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Contingent Capital: The Trigger Problem

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Abstract

Price triggers in contingent capital bonds are analyzed. Pervasiveness of multiple equilibria and nonexistence of equilibrium in theoretical models is illustrated. Evidence of these problems from market experiments is summarized. Possible solutions are evaluated.

Keywords: bank regulation; contingent capital

JEL Code G14; G28; G32

1 Introduction

Contingent capital is long-term debt that automatically converts to equity when a trigger is breached. It is a new and innovative security that many people are proposing as part of a reform in bank capital regulations.[1] The security was first proposed by Flannery (2005), but with the recent financial crisis many others, including Flannery (2009), Huertas (2009), Squam Lake Group (2010), McDonald (2010), Pennacchi (2011), Pennacchi, Vermaelen and Wolff (2011), Plosser (2010), Hart and Zingales (2011), and Calomiris and Herring (2011), are also advocating it.[2] Furthermore, the Dodd-Frank Wall Street Reform and Consumer

*The views expressed here are those of the author and not necessarily those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1]The changes to bank capital regulations that are already under way are increases in levels of bank capital and making capital requirements more procyclical, that is, requiring banks to increase capital in good times in order to have more of a buffer for bad times.

[2]See Calomiris and Herring (2011) for a more detailed list of the various contingent capital proposals.

Protection Act of 2010 mandated a study of contingent capital, while the Independent Commission on Banking's report on banking in the UK recommended that bank capital structure include loss-absorbing debt like contingent capital.

Contingent capital has three appealing properties. First, it increases a bank's capital when a bank is weak, which is precisely when it is hardest for a bank to issue new equity. In doing so, contingent capital reduces the "debt overhang" problem, which is the inability of a bank to raise funds to finance new loans because their return partially accrues to existing debt holders. During the recent financial crisis, many U.S. banks were forced to raise new equity. If they had had contingent capital securities, this process would have been much easier. Second, contingent capital automatically restructures part of a bank's capital structure, reducing the chance it fails and is put in resolution or bankruptcy.[3] Many people think that the abrupt nature of Lehman's bankruptcy was very disruptive to financial markets, so a pre-bankruptcy reorganization of a financial firm may be valuable. Third, it is a way to force regulators to act, at least when the trigger is tied to an observable variable, like the price of a bank's equity.

All contingent capital proposals rely on a trigger to implement conversion. Most of the proposals advocate the use of a market-price trigger (e.g., Flannery (2005, 2009)), but some of them rely on accounting numbers (e.g., Huertas (2009)), and others also include a role for regulators. For example, Squam Lake Group (2010) advocates as a trigger the use of accounting numbers at the firm level plus a regulatory declaration that there is a systemic crisis.

This paper argues that the trigger is the weak point of contingent capital. In particular, it illustrates how a trigger based on a market price, be it a fixed trigger or a signal for a regulator to act, suffers from an inability to price contingent capital. This inability will be more precisely defined later, but the problem arises because asset prices incorporate the possibility of conversion and the way in which contingent capital is triggered makes this feedback problematic. In practice, this will mean conversion could occur when it is not desired. Unless the price trigger can be designed in a way to overcome this problem, contingent capital with a price trigger will not work.

[3] It is worth noting that even though converting debt to equity raises the book value of equity, it does not bring new cash into a firm (other than from the savings in interest payments on the debt) like a new issuance of equity.

An alternative to a price-based trigger is an accounting-based one. This paper does not focus on this type of trigger except to note that accounting measures of a bank's quality seem to lag its actual condition. For example, the prompt corrective action (PCA) of the Federal Deposit Insurance Corporation Improvement Act of 1991 is an accounting-based regulatory trigger system. It does not convert debt to equity like with contingent capital, but under it, regulators are required to restrict the activities of a bank and even shut it down if regulatory capital drops below certain thresholds. The motivation behind PCA was to force regulators to shut down banks that were in trouble before their losses got too big. In the recent crisis, losses to the deposit insurance fund have been very high despite the existence of PCA (GAO 2011).[4] Based on this experience, caution about the timeliness of accounting measures seems warranted.

