MERTON & PEROLD FOR DUMMIES

In "Theory of Risk Capital in Financial Firms," *Journal of Applied Corporate Finance,* Fall 1993, Robert Merton and Andre Perold develop a framework for analyzing the usage of capital by financial firms, like banks and insurers. Their methodology is summarized below, followed by a discussion of it.

What is risk capital?

M&P lay out a method to construct a risk balance sheet for a firm, with risk-adjusted assets, liabilities, and capital. These are calculated from the actual assets, liability, and capital of the firm, with adjustments for their riskiness.

The risk adjustment is easiest to explain for liabilities. They are re-evaluated by keeping all cash flows the same but removing any risk of default. For example, a corporate bond with face value of $1000 might have a market value of $985, recognizing some possibility of default. The risk-adjusted no-default value would just be $1000. The risk-adjusted bond should earn the risk-free rate, so its value can be backed out from its cash flows.

M&P use the term "net assets" for the invested assets less the no-default liabilities. (However, investments in hedge contracts that protect the firm are a part of the firm's total assets but are not considered part of net assets.) They then define "risk capital" as the value of a put option that will guarantee that net assets grow at least at the risk-free rate. Let's call that option the "risk put." Such an option would pay enough at expiration to true up the net assets to their original value increased by the risk-free rate in the event that the actual growth falls short of this.

Assets are increased by the risk capital to get risk-adjusted assets. But any actual hedge contracts that protect net assets are already counted in total assets, so they are not added in again. Holders of risky bonds are deemed to be carrying a portion of the risk put, valued at the difference between the bond's actual value and its default-free value. This amount compensates the bondholders for the default risk they carry. In effect buying a risky bond is considered as buying a risk-free bond plus selling a put option on the default risk. A similar situation holds for customers who hold assets that are liabilities of the firm. M&P consider the rest of the risk put – that is the part not carried by customers, bondholders, or covered by actual put options – to be carried by the equityholders.

An example taken from the paper should help clarify these definitions.

A company sells guaranteed investment contracts (GIC's). The current market value of the outstanding portfolio ($000,000) of the GIC holders is 990. The default-free value is 1,000. The firm has raised capital from bondholders and equityholders. The bondholders own 900 worth of bonds with a default-free value of 1,000. (Since the bondholders get paid after the GIC holders, they are more at risk of default, so their risk premium is greater.)

Invested assets are 2,500, plus the firm owns a put option worth 200 protecting these assets, for total assets of 2,700. (The put option will pay up to 300 if the ending invested asset value is less than 2,750, which is based on a postulated risk-free rate of 10% in the risk capital calculation.) With 2,700 in assets and a value of liabilities of 1,890, the equity is 810. In balance sheet form:

Assets (Accounting Basis)		**Liabilities and Equity (Accounting Basis)**	
Investment portfolio	**2,500**	**GIC's (par 1000)**	**990**
Put option	**200**	**Bonds (par 1000)**	**900**
		Equity	**810**
Total	**2,700**	**Total**	**2,700**

Assume that the risk put, which protects the investment portfolio from any growth rate less than 10%, is worth 500, so that is the risk capital. (Technically this put option guarantees that the net assets will grow at the risk-free rate. In this example this is the same as protecting the investment portfolio. This will hold in more general cases as long as liabilities are deterministic, since the net assets are defined using default-free liabilities, which should grow at the risk-free rate.)
The put option the firm owns is part of risk capital, but there is another 300 of risk capital that does not appear on the accounting balance sheet. The debt and GIC holders are deemed to hold 110 of this (difference between default-free and actual positions), leaving 190 to the equityholders. The risk balance sheet is shown below.

Assets (Risk Basis)		**Liabilities and Equity (Risk Basis)**
Investment portfolio	**2,500**	**Default-free cash capital**

		GIC's	**1,000**
Risk Put		**Bonds**	**1,000**
Purchased put option	**200**	**Equity**	**500**
GIC buyers	**10**	**Total**	**2,500**
Bondholders	**100**		
Equityholders	**190**	**Risk capital**	**500**
Total Risk Put	**500**	**(Equityholders)**	
Total	**3,000**	**Total**	**3,000**

This balance sheet assumes that the risk put is in place. It protects 2,500 of assets from growing at less than the risk-free rate, so 500 of the equityholders value is considered risk free. The equityholders are deemed to have provided the 500 of risk capital, but 310 of this has been used to purchase partial protection from other sources. Thus their 810 position can be viewed as consisting of 500 that went into investments and 310 that went to purchasing (explicit and implicit) options from the other players. They also can be viewed as having invested 1,000 total capital, with the firm paying them 190 for the value of their risk position. Thus the equity of the firm is 190 greater on the risk basis (1000 vs. 810), while total assets are greater by 300 – this 190 plus 110 of put options provided by the liability holders (which has been offset by a like increase in liabilities).

