capital structure on the pay-off to precautionary contingent capital holders. The pay-off for various asset values differs across contractual features and the notional value of precautionary contingent capital. But a common feature is that the functions do not exhibit jumps (eg at the level of assets at which conversion of contingent capital occurs). This is because in this model the implications of conversion are fully priced into the precautionary contingent capital instrument at the point of issue of the instrument.

Chart A shows the effect of varying the coupon received by precautionary contingent capital holders around a base case coupon on the pay-off to contingent capital. Increasing the coupon (to 7% or 9%) increases the pay-off for high values of assets. This reflects the higher stream of coupon streams received by precautionary contingent capital holders. But for a value of assets closer to the value of assets at which the conversion trigger would be pulled, the pay-off function is steeper for a higher coupon. A value of assets closer to the trigger level means conversion is more likely and precautionary contingent capital holders lose more from conversion when the coupon is higher. For a low coupon (3%), the pay-off function becomes flatter for asset values above the trigger value since the precautionary contingent capital holder has lower coupon payments to lose at conversion.

The effect of varying the value of the conversion trigger is shown in **Chart B**. A trigger higher than the base case of 7% of risk-weighted assets (9% or 11%) changes the pay-off function in two ways. It makes the pay-off function steeper as the value of assets approaches the trigger value from above. A lower trigger (5%) has the opposite effect on the shape of the pay-off function. The other effect of varying the trigger is to shift the kink in the pay-off function — this happens because the kink is at the value of assets at which the trigger is hit.

The third contractual feature that is varied is the conversion price. **Chart C** shows how increasing the conversion price (to 1.5 times the equity price at conversion), so that conversion is anti-dilutive towards incumbent equity holders, causes the pay-off function to be lower than the base case for values of assets for which contingent capital will have converted. As a consequence, the pay-off function is steeper as the value of assets approaches the trigger value from above. The pay-off

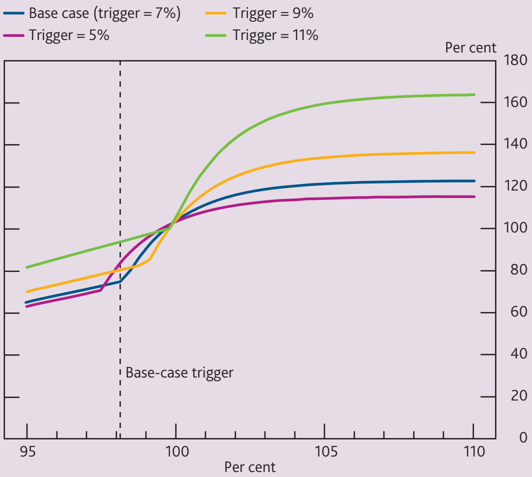
Chart A The effect of varying the coupon on the pay-off to contingent capital[(a)]



Source: Bank calculations.

(a) The vertical axis shows the pay-off to contingent capital as a percentage of the initial value of contingent capital. The horizontal axis is the value of the bank assets as a percentage of the initial value of the bank assets.

Chart B The effect of varying the trigger on the pay-off to contingent capital[(a)(b)]



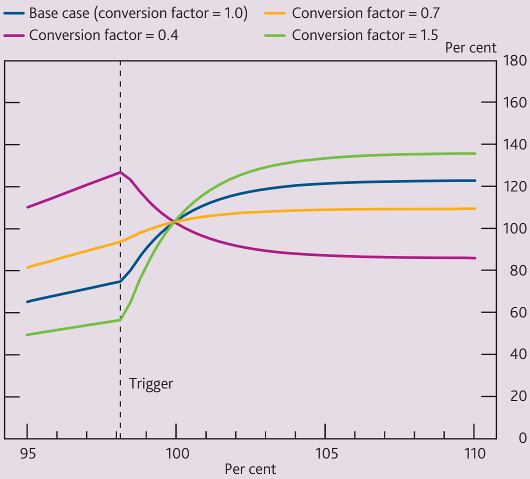
Source: Bank calculations.

(a) The vertical axis shows the pay-off to contingent capital as a percentage of the initial value of contingent capital. The horizontal axis is the value of the bank assets as a percentage of the initial value of the bank assets.
(b) The trigger is expressed in terms of the ratio of bank equity to risk-weighted assets. The value of risk-weighted assets is transformed into a value of assets by applying a constant term calibrated based on UK banks' data (see Appendix A2).

function is said to be more 'convex'. In other words, the pay-off function 'bulges upwards'; by a concave pay-off function, we mean the opposite. (See Appendix A3 for a discussion about the relationship between the conversion price and the convexity of the instrument value.)

