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Risk-shifting and investment asymmetry

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ABSTRACT

I show that when shareholders can change not only the variance of the future firm value, but also its asymmetry, they can shift costly risk to bondholders while *lowering* the firm risk, and more importantly, the equity risk and the probability of bankruptcy. The implication of this result is that risk-shifting behavior can be more beneficial to shareholders than currently perceived in the literature.

1. Introduction

The risk-shifting (asset substitution) problem introduced by Jensen and Meckling (1976) suggests that shareholders can transfer wealth from bondholders by engaging in risky projects. This agency problem has attracted a great deal of interest in the literature, mainly in attempting to identify ways to mitigate the problem, and to assess its magnitude.

The common assumption in analyses of risk-shifting is that in order to transfer wealth from bondholders, the shareholders must increase the risk of the firm's total assets. As a result of the higher firm risk, the risk of the equity also rises, and the probability of bankruptcy either increases or remains the same, but cannot decrease. Thus the extra risk the shareholders must bear when engaging in risk-shifting behavior, as well as the costs associated with a potentially higher bankruptcy risk, may significantly reduce or even offset the benefits of the wealth transfer.

In this paper, I argue that if shareholders can change not only the variance of the future firm value, but also its asymmetry, they can shift costly risk to bondholders while *lowering* the firm risk, and more importantly, the equity risk and the bankruptcy risk. To see the intuition of this argument consider a

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project with low likelihood to exhibit a dramatic failure, and high likelihood to gain a moderate success (i.e., a negatively skewed payoff distribution). Accepting such a project can reduce the firm risk, as well as the equity risk, due to the heavy concentration of possible positive outcomes in a fairly narrow range; it also reduces the bankruptcy risk due to the low likelihood that the project will fail; but at the same time it imposes higher risk on the bondholders who will bear large costs in case of failure. Using a standard two-date setup, I show that when investments with non-symmetric payoffs are available, shareholders can shift costly risk to bondholders while decreasing both the equity risk and the default risk, and moreover, that this form of risk-shifting is not driven by specific scenarios and can be very feasible to shareholders.

It is important to note that negatively skewed investment opportunities are rather common in financial markets, and thus allow shareholders to exercise the non-symmetric form of risk-shifting analyzed in this study. For example, there is strong evidence that aggregate stock returns exhibit negative skewness, both in the US (see, e.g., Glosten et al., 1993; David, 1997; Harvey and Siddique, 1999; Hong and Stein, 2003) and in most developed countries (see, e.g., Das and Uppal, 2004; Poon et al., 2004). Another example is the distribution of changes in exchange rates, which are typically skewed to the left (see, e.g., Hsieh, 1989; Hausmann et al., 2006).

The paper contributes to the corporate finance literature by identifying an investment strategy that allows shareholders to enjoy the traditional risk-shifting benefits, without bearing any costs associated with additional equity risk and typically a higher probability of bankruptcy. This suggests therefore that the well-documented risk-shifting problem may be more severe than it is perceived in the literature.

2. Risk-shifting and payoff distributions

Since Jensen and Meckling (1976) uncovered the shareholders' incentive to engage in risk-shifting behavior to transfer wealth from bondholders, many studies have attempted to identify ways to mitigate this agency problem. These include debt covenants (Smith and Warner, 1979), debt maturity (Barnea et al., 1980), convertible debt (Green, 1984), and managerial compensation (Brander and Poitevin, 1992; John and John, 1993). Other studies have tried to assess the magnitude of the risk-shifting problem, using theoretical frameworks (Leland, 1998; Ericsson, 2000), simulation techniques (Parrino and Weisbach, 1999), managerial surveys (De Jong and Van Dijk, 2001; Graham and Harvey, 2001), and empirical evidence (Eisdorfer, 2008).

These analyses and others assume that in order to shift risk to the bondholders, the shareholders must increase the risk of the firm's total assets, and thereby the risk of the equity and the probability of bankruptcy. The common ways assumed in the literature to increase firm risk is changing only the variance of a given distribution (see, for example, Jensen and Meckling, 1976; Eisdorfer, 2008) and switching from a safe project to a risky one (see, for example, John and John, 1993). Although some of the risk-shifting studies allow the investment's payoffs to follow an asymmetric distribution, no study has directly addressed the effect of payoff asymmetry on the risk of the firm's claims.

I show first that if only symmetric payoff distributions are available, shifting risk to bondholder can be achieved only by increasing the firm risk, and thereby the equity risk, where the probability of bankruptcy either rise or does not change; all are well-known consequences of the standard risk-shifting problem. I then show that if the shareholders can change the asymmetry of the payoffs, they can shift costly risk to the bondholders while lowering the firm risk, the equity risk, and the bankruptcy risk.