Underlying the use of price triggers in contingent capital is the fundamental idea that prices aggregate information, so regulatory arrangements should be able to use them to make decisions. Indeed, one of the most robust findings in financial economics is that prices are efficient in the sense that prices incorporate all available information (Fama (1970)). A striking example is found in Roll (1984), who documents that the price of orange juice futures better predicts variations in Florida weather than the National Weather Service. Indeed, the empirical banking literature surveyed in Flannery (1998) documents that bank security prices can predict changes in supervisory ratings.[5]

This paper illustrates how the usual theoretical and empirical properties of financial prices break down for contingent capital with a price trigger. In particular, the discrete jumps in security prices resulting from conversion interfere with the ability of prices to aggregate information. This problem was noted by Sundaresan and Wang (2011) who found that contingent capital with a fixed-price trigger could not be priced because there did not

[4]Using FDIC data as of September 19, 2011, losses measured as a percentage of assets have been 12.02%, but this number is a much higher 23.90% when Washington Mutual is excluded. Washington Mutual is excluded for two reasons. First, including it skews the average because it had about $300 billion in assets and the FDIC took no loss on it when they arranged a sale through receivership to J.P. Morgan Chase. The high average illustrates that there were a lot of banks for which the accounting numbers substantially lagged their actual condition, otherwise losses would have been much smaller. Second, Washington Mutual was not shut down because of a violation of PCA triggers, but because of liquidity problems. Indeed, it was well capitalized by PCA standards as of September 25, 2008 (OIG 2010), so its accounting numbers lagged its actual condition.

[5]Based on this logic, there is an older and related set of proposals (e.g., Stern (2001)) that advocate that bank supervisors use market prices to supplement their surveillance of banks.

necessarily exist a unique set of prices for a conversion rule that depended on the price of equity. When conversion heavily diluted equity they found that there were multiple equilibria. When conversion did not dilute equity they found that there were no equilibria.

Birchler and Facchinetti (2007) and Bond, Goldstein, and Prescott (2010) studied the related problem of a regulator who could intervene in the operations of a bank and thus affect the value of the bank. In both papers, the regulator did not know the fundamental value of the bank, but instead had to infer it from the prices of the traded bank securities. Instead of using a price-trigger rule, the regulator had trigger-like preferences in that he wanted to intervene only when the fundamental quality of the bank was below some threshold. The effect of the intervention decision is mathematically similar to the effect from a price trigger; there is nonexistence of equilibrium when the regulator cannot commit to an intervention rule, though in the simplest environments there are no multiple equilibria when there is dilution. Indeed, the implication of their work is that when prices are used as a trigger, prices need *not* aggregate all available information.

Birchler and Facchinetti (2007), Bond, Goldstein and Prescott (2011), and Sundaresan and Wang (2011) all use theory to evaluate contingent capital. Unfortunately, there is almost no corresponding empirical evidence. Sundaresan and Wang (2011) report only four issuances of contingent capital, all of which were within the last few years. The only source of data is the contingent capital market experiments reported in Davis, Korenok, and Prescott (2011). Market experiments are small scale economies run in laboratories with human subjects who trade in a market. Their findings were similar to the theory, with some caveats, but also with a much richer set of results about inefficiencies and frequency of conversion errors. A summary of their findings is provided.

Section 2 illustrates the pricing problem with a simple theoretical model. Section 3 discusses possible ways around the pricing problem as well as whether the various proposals are subject to this concern. Section 4 is a digression on contingent capital and incentives. Section 5 briefly discusses the experimental results and section 6 concludes.

2 The Model

There is a bank that is financed by one unit of equity and one unit of debt. Debt is scheduled to pay one and there is one share of equity. The value of the bank, that is, the amount of cash it has to distribute, is $\theta > 0$.

The bank's equity is traded in a market by risk-neutral traders. These traders know the value of θ and use that information plus their expectation of whether debt will be converted to equity to trade the equity. The price of equity depends on θ and is written $p(\theta)$.

For simplicity, this paper only considers conversion rules in which all the debt is converted to equity. This assumption is not important for the results. The *conversion rule* is $\alpha(p)$, which at price p converts the single unit of debt into α shares of equity. As with the trigger rule proposals, the conversion depends on the price of equity. There are a lot of possible conversion rules, but the rules most of the proposals consider are of the form

$$\alpha(p) = \begin{cases} \alpha > 0 & \text{if } p \leq \hat{p} \\ 0 & \text{if } p > \hat{p} \end{cases},$$

where $\hat{p}$ is some fixed cutoff. The idea is that as a bank gets closer to insolvency, its share price will drop and that is when it is best to automatically convert debt to equity.

Definition 1 *Given a trigger rule, $\alpha(p)$, an equilibrium is a price of equity, $p(\theta)$, such that, $\forall\theta$*

$$p(\theta) = \begin{cases} \frac{\theta}{1+\alpha(p(\theta))} & \text{if } \alpha(p(\theta)) > 0 \\ \theta - 1 & \text{if } \alpha(p(\theta)) = 0 \end{cases}. \quad (1)$$

Equilibrium requires that prices, $p(\theta)$, be consistent with the conversion rule. As we will see, for some conversion rules no $p(\theta)$ that solves (1) will exist and for others multiple $p(\theta)$ will exist.