The intuition is that since precautionary contingent capital holders receive fewer shares at conversion, they lose more from conversion relative to the base case. The opposite is true with a dilutive conversion price (such as 0.7 times the equity price at conversion). In this case, precautionary contingent capital holders receive more shares on conversion. The shape

Chart C The effect of varying the conversion price on the pay-off to contingent capital[(a)]



Source: Bank calculations.

(a) The vertical axis shows the pay-off to contingent capital as a percentage of the initial value of contingent capital. The horizontal axis is the value of the bank assets as a percentage of the initial value of the bank assets.

of the pay-off function changes at a sufficiently low conversion price (eg 0.4 times the equity price at conversion). The function inverts so that it increases as the value of assets gets closer to the trigger value from above. With such a low conversion price, the precautionary contingent capital holders are better off post-conversion.

The shape of the pay-off function for a precautionary contingent capital instrument has implications for investors engaged in relative-value investment strategies.

The introduction of precautionary contingent capital into a bank's capital structure creates a 'kink' in the pay-off function for equity. The effect on the shape (ie making it more convex or concave) of the pay-off function for equity depends on the conversion terms. (This is shown in equation (**A2**) in Appendix A1, where the expression for equity takes on a different functional form above and below the trigger.) The convexity (concavity) of the pay-off function for equity has a counterpart in the concavity (convexity) of the pay-off function for precautionary contingent capital (see equation (**A1**) in Appendix A1). In other words, if equity is convex, contingent capital is concave and *vice versa*.

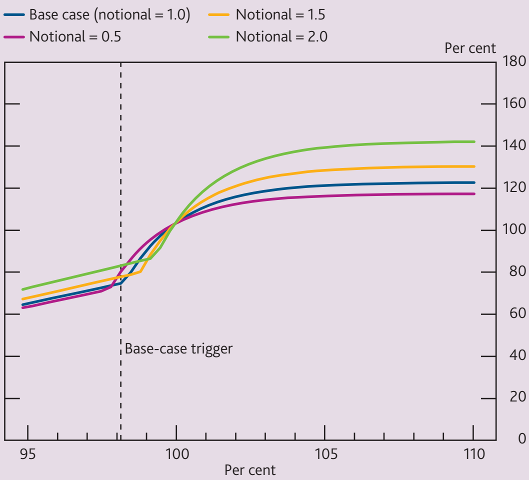
For relative-value investors, if precautionary contingent capital with a concave pay-off function is hedged with the equity of the bank the investor will sell more equity as the value of assets falls and buy more equity as the value of assets rises. This is because the pay-off function for precautionary contingent capital gets steeper as the value of assets falls and gets shallower as the value of assets rises (as shown in the charts). As the pay-off function steepens, the sensitivity of the pay-off to changes in the value of assets increases. Since the pay-off for equity and the value of assets have a close to a one-to-one relationship if the value of assets is far above the level of assets at which the bank would be bankrupt, an investor would need to sell increasing amounts of a bank's equity to hedge its position in a bank's precautionary contingent capital as the value of assets declines.[(1)] The opposite is true if the precautionary contingent capital instrument has a convex pay-off function.[(2)]

If relative-value investors are a significant part of the investor case for a precautionary contingent capital instrument and they use the issuing bank's equity to hedge their positions in this instrument, their trading strategies may amplify volatility in a bank's equity price, in the case of a concave pay-off function for precautionary contingent capital, or dampen volatility, in the case of a convex pay-off function. The strength of these effects is greatest around the trigger (where the convexity or concavity of the pay-off function for precautionary contingent capital is greatest).

The implication of relative-value hedging strategies is that a lower conversion price, which makes the precautionary contingent capital pay-off function less convex, might lead to greater bank equity price volatility than there would be with a higher conversion price.

Chart D shows the implications of varying the notional amount of precautionary contingent capital on the pay-off function. A higher notional value (1.5 or 2.0) shifts up the pay-off function for all possible values of bank assets. The trigger value in terms of the value of assets also changes. For instance, a higher notional value increases the trigger value — the level of assets at which the pay-off function kinks shifts rightwards.

Chart D The effect of varying the notional value of contingent capital on the pay-off to contingent capital[(a)]



Source: Bank calculations.

(a) The vertical axis shows the pay-off to contingent capital as a percentage of the initial value of contingent capital. The horizontal axis is the value of the bank assets as a percentage of the initial value of the bank assets.

