On the Relevancy of Modigliani and Miller to Banking: A Parable and Some Observations

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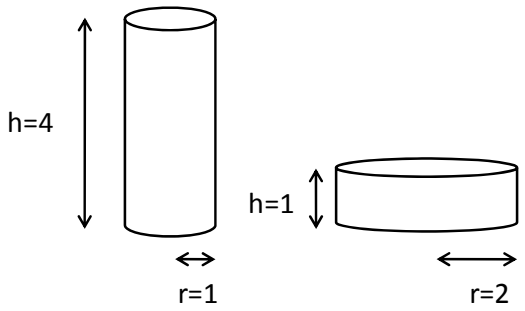
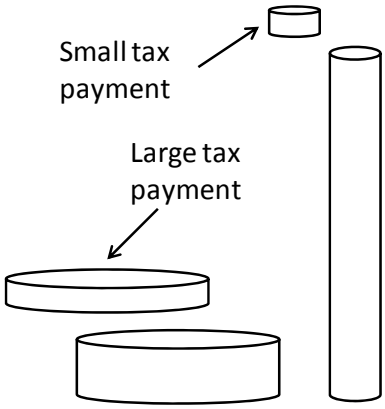
The Parable:

In a realm quite different from our own exists the small city state of Metallia. The economy of Metallia is based on mining various metals that are found deposited outside of the city. Once they are mined, these metals are stored in the form of giant, solid cylinders within the city walls. Over the years, a great controversy has raged over the optimal shape for these cylinders. It is well understood that the shape and size of a cylinder are determined by only two variables: the cylinder's height (*h*) and the radius of its base (*r*). Some Metallians have contended that height is good, since a taller cylinder generally has more metal in it than a shorter one. Because of this, these Metallians have argued, it is good to have a high *h* to *r* ratio. Based on this notion, many cylinders have been melted down and reshaped to give them higher *h* to *r* ratios.

Not terribly long ago the controversy over cylinder shape came to a head when two Metallian metallurgists, Ferrous Modigliani and Molybdenum Miller, argued that there is nothing magical about height: *unless other factors beyond the simple principles of solid geometry are involved,* no additional volume of metal can be created by reshaping cylinders. Indeed, they devised a formula, $V = h\pi r^2$, which shows that if one quadruples *h*, the value of *r* is automatically halved and the volume of metal stays the same. This means that shape is irrelevant to the volume of metal contained in the cylinder. This became known as the M&M irrelevancy result. Many Metallians were deeply suspicious of the Modigliani and Miller result and thought it had to be wrong or didn't apply to actual cylinders.



Now Modigliani and Miller were very smart metallurgists, and they realized that there would be circumstances in which cylinder shape would matter. For example, they knew that the Metallian tax system favored height over width. Every year the tax authorities cut off a layer ten feet thick from the top of each cylinder. This means that tall and thin cylinders retain more of their volume, after tax, than short and wide ones. There are other considerations that can make cylinder shape matter. For example, tall and thin cylinders are more likely to be blown over by the wind, and when a cylinder falls, some of the metal it contains can be lost.



Additional losses occur because metal needs to be paid to the Chapter 11 Crane Company, which is charged with putting the cylinder upright again. This means that it is not wise to make *h* too large relative to *r*. Optimal cylinder shape also potentially depends on the type of metal. For example, iron oxidizes so it is better to have less surface area exposed to the air, which means that a high ratio of *h* to *r* is not desirable for an iron cylinder. All of these considerations that take us beyond the rules of solid geometry can be considered "frictions."

Many Metallians have come to believe that when there are frictions, Modigliani and Miller's insights about cylinder volume are completely irrelevant and can be ignored: "Modigliani and Miller does not apply." But other Metallian metallurgists have pointed out that this is false. One of them said the following at a recent conference of the Metallian Metallurgical Society:

> "Some are claiming that Modigliani and Miller does not apply when there are frictions. It is very important to realize that the existence of frictions does not mean that the laws of solid geometry are suspended. Consider a Metallian who is planning to melt down his iron cylinder and reshape it to have a higher *h*. Is this a good idea? The answer obviously is that this is a good idea only if increasing the cylinder's height (and reducing its width) increases the volume that remains by somehow reducing what is lost to frictions. Only by determining and comparing the magnitudes of the original and the remaining frictions can this Metallian determine whether it is in *his* interest to reshape the cylinder to increase its height."