The GIC and bondholders are looked at as having paid in the default-free amounts and having received a payment of 110 for the value of the risk of their positions being affected by default. In the case of the equityholders, however, the 190 they are deemed to receive is for bearing the risk of growth of less than the risk-free rate for their cash capital contribution, which is more likely than the risk of default. Another way to look at this is to consider growth of less than the risk-free rate on cash capital to be default from the point of view of the equityholder. This puts all capital providers on a similar footing, in that they all are guaranteed at least the risk-free growth rate on their portions of cash capital, although of course they are to some extend providing this guarantee themselves.

In the more general case where liabilities are stochastic, the simplification of considering the risk put to be protecting invested assets doesn't work. The entire risk of the net asset position has to be considered as a whole in calculating risk capital in this case.

Risk-adjusted profitability and the cost of capital

So once you've calculated risk capital, what do you use that computation for? One application is to calculate risk-adjusted profitability. Risk capital generally increases the capital of the firm, so it can be used as a part of total capital to compute a risk-adjusted return on equity, which will be lower because it uses a higher denominator. But risk-adjusted earnings will also be lower, because risk capital is an annual cost that is used up by carrying the risk. Subtracting this from earnings will reduce the risk-adjusted return still further.

M&P show two different approaches to computing the impact of risk capital on earnings. In one example a parent is guaranteeing the solvency of a subsidiary, which allows the subsidiary to transact business. In that example the risk capital is the market value of having the guarantee in place for a year, and this is added to cash capital and subtracted from earnings to calculate the risk-adjusted return of the subsidiary. Let's call this the parent guarantee case.

However, for planning for an entire firm, M&P advocate using the *economic* cost of risk capital as part of the calculation of the overall capital cost. By economic cost they mean the spread above fair market value. Thus an option selling for its fair market value would not have any economic cost by this definition.

Why would a financial firm have to pay such a spread? M&P give several reasons, all related to what they call the opaqueness of the firm:

- Adverse selection – arising from some firms having less risk than others, and the market not being able to distinguish
- Moral hazard – purchase of the option changes the firm's risk taking behavior
- Agency costs – e.g., inefficiency or mismanagement not identifiable to the market

Separately identifying risk-free and risky capital can also help compute the cost of capital. As an example consider the GIC-selling company described above. The cash capital is risk free, so should cost the risk-free rate r. Thus this portion of capital costs 2500r. We don't know the spread built into the risk capital of 500, but suppose the fair market value of the risk capital is 470, and the spread is 30. Then total capital costs are 30 + 2500r. Expected profits would have to exceed this for the firm to be adding economic value.

Options pricing methods could be used to calculate the fair market value of the risk capital.

Hedges of broad market risk can often be bought for little in the way of spread, so if these can be used to reduce a firm's risk capital, they might reduce capital costs. Reinsurance from knowledgeable markets might also have less spread built in than would options on an insurer's overall finances, so might reduce the cost of risk capital.

Allocating capital costs to business units

Addressing the customers' evaluation of a business unit's financial strength, M&P state:

"The commitment made by the underwriting business is backed by the entire firm. Therefore, the strength of the guarantee is measured by the overall credit standing of the firm. The problem of capital allocation within the firm is thus effectively the problem of correctly charging for the guarantees provided by the firm to its constituent businesses."

A firm with several business that are not perfectly correlated with each other will generally require less risk capital than would the businesses evaluated separately. Further, an even lower requirement would be the sum over the business units of the marginal risk capital that could be saved by eliminating each of the units separately. M&P argue on the basis of the general principle of matching marginal costs to marginal revenues that it is these marginal risk capital needs that should be used to evaluate business unit profitability.

One way to think of this is to evaluate the decision of eliminating a business unit. If the profit of the unit is greater than its marginal capital cost, then the firm will lose money by dropping the unit. Suppose a manager wants to allocate the full risk capital of the firm in proportion to marginal capital. It could happen that this would increase the allocated capital costs enough to make the unit seem unprofitable, which would lead to the wrong decision on its fate. M&P conclude:

"Attempts at such a full allocation can significantly distort the true profitability of individual businesses."

Evaluation of findings

The definition of risk capital seems appealing but perhaps somewhat arbitrary. It provides a measure of riskiness useful for risk-adjusting earnings, but M&P do not provide

any arguments that this is the unique and correct measure. Having the put option exercise when net assets grow at less than the risk-free rate does view the equityholder somewhat similarly to the customers and bondholders, in that all their risk-adjusted cash positions are guaranteed to grow at least at the risk-free rate, and they each are viewed as holding the put option that provides this guarantee. Of course in most situations the equityholders are the only ones who benefit from growth beyond this, so the situations are not entirely symmetric.

The management of risk spreads above fair market value is an important area M&P discuss, and more on this is needed, ideally a complete catalogue of all the reasons for such spreads and how they might be quantified. It might be more appropriate to consider these as spreads above ideal market costs, or even more simply as spreads above Black-Scholes and CAPM prices, in that the spread prices reflect economic reality and could thus be considered part of the fair market value.