Table 1 Risk and return characteristics of equity and precautionary contingent capital

		Direction of the effect on (relative to base case)		
		Expected return	Standard deviation	5% quantile return
Higher coupon (0.07)	Equity	–	–	+
	Precautionary contingent capital	+	+	–
Lower coupon (0.03)	Equity	+	+	–
	Precautionary contingent capital	–	–	+
Higher trigger (9%)	Equity	–	–	–
	Precautionary contingent capital	+	+	+
Lower trigger (5%)	Equity	+	+	–
	Precautionary contingent capital	–	–	+
Higher conversion factor (1.5)	Equity	–	–	+
	Precautionary contingent capital	+	+	–
Lower conversion factor (0.7)	Equity	+	+	–
	Precautionary contingent capital	–	–	+
Higher notional value of contingent capital (1.5)	Equity	–	+	+
	Precautionary contingent capital	+	+	–
Lower notional value of contingent capital (0.5)	Equity	+	–	–
	Precautionary contingent capital	–	–	+

An alternative way to characterising how the pay-off function for precautionary contingent capital varies with the contractual features is a statistic introduced by Albul, Jaffee and Tchistyi (2010), which they refer to as 'lambda'. The numerator of this ratio is the value of equity received by holders of precautionary contingent capital on conversion. The denominator is the present value of a perpetual stream of the coupon payments received by holders of precautionary contingent capital. In other words, the numerator represents the benefit for precautionary contingent capital holders from conversion and the denominator represents the cost to them of conversion.

For example, if the coupon is higher (lower) than in the base case, the value of lambda is lower (higher) since the cost to precautionary contingent capital holders of a conversion is higher (lower). If the conversion price is higher (lower) than in the base case, the value of lambda is lower (higher) since precautionary contingent capital holders receive fewer (more) shares on conversion.(3)

The effects of varying the contractual features of the precautionary contingent capital instrument are also reflected in the risk and return characteristics for this instrument and for equity. **Table 1** shows the direction of the effects of varying contractual features, relative to the baseline case, on expected return, the standard deviation of return, and tail risk (measured by the 5% quantile return).

(1) Investors hedging portfolios with concave pay-off functions in this way are described as pursuing 'short-gamma' hedging strategies.
(2) Investors are then said to be pursuing 'long-gamma' hedging strategies.
(3) The value of lambda does not vary with the value of the trigger or the notional value of precautionary contingent capital in our model because neither affects the numerator or denominator of the lambda ratio.

Appendix A1
A model of precautionary contingent capital

The model of Leland (1994) applies the capital structure framework of Merton (1974) to price the debt and equity of a firm and provides a starting point for modelling precautionary contingent capital. This model incorporates:

- the level of the firm's assets if bankruptcy occurs;
- the value of bankruptcy costs; and
- the value of tax advantages of debt for a firm if interest payments are tax deductible.

The key assumptions of the model that make the model tractable (ie which mean that closed-form solutions can be derived) are that:

- debt is perpetual and the notional value of debt outstanding is constant;
- the risk-free yield curve is flat; and
- Black-Scholes style replicating portfolios can be constructed (ie it is possible to trade the assets of the firm as opposed to, and as well as, pieces of the capital structure).

The model is meant to provide useful insights about how values of a bank and the capital instruments it issues are affected by the introduction of precautionary contingent capital and the contractual features of contingent capital instruments. Several assumptions are made in the model that mean that it is a stylised representation of the real world and more complex models would be more appropriate for producing precise valuations of banks' capital instruments.

- As the firm's assets evolve randomly but the level of debt is held constant, leverage is an output of the model and the level of debt is not assumed to respond to a rise or fall in assets. In reality, banks could be expected to issue more debt as assets rise and as a result leverage is likely to vary less than the model would predict.

- For highly levered firms (like banks) the measurements of asset volatility may be too low to fit market prices. This may in part be due to a lack of kurtosis in the assumed distribution of the assets. Additional structure such as stochastic volatility, additional factors, fat-tailed distributions, and jumps could be introduced to deal with these limitations.

In this model, the risk-free rate is σ. The assets of the firm r evolve as a geometric Brownian motion with volatility σ. Black-Scholes-Merton-type equations for each of the parts of capital structure are derived and solved in turn. The lack of time dependency of the debt is crucial to making the model tractable.

Each capital instrument J (aside from equity) paying coupons at a rate of C per unit time is shown to obey the partial differential equation:

$$\frac{1}{2}\sigma^2 V^2 \frac{\partial^2 J}{\partial V^2} + rV\frac{\partial J}{\partial V} + \frac{\partial J}{\partial t} + C = rJ$$

Since the capital structure is assumed to be time-invariant, the partial derivative with respect to time ($\partial J / \partial t$) is zero for each capital instrument. This gives rise to a series of second order ordinary differential equations which lend themselves to closed-form solutions.