2.1. Standard risk-shifting assuming symmetric payoffs

Consider a standard two-date setup. Let V be the expected value of the firm at date 0, reflecting two possible realizations of firm value at date 1: $V - \frac{\delta}{2}$ and $V + \frac{\delta}{2}$ with equal probability. The firm's capital structure includes common equity and debt, with a face value of $F \leqslant V$, that matures at date 1. For simplicity, assume no taxes, no bankruptcy costs, and that the risk-free rate is zero. At date 0, the value-maximizing shareholders control the firm risk using the parameter δ. At date 1 the firm value is realized, and the firm is liquidated.

Table 1
Payoffs, values, and volatilities of the firm's claims.

Panel A. Symmetric payoffs				
	Probability = 0.5	Probability = 0.5	Value	Volatility
Firm	$V-\frac{\delta}{2}$	$V+\frac{\delta}{2}$	V	$\frac{\delta}{2}$
Debt	$\min\left[V-\frac{\delta}{2},F\right]$	F	$\frac{\min\left[V-\frac{\delta}{2},F\right]+F}{2}$	$\frac{F-\min\left[V-\frac{\delta}{2},F\right]}{2}$
Equity	$\max\left[V-\frac{\delta}{2}-F,0\right]$	$V+\frac{\delta}{2}-F$	$\frac{\max\left[V-\frac{\delta}{2}-F,0\right]+V+\frac{\delta}{2}-F}{2}$	$\frac{V+\frac{\delta}{2}-F-\max\left[V-\frac{\delta}{2}-F,0\right]}{2}$
Panel B. Non-symmetric payoffs				
	Probability = α	Probability = $(1-\alpha)$	Value	Volatility
Firm	$V-(1-\alpha)\delta$	$V+\alpha\delta$	V	$\delta\sqrt{\alpha(1-\alpha)}$
Debt	$\min[V-(1-\alpha)\delta, F]$	F	$\alpha\min[V-(1-\alpha)\delta, F]$ $+(1-\alpha)F$	$(F-\min[V-(1-\alpha)\delta, F])$ $\times\sqrt{\alpha(1-\alpha)}$
Equity	$\max[V-(1-\alpha)\delta-F, 0]$	$V+\alpha\delta-F$	$\alpha\max[V-(1-\alpha)\delta-F, 0]$ $+(1-\alpha)(V+\alpha\delta-F)$	$(V+\alpha\delta-F-\max[V-(1-\alpha)\delta$ $-F, 0])\sqrt{\alpha(1-\alpha)}$

Panel A shows the payoffs, expected values, and standard deviations (volatilities) of the firm's total assets, its debt, and its equity, given that the value of the firm will be either $V-\frac{\delta}{2}$ or $V+\frac{\delta}{2}$ with equal probability, and the face value of debt is F. Panel B shows the equivalent measures given that the value of the firm will be $V-(1-\alpha)\delta$ with probability α, and $V+\alpha\delta$ with probability $(1-\alpha)$.

Panel A of Table 1 shows the payoffs, values, and volatilities (measured by standard deviations) of the firm's claims. It is easy to see that in order to shift risk to the bondholders that will reduce the debt value, the shareholders must bear extra risk as well. The value of the debt will be risky only when there is a positive default risk, i.e., when $V-\frac{\delta}{2}<F$. This inequality implies that the volatility of the debt is $\frac{F-V+\left(\frac{\delta}{2}\right)}{2}$. That is, to increase the risk of the debt the shareholders have to increase δ. As a result, the volatilities of the firm $\left(\frac{\delta}{2}\right)$ and the equity $\left(\frac{V+\left(\frac{\delta}{2}\right)-F}{2}\right)$ rise as well (both are increasing with δ).

It is also easy to see that the shareholders cannot reduce default risk when shifting risk to bondholders, i.e., by increasing δ. Default risk is present only when $V-\frac{\delta}{2}<F$. That is, the default risk is zero for $0\leqslant\delta\leqslant 2(V-F)$, and is equal to 0.5 for $\delta>2(V-F)$, i.e., the likelihood of default is a non-decreasing function of δ.

2.2. Risk-shifting when allowing for non-symmetric payoffs

Building on the setup outlined above, assume now that instead of equal probability of the possible outcomes, the value of the firm at date 1 will be $V-(1-\alpha)\delta$ with probability α, and $V+\alpha\delta$ with probability $(1-\alpha)$. That is, α represents the asymmetry of the distribution of the firm value, while keeping the same expected firm value (V), and the same range between the upper and the lower realizations of firm value (δ). This payoff distribution allows to isolate the effect of asymmetry on the values and volatilities of the firm's claims. At date 0, the value-maximizing shareholders choose the asymmetry level of the payoffs (α), and at date 1 the firm value is realized and the firm is liquidated.