No Conversion

As a benchmark, consider the case of no conversion of debt. In this case, the price of equity is

$$p(\theta) = \begin{cases} 0 & \text{if } \theta \leq 1 \\ \theta - 1 & \text{if } \theta > 1 \end{cases}.$$

When $\theta \leq 1$ all the firm's payments go to the debt holders and there is nothing left for equity holders. When $\theta > 1$, the debt holders get the full payment of one and the equity holders get what is left.

Heavy Equity Dilution

Most contingent capital proposals advocate setting conversion so as to heavily dilute equity in order to "punish" the owners of the bank.[6] The problem with a trigger rule that heavily dilutes equity is that there are multiple equilibria. To illustrate the problem, consider the trigger rule that if the price of equity is less than or equal to 1.5 then the debt is converted to one share of equity, so there are two shares of equity total. Formally,

$$\alpha(p) = \begin{cases} 1 & \text{if } p \leq 1.5 \\ 0 & \text{if } p > 1.5 \end{cases} .$$

Under this trigger rule, an equilibrium exists. One of them is

$$p(\theta) = \begin{cases} \theta/2 & \text{if } \theta \leq 3 \\ \theta - 1 & \text{if } \theta > 3 \end{cases} .$$

To see this, if at $\theta \leq 3$, the traders assume that there will be conversion, then the price is less than or equal to 1.5, which is consistent with the conversion rule. Similarly, for $\theta > 3$, if the traders assume that there is no conversion, then the price is $\theta - 1 > 1.5$, which is also consistent with the conversion rule.

A second equilibrium is

$$p(\theta) = \begin{cases} \theta/2 & \text{if } \theta \leq 2.5 \\ \theta - 1 & \text{if } \theta > 2.5 \end{cases} .$$

At $\theta \leq 2.5$, if traders assume there will be conversion, then the price will be less than or equal to 1.25, which is consistent with the conversion rule. Similarly, for $\theta > 2.5$, if the traders assume that there is no conversion, then the price is $\theta - 1 > 1.5$, which is also consistent with the conversion rule.

As should be apparent, any price function in which traders assume that there will be conversion for values of θ below any cutoff between 2.5 and 3.0 will be an equilibrium. But actually, the multiple equilibrium problem is even worse than this. There are *lots* of other price functions that are equilibria, some of which are rather strange. For example,

$$p(\theta) = \begin{cases} \theta/2 & \text{if } \theta \leq 2.5 \\ \theta - 1 & \text{if } 2.5 < \theta \leq 2.6 \\ \theta/2 & \text{if } 2.6 \leq 3 \\ \theta - 1 & \text{if } \theta > 3 \end{cases}$$

[6] See Section z for a discussion of incentives for equity owners.

is also an equilibrium!

Multiple equilibria is a serious problem for contingent capital. How do you price it in practice? As we will see, in the experimental evidence a variety of prices occur. In terms of the proposal this means that conversion need not happen when it desired or it may happen when it is undesired.

Increased Value of Equity

The proposals do not advocate conversion to increase the value of equity, but this case still has to be studied for two reasons. First, there may very well be states of the world where the price of equity is low, but conversion would increase the value of equity. For example, imagine a very high probability that θ will be less than 1, the amount owed to debtors. Equity does not have much value in this case, but if the debt is converted to equity, then the price of equity may very well go up even if it is heavily diluted. After all, a high probability of a small payment can be more valuable than a low probability of a high payment. Second, the proposals for regulators to use prices to take regulatory actions, like replacing management or something similar, could very well *increase* the value of the bank. This was the scenario studied in Birchler and Facchinetti (2007) and Bond, Goldstein, and Prescott (2010).

If the value of equity increases from a conversion then the problem is not one of multiple equilibria, but instead one that no equilibrium even exists. To see this, consider the same price trigger level as above, but now convert debt into 0.5 shares, that is,

$$\alpha(p) = \begin{cases} 0.5 & \text{if } p \leq 1.5 \\ 0 & \text{if } p > 1.5 \end{cases} .$$

Under this trigger rule, no equilibrium exists. To see this, consider what the price can be if $\theta = 2.5$. If traders assume there is conversion then there is no debt and 1.5 shares of equity. The price of equity would then have to be 2.5/1.5, but that is greater than the 1.5 trigger, so there cannot be conversion. Alternatively, if traders assume that there is not conversion then the price of equity is 1.5 without conversion, but that violates the trigger rule of converting when the price is less than or equal to 1.5.[7]

Figure 1 illustrates the problem. The gray line shows what prices would be *if* conversion could be tied directly to the fundamental value θ. The problem here is that a conversion

[7]This is not just a problem right at the trigger point. The same logic applies to a range of fundamentals below 2.5, in this example, down to 2.25.