Table A1 describes the elements that are part of the value of the firm and identifies the conditions determining their solutions.

Table A1 A summary of the Leland (1994) model

Element	Notation	Lower boundary condition	Upper boundary condition	Solution
Value of the firm's assets	V	V_B	At infinity	Equity holders choose the optimal level of V_B at which bankruptcy should occur so as to maximise the value of equity (solution given below).
Bankruptcy costs	$B(V)$	$V(V_B) - aV_B$ as $V = V_B$	$B(V) \rightarrow 0$ as $V \rightarrow \infty$	Solution of second order ordinary differential equation: $B(V) = \alpha V_B \left(\frac{V}{V_B}\right)^{\theta}$
Tax benefits	$T(V)$	$T(V_B) = 0$ as $V = V_B$	$T(V) \rightarrow \frac{\tau C_D}{r}$ as $V \rightarrow \infty$	Solution of second order ordinary differential equation: $\frac{\tau C_D}{r}\left[1 - \left(\frac{V}{V_B}\right)^{\theta}\right]$
Total value of firm	$W(V) = V + T(V) - B(V)$			Sum of the parts: $W(V) = V + \frac{\tau C_D}{r}\left[1 - \left(\frac{V}{V_B}\right)^{\theta}\right] - \alpha V_B \left(\frac{V}{V_B}\right)^{\theta}$
Debt	$D(V)$	$D(V) = (1 - a)V_B$ as $V = V_B$	$D(V) = \frac{C_D}{r}$ as $V \rightarrow \infty$	$D(V) = \frac{C_D}{r}\left[1 - \left(\frac{V}{V_B}\right)^{\theta}\right] + V_B(1-\alpha)\left(\frac{V}{V_B}\right)^{\theta}$
Equity	$E(V) = (W(V) - D(V)$			Residual after debt has been deducted from the total value of the firm: $V - \frac{(1-\tau)C_D}{r}\left[1 - \left(\frac{V}{V_B}\right)^{\theta}\right] - V_B\left(\frac{V}{V_B}\right)^{\theta}$
Bankruptcy value	V_B			$V_B = \left(\frac{\lambda}{\lambda - 1}\right)(1-\tau)\left(\frac{C_D}{r}\right)$

Notation:

$V_B =$ value of coupons paid on debt.
$r =$ risk-free rate.
$\tau =$ tax advantage from paying coupons on debt.
$a =$ loss given default.
$\theta = 2r / \sigma^2$

Note that the solution for debt is the weighted average of the coupon stream and the recovery value where the weights are the probabilities of bankruptcy. These are functions of the 'distance to bankruptcy', (V / V_B). As we will see in the next section, the solution for precautionary contingent capital has a similar interpretation.

Extending the model to include precautionary contingent capital

Precautionary contingent capital, denoted as $N(V)$, can be introduced into this model. The contingent capital instrument is assumed to be perpetual and non-callable.

There are three features to note:

- For large values of V, $N(V)$ looks like debt, though it will pay a different coupon, C_N.
- For small values of V (but above V_B), $N(V)$ is equity.
- The dividing line between the two states is defined by that asset level which corresponds to the solvency ratio which triggers conversion, V_T. In order for a unique price for contingent capital to exist there must be a one-to-one mapping between this solvency ratio and the assets of the bank.

The introduction of precautionary contingent capital means that part of the firm's tax shield will disappear at the conversion trigger event. As a result, the value of the firm becomes

$$W(V) = V + \frac{\tau C_D}{r}\left[1-\left(\frac{V}{V_B}\right)^{\theta}\right] + \frac{\tau C_N}{r}\left[1-\left(\frac{V}{V_T}\right)^{\theta}\right] - \alpha V_B\left(\frac{V}{V_B}\right)^{\theta}$$

where the cash flows to debt and precautionary contingent capital are separately identified. The third term in the equation is that part of the firm's value due to the contingent capital tax shield.

