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# A Consumption-Investment Problem with Constraints on Minimum and Maximum Consumption Rates \*

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## Abstract

We develop famous Merton's financial model to more realistic and interesting situation: consumption rate has lower and upper constraints. The aim is to find optimal strategies for consumption and investment. The corresponding HJB equation is a fully nonlinear ordinary differential equation. We use stochastic analysis and differential equation technique to find optimal strategies. The regularity of the value function is obtained as well. The method and result are meaningful and interesting in both of finance and mathematics.

**Keywords.** Consumption-investment problem; Free boundaries; Constraints on consumption rate; Optimal strategies.

**Mathematics Subject Classification.** 60G40; 91B70; 93E20; 35R35.

## 1 Introduction

Merton (1969), basing on the work of Samuelson (1969), Pratt (1964), Arrow (1965), etc. formulated the consumption-portfolio problem in continuous time with the risky asset yielding log-normally distributed returns. In a pioneering paper, Merton (1971) extended his 1969 paper to incorporate an important class of utility functions known as the HARA (Hyperbolic Absolute Risk Aversion) family. He used Itô's lemma as a tool for analyzing the dynamics of asset prices, wealth and consumption. Using stochastic dynamic programming, he derived the Hamilton-Jacobi-Bellman(HJB) equation for the value function of the problem. The problem according to Merton (1975) is the natural beginning point for the development of a theory of finance.

With respect to the consumption-investment problem with constraints, Fleming and Zariphopoulou (1991) considered the optimal consumption-investment problem with borrowing constraints. Cvitanic and Karatzas (1992) considered the scenario in which the

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