Panel B of Table 1 shows the payoffs, values, and volatilities of the firm's claims. To be able to increase the bondholders' risk using a negative payoff asymmetry (i.e., by lowering α) such that – as in the standard risk-shifting problem – the debt value will fall and the equity value will rise; and – as opposed to the standard risk-shifting problem – both the equity risk and the default risk will decrease, there must be a positive range of $\alpha\in(0,1)$ that satisfies the following conditions:

(i) A positive default risk: $V-(1-\alpha)\delta<F$

If this condition does not hold, the debt will not be risky. As the likelihood of default is exactly α as long as there is a default risk, this condition implies that the default risk increases in α. (This inequality is incorporated to the values and volatilities of the firm's claims appearing in the remaining conditions.)

Table 2
Numerical example.

Panel A. Original symmetric distribution				
	Probability = 0.5	Probability = 0.5	Value	Volatility
Firm	800	1200	1000	200
Debt	800	850	825	25
Equity	0	350	175	175
Panel B. Non-symmetric payoffs				
	Probability = 0.3	Probability = 0.7	Value	Volatility
Firm	720	1120	1000	183.3
Debt	720	850	811	59.6
Equity	0	270	189	123.7

Panel A shows the payoffs, expected values, and standard deviations (volatilities) of the firm's total assets, its debt, and its equity, given that the value of the firm will be either 800 or 1200 with equal probability, and the face value of debt is 850. Panel B shows the equivalent measures given that the value of the firm will be 720 with probability 0.3, and 1120 with probability 0.7.

(ii) The debt volatility decreases in α: $\frac{\partial[(F-V+(1-\alpha)\delta)\sqrt{\alpha(1-\alpha)}]}{\partial\alpha} < 0$.

(iii) The debt value increases in α: $\frac{\partial[\alpha(V-(1-\alpha)\delta)+(1-\alpha)F]}{\partial\alpha} > 0$.

(iv) The equity volatility increases in α: $\frac{\partial[(V+\alpha\delta-F)\sqrt{\alpha(1-\alpha)}]}{\partial\alpha} > 0$.

(v) The equity value decreases in α: $\frac{\partial[(1-\alpha)(V+\alpha\delta-F)]}{\partial\alpha} < 0$.

It is easy to find a set of parameter values $[V, F, \delta, \alpha]$ that satisfies these conditions. For example, let $V = 1000$, $F = 850$, $\delta = 400$, and α ranges between 0.3 and 0.5. Table 2 shows the payoffs, values, and volatilities of the firm's claims. That is, by substituting a symmetric payoffs ($\alpha = 0.5$) with a negatively skewed payoffs ($\alpha = 0.3$), the debt volatility increases (25 to 59.6), the debt value decreases (825 to 811), the equity value increases (175 to 189), whereas most interestingly, the firm volatility is reduced (200 to 183.3), the equity volatility is reduced (175 to 123.7), and the probability of default is reduced (0.5 to 0.3).

2.3. The feasibility of the agency problem

To provide a general assessment of the feasibility of the asymmetry-based risk-shifting problem, I examine the range of payoff asymmetry (α) under which shareholders can shift risk to bondholders, yet at the same time reduce the equity risk and default risk. For asset value (V) equals to 1000, I consider three face values of debt: 700, 800, and 900 that represent highly levered firms (leverage ratios of at least 70%) in which risk-shifting incentives are stronger, and three values of δ: 300, 400, and 500 that represent realistic changes in firm value up to 15%, 20%, and 25%, respectively.

Fig. 1 shows the effect of asymmetry on the volatilities of the firm's total assets, the debt, and the equity. For all cases except one there is a range of α in which reducing α (i.e., adopting more left-skewed investments) increases the volatility of debt, while decreasing the volatility of the firm, as well as the volatility of the equity. Within that range, the shaded area in each box represents the sub-range of α in which reducing α results also in a decline in the value of debt, a rise in the value of equity, and a lower default risk. The bottom line in each box indicates the potential percentage change in the values of the debt and equity when α is decreasing.

The figure reveals several results. First and most important, there is a fairly wide range of α under which shareholders can use payoff asymmetry to shift costly risk to bondholders while lowering both the equity risk and the default risk. For example, for the case of leverage ratio = 80% and $\delta = 400$, reducing α within the range (0.19–0.5) will achieve these aforementioned benefits. Second, the wealth transfers associated with changing the payoff asymmetry can be very significant. The shareholders can gain up to 80% and the bondholders can lose up to 9% of their claim values. Third, for most cases of a simultaneous decline in equity risk and a rise in debt risk, the risk of the firms' total assets declines as well;