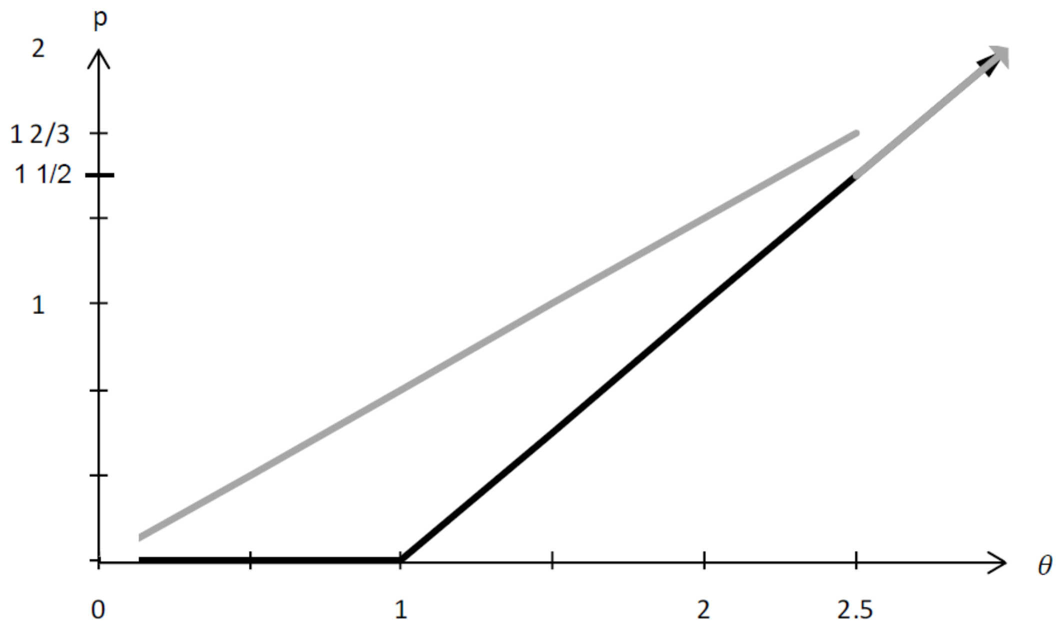

Figure 1: Increased Value of Equity Case: The black line shows the price of equity with non-convertible debt. The gray line shows the price of equity with convertible debt *assuming* that it converts to equity when $\theta \leq 2.5$. The gray line is nonmonotonic, which is suggestive as to why there is no equilibria when the price trigger is set at 1.5. For θ just below 2.5, the price drops below 1.5 without conversion and increases above 1.5 with conversion. Neither possibility is consistent with the trigger rule.

rule that increases the price of equity requires a price function that is above the trigger value for a range of θ values below the trigger. This non-monotonicity in prices around the trigger implies that the trigger rule, as commonly proposed, cannot distinguish between values of θ for which conversion is desirable and values for which it is not.

3 Solutions?

These two problems - multiple equilibria under dilutive conversion and nonexistence under nondilutive conversion – are a serious challenge to contingent capital proposals. Certainly, triggers of the form analyzed above would not work. There are, however, alternative ways to structure the trigger that avoid these problems. Below, some possible solutions are described and assessed.

Getting the Conversion Ratio Just Right

If conversion is set so that the value of equity does not change at conversion, then there is a unique equilibrium. In the example above, a trigger rule that works is at a price of 1.5, convert the debt to 2/3 a share. In this case, the conversion occurs at $\theta = 2.5$, which keeps equity at a price of 1.5.

For this example, this conversion rule works, but the problem is that the conversion ratio needs to be set just right. The above example had no uncertainty, but in a dynamic model the trigger rule needs to be designed to be robust over a variety of paths of uncertainty, and specifying this just right is difficult. Furthermore, in this example this conversion rule actually helps the original equity owner! For values of θ less than 2.5, the value of a share is more than it would be without conversion.

Sliding Conversion Rules

One way to "get the conversion ratio just right" without rewarding equity owners is to use a "sliding conversion rule." The idea is to make the amount of dilution vary so that as θ declines, the price continuously decreases. The monotonicity is needed for existence and the continuity is needed for uniqueness. Birchler and Facchinetti (2007) used a similar concept in their regulatory action model to get existence when there was a value-increasing action.

