Economic Modelling 29 (2012) 1679–1685

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

# Incentive contracts in delegated portfolio management under VaR constraint ☆

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ARTICLE INFO

Article history:
Accepted 2 May 2012

JEL Classifications:
D81
D82
J33

Keywords:
VaR constraint
Incentive contract
Delegated portfolio management
Private information

ABSTRACT

This paper studies the incentive effect of linear performance-adjusted contracts in delegated portfolio management under a value-at-risk (VaR) constraint. It is shown that a linear performance-based contract can provide incentives for the portfolio manager to work at acquiring private information under a VaR risk constraint. The expected utility and optimal effort of a risk-averse manager are increasing functions of the return sharing ratio in the contract. However, a risk constraint causes the portfolio manager to reduce effort in gathering private information, suggesting that the VaR constraint increases the moral hazard between the investor and the manager.



## 1. Introduction

In the past few decades, the industry of delegated portfolio management has developed tremendously. Investors delegate professional investment managers to manage their wealth believing that portfolio managers possess the ability to collect, interpret, and apply profitably the information on risk and return of financial assets. However, because managerial ability and effort are not observable, investors have to design an appropriate compensation contract to induce managers to work hard to acquire better information in the market so as to reduce the agency cost.

Although the performance-based linear incentive contract has been widely used in the delegated portfolio management industry, its incentive effect has not been fully developed theoretically, especially under various market or institutional complications. Stoughton (1993) and Admati and Pleiderer (1997) find that a linear contract cannot induce managers to work hard to acquire private information, which is the well-known “no-incentive” feature of linear contract under ideal market conditions. In addition, Admati and Pleiderer (1997) argue that the commonly used benchmark-adjusted compensation schemes are generally inconsistent with optimal risk-sharing and do not lead to the choice of an optimal portfolio for the investor.

This paper studies the linear incentive contract under a value-at-risk (VaR) constraint in a framework similar to Stoughton (1993) and Gomez and Sharma (2006). As Jorion (2003, 2007) and Pearson (2002) note, the fund management industry is increasingly using VaR to: (1) allocate assets among managers, (2) set risk limits, and (3) monitor asset allocations and managers (these activities are often referred to as ‘risk budgeting’). However, the incentive effect of linear contracts of delegated portfolio management under a VaR constraint has not been investigated in the literature. In this paper we show that a linear contract with a VaR risk constraint can raise the manager's efforts on information acquisition. A risk-averse manager's expected utility and optimal effort levels increase with the return sharing ratio, suggesting that a linear contract can not only allocate risks efficiently between the investor and the manager, but also induce the manager to work hard. Furthermore, under a VaR constraint, the manager's effort level is lower than that without such a constraint, suggesting that the VaR constraint increases the moral hazard between the investor and the manager.

### 1.1. Literature review

Despite the somewhat surprising result in Stoughton (1993), the linear contract is still the most popular contract in asset management

☆ This study is supported by the National Natural Science Foundation of China (#71161013) and the Social Science Foundation of the Ministry of Education of China (#10YJC630203). Financial support from the Social Science Foundation of Higher Education of Jiangxi, China (#GL1121) is gratefully acknowledged.

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doi:10.1016/j.econmod.2012.05.003

due to its simplicity and intuitiveness.[1] Two strands of literature have addressed the no-incentive feature of linear contracts.[2] The first strand studies nonlinear incentive contract and the second strand investigates the impact of various practical complications or restrictions (some of which are discussed in Almazan et al., 2004) on the incentive effect of linear contracts. The general finding of these studies is that the practical complications (e.g., restriction on short-selling or the investment manager's possession of market power) can usually overcome the underinvestment of effort in the linear contract.

In the first strand of literature, Bhattacharya and Pleiderer (1985) prove the existence of incentive contracts that can distinguish the types of managers and make the managers to truthfully reveal their ability and private information. In such a contract the compensation of the manager should be a quadratic function of the asset return. A nonlinear contract is optimal for investors with high risk tolerance. Ross (2004) examines the incentive effects of some common structures such as puts and calls, and briefly explores the duality between a fee schedule that makes an agent more or less risk-averse, and gambles that increase or decrease risk. Li and Tiwari (2009) argue that a benchmark-adjusted option-type incentive can help overcome the problem of underinvestment in effort that undermines linear contracts.

In the second strand of related literature, Gomez and Sharma (2006) and Agarwal et al. (2007) show that under short-sell constraints a linear contract can provide portfolio managers with incentives to gather information. Sheng and Yang (2010) demonstrate that when the manager has market power, that is, her asset selection can influence the equilibrium market price, a linear contract has incentive effects. Dybvig et al. (2010) show that trading restrictions are an essential part of an optimal contract because they prevent the manager from undoing the incentive effects of performance-based fees. Kyle et al. (2011) endogenize information acquisition and portfolio delegation in a one-period strategic trading model, and find that a higher powered linear contract induces the manager to exert more effort for information acquisition. Fabretti and Herzel (2012) consider the problem of how to establish compensation for a portfolio manager who is required to restrict the investment set because of socially responsible screening. Palomino and Prat (2003) show that when an agent can control the riskiness of the portfolio in a two-period model, the optimal contract is simply a bonus contract: the agent is paid a fixed sum if the portfolio return is above a certain threshold; in a multi-period framework, the optimal contract is linear. Heinkel and Stoughton (1994) also investigate the dynamics of portfolio management contracts in a two-period model.

