



An incentive problem of risk balancing in portfolio choices



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ABSTRACT

This study provides a new perspective on the incentive of risk balancing by examining how investors adjust their portfolio weights in response to changes in volatility risk, market risk, and liquidity risk. We find that investors have motives to mitigate the disproportionate impacts of these potential risks. Investors significantly reduce the weight of stock they hold, as opposed to increasing the weight of stock, to offset the impacts of the three potential risks, even though one risk has diversification benefits, while other risks generate adverse impacts. Moreover, we conclude that investors have a desire to greatly reduce the weight of stock, given some scenarios of a lower-growth stock, a higher asset correlation, a more risk-averse investor, and a greater intensity of crisis events.

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1. Introduction

Investors participate in stock markets to pursue potential interests, but they must also bear the potential risks. To control these potential risks' impacts, investors desire to adjust the weights of both the stocks and cash in their portfolios to maximize their expected utilities. Due to the presence of multiple risks with disparate impacts, investors will have difficulty achieving an ideal balance between the weights of stocks and cash in their portfolios. The purpose of this study is to provide a new perspective by considering the incentives to balance risk which inform investors' adjustments of the asset shares in their portfolios, specifically focusing on investors' responses to the differing impacts of volatility risk, market risk, and liquidity risk. The investors' problem is that the potential risks of investing in stocks cause disproportionate impacts on their portfolios' values and utilities. Some risks have stronger effects on investor's portfolios, while other risks have lesser effects. Moreover, some risks appear to have positive impacts, while other risks have adverse effects on investors'

interests. To some extent, investors can avoid the influences of some risks by increasing the weights of stocks. However, increasing the weights of stocks may also strengthen the impacts of other risks. Thus, investors have a desire to balance the effects of these positive and negative impacts on their portfolio.

An increase or decrease in the weights of stocks or cash assets in investors' asset portfolios may boost or lower their utility, giving rise to the investors' incentive problem of how to mitigate the influences of the potential risks. The investors' incentive problem refers to how they strategically adjust the weights of assets in response to changes in the potential risks, as measured by the risk sensitivity, in order to maximize their utility of wealth value, since all these various risks affect the investor's interests or utilities. Balancing the risks' impacts tends to increase investors' utility, which in turn spurs the investors' willingness to take strategic actions to shift, mitigate, or control potential multiple risks. The incentive problem of risk balancing shows how investors increase or decrease the weights of assets to balance the favorable or unfavorable impacts of the potential risks. Johnson and Tian (2000), Duan and Wei (2005), and Beladi and Quijano (2013) also employ risk sensitivities to serve as the metrics of incentives.

There are several risk sources when investors keep risky assets in their portfolios. First, the stocks themselves have return volatilities corresponding to the variance of stock price. Second, investors who invest in stocks suffer from financial market risk, in that the return dynamics of the stocks' prices vary with the market risk. Third, financial crisis events, which frequently appear in financial

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markets nowadays, give rise to a liquidity risk for the investors' portfolios. These risks may have disparate effects on the investors' asset allocations.

Despite the widespread popularity of the subject, studies of portfolio choice are lacking in terms of the analysis of controlling multiple risks. Previous studies of portfolio selections have voluminously analyzed the effects of various risks (Bodnar, Parolya, & Schmid, 2015; Brennan, 1979; Cox, Ingersoll, & Ross, 1985; Friend & Blume, 1975; Li, Zhu, Li, & Li, 2013; Ling, Sun, & Yang, 2014; Liu, Longstaff, & Pan, 2003; Mao, Carson, Ostaszewski, & Wen, 2013; Matos & Silva, 2014; Merton, 1969, 1971). In particular, researchers have discussed the determinants of *why* investors invest their wealth in stocks and have expressed their conclusions in terms of the investors' speculative demands and hedging demands (Jin & Zhang, 2012, 2013; Lioui, 2013; Liu et al., 2003; Merton, 1971). However, the reality is that there are multiple risks simultaneously appearing in any financial market, with each type of risk influencing investor's portfolios in different ways.

In this paper, we provide concrete answers to two problems. First, we look at which risks cause larger influences on stock holding rates: volatility risk, liquidity risk, or market risk. We solve this problem by conducting an analysis of the risk sensitivities of asset allocations with respect to these various risks. Second, we examine investors' incentives to balance the influences of these potential risks. Given some scenarios, will they desire to decrease or increase the weights of their stock holdings? We solve the second problem by analyzing the movements of stock weights in different scenarios.

