

Option Pricing for a Large Trader with Price Impact and Liquidity Costs

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Abstract

This paper concerns the pricing of options for a large trader in a market with liquidity risk. The investor's trading action is assumed to have some lasting impact on the underlying asset, and the effect of illiquidity is modeled via trading speed (rate of change in holdings). For such a large trader, liquidity risk is quite important since the permanent price impact as well as liquidity costs incurred during trading must be taken into account. The utility maximization approach to determine option prices leads to optimal control problems. This paper shows that the value functions of these optimal control problems are the unique viscosity solutions of a fully nonlinear second-order PDE. Moreover, some illustrative examples with explicit optimal solutions and numerical results are presented.

Keywords: option pricing, liquidity risk, large trader, price impact, utility maximization

1 Introduction

Liquidity risk is considered as the most important risk in finance industry these days. Although there seems no unanimous agreement on the definition of liquidity risk, there has been a growing literature on “illiquidity” which is to model the effect of illiquidity and to solve important problems within the model. Apparently, modeling of liquidity risk is challenging but very important.

In the literature on market liquidity for the underlying asset, there are two approaches for modeling; one is temporary price impact and the other is permanent price impact. The first one is the effect of liquidity cost incurred while changing position as a price-taking trader. Roughly speaking, this arises on short time scales as the result of trading, and can be thought of as a trader having to

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