For this example, assume that the lower bound on θ is 0.5. A conversion function that generates a unique price function is

$$\alpha(p) = \begin{cases} (9p - 0.5)/p & \text{if } 0.10 \leq p \leq 0.25 \\ (4.75 - 1.5p)/2.5p & \text{if } 0.25 < p \leq 1.5 \\ 0 & \text{if } p > 1.5 \end{cases}.$$

Figure 2 shows the price function that results from this conversion rule. It is the piecewise linear gray line, and it is straightforward to show that it is the unique price function. There are three things to note about this function. First, the continuity prevents the multiple equilibria that arose in the heavy dilution example. Second, the monotonicity prevents the discrete drop in price at and above a trigger point, which was the source of nonexistence in the increased value example. Third, the price schedule rewards equity owners at low values of θ, but not by much. This feature is there to prevent the price from being zero. If there is a trigger that that wipes out equity and thus makes the price of equity zero, then there is also an equilibrium where the price of equity is zero for any value of θ.

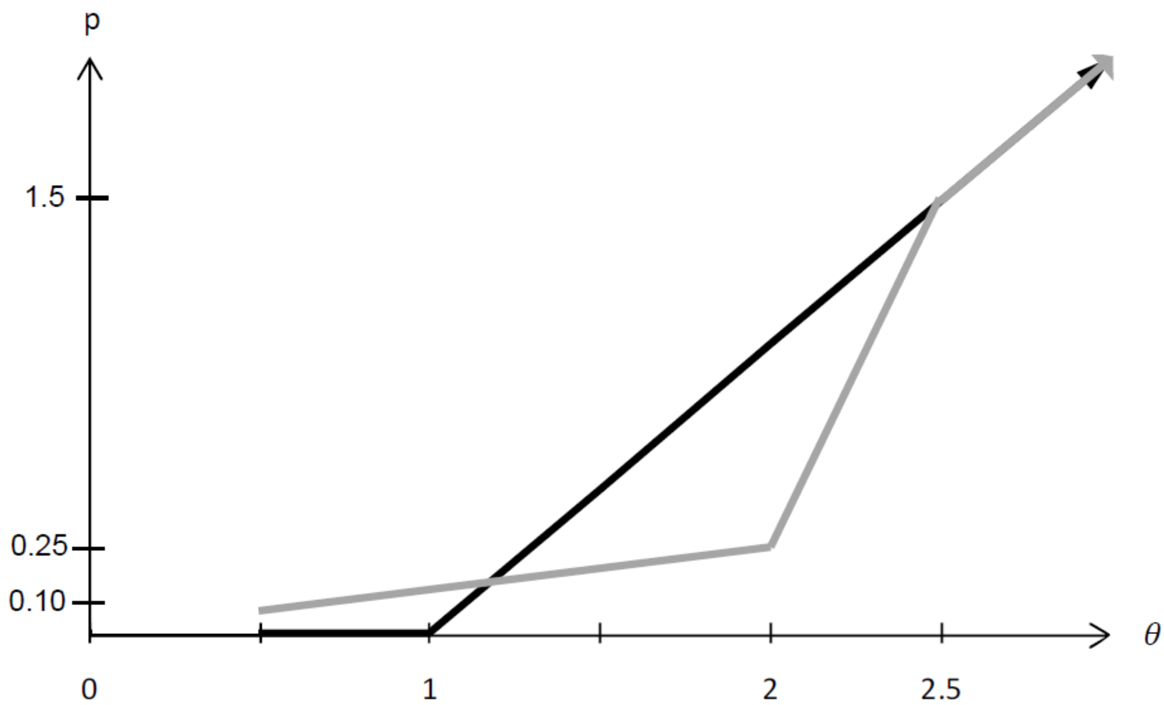

Figure 2: The black line shows the price of equity with non-convertible debt. The gray line shows the price of equity with debt that converts to equity using the sliding conversion rule in the text. The price function is continuous and monotonically increasing. Relative to non-convertible debt, it hurts original equity owners for high values of θ, but helps them for low values of θ.

Price Restrictions

A simple way to deal with the multiple equilibria is to forbid exchanges of equity at certain prices. In the heavy dilution example above, if equity were forbidden to trade over the range $(1.25, 1.5]$ then the only equilibrium would be the one where conversion occurs for $\theta \leq 2.5$. The other equilibria discussed above simply cannot occur.

Even if it were feasible to prohibit trading at certain prices, this solution would still require a lot of information to set up. The amount of the drop in the price of equity will depend on the aggregate state, (something which was not in the model above). That requires a lot of information on the part of regulators to set up.

Use Other Information

Another possible solution is to make the conversion depend on the total value of the firm (e.g., Pennacchi (2011)). In the example, this is simply the value of equity plus debt. If the trigger were set so that the value of equity plus debt is less than or equal to 2.5, then a price equilibrium would exist and it would be unique. The reason is that the value of equity plus debt is simply the value of firm, that is, the cash flow θ, and that does not change with the conversion.

