Available online at www.sciencedirect.com
ScienceDirect
Journal of Economic Theory 173 (2018) 142–180
JOURNAL OF Economic Theory
www.elsevier.com/locate/jet

Asset pricing under optimal contracts ☆

Jakša Cvitanić [a,*], Hao Xing [b]

[a] Caltech, Humanities and Social Sciences, M/C 228-77, 1200 E. California Blvd., Pasadena, CA 91125, USA
[b] Department of Statistics, London School of Economics and Political Science, Columbia House, Houghton St, London WC2A 2AE, UK

Received 21 February 2017; final version received 10 October 2017; accepted 16 October 2017

Abstract

We consider the problem of finding equilibrium asset prices in a financial market in which a portfolio manager (Agent) invests on behalf of an investor (Principal), who compensates the manager with an optimal contract. We extend a model from Buffa, Vayanos and Woolley (2014) by allowing general contracts, and by allowing the portfolio manager to invest privately in individual risky assets or the index. To alleviate the effect of moral hazard, Agent is optimally compensated by benchmarking to the index, which, however, may incentivize him to be too much of a "closet indexer". To counter those incentives, the optimal contract rewards Agent for taking specific risk of individual assets in excess of the systematic risk of the index, by rewarding the deviation between the portfolio return and the return of an index portfolio, and the deviation's quadratic variation.

JEL classification: C61; C73; D82; J33; M52

Keywords: Asset-management; Equilibrium asset pricing; Optimal contracts; Principal–agent problem

☆ We would like to express our gratitude to Andrea Buffa, Dylan Possamaï and Nizar Touzi for helpful discussions, as well as to the anonymous Associate Editor and referees for their helpful comments and suggestions.
* Corresponding author.
E-mail addresses: cvitanic@hss.caltech.edu (J. Cvitanić), H.Xing@lse.ac.uk (H. Xing).

https://doi.org/10.1016/j.jet.2017.10.005
0022-0531/

1. Introduction

We consider the problem of asset pricing with delegated portfolio management, that is, of finding asset prices so that the financial market is in equilibrium when the portfolio managers are offered optimal compensation contracts. The fact that an increasing percentage of investment funds is run by investment managers underlines the importance of studying the effect of managerial actions on asset prices. Thus, the problem is important, however, it is also difficult. There are extensive studies that consider various equilibrium models of asset prices, but, partly due to technical difficulties, there are almost no results where asset pricing is combined with optimal contracting between portfolio managers and investors. A notable exception is Buffa et al. (2014), henceforth BVW (2014), which inspired the current paper.[1]

BVW (2014) considers a market with three types of participants: portfolio managers who decide on the investment strategy, but who can also get benefit from (non contractible) shirking that reduces the managed return; rational investors who can hire managers to invest on investors behalf in individual assets, while investors invest privately only in the index; and buy-and-hold investors. Portfolio managers have expert knowledge about individual assets, which is why investors can benefit from contracting managers to get access to individual assets. Both the investor and the portfolio manager have CARA utility functions. BVW (2014) considers two models: one in which the dividends have square-root dynamics, and the other in which they have OU (Orstein–Uhlenbeck) dynamics. The representative CARA investor chooses optimally the contract to pay the representative manager, but is allowed to do so only in a subfamily of all possible contracts – those that are linear in the investor's portfolio value and the stock index. This would, indeed, be optimal in the classical moral hazard continuous-time models of Holmstrom and Milgrom (1987) and Sannikov (2008), in which the manager can only affect the return of the output process. However, when the manager can also affect the volatility of the output, as is the case in portfolio management, it was shown in Cvitanić et al. (2017a) and (2017b), henceforth CPT (2017a, 2017b), that the optimal contract makes use also of the quadratic (co)variations of the contractible factors. We use that insight to extend the family of admissible contracts in this paper.

The differences between this paper and CPT (2017a, 2017b) are as follows. In the latter, the manager is paid only once, at the final time, and the model is one of partial equilibrium, that is, the asset prices are exogenous. In contrast, in this paper the manager is paid at a continuous rate on an infinite horizon, and the asset prices are determined endogenously in equilibrium, as in BVW (2014). We use a mathematical methodology similar to that of CPT (2017a, 2017b), but adapted to the infinite horizon and continuous payments. In our setting, as in CPT (2017a, 2017b), the optimal contract uses quadratic (co)variations of contractible variables. More precisely, in the OU model, the optimal contract is linear in the investor's portfolio value, the index, and the quadratic variation of the deviation of the portfolio return from the return of an index portfolio. We find that the contract sensitivity to the quadratic variation of the deviation is positive, meaning that the contract rewards the agent for taking specific risk of individual risky assets beyond the systematic risk of the index. We show in a numerical example that the contract with the quadratic variation component can substantially increase investor's optimal value.

To the best of our knowledge, this, together with Leung (2016), is the first general equilibrium model in which such a contract is shown to be optimal. The use of the quadratic variation, which, in practice, would correspond to using the sample variance, is, as noted in CPT (2017a), in the

[1] Other related literature is discussed below.