Recently, the economy of Metallia has been suffering because of problems caused by the city's gold cylinders. Over the last few years the city's gold storage managers substantially increased the height of their cylinders. Part of this increase came about because gold miners found new gold outside the city, but a good part of the increase was due to the gold storage managers significantly increasing their cylinders' *h* to *r* ratios, which made their cylinders very tall and very thin. (Some Metallians have claimed that one reason that the city's gold cylinders became so tall was that gold storage managers' compensation was tied to cylinder height.) Not too long ago a strong wind blew on the city and the gold cylinders started to topple. A few did fall to the ground and some others (ones that were considered "too big to fall") would have fallen if the city government hadn't stepped in and provided physical support at great cost to the city. Since the city's gold cylinders had all been located very close together, the city government was especially worried that if one fell, it would take others with it and the collateral damage would be significant. The precariousness of the gold cylinders caused a general panic throughout the city and mining efforts were greatly reduced as a result. In an effort to make the cylinders much less likely to topple and do damage to the city, some Metallians have called for restrictions on how tall gold cylinders can be relative to their width. In fact, it was argued that incentives to build tall and skinny cylinders may have increased since gold managers now realize that the city will support their cylinders if they begin to topple.

The following is a partial transcript of a recent interview in which a gold storage manager was questioned about height restrictions:

Interviewer: Several Metallians are calling for a restriction on the height of gold cylinders in the city. Do you agree that gold cylinders were too tall and thin?

Gold Manager: Perhaps they were somewhat too tall, but we must be careful not to restrict their height too much. Width is expensive. If you force us to use more width, not as much gold will be mined and stored in the city, and that will be very bad!

Interviewer: Why is "width" expensive?

Gold Manager: Because width reduces height and if you rely too much on width, you lose.

Interviewer: I'm not sure I understand. It seems a bit confusing.

Gold Manager: No, it's actually rather simple. Let's say I have a cylinder that is 1000 feet high and 40 feet wide. If you tell me that I have to increase my cylinder width to 50, my cylinder height will drop to 640. A 25% increase in my width causes a 36% drop in my height. That is a huge drop in height. It's very costly.

Interviewer: How is it costly? Isn't that contrary to what Ferrous Modigliani and Molybdenum Miller showed?

Gold Manager: Modigliani and Miller doesn't apply to gold. Gold is different.

Interviewer: Why is gold different?

Gold Manager: Because gold is meant to be stored with a high h and a low r. It is the nature of gold.

Interviewer: And why is that the nature of gold?

Gold Manager: Because when you store it that way, you end up having more gold. It is important to economize on width. Width is very costly because it has a huge effect on height.

Interviewer: This doesn't seem to be getting us anywhere. It is clear that there are significant costs when gold cylinders are tall and thin. They can do

terrible damage to the city. You seem to be saying that there are some benefits to having tall and skinny gold cylinders.

Gold Manager: Yes, height is very important in our business. It saves on width.

Interviewer: But if height is important, it must be because it produces benefits and these benefits must come from reducing costs due to some frictions. The laws of geometry still matter. Simply changing shape by itself doesn't change the amount of gold. If cylinder shape matters, it must be because of frictions. Isn't that correct?

Gold Manager: I'm not sure. I suppose that is true.

Interviewer: Isn't it important that we measure what the benefits are to the city (if any) of tall and thin cylinders and compare those with the costs to the city?

Gold Manager: If you do that, just remember that width is expensive, especially for gold.

[Here the transcript ends and so does this parable.]

Observations:

The Metallian M&M results (those due to Ferrous and Molybdenum) are based on a simple conservation principle: changing the shape of a metal cylinder does not *in and of itself* change the volume of metal that the cylinder contains. If the volume of metal changes, it must be due to changes in some metallurgical frictions that occur as a result of the change, not simply because of the change in the dimensions themselves. This applies to cylinders of any metal, including gold.

The M&M results of Franco Modigliani and Merton Miller are also based on a simple conservation principle. A firm's assets generate cash flows, and changing the way those cash flows are paid out to shareholders and debtholders who fund the firm does not *in and of itself* change firm value. If funding costs or total value is affected, it must be due to how frictions are affected by the change, not simply because of a change in the funding mix of debt and equity. This applies to any type of firm, including banks.

In the parable there is some confusion about the roles height and width play in determining volume. (The gold storage manager is focused on height and laments that a 25% increase in width results in a 36% drop in height.) These are confusions about dimensions and their relation to volume. Similar confusions are found in many discussions about bank capital.

These take the form of confusions about rates of return and their relation to value. Here are some examples:

(C1) It is sometimes assumed that the required rate of return that bank shareholders demand on their equity is fixed and is not affected by the bank's leverage, at least over some range.

(C2) Concern is voiced that anything that leads to lower levels of ROE (Return on Equity) causes a loss of value, and higher capital requirements reduce ROE.