The obvious concern with this solution is that markets for bank debt (not to mention bank deposits) are far less liquid than those for equity. But even if those issues could be overcome, the deeper issue is whether conversion affects the value of a firm. The firm-value trigger works in this example because it is a Modigliani-Miller environment in that the capital structure does not affect the value of the firm. However, implicit in many of the arguments behind contingent capital is that bond to equity conversion will *improve* the value of the firm by eliminating "debt overhang" or other problems, that is, these proposals are *not* in a Modigliani-Miller world. Thus, a change in the capital structure can create a discrete change in the value of the firm and the situation is the same as analyzed above.[8]

Prediction Markets

Another possible solution is to introduce prediction markets in whether there is conversion and use that information as part of the trigger. Bond, Goldstein, and Prescott (2010) show that in the regulatory action with heavy dilution case, when prediction markets are added, a unique equilibrium exists. With price trigger rules that also depend on the price of the prediction security, a unique equilibrium exists for both the dilution and nondilution cases.

The prediction market is a market in a security that pays one if there is conversion and zero otherwise. The same traders who trade equity also trade the prediction security. The price of the prediction security is $q(\theta)$ and the trigger rule now depends on both prices, that is, $\alpha(p, q)$. A price of one means that traders expect conversion and a price of zero means they do not.

[8]The Birchler and Facchinetti (2007) and Bond, Goldstein, and Prescott (2010) studies were precisely worried about regulatory interventions that changed, and more specifically improved, the value of the bank.

Definition 2 *Given a trigger rule, $\alpha(p,q)$, an equilibrium is a price of equity, $p(\theta)$ and a price of the prediction security, $q(\theta)$, such that, $\forall\theta$*

$$p(\theta) = \begin{cases} \frac{\theta}{1+\alpha(p(\theta))} & \textit{if } \alpha(p(\theta),q(\theta)) > 0 \\ \theta - 1 & \textit{if } \alpha(p(\theta),q(\theta)) = 0 \end{cases} \tag{2}$$

$$q(\theta) = \begin{cases} 0 & \textit{if } \alpha(p(\theta),q(\theta)) = 0 \\ 1 & \textit{if } \alpha(p(\theta),q(\theta)) > 0 \end{cases} . \tag{3}$$

For the heavy dilution example above, consider the following modification to the earlier trigger rule

$$\alpha(p,q) = \begin{cases} 1 & \text{if } p \leq 1.25 \\ 1 & \text{if } 1.25 < p \leq 1.5 \text{ and } q = 0 \\ 0 & \text{if } 1.25 < p \leq 1.5 \text{ and } q = 1 \\ 1 & \text{if } p > 1.5 \end{cases} .$$

The price function

$$p(\theta) = \begin{cases} \theta/2 & \text{if } \theta \leq 2.5 \\ \theta - 1 & \text{if } \theta > 2.5 \end{cases}$$

$$q(\theta) = \begin{cases} 0 & \text{if } \theta \leq 2.5 \\ 1 & \text{if } \theta > 1 \end{cases}$$

is an equilibrium. For $\theta \leq 2.25$, conversion has to happen, while for $\theta > 3$, conversion cannot happen. Where the prediction security gets used is for the range of θ where multiple equilibria was an issue without the prediction security. First, consider the range $2.25 < \theta \leq 2.5$. If traders assume that there will be no conversion, then $1.25 < p \leq 1.5$ and $q = 0$, but by the trigger rule there will be conversion. If traders assume there will be conversion, then $p \leq 1.25$, and there is conversion (and $q = 1$), which is consistent with the trigger rule. Second, consider the range $2.5 < \theta \leq 3$. If traders assume that there will be conversion, then $1.25 < p \leq 1.5$ and $q = 1$, but by the trigger rule there will not be conversion. In contrast, if traders assume there will not be conversion, then $p > 1.5$, and there is no conversion (and $q = 0$), which is consistent with the trigger rule. This trigger rule eliminates the multiple equilibria by making it impossible for prices to fall in the range between 1.25 and 1.5, which prevents conversion at values of $\theta > 2.5$. Essentially, this solution uses the trigger rule to restrict the equilibrium prices traded to get the same effect as the price restriction solution discussed above.