The solution for precautionary contingent capital is derived in a similar fashion to the rest of the capital structure, ie

$$N(V) = \begin{cases} \frac{C_N}{r}\left[1-\left(\frac{V}{V_T}\right)^{\theta}\right] + \left(\frac{n_N}{n_N+n_E}\right)[W(V_T)-D(V_T)]\left(\frac{V}{V_T}\right)^{\theta} \\ \frac{n_N}{n_N+n_E}[W(V)-D(V)] \end{cases}$$

if $V(t): \inf\{V(s)|s \le t\} > V_T$

if $V(t): \inf\{V(s)|s \le t\} \le V_T$, respectively **(A1)**

The parameters n_N and n_E are the number of shares held by precautionary contingent capital holders (after conversion) and equity holders, respectively. We assume that the value of n_N is determined by dividing the notional value of contingent capital (N_0) by a conversion price:

$$\delta\frac{E(V_T)}{n_E}$$

where $E(V_T)/n_E = [W(V_T) - D(V_T) - N(V_T)]/n_E$ is the equity price for the value of assets V_T prior to conversion. If the term δ is less (greater) than one, the conversion price is at a discount (premium) to the prevailing equity price at conversion. Substituting the value of $N(V_T)$ from equation **(A1)** into the expression $n_N = N_0/(\delta E(V_T)n_E)$ and rearranging, we get an expression for n_N:

$$n_N = \frac{(N_0/\delta)n_E}{W(V_T)-D(V_T)-(N_0/\delta)}$$

As with the solution for debt, contingent capital is the probability weighted average of the coupon stream and the share of equity where the weights are the probability of hitting the conversion trigger and the value of (total) equity shown in equation **(A2)**.

$$E(V) = \begin{cases} W(V)-D(V)-N(V) \\ \frac{n_E}{n_N+n_E}[W(V)-D(V)] \end{cases}$$

if $V(t): \inf\{V(s)|s \le t\} > V_T$

if $V(t): \inf\{V(s)|s \le t\} \le V_T$, respectively **(A2)**

Below the exercise trigger, the capital structure of the firm changes to reflect the fact that there is now more equity and the precautionary contingent capital holders own $n_N/(n_N + n_E)$ of the equity. So clearly total equity will step up by $N(V_T)$ as the value of assets falls below the trigger V_T.

To understand the behaviour of the pay-off to precautionary contingent capital, it is helpful to define the ratio λ (Albul, Jaffee and Tchistyi (2010):

$$\lambda = \frac{\left(\frac{n_N}{n_N+n_E}\right)[W(V_T)-D(V_T)]}{C_N/r}$$

The numerator is the value of the equity stake that precautionary contingent capital holders receive at conversion and the denominator is the perpetual flow of coupons that precautionary contingent capital holders would receive if their claims did not convert to equity. A higher value of λ indicates that precautionary contingent capital holders gain more from conversion.

There is a close link between λ and the conversion price. To see this substitute the expression for n_N into the expression for λ and rearrange:

$$\frac{\lambda C_N}{r} = \frac{N_0}{\delta}$$

A lower (higher) conversion price means λ has a higher (lower) value.

To understand the behaviour of the pay-off to precautionary contingent capital holders it is also helpful for $V > V_T$ to think of the shadow value of precautionary contingent capital as:

$$\frac{n_N}{n_N + n_E}[W(V) - D(V)]$$

The shadow value is also closely linked with λ. Rearranging the expression for λ and substituting this for $n_N / (n_N + n_E)$ we can see that the shadow value of contingent capital equals

$$\left(\frac{\lambda C_N}{r}\right)\left(\frac{W(V) - D(V)}{W(V_T) - D(V_T)}\right)$$

A higher value of λ implies a higher shadow value of precautionary contingent capital.

Appendix A2
A stylised balance sheet

Table A2 sets out the main elements of the capital structure for a hypothetical bank and the contractual features of the precautionary capital instrument that serve as a base case for analysing how the values of a bank's liabilities change in response to changes in the features of precautionary contingent capital. Consistent with the Leland model, precautionary contingent capital and straight debt are both assumed to be perpetual instruments.

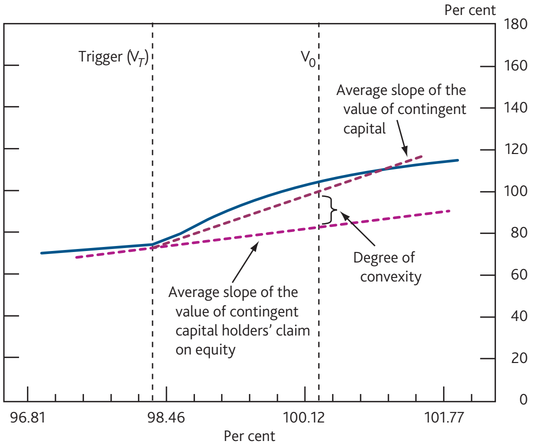
Table A2 Different types of precautionary contingent capital

