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A theory of risk capital ☆

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ABSTRACT

We present a theory of risk capital and of how tax and other costs of risk capital should be allocated in a financial firm. Risk capital is equity investment that backs obligations to creditors and other liability holders and maintains the firm's credit quality. Credit quality is measured by the ratio of the value of the firm's option to default to the default-free value of its liabilities. Marginal default values provide a full and unique allocation of risk capital. Efficient capital allocations maintain credit quality and preclude risk shifting. Our theory leads to an adjusted present value (APV) criterion for making investment and contracting decisions. We set out implications for risk management and corporate finance.

1. Introduction

This paper presents a theory of risk capital and a general procedure for allocating the tax and other costs of risk capital to lines of business in a financial firm. "Risk capital" is equity investment that backs up obligations to liability holders, including creditors, customers, and contract counterparties.

Risk capital is not the same thing as cash capital. "Cash capital" refers to funds available to invest. If a start-up firm issues $50 million in debt securities and $50 million in common stock, it has $100 million of cash capital but at most $50 million of risk capital. Requirements for cash vs. risk capital can differ dramatically. For example, a swap contract requires no cash up front, but does require risk capital. A book of high-quality, floating-rate mortgage loans might require a large cash investment but little risk capital.

One can imagine a tax-free Modigliani-Miller (MM) world in which equity financing is always available on fair

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(zero net present value (NPV)) terms. In this case, risk capital would be free of charge and there would be no need to allocate it. But risk capital is costly in practice, for at least two reasons. First, returns to equity are subject to corporate income tax. (Corporate finance would say that returns to equity do not generate interest tax shields.) Second, additional capital may increase agency costs and monitoring costs borne by shareholders.

Of course, risk capital has benefits, too. More capital reduces possible debt-overhang and risk-shifting problems and it makes costs of bankruptcy or financial distress more remote. Costs incurred by creditors to monitor and to protect their interests are reduced.

We consider a value-maximizing financial firm operating in two or more lines of business with different risks. (We focus on lines of business for expositional convenience, although risk-capital allocations are in principle required any time a firm contemplates an investment or a commitment, even for a one-off transaction.) The firm decides on a target level of credit quality by trading off the tax and agency costs of risk capital against costs of financial distress or default. Credit quality is defined as the ratio of the value of the firm's option to default to the default-free value of its liabilities. The required amount of risk capital depends on target credit quality and on the risk of the portfolio of businesses.

Capital, because it is costly, must be allocated to assess profitability, to make investment decisions, to price products and services, and to set compensation. The efficient risk-capital allocation for a line of business depends on its *marginal default value*, which is the derivative of the value of the firm's option to default (its *default put*) with respect to a change in the scale of the business. Marginal default values add up exactly and support a unique allocation of risk capital. The businesses with the largest marginal default values should be allocated the most risk capital and charged the most for the costs of risk capital. We derive a capital allocation formula that holds for any joint probability distribution of line-of-business returns.

Efficient risk-capital allocations satisfy two requirements. First, *no risk-shifting*: risk capital should be allocated so that a marginal change in the composition of the firm's portfolio of businesses does not affect the credit quality of the firm's liabilities. Second, *no internal arbitrage*: risk capital should be allocated so that it is not possible to add value at the margin merely by shifting risk capital from one business to another. These requirements are general and require no restrictions on the distribution of returns.

All firms deploy risk capital, but our theory and procedures are especially important for financial firms dealing with customers and counterparties that are not prepared to bear significant default risk.[3] Such firms must put up enough risk capital to maintain an acceptable credit quality for their obligations. They typically operate in both safe and risky businesses, and therefore must take care not to give the risky businesses "free passes" to expand. Expansion of risky businesses should consider the costs or consequences of (1) increasing the firm's risk capital or (2) imposing additional default risk on creditors, customers, and counterparties. Consequence (2) amounts to a decision to operate at a lower credit quality. The lower credit quality would then feed back to revised risk-capital allocations.

Whether a business, product, or contract is a safe or risky call on the firm's risk capital depends on the firm's portfolio. For example, a forward contract for heating oil could be a speculative position for firm A and require a high offsetting allocation of risk capital. The same forward contract could act as a hedge for firm B and require a low allocation.

Our theory yields a two-step adjusted present value (APV) procedure for valuing expansion of a business. The first term of the APV is the pre-tax NPV of the investment, calculated as if risk capital were costless. The second term is a charge for the tax and other costs of risk capital. The cost depends on the amount of risk capital allocated to the business and, therefore, "supporting" it. The cost is *not* expressed as an interest rate or "cost of equity" on the allocated risk capital. It is a dollar charge, e.g., for taxes. We show how the APV rule applies to specific cases, including swap and forward positions and hedging transactions.

Section 2 of this paper reviews related research. Section 3 defines risk capital and identifies the costs and benefits of deploying more or less of it. Section 4 shows how risk-capital allocations should be set. The key is to adjust allocations to offset differences in marginal default values, subject to the no-risk-shifting and no-internal-arbitrage conditions. In Section 5 we allow both scale and composition of the portfolio of lines of business to vary and derive conditions for optimal credit quality and optimal portfolios. Section 6 presents allocation formulas assuming that returns are normally distributed. Section 7 considers applications and implications. For example, we discuss the APV rule derived in Section 4 more specifically and compare it to the APV rule for nonfinancial corporations. We also contrast our method with allocations based on value at risk (VaR) or risk adjusted return on capital (RAROC). Section 8 concludes.

2. Related research

There is a large literature on risk management and investment decisions in banks and other financial corporations.[4] Prior work specifically on allocation of risk capital is much more limited. Merton and Perold (1993) is the best place to start. They define risk capital as the present-value (PV) cost of acquiring complete insurance against negative returns on the firm's net assets—the value of a one-period at-the-money-forward put (a put with an exercise price equal to the current value of net assets plus one period's interest at the risk-free rate). We start with the firm's default put, which determines credit quality. The value of the default put equals the cost of insurance for the firm's debt and other liabilities.

[3] Merton and Perold (1993) discuss why some liability holders can be especially "credit-sensitive."

[4] Texts include Hull (2010), Jorion (2006), Matten (2000), Saunders and Cornett (2008), and Stulz (2003).