The principle of allocating risk capital by marginal costs is an important insight with a good deal of potential application. It could however leave the firm in the position of not being profitable enough in relationship to its capital, but with the dilemma that reducing volume in any one of its businesses would lower profitability more than it would reduce capital. In such a case the firm's best choices might be either to grow enough so that the fixed capital costs are covered or stop underwriting entirely.

M&P are a little confusing on the topic of charging a business its full risk capital or just the spread. They say that this distinction should be based on whether you are planning for the future, in which case you would use just the spread, or looking at actual results, where the full risk capital would be considered as an expense. The trouble with that distinction is that the future rapidly becomes the past. In the case of the GIC-seller, for example, an expected profit of more than 30 would constitute an added economic value. But the actual profit would have to be over 500 to have a positive result.

The cases where M&P show the entire risk capital as an expense all involve parent company guarantees whose value is not considered in accounting treatments. This could be the criterion that distinguishes whether to use the full cost of the guarantee – which is the definition of risk capital – or just the spread cost. When looking at a stand-alone operation the spread cost may be the relevant measure.

Insurer applications

Insurers often express their capital questions in terms of return on capital – is the company as a whole and each division separately earning enough of a return? To answer this they often try to allocate surplus to operating unit, look at the unit's profitability as a return on that surplus, and compare to other returns available from investments with comparable risk.

Another way of addressing these questions would be to look at the cost of the capital to the company and each unit, and subtract that from the earnings. The capital cost would already incorporate an adjustment for riskiness, so any positive earnings above the cost of capital would be an added economic value provided by the unit. This is the EVA, or economic value added approach. Usually it is done prospectively, so expected earnings are used. If done retroactively, some adjustment to earnings would usually be needed, at least to take out the random outcomes realized from highly random processes, like cats.

An important part of the capital cost would be the spread charges. The risk capital of an insurer would have significant spread costs, and these could go beyond the areas that M&P discuss. The risk capital and the loading for spread could both be reduced by reinsurance. Quantifying this could be one way to show the economic value of the reinsurance to the firm as a whole, and to compare alternative programs.

Allocation of capital to business units could build from the parent guarantee framework. Each business unit could be viewed as having no capital of its own, but as having a guarantee from the firm to cover its losses. This guarantee could be viewed as a put option that triggers when the funds generated by the business unit are insufficient to pay losses. However it would not be an absolute guarantee, as it would run out at the insolvency of the entire firm.

The calculation of the perfect market value of the guarantee would be as a difference between two put options – one triggered when the business unit runs out of funds, and the other at the hopefully much more remote case of the insolvency of the firm. Spread costs could be estimated as well. The value of reinsurance to a business unit would be the reduction in the cost of the guarantee produced by buying the reinsurance.

One complication is business units that pay losses over a long lag. If you were evaluating just a single accident year, the guarantee would have to cover many future years of payments. During that time the insolvency of the entire firm could become less of a remote possibility, and so the second put option in the calculation would become more significant. The losses could also be exposed to more random processes, changing the probability that the business unit would have to tap the guarantee. One way to do the calculation might be to consider the guarantee as a series of single-year guarantees, and price each of these using options methods.

Another question to consider is whether these guarantees should be based on the cash or incurred position of the business unit. Cash would seem to be more concrete and simplify discounting, but the guarantee could impact the parent's overall capital on an incurred basis much before cash is impacted. However this would be significant only if the parent would otherwise dispose of its equity. The guarantee could thus be regarded as a loss payment commitment. This would be the viewpoint of the customer as well. However the tax impacts on the parent of the business unit incurred loss should probably be credited back.

The cost of the parent guarantee would reduce earnings in calculating whether the unit generated more profit than its capital costs. This is the economic value added approach. However the return as a percentage of the capital allocated might not be meaningful. In effect, a cost is being allocated – the cost of the parent's guarantee – and this is not necessarily a relevant measure for percentage return. Nonetheless this approach provides enough information to determine whether or not the business unit is earning enough to cover its capital costs, and seems to describe the fundamental relationship a business unit has to the overall firm. The difficult calculations might be the spread portion of the cost of the guarantee.

An alternative approach that seems consistent with the allocation portion of this paper would be to first establish a criterion for the overall capital need of the firm, such as its probability of insolvency or probability of losing a predetermined portion, like 15%, of surplus, perhaps based on comparable standards for corporate bonds of a desired rating. Then it should be possible to calculate the capital saved by maintaining this same criterion while eliminating a particular business unit. That would be the marginal capital used by the unit. The cost of this capital could be used to calculate the economic value added by the unit.

This would be a simpler calculation, but has the problem that it starts with a somewhat arbitrary standard. Doing the risk capital calculation for the entire firm would provide another view of required capital. This could start by assuming the insurer has enough assets to just cover the mean value of liabilities if it gets the risk-free rate on those assets, and then computing risk capital as the cost of the option that would compensate for any lower growth of net assets. It would be interesting to compare the risk capital from this calculation to the capital need implied by the VAR-like standards above.