Parameter	Notation	Calibration
Total value of asset	V_0	100
Notional value of debt	D_0	94.6
Notional value of precautionary contingent capital	N_0	1
Tangible equity	E_0	4.4
Risk-weighted assets/ Total assets	φ	0.39
Core Tier 1 to risk-weighted assets ratio	$E_0 / \varphi V_0$	11%
Conversion trigger (in terms of the core Tier 1 to risk-weighted assets ratio)	k	7%
Level of tangible equity at conversion	$k\varphi\,(N_0 + D_0) / 1 - k\varphi)$	2.7%
Value of assets at conversion	$(N_0 + D_0) / 1 - k\varphi)$	98.3
Coupon on debt	C_D / D_0	3.2%
Coupon on precautionary contingent capital	C_N / N_0	5%
Existing number of shares	n_E	10000
Loss given default	a	50%
Asset volatility	σ	3.4%
Risk-free interest rate	r	3%
Tax rate	τ	25%

Appendix A3
The conversion price and the convexity of precautionary contingent capital

The pay-off function for precautionary contingent capital exhibits a degree of convexity, which is linked to the price at which contingent capital claims convert into equity. The convexity reflects the difference in the slopes of the two parts of the precautionary contingent capital pay-off function. **Chart A1** shows the average slope of the pay-off function to precautionary contingent capital holders prior to conversion and the slope of the contingent capital holders' claim on equity (the shadow value of contingent capital) at the trigger value. The precautionary contingent capital pay-off function is more convex if the difference between the slopes is larger.

Chart A1 Change in the slope of the contingent capital pay-off function above and below the trigger



Source: Bank calculations.

The difference between the two slopes is derived by first considering the difference between the equity price prior to conversion ($E(V) / n_E$) and the effective price from the perspective of precautionary contingent capital holders ($N(V) / n_N$), which can be expressed as:

$$\frac{E(V)}{n_E} - \frac{N(V)}{n_N} = \frac{W(V) - D(V) - N(V)}{n_E} - \frac{N(V)}{n_N}$$

Define $W_{NC}(V)$ to be the value of the bank when there is no precautionary contingent capital in its capital structure. Since precautionary contingent capital is introduced by replacing equity, the value of debt is unchanged by the introduction of precautionary contingent capital. It follows that:

$$W(V) = V + \frac{\tau C_D}{r}\left[1 - \left(\frac{V}{V_B}\right)^{\theta}\right] + \frac{\tau C_N}{r}\left[1 - \left(\frac{V}{V_T}\right)^{\theta}\right] - \alpha V_B\left(\frac{V}{V_B}\right)^{\theta}$$
$$\equiv W_{NC}(V) + T_C(V)$$

where $T_C(V)$ is the tax shield benefit associated with precautionary contingent capital. Substituting $W_{NC}(V) + T_C(V)$ for $W(V)$ we get:

$$\frac{E(V)}{n_E} - \frac{N(V)}{n_N} = \frac{W_{NC}(V) + T_C(V) - D(V) - N(V)}{n_E} - \frac{N(V)}{n_N}$$
$$= \frac{W_{NC}(V) - D(V)}{n_E} - \left[\frac{N(V)}{n_N} + \frac{N(V)}{n_E}\right] + \frac{T_C(V)}{n_E}$$
$$= \frac{1}{n_E}\left(\frac{n_N + n_E}{n_N}\right)\left[\left(\frac{n_N}{n_N + n_E}\right)[W_{NC}(V) - D(V)] - N(V)\right] + \frac{T_C(V)}{n_E} \quad \textbf{(A3)}$$

The term in the square brackets in equation **(A3)** is the difference between the shadow value of precautionary contingent capital and the theoretical value of precautionary contingent capital. Since this term is zero at the trigger, it follows that this difference is a function of the difference between the slopes of the component terms over the interval $[V_T, V_0]$. That is,

$$\left(\frac{n_N}{n_N + n_E}\right)[W_{NC}(V_0) - D(V_0)] - N(V_0) = (V_0 - V_T)\left[\left(\frac{n_N}{n_N + n_E}\right)\left(\overline{\frac{d[W_{NC}(V_0) - D(V_0)]}{dV}}\right) - \overline{\left(\frac{dN}{dV}\right)}\right]$$

where $\overline{(d[W_{NC}(V_0) - D(V_0)] / dV)}$ and $\overline{(dN / dV)}$ are the average slopes of these terms over the interval $[V_T, V_0]$. This is what **Chart A1** shows: originating from the trigger value of assets, the convexity of the value of the precautionary contingent capital instrument at the trigger value is a function of the difference between these slopes.

References

Admati, A R, DeMarzo, P M, Hellwig, M F and Pfleiderer, P (2011), 'Fallacies, irrelevant facts, and myths in the discussion of capital regulation: why bank equity is not expensive', *mimeo*.

