



Optimal portfolio policies with borrowing and shortsale constraints[☆]

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Abstract

We characterize optimal intertemporal portfolio policies for investors with CRRA utility facing either a borrowing constraint, or shortsale restrictions, or both. The optimal constrained portfolios are identified as optimal unconstrained portfolios for a higher riskless rate, or for a subset of the risky assets, or for a combination of the two settings. Our characterization is based on duality results in Cvitanić and Karatzas (1992, *Annals of Applied Probability* 2, 767–818) for optimal portfolio investment when portfolio values are more generally constrained to a closed, convex, nonempty subset of \mathbb{R}^n . © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

This paper characterizes optimal intertemporal portfolio policies for CRRA-utility investors facing either a borrowing limit on the total wealth invested in

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the risky assets, or shortsale restrictions on all risky assets, or both. The characterization is based on the first-order conditions to a minimization problem identified by Cvitanić and Karatzas (1992) as underlying the dual formulation of the optimal portfolio investment problem when portfolio values are more generally constrained to a closed, convex, nonempty subset of \mathbb{R}^n (when there are n risky assets). In each setting, the optimal constrained portfolio is identified as an optimal ‘unconstrained’ portfolio. Specifically, with borrowing constraints only, CRRA-utility investors act as if unconstrained but facing a higher interest rate. With shortsale constraints only, these investors act as if unconstrained when investing only in a subset of the risky assets. With borrowing and shortsale constraints, both effects obtain. Specifically, the optimal portfolio is equivalent to the optimal borrowing-constrained-only portfolio for a subset of the risky assets, and thus to the optimal unconstrained investment in these assets at a higher interest rate.

Results closely related to a number of those derived here in a dynamic setting have previously been identified as holding in a one-period, mean-variance or Markowitz framework. Black (1972) establishes that an investor who cannot borrow at all chooses a tangency portfolio corresponding to a higher interest rate. Brennan (1971) considers the setting in which the investor can borrow without limit, but faces a borrowing rate which is greater than the lending rate. The optimal portfolio is again equivalent to a tangency portfolio, in this case corresponding to one of three possible ‘risk-free’ rates.¹ Separately, Lintner (1965) identifies the optimal shortsale-constrained Markowitz portfolio as the optimal unconstrained portfolio for a subset of the risky securities. The fact that we obtain very similar results for CRRA-utility investors in the dynamic setting is not entirely unexpected given that it is well-known that, for the model we consider, these investors’ optimal unconstrained portfolios are instantaneously mean-variance efficient.² Nonetheless, to date, some of these results, particularly those concerning shortsale constraints, have been missing from the continuous-time literature. Grossman and Vila (1992), using a stochastic dynamic programming approach, study the optimal intertemporal portfolio policies of a borrowing-constrained power-utility investor in the standard Merton (constant-coefficient) setting. Rather than restricting investment in the risky assets to be less than some constant proportion of wealth, as we do here, Grossman and Vila consider the effects of a borrowing limit which is affine in wealth.³ Because their model features only one risky asset, it does not identify how a borrowing

¹ The relevant rate is either the borrowing rate, the lending rate, or a rate at which the optimal investment results in neither borrowing nor lending.

² See, for example, Merton (1990, pp. 170–171). Here we assume a deterministic investment opportunity set, so there is no hedging demand.

³ This feature leads the investor to alter his optimal portfolio holdings even when the constraint is not binding (see Grossman and Vila, 1992).

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