Solving the liquidity constraint by options on futures

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HIGHLIGHTS

- An option on futures may solve the liquidity constraint problem.
- Constrained consumption resembles a short position of a put option on income.
- An option on futures restores the smooth consumption as a function of future income.
- The option of futures is strictly improving compared to the risk-free investment.

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ABSTRACT

The aim of this paper is to show that an option on futures may solve the liquidity constraint problem. I consider a consumer (or an investor) who wishes to discount her future income in order to finance her present consumption (investment). Under asymmetric information, such an agent may incur a liquidity constraint (credit rationing). However, the optimal constrained consumption, as a function of future income, resembles a short position of a put option written on future income. This implies that allocating savings to a long call option position on futures may restore the unconstrained relationship between the optimal present consumption and future income. The option on a futures contract is constructed so that the (future) agent's income is correlated with some futures contract (but this is private information) on which the option is issued. The allocation of savings of the borrower to the option on futures turns out to be financially beneficial compared to the allocation of savings to the risk-free investment.

0. Introduction

This paper proposes a micro-founded solution to the problem of liquidity constraints. The proposed solution relies on the use of options on futures, O-F (see Hull, 2009, chapter 16[1]). I show that the O-F provides an alternative way to access funding. I also show that shifting savings from the risk-free investment to the investment based on O-F is, for the borrower, strictly improving.

Liquidity constraints have several economic consequences. At the microeconomic level, this implies that the market may fail, leading to an inefficient allocation of resources. At the macroeconomic level, liquidity constraint can be considered as a rigidity preventing the economy from quickly restoring optimality once a shock occurs; thus the liquidity constraint implies more (costly) policy interventions. The empirical evidence on consumption and liquidity constraints shows that the magnitude of this phenomenon is far from being considered negligible (see, for example, Campbell and Mankiw (1990, 1991) for some estimates). All these issues raise the question of how to remove such constraints.

The present literature can be divided into three strands.

The first strand describes the phenomenon in question at the microeconomic level. In particular, liquidity constraints are found to be the outcome of a malfunctioning market affected by information asymmetries. This problem manifests itself in, for example, adverse selection, moral hazard and costly monitoring. If consumers or firms expect a high future income, they find it optimal to sell the stream of their future income to the banking system in order to obtain the present cash flow (for consumption or investment). However, under asymmetric information, the market may fail, so that people who are willing to pay an interest rate higher than the market rate are rationed and consequently, consumption or investment suffers from the liquidity constraint. Hence, because of information asymmetries, either the credit market fails or it does not

allocate resources efficiently: Whited (1992), for example, showed that firms which are unable to obtain external financing significantly change their allocation of real investment expenditure over time. In Chen et al. (2008), the authors demonstrate that credit market imperfections widen financial spreads and lower effective bank loans.

A second strand of literature has concentrated on the macroeconomic consequences of the problem in question and on the potential solutions. For example, the liquidity constraint may cause an excess of aggregate saving and hence a loss of welfare as found in Jappelli and Pagano (1994). Furthermore, Zeldes (1989) shows that the probability of facing liquidity constraints in the future, decreases the optimal level of present consumption. Still at the macroeconomic level, the liquidity constraint can be seen as a source of rigidity, causing the present consumption to respond to the present income and not to the life time income. This rigidity may also propagate economic disturbances as Williamson (1987) and Bernanke and Gertler (1989) have shown. However, as found in Chah et al. (1995), consumers – even though liquidity constrained – remain rational and forward-looking and do not necessarily follow the Keynesian rule of consumption. This implies that once such rigidities are removed at the microeconomic level, the economy becomes more resilient and requires both less policy intervention and less time to return to its long-run path.

A third strand of literature regards how financial engineering can solve or mitigate similar problems. All the relevant solutions are based on the role of options in expanding contingencies covered by the market, as shown in the seminal work of Ross (1976). For example, Moschini and Lapan (1995), outline a hedging role of O-F but they aimed to demonstrate that a combination of O-F and futures contracts hedge a producer who faces basis, production and price risk. Adam-Mueller Axel and Panaretou (2009) analyze the role of an O-F when a firm faces a joint price risk and liquidity risk. In particular, the future position is designed to hedge the price risk. However, due to marking to market, the future position creates a liquidity risk which can be hedged with the O-F. The latter is sold whenever the future position leads to interim cash outflows.