Albul, B, Jaffee, D M and Tchistyi, A (2010), 'Contingent convertible bonds and capital structure decisions', *mimeo*.

Basel Committee on Banking Supervision (2010), Group of Governors and Heads of Supervision announces higher global minimum capital standards, September.

Basel Committee on Banking Supervision (2011a), Basel Committee issues final elements of the reforms to raise the quality of regulatory capital, January.

Basel Committee on Banking Supervision (2011b), Measures for global systemically important banks agreed by the Group of Governors and Heads of Supervision, June.

Basel Committee on Banking Supervision (2011c), Global systemically important banks: assessment methodology and the additional loss absorbancy requirement, November.

Bond, P, Goldstein, I and Prescott, E S (2010), 'Market-based corrective actions', *Review of Financial Studies*, Vol. 23, pages 781–820.

Calomiris, C W (2010), 'Beyond Basel and the Dodd-Frank Bill', *mimeo*.

Calomiris, C W and Herring, R (2011), 'Why and how to design a contingent convertible debt requirement?', *mimeo*.

Claessens, S, Herring, R J and Schoenmaker, D (2010), 'A safer world financial system: improving the resolution of systemic institutions', *Geneva Reports on the World Economy*, No. 12.

Coffee Jr, J C (2011), 'Systemic risk after Dodd-Frank: contingent capital and the need for regulatory strategies beyond oversight', *Columbia Law Review*, Vol. 111, No. 7, pages 795–847.

Collazos, P (2011), 'The big financial crisis', in Cannata, F and Quagliariello, M (eds), *Banking regulation: Basel II revised and beyond*, Riskbooks.

Davis, D, Korenok, O and Prescott, E S (2011), 'An experimental analysis of contingent capital triggering mechanisms', *Federal Reserve Bank of Richmond Working Paper Series*, WP 11-01R.

De Jong, A and Van Dijk, R (2007), 'Determinants of leverage and agency problems: a regression approach with survey data', *European Journal of Finance*, Vol. 13, No. 6, pages 565–93.

Duffie, D (2001), *Dynamic asset pricing theory*, Princeton University Press.

Duffie, D (2011), *How big banks fail and what to do about it*, Princeton University Press.

Easterbrook, F H and Fischel, D R (1985), 'Limited liability and the corporation', *University of Chicago Law Review*, Vol. 52, pages 89–117.

Eisdorfer, A (2008), 'Empirical evidence of risk shifting in financially distressed firms', *Journal of Finance*, Vol. 63, No. 2, pages 609–37.

European Banking Authority (2011), 'EBA recommendation on the creation and supervisory oversight of temporary capital buffers to restore market confidence', EBA/REC/2011/1, December.

European Commission (2011), 'Technical details of a possible EU framework for bank recovery and resolution', DG Internal Market and Services Working Document.

European Commission (2012), 'Discussion paper on the debt write-down tool — bail-in'.

Evanoff, D D and Wall, L D (2000), 'Subordinated debt and bank capital reform', *Federal Reserve Bank of Atlanta Working Paper*, No. 2000-24.

Financial Stability Board (2011), 'Policy measures to address systemically important financial institutions', November.

FINMA (2010), 'Addressing 'too big to fail': the Swiss SIFI policy', October.

Flannery, M (2005), 'No pain, no gain': effecting market discipline via reverse convertible debentures', in Scott, H S (ed), *Capital adequacy beyond Basel: banking, securities and insurance*, Oxford University Press.

Flannery, M (2009a), 'Stabilizing large financial institutions with contingent capital certificates', *mimeo*.

Flannery, M (2009b), 'Market-valued triggers will work for contingent capital instruments', *mimeo*.

Flannery, M and Perotti, E (2011), 'CoCo design as a risk preventive tool', VoxEU, February.

Glasserman, P and Nouri, B (2010), 'Contingent capital with a capital-ratio trigger', *mimeo*.

Graham, J R and Harvey, C R (2001), 'The theory and practice of corporate finance: evidence from the field', *Journal of Financial Economics*, Vol. 60, pages 187–243.

Griffin, J M (1988), 'A test of the free cash flow hypothesis: results from the petroleum industry', *Review of Economics and Statistics*, Vol. 70, pages 76–82.

Grossman, R S and Imai, M (2011), 'Contingent capital and bank risk-taking among British banks before World War I', *Wesleyan Economic Working Papers*, No. 2011-003.

G20 (2011), Cannes summit final declaration, November.