In the weak dilution case, where existence of equilibrium was the problem earlier, the prediction market gives the trigger rule enough extra information to recover existence. Consider the trigger rule

$$\alpha(p,q) = \begin{cases} 0.5 & \text{if } p \leq 1.5 \\ 0.5 & \text{if } 1.5 < p \leq 1\frac{2}{3} \text{ and } q = 1 \\ 0 & \text{otherwise} \end{cases} .$$

The price function

$$p(\theta) = \begin{cases} \theta/2 & \text{if } \theta \leq 2.5 \\ \theta - 1 & \text{if } \theta > 2.5 \end{cases}$$

$$q(\theta) = \begin{cases} 0 & \text{if } \theta \leq 2.5 \\ 1 & \text{if } \theta > 1 \end{cases}$$

is a unique equilibrium. To see this, first consider $\theta \leq 2.5$. If traders assume conversion, then $p \leq 1\frac{2}{3}$ and $q = 1$, which is consistent with the trigger rule. If traders assume no conversion then $p(\theta) < 1.5$, but that requires conversion according to the trigger rule, so that is not a possibility. Now consider $\theta > 2.5$. If traders assume that there is no conversion, then $p > 1.5$ and $q = 0$, which is consistent with the trigger rule. However, if traders assume conversion, then $p > 1\frac{2}{3}$, which by the trigger rule requires no conversion, so that is not a possibility.

4 A Digression on Incentives

Many of the proposals advocating contingent capital emphasize the value of "punishing" the equity owners by diluting equity (e.g., Calomiris and Herring (2011)) in order to improve equity owners ex ante incentives. Structuring bank capital structure to improve incentives is an idea with a long tradition in the banking literature (e.g., Karekan and Wallace (1978)). The banking literature that came out of the S & L crisis emphasized the risk-shifting incentives that bank equity owners have under a legal and regulatory system that includes limited liability and deposit insurance (e.g., White (1991)).

This perspective is one that I am sympathetic with, but if incentives are the goal, then the analysis is better served by directly using an incentive model with an explicit treatment of moral hazard. The standard approach is to use a moral hazard model where bank equity owners have limited liability and can choose the amount of risk the bank takes.[9] Interestingly,

[9]Implicitly, these models assume that bank managers act in the best interest of equity owners.

in this class of models, Marshall and Prescott (2001, 2006) found that the most effective way to discourage a bank from taking excessive risk was to, counterintuitively, "punish" the bank when it did well! (In their context, punishment meant requiring that the bank's capital structure include warrants with a high strike price that essentially reduced the upside gain to the bank. For a summary of their argument, see Prescott (2001).) The reason for their surprising result was that very high returns were more likely when a bank took an excessive amount of risk than an appropriate amount, so reducing equity holders payoff in these states was desirable. In their model, it was also desirable to "punish" the equity holders when the bank did poorly, but limited liability limited the amount of punishment that could be provided in this case.

The point of this digression is that bank incentives need to be viewed from a broad perspective that may well put little emphasis on "punishing" equity holders when a bank does poorly, or more accurately, that the incentive implications of a heavy dilution are only a part, and possibly a small part, of the total incentives created by a bank's capital structure. For this reason, I think recapitalization effects rather than any incentive effects are what is potentially most valuable about contingent capital.

5 Evidence

There is very little empirical evidence on the effectiveness of contingent capital. Sundaresan and Wang (2011) report only four examples of contingent capital, all of which were issued after the financial crisis. The only source of evidence that I am aware of is from the laboratory experiments reported in Davis, Korenok, and Prescott (2011). Laboratory experiments are games played by subjects (typically college students) for real stakes. The experiments can be used to study individual decision making or more complex group interactions.

Davis, Korenok, and Prescott (2011) ran experiments where the subjects used an auction market to trade an asset that could change in value if a price trigger were breached. The price trigger worked just like the examples above. If breached, the underlying value of the asset jumped up in some of the experiments and dropped in others. They ran experiments where there was a price trigger, where there was a regulator who could look at the price of the asset to decide whether to intervene and change the value of the asset, and where there was a regulator who also observed the results of a prediction market before deciding to intervene.[10]

As predicted by theory, they found that the fixed-price trigger created informational inefficiencies in the sense that prices deviated from fundamentals. This was true in both the dilution and non-dilution experiments. Furthermore, compared with a no-conversion baseline, they found that conversion made the allocation less efficient in the sense that assets ended up less frequently in possession of the the traders who valued them the most. Finally, they also found the trigger was frequently breached when the fundamentals did not warrant conversion. For some ranges of fundamentals, these errors exceeded 50 percent of the time. There were some caveats to their findings. In particular, conversion errors in the heavy dilution experiments were concentrated in the range of fundamentals just above the trigger, which may be tolerable. For more details see the paper, but overall they concluded that the feedback between prices and conversion reduced the effectiveness of using a price trigger.

6 Conclusion

This paper illustrated the potential pitfalls of using a market-price trigger in contingent capital. The multiple equilibria and nonexistence results are problematic for these proposals. Indeed, in the closest thing we have to empirical evidence, the market experiment data, the use of a trigger made prices and allocations less efficient and led to numerous conversion errors.