In this paper, the role of O-F, is different to these other approaches. First, its application can be generalized to consumption decisions. Second, firms are not subject to production and price risks. Firms (or consumers) are liquidity constrained because they suffer from information asymmetry about their future income. Third, since, in this setting, the agent is not assumed to incur losses,[2] the functioning of the hedging role of the O-F changes. It turns out that the liquidity constraint becomes binding when the value of future income becomes high and not low as the usual principles of hedging postulate. As a consequence, differently from Moschini and Lapan (1995) and from Adam-Mueller Axel and Panaretou (2009), it turns out to be optimal to detain a long position in the O-F.

This paper is organized as follows. The next section clarifies the notation and assumptions. Section 2 two describes the hedging property of the O-F when the liquidity constraint is binding. Section 3 shows that the allocation of savings to the O-F is optimal with respect to the allocation based on "traditional savings". Finally, some conclusions are drawn.

1. Notation and assumptions

I assume a representative borrower (consumer or investor) seeking to maximize her objective function (utility or profit function) over a horizon of three Periods. The borrower is risk-averse,

forward-looking and in Period 2, may be liquidity constrained. In order to avoid this constraint, she may shift additional wealth (savings) from Period 1 to Period 2 (to smooth consumption or to fund an investment). Alternatively, she may take a long position in an O-F.

I also assume competitive markets for non-risky assets, futures and O-F, in which lenders are risk neutral and have constant returns to scale. In particular, the lenders' unit profit from operating in the O-F market is the difference between the capitalized price of the O-F and its pay-off. These lenders have a linear technology transforming non-risky assets into O-F contracts. The borrower cannot sell her stream of future income because of asymmetries in information.

In particular, the following assumptions are made:

(a) the economy lasts three Periods;

(b) the futures market is complete and efficient: participants are rational, risk neutral, competitive and hold no private information. In this market, a continuum of futures is issued, whose underlying value is denoted by $X: X \in \varXi$. The price of the futures is set in Period 2; due to potential arbitrage, this price equals the expected discounted value of X_3;

(c) one-Period interest rates are set in a competitive market of risk neutral lenders; the gross rate is defined as R_j, such that R_j is set in Period $J-1$, with $J=2, 3$. They are all known at Period 1. The government supplies or demands any quantity of non-risky assets at the market interest rates defined above such that this market always clears, $\forall J$;

(d) borrowers (consumers or investors) are rational, risk-averse and obtain a flow of stochastic income Y_1, Y_2, Y_3, such that $Y_j \geq 0 \, \forall j$. If the borrower is a consumer, she wishes to discount Y_3 in order to smooth her consumption in Period 2. If she is an investor, she wishes to discount the (potential) value Y_3 in order to finance her investment, yielding Y_3;

(e) each income level Y_j correlates with one (combination of) X, but this correlation is private information of each borrower. Without loss of generality, it is assumed that this correlation is perfect. This is the source of the liquidity constraint: the borrower cannot exploit her private information about the correlation between Y and some X, in order to obtain some funding (and the lender cannot infer the type (riskiness) of borrower through knowledge of X). Furthermore, incomes Y_2 and Y_3 are independent[3]:

$E_2[Y_3] = E_1[Y_3]$ that is, $E[Y_3|Y_2, I_2] = E[Y_3|I_2]$ where I_2 includes all information available to the public in Period 2 except for Y_2 Note that, if this were not so, agents could exploit the correlation to avoid the liquidity constraint[4];

(f) in the O-F market, (call) option contracts are issued in Period 1 and expire in Period 2. Denote the price as CO_1 and the quantity demanded as $Q, Q \in [0, \infty)$. Each option gives the right to buy a futures contract at the strike price K in Period 2. The O-F market is complete;

(g) since the value of each future is the discounted expected value of some X, and if Y_3 is (perfectly) correlated[5] with X_3, then the payoff of the option is,[6] in Period 2, $\max(E_2[X_3]/R_3 - K, 0) \equiv \max(E_2[Y_3]/R_3 - K, 0)$;

(h) In the O-F market, there are identical, rational, risk neutral lenders with constant returns to scale. The lenders seek to maximize the following expected profit in Period 2: $E_2[\Pi_3^L] =$

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[2] In all cases, consumers (and investors) may want to borrow against future income which, in the worst scenario, is zero.

[3] $E[.]$ is the mathematical expectation operator.

[4] Note, however, that this assumption serves mainly to simplify subsequent calculations. I may interpret the flow of Y as the unexplained part of income, having considered the past incomes as predictors.

[5] See assumption (e).

[6] See Adam-Mueller Axel and Panaretou (2009).