Haldane, A G (2011), 'Capital discipline', available at www.bankofengland.co.uk/publications/Documents/speeches/2011/speech484.pdf.

Halpern, P, Trebilcock, M and Turnbull, S (1980), 'An economic analysis of limited liability in corporation law', *University of Toronto Law Journal*, Vol. 30, pages 117–50.

Harris, M and Raviv, A (1991), 'The theory of capital structure', *Journal of Finance*, Vol. 46, No. 1, pages 297–355.

Hart, O (2001), 'Financial contracting', *Journal of Economic Literature*, Vol. 34, pages 1,079–100.

Herring, R J (2011), 'The capital conundrum', *International Journal of Central Banking*, Vol. 7, No. 4, pages 171–87.

Hillion, P and Vermaelen, T (2004), 'Death spiral convertibles', *Journal of Financial Economics*, Vol. 71, No. 2, pages 381–415.

Hindlian, A, Lawson, S and Strongin, S (2009a), 'Effective regulation: part 5 — ending too big to fail', Goldman Sachs Global Market Institute, December.

Hindlian, A, Lawson, S and Strongin, S (2009b), 'Effective regulation: Part 5 — addendum ending too big to fail', Goldman Sachs Global Market Institute, December.

Independent Commission on Banking (2011), *Final report: recommendations*, September.

Jensen, M C (1986), 'The agency costs of free cash flow: corporate finance and takeovers', *American Economic Review*, Vol. 76, No. 2, pages 323–29.

Jensen, M C and Meckling, W H (1976), 'The theory of the firm: managerial behavior, agency costs and ownership structure', *Journal of Financial Economics*, Vol. 3, pages 305–60.

Kashyap, A, Rajan, R and Stein, J (2008), 'Rethinking capital regulation', *mimeo*.

Koziol, C and Lawrenz, J (2012), 'Contingent convertibles: solving or seeding the next banking crisis?', *Journal of Banking & Finance*, Vol. 36, pages 90–104.

Lehn, K and Poulsen, A (1989), 'Free cash flow and stockholder gains in going private transactions', *Journal of Finance*, Vol. 44, No. 3, pages 771–87.

Leland, H (1994), 'Corporate debt value, bond covenants and optimal capital structure', *Journal of Finance*, Vol. 49, No. 4, pages 1,213–52.

Leland, H and Toft, K B (1996), 'Optimal capital structure, endogenous bankruptcy and the term structure of credit spreads', *Journal of Finance*, Vol. 51, No. 3, pages 987–1,019.

Library of Congress (2010), 'Dodd-Frank Wall Street Reform and Consumer Protection Act', July.

McDonald, R L (2010), 'Contingent capital with a dual price trigger', *mimeo*.

Merton, R C (1974), 'On the pricing of corporate debt: the risk structure of interest rates', *Journal of Finance*, Vol. 29, No. 2, pages 449–70.

Miles, D (2010), 'Monetary policy and financial stability', available at www.bankofengland.co.uk/publications/Documents/speeches/2010/speech443.pdf.

Modigliani, F and Miller, M (1958), 'The cost of capital, corporation finance and the theory of investment', *American Economic Review*, Vol. 48, No. 3, pages 261–97.

Modigliani, F and Miller, M (1963), 'Corporate income taxes and the cost of capital: a correction', *American Economic Review*, Vol. 53, No. 3, pages 433–43.

Myers, S C (1977), 'Determinants of corporate borrowing', *Journal of Financial Economics*, Vol. 5, pages 147–75.

Myers, S C and Majluf, N S (1984), 'Corporate financing and investment decisions when firms have information that investors do not have', *Journal of Financial Economics*, Vol. 13, pages 187–221.

Pennacchi, G (2010), 'A structural model of contingent bank capital', *mimeo*.

Pennacchi, G, Vermaelen, T and Wolff, C C P (2010), 'Contingent capital: the case for COERCs', *INSEAD Working Paper*, No. 2010/55/FIN.

Prescott, E S (2011), 'Contingent capital: the trigger problem', *Federal Reserve Bank of Richmond Working Paper Series*, WP 11-07.

Squam Lake Working Group on Financial Regulation (2009), 'An expedited resolution mechanism for distressed financial firms: regulatory hybrid securities', *mimeo*, April.

Sundaresan, S and Wang, Z (2010), 'Design of contingent capital with stock price trigger for conversion', *Federal Reserve Bank of New York Staff Reports*, No. 448.

Wells, B P, Cox, L A and Gaver, K M (1995), 'Free cash flow in the life insurance industry', *Journal of Risk and Insurance*, Vol. 62, No. 1, pages 50–66.