In my view, any contingent capital proposal that uses market-based prices needs to confront these problems. A viable proposal needs to find a trigger that is not subject to multiple equilibria and nonexistence or, alternatively, one that leads to few conversion errors and minor inefficiencies.

[10] They did not run experiments where a prediction market was combined with a fixed-price trigger.

References

[1] Birchler, Urs and Matteo Facchinetti. 2007. ”Self-Destroying Prophecies? The Endogeneity Pitfall in Using Market Signals for Prompt Corrective Action.” Manuscript, University of Zurich.

[2] Bond, Philip, Itay Goldstein and Edward Simpson Prescott. 2010. “Market-Based Corrective Actions.” *The Review of Financial Studies* 23: 781-820.

[3] Calomiris, Charles and Richard Herring. 2011. “Why and How to Design a Contingent Convertible Debt Requirement.” Wharton Financial Institutions Center Working Paper No. 11-41.

[4] Davis, Douglas, Oleg Korenok, and Edward Simpson Prescott. 2011. “An Experimental Analysis of Contingent Capital Triggering Mechanisms.” Federal Reserve Bank of Richmond Working Paper No. 11-01R.

[5] Flannery, Mark J. 1998. “Using Market Information in Prudential Bank Supervision: A Review of the U.S. Empirical Evidence.” *Journal of Money, Credit and Banking*: 273-305.

[6] Flannery, Mark J. 2005. “No Pain, No Gain? Effecting Market Discipline via ‘Reverse Convertible Debentures.’” In *Capital Adequacy Beyond Basel: Banking, Securities, and Insurance,* Ed. Hal Scott, Oxford: Oxford University Press, 2005.

[7] Flannery, Mark J. 2009. “Stabilizing Large Financial Institutions with Contingent Capital Certificates.” Manuscript, University of Florida.

[8] Government Accountability Office. 2011. “Bank Regulation: Modified Prompt Corrective Action Framework Would Improve Effectiveness.” GAO-11-612. June.

[9] Hart, Oliver and Luigi Zingales. 2010. “A New Capital Regulation for Large Financial Institutions.” FEEM Working Paper No. 124.2009.

[10] Huertas, Thomas F. “Too Big to Fail, Too Complex to Contemplate: What to do about Systemically Important Firms.” Manuscript, September 15, 2009.

[11] Karekan, John and Neil Wallace. 1978. "Deposit Insurance and Bank Regulation: A Partial-Equilibrium Exposition." *Journal of Business* 53: 365-381.

[12] Independent Commission on Banking. 2011. "Final Report Recommendations." September.

[13] Marshall, David A. and Edward Simpson Prescott. 2001. "Bank Capital Regulation with and without State-contingent Penalties." *Carnegie-Rochester Conference Series on Public Policy* 54: 139-184.

[14] Marshall, David A. and Edward Simpson Prescott. 2006. "State-contingent Bank Regulation with Unobserved Actions and Unobserved Characteristics." *Journal of Economic Dynamics & Control* 30: 2015-2049.

[15] McDonald, Robert L. 2011. "Contingent Capital with a Dual Price Trigger." Manuscript, Northwestern University.

[16] Offices of Inspector General. 2010. "Evaluation of Federal Regulatory Oversight of Washington Mutual Bank." Report No. EVAL-10-002, Federal Deposit Insurance Corporation. April.

[17] Pennacchi, George. 2011. "A Structural Model of Contingent Bank Capital." Manuscript, University of Illinois.

[18] Pennacchi, George, Theo Vermaelen, and Christian C. P. Wolff. 2010. "Contingent Capital: The Case for COERCs." INSEAD Working Paper 2010/89/FIN.

[19] Plosser, Charles. 2010. "Convertible Securities and Bankruptcy Reforms: Addressing Too Big to Fail and Reducing the Fragility of the Financial System." Conference on the Squam Lake Report: Fixing the Financial System, Manuscript, June 16.

[20] Prescott, Edward Simpson. 2001. "Regulating Bank Capital Structure to Control Risk." Federal Reserve Bank of Richmond *Economic Quarterly* 87(3): 35-52.

[21] Roll, Richard. 1984. "Orange Juice and Weather." *American Economic Review* 74: 861-880.

[22] Squam Lake Group. 2010. The Squam Lake Report: Fixing the Financial System. Princeton University Press, Princeton.

[23] Stern, Gary. 2001. "Taking Market Data Seriously." *The Region* Federal Reserve Bank of Minneapolis, September 2001.

[24] Sundaresan, Suresh and Zhenyu Wang. 2011. "On the Design of Contingent Capital with Market Trigger," Federal Reserve Bank of New York Staff Report No. 448.

[25] White, Lawrence J. 1991. *The S&L Debacle.* Oxford University Press, New York.