To address the above questions, we examine three aspects of two-asset portfolio selections. We first explore the determinants of stock holdings within a stochastic environment. We find that investors have both speculative demand and hedging demand for the stocks. This effectively demonstrates that it is possible for us to explain why investors prefer to keep the stock asset as opposed to the cash asset. Second, we derive the risk sensitivities, expressed in terms of the change rate of the stock weight with respect to risk parameters. We point out that these risks exert disproportionate effects on the investors' portfolio selections. Third, based on the foregoing, we further discuss the incentive problems of risk balancing. We find strong evidence to suggest that investors are motivated to decrease the weights of stock to balance the effects of potential risks comprehensively, even though some risks generate greater impacts on their portfolios than others.

The study is composed of five parts. In the next section, we provide an overview of the related literature. In Section 3, we develop a portfolio selection model in a continuous-time setting. Section 4 provides numerical illustrations for the purpose of analyzing the asset allocations, sensitivities, and incentives. The final section concludes the study.

2. Related literature

Our paper contributes to the literature that studies how investors allocate wealth capital between risky assets or cash in their portfolios. Starting with Merton (1969), several papers have taken on this theme, and there is a long line of research that examines various aspects of portfolio selections and how they interact with the market environment. Perhaps the earliest example relates to the extents of portfolio selections, either in a continuous-time asset allocation (Friend & Blume, 1975; Liu et al., 2003; Merton, 1969, 1971), or in an asset pricing model (Brennan, 1979; Cox et al., 1985). Under a framework of a stochastic environment, Merton (1969, 1971) and Friend and Blume (1975) systematically explored asset holdings in investors' asset portfolios and conducted a demand analysis for risky assets. Cox et al. (1985) looked at asset pricing under a stochastic environment and presented the results

framed in an inter-temporal general equilibrium model of asset pricing.

Regarding the issue that we are attempting to analyze, namely, risk management framed in terms of a portfolio-selection analysis, there are numerous recent studies concerning price-jump events or crisis events (Jin & Zhang, 2012, 2013; Ling et al., 2014). Jin and Zhang (2012) stress the decomposition of optimal portfolio weights in a jump-diffusion model. The authors decompose the optimal decisions into constituent components and find that investors do not reduce the stock weights in their portfolios when they face more frequent jumps. Considering a decision problem in a jump-diffusion model, Jin and Zhang (2013) provide some equivalent optimality conditions for an indirect value function and optimal shares of assets. Ling et al. (2014) analyze the question of how the presence of jump risks affects agents' asset allocations, and find that the agents formulate a hedging demand for the risky assets against the jump risk.

Other studies regarding optimal portfolio selection decisions and risk managements concern the tail risk, background risk, parameter risk, systematic risk, or downside risk (Cvitanić, Lazrak, Martellini, & Zapatero, 2006; Eichner & Wagener, 2012; Li et al., 2013; Liang, 2011; Owadally & Landsman, 2013; Polak, Rogers, & Sweeney, 2010). Owadally and Landsman (2013) focus on the tail mean-variance analysis, which involves a criterion comprising the risk of rare but large losses. Analyzing a tempering effect of dependent background risks, Eichner and Wagener (2012) use a mean-variance methodology for analyzing portfolio selection optimization. In addition, a recent paper closely related to ours was authored by Li et al. (2013), who analyzed active allocations of systematic risk and the controlling of risk sensitivity. Specifically, in their work, portfolio risk is decomposed into a systematic risk and a nonsystematic risk.

Authors of recent papers have studied the incentive problems related to risk shifting in terms of how an agent shifts risks to other agents. Examples of these studies include investigations of risk management (Duan & Wei, 2005; Johnson & Tian, 2000; and so on) and corporate governance (Anantharaman & Lee, 2014; Beladi & Quijano, 2013; and so on). Focusing on CEOs' incentives for risk shifting, Beladi and Quijano (2013) employ a proxy of the option Vega for discussing the relationship between risk-shifting and the cost of corporate bank loans. They suggest that equity-based compensation can enhance risk-shifting incentives. Anantharaman and Lee (2014) also demonstrate that the compensation incentives change the extent of risk shifting. In addition, Johnson and Tian (2000) and Duan and Wei (2005) analyze the incentive effects of executive stock options. In contrast to these studies of risk shifting between various agents, we instead analyze the risk balancing as between various risks in an investor's portfolio.

In this study, as we have mentioned before, because potential risks affect investors' utility and wealth, investors may have motives to adjust their stock-holdings to protect their asset portfolios. This raises the question of *how* investors' behave strategically to balance the disproportionate impacts of potential risks on their portfolio selections. Some risks bring about unfavorable impacts, while other risks have favorable impacts on investors' portfolios and interests. There is room for argument on this point, however, and therefore it would seem to be appropriate to develop a decision model of portfolio selections to examine the incentive problem of risk balancing.

3. Two-asset portfolio choice

We establish a continuous-time decision model of two-asset portfolio selections for a representative investor. This study first describes the price dynamics of investable assets and sets out

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