In delegated portfolio management, the manager wants to maximize her expected utility, but preferences on risk taking may differ between the investor and the manager. To protect her interest the investor may want to introduce risk constraints into the delegated portfolio management contract. Risk constraints can change investing opportunities and behavior of the manager. Jorion (2003) finds that adding a constraint on the total portfolio volatility can substantially improve the performance of an active portfolio. In a mean tracking error variance (TEV) framework, Alexander and Baptista (2008) find that a VaR constraint can mitigate the well-known problem that when an active manager seeks to track (or outperform) a benchmark, she may select a particularly inefficient portfolio.

This paper falls into the second strand of literature by studying the incentive effect of a linear contract under a VaR risk constraint.

[1] An institutional reason for the popularity of linear contracts is that SEC restricts compensation contracts in the mutual fund industry to only linear symmetric contracts. As reported in Ma et al. (2012), over ninety-five percent of portfolio managers have salary-plus-bonus type of compensation contracts in the U.S. mutual fund industry.

[2] See Stracca (2006) for a review of theoretical literature on delegated portfolio management.

### 1.2. VaR in financial risk management

The origin of VaR can be traced back to quantitative trading groups at several financial institutions in the 1980s, notably Bankers Trust, although neither the acronym "VaR" nor the definition were standardized. When the financial events of the early 1990s called for some measure on firm-wide risk, VaR was the natural choice because it was the only common risk measure that could be both defined for all businesses and aggregated without strong assumptions. In 1994, J. P. Morgan published the methodology, which, two years later, was spun off into an independent for-profit business now part of RiskMetrics Group.

In 1997, the U.S. Securities and Exchange Commission ruled that public corporations must disclose quantitative information about their derivatives activity. Major banks chose to implement the rule by including VaR information in the notes of their financial statements. Worldwide adoption of the Basel Accords since late 1990s gave further impetus to the use of VaR. In the meantime, many academic researches have studied its application and impact in portfolio management (e.g., Basak and Shapiro, 2001; Campbell, et al., 2001; Jarrow and Zhao, 2006; Natarajan, et al., 2008).

The current paper proceeds as follows. Section 2 describes the basic model employed. Section 3 outlines the results of Stoughton (1993) and Gomez and Sharma (2006), used as a benchmark for our findings, which propose that there is no incentive effect in a linear contract. The VaR constraint is introduced in Section 4. Section 5 studies the manager's utility function with a risk constraint. Section 6 investigates the impact of a VaR constraint on the incentive effect in a linear contract. Concluding remarks are in Section 7.

## 2. The model

The basic setup of the model is very similar to that in Stoughton (1993) and Gomez and Sharma (2006). In an economy there are two representative agents, an investor and an investment manager. There are two types of assets on the market, a risky asset and a riskless asset. The expected return of the riskless asset is zero. The manager receives a private signal about the return of the risky asset, $\tilde{y}=\tilde{x}+\tilde{z}$, where $\tilde{x}$ is the true rate of the return of the risky asset and $\tilde{z}$ represents a noise term that is uncorrelated with $\tilde{x}$. We assume that $\tilde{x}$ is of a standard normal distribution $\tilde{x}\sim N(0,1)$.[3] Let $\tilde{z}\sim N(0,\sigma_z^2)$, with $\sigma_z^2<\infty$, such that a higher $\sigma_z^2$ implies a less precise signal, which in turn is caused by a lower level of effort by the manager to acquire the signal. Suppose that $\rho$ represents the effort level of the manager, so $\sigma_z^2=\rho^{-1}$ reflects the manager's effort level. As per Stoughton (1993), the signal's precision is $\rho/(1+\rho)$, which is an increasing and concave function of the effort level. When the manager receives her private signal $\tilde{y}=y$, she updates her expectation on the return of the risky asset by the Bayesian rule. Now its conditional expectation and variance are $E(\tilde{x}|y)=\frac{\rho}{1+\rho}y$ and $\mathrm{Var}(\tilde{x}|y)=\frac{1}{1+\rho}$ respectively, that is, $\tilde{x}|y\sim N\left(\frac{\rho}{1+\rho}y,\frac{1}{1+\rho}\right)$. The manager is a price taker, so her behavior does not affect the equilibrium market price. In her portfolio, the proportions invested in the risky and the riskless assets are $\theta(y)$ and $1-\theta(y)$ respectively.

The investor delegates the investment decision-making power to the manager, and provides a linear fee schedule $\beta_0+\beta\tilde{W}$ to the manager, with $\beta_0,\beta>0$ as contract parameters. $\tilde{W}=\theta(y)\tilde{x}$ represents the return of the portfolio at the end of the period. For not losing generality, we assume that the initial amount of investment is one.

Similar to Stoughton (1993), we assume the cost of effort of the manager is $V(r,\rho)$, where $r$ is the absolute risk aversion coefficient, $V'_\rho(r,\rho)>0$, $V''_{\rho\rho}(r,\rho)\geq 0$, $V(r,0)=0$, and $V'_r(r,\rho)\geq 0$. $V(r,\rho)$ represents

[3] The results do not change if the expected return is not zero. Moreover, none of our results depends, qualitatively, on the assumptions of normal distribution.