(C3) Claims are made that banks will be willing to invest in a loan that earns, say, 6% if the loan can be "financed" with debt that costs less than 6%, but banks will not be willing to fund the loan if it must be "financed" with "high cost" equity.

(C4) Sometimes the simple assertion is made that, because equity holders in their role as residual claimants bear much of a bank's risk, they demand high returns and this makes equity expensive and gives rise to a need to economize on equity.

These claims, as stated, are all false. For example, the first is similar to claiming that if you reduce the height of a metal cylinder of fixed volume, the width of the base stays the same. The second is akin to saying that anything that reduces the height of a metal cylinder reduces its volume, a claim that can only be made if one ignores the change in width that occurs when height is changed. Unfortunately, while it is rather easy to spot the mistakes made in Metallia about cylinder dimensions, the confusions and errors made in discussions about bank regulation are less transparent, since it is harder to visualize how value is related to returns and risk than it is to visualize how volume is related to height and radius.

All of this shows why the insights of Modigliani and Miller are ***extremely*** relevant to discussions about banking and bank capital regulation. When people dismiss "Modigliani and Miller" as not relevant to banks, they appear to be dismissing Modigliani and Miller's so-called irrelevancy results. The main irrelevancy result is:

> **Irrelevancy Proposition:** Under the assumption of perfect markets (no frictions), capital structure is irrelevant. The value of a firm is independent of how it finances itself.

It is clear that the assumption of no frictions does not hold in our world. For example, most tax codes favor debt just as the Metallian tax code favors height. This means that the pure-form irrelevancy proposition does not apply to any firm. But this does not mean that one can dismiss Modigliani and Miller. The M&M Irrelevancy Proposition gives rise to an immediate corollary, which is extremely important:

Corollary: If the value of a firm does depend on how it finances itself, then it must be because of the impact of the funding mix on some frictions.

This can be made specific to banks:

Corollary for banks: If changes in leverage or capital requirements affect the value created by banks, then it must be because one or more market frictions exist that are affected by leverage and capital requirements.

This M&M corollary means that simple statements like C1 to C4 given above are not just wrong and misleading, they completely miss what is at the heart of the discussion: identifying the relevant frictions and quantifying the *social* costs and *social* benefits of changing capital requirements in light of those frictions. While on occasion the discussion is framed in this way, all too often it is not. It is important that the discussion be focused on actual frictions and their costs and not mired in fallacies and confusions. And when considering the frictions and their implications for capital requirements, it is important to focus only on *social* costs and benefits. It is also important that an analysis consider *all* significant frictions. It is not enough to point to one friction that might potentially be alleviated by one form of funding and ignore other frictions.

Two other points should be made.

First, the Metallian gold storage manager might have defended his position about height as follows:

Interviewer: Now please explain to me again why height is important.

Gold Manager: Well, the real reason is that people are impressed with height. I understand that I really don't have any more gold when I increase my height by reducing my width. The problem is that other people don't understand this. They truly think that I am doing better when my cylinder is higher, even if it is only higher because I reshaped it and made it narrower. Now if you tell me I must increase my width, my height will go down and people will think I have less gold. I don't want that! That would be bad for the city!

One sometimes hears the analogue to this applied in the banking context. The idea is that if banks are required to hold more equity, the market will not understand how risk and return have been redistributed and this will result in a loss because the market will not price the bank's securities correctly. Of course, if the market systematically misprices securities and does not understand how to adjust for the risk on something as simple as common stock, then we

have much bigger problems, since much of modern banking requires that extremely complex securities be priced correctly.

Second, some economists believe that the decisions of individual agents in a competitive market lead to the best outcomes. In the parable this would mean that since we see that gold cylinders are tall and skinny, there must be a "positive" theory that explains why this shape for gold cylinders is optimal. But high gold cylinders (and highly leveraged banks) may be the results of private incentives of managers, and it cannot be presumed that private incentives always lead to the best social outcomes. Indeed, with frictions such as the inability to commit to future actions, private incentives may not even lead to the best private outcome that can be obtained absent frictions.

In summary, Modigliani and Miller is relevant to banks. If a man has $20 in his left pocket and $20 in his right pocket and is asked to transfer $10 from one pocket to the other, that man will still have $40 unless something was lost or gained in the transfer due to frictions. If the claim is made that the transfer of $10 is a good idea (or a bad idea), we must identify what those frictions are and what their net effect is on the man's cash position. Understanding the effects of increasing bank capital requirements is obviously much more complicated than shifting money from the left pocket to the right pocket and looking for any frictions that might affect the transfer, but the essence of the problem is the same.

For a detailed discussion of how the principles of corporate finance, including what we know about frictions, can be applied to the debate on capital regulation, see Admati, DeMarzo, Hellwig and Pfleiderer (2010).

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References

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