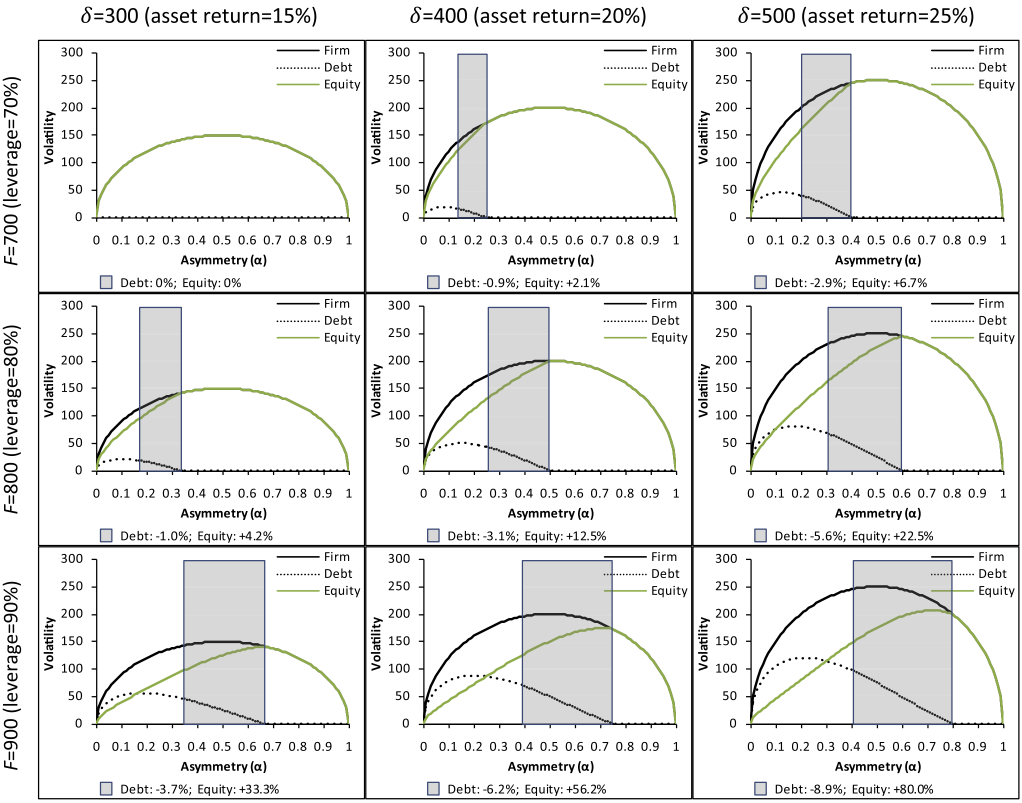

Fig. 1. The effect of payoff asymmetry on the volatilities and values of the firm's claims. The figure shows the effect of asymmetry (α) on the volatilities of the firm's total assets, its debt, and its equity, given that the value of the firm will be $V-(1-\alpha)\delta$ with probability α, and $V+\alpha\delta$ with probability $(1-\alpha)$, and the face value of debt is F. The results are based on a constant V at 1000 and different values of F, δ, and α. The shaded area in each box represents the range of α in which reducing α increases the volatility of debt, decreases the volatility of equity, decreases the value of debt, increases the value of equity, and decreases the default risk. The bottom line in each box indicates the potential percentage change in the values of the debt and equity when α is decreasing.

yet there are ranges of α under which the firm risk rises. This will occur, for example for $\alpha \in (0.5, 0.59)$ in the case of leverage ratio = 80% and δ = 500. Fourth, the effect of asymmetry on the values of debt and equity is not monotonic. For example, for the case of leverage ratio = 80% and δ = 400, when α decreases to values below 0.25, the volatilities of the equity and debt keep to decrease and increase, respectively, but there is no wealth transfer. Fifth, the magnitude of this agency problem (indicated by the range of α) as well as its cost (indicated by the potential wealth transfer) increase with the leverage ratio and with δ. This result is expected as both higher leverage and higher range of possible outcomes represent higher default risk. Sixth, and last, the agency problem can arise also under positively skewed payoffs, especially when the leverage ratio is high; for example, when α is reduced from 0.7 to 0.6 (i.e., within the range of positive skewness) for the case of leverage ratio = 90% and δ = 400.

The results thus indicate that the non-symmetric risk-shifting identified in this study is not driven by specific scenarios, and can be very feasible and valuable to shareholders.

3. Conclusions

I show that the risk-shifting problem should not necessarily be associated with an increase in firm risk, equity risk, and default risk. When shareholders can change not only the variance of the future firm value, but also its asymmetry, they can reap the benefits of the wealth transfer by imposing more risk on bondholders, and at the same time reduce the firm risk, and more importantly, the equity risk and the probability of bankruptcy. I further demonstrate that this form of risk-shifting can be very feasible to shareholders, and can involve significant wealth transfers from the bondholders.

This analysis suggests therefore that risk-shifting behavior can be much more beneficial to shareholders, and thus the risk-shifting problem may be more severe than currently perceived in the literature.

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