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Asset pricing with heterogeneous preferences, beliefs, and portfolio constraints

Georgy Chabakauri ¹

Department of Finance, London School of Economics, Houghton Street, London WC2A 2AE, United Kingdom

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ABSTRACT

Portfolio constraints are widespread and have significant effects on asset prices. This paper studies the effects of constraints in a dynamic economy populated by investors with different risk aversions and beliefs about the rate of economic growth. The paper provides a comparison of various constraints and conditions under which these constraints help match certain empirical facts about asset prices. Under these conditions, borrowing and short-sale constraints decrease stock return volatilities, whereas limited stock market participation constraints amplify them. Moreover, borrowing constraints generate spikes in interest rates and volatilities and have stronger effects on asset prices than short-sale constraints.

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1. Introduction

Portfolio constraints have long been considered among the key factors that affect investment decisions and asset prices. Moreover, the tightening of borrowing and short-sale constraints during the recent financial crisis sparked further interest in the effects of constraints on financial markets. The main objective of this paper is to provide a comparison of the effects of borrowing, short-sale, and limited stock market participation constraints on asset prices in a dynamic economy in which investors have different risk aversions and beliefs about the rate of economic growth. The paper shows that constraints and preferences interplay in complex ways, giving rise to spikes in interest rates and stock return volatilities. Furthermore, by relaxing the assumption of logarithmic constrained investors, popular in the literature, this paper demonstrates that investors' elasticities of intertemporal substitution (EIS) play a key role in matching certain empirical facts about asset prices and determining whether constraints increase or decrease asset prices and the volatilities of their returns.

The paper considers a pure-exchange Lucas (1978) economy with one tree populated by two investors with heterogeneous constant relative risk aversion (CRRA) preferences and heterogeneous beliefs about the mean growth rate of aggregate output. The investors trade in a riskless bond and a stock, representing a claim to the stream of dividends produced by the tree. One investor is unconstrained, whereas the other may face borrowing, short-sale, or limited stock market participation portfolio constraints. The paper studies the market prices of risk, interest rates, stock return volatilities and stock price-dividend ratios and derives them as functions of the constrained investor's share of the aggregate consumption, which acts as a state variable in the model.

E-mail address: G.Chabakauri@lse.ac.uk

¹ Tel.: +44 20 7107 5374.

The main results on the effects of borrowing constraints are as follows. First, under these constraints, interest rates and stock return volatilities are complex non-monotone functions of the state variable with spikes. The spikes are due to a kink in the constrained investor's portfolio weight at a time when constraints start to bind. Second, in economies where stock return volatilities are countercyclical (i.e., negatively correlated with the aggregate output) and exceed dividend volatilities, as in the data, constraints decrease volatilities and destroy their countercyclicality. The intuition is that constraints homogenize investors' portfolios, and hence, the volatility decreases toward that in a homogeneous-investor economy, in which stock and aggregate output volatilities coincide. Third, constraints lead to higher market prices of risk, compensating the unconstrained investor for holding more stocks to clear the market, and to lower interest rates because the constrained investor borrows less.

The effects of constraints on investors' wealth-consumption (W/C) and price-dividend (P/D) ratios depend on investors' EIS, which determine the relative strength of income and substitution effects.² When the substitution effect dominates, borrowing constraints tend to decrease W/C ratios because of the low opportunity cost of consumption. This is due to low interest rates and the fact that investors cannot take full advantage of investing in stocks because in the model the unconstrained investor is pessimistic, whereas the other investor is constrained. The opposite happens for the income effect. The paper shows that the P/D ratio is a weighted average of investors' W/C ratios and, hence, responds to constraints in a similar way. The paper formalizes the intuition by deriving closed-form approximations for W/C and P/D ratios, which capture the interaction between constraints and EIS. The intuition for other constraints is analyzed similarly.

Next, the paper contributes to the debate on the economic effects of short-sale bans. It shows that in economies where stock return volatilities are countercyclical and exceed dividend volatilities, short-sale bans decrease volatilities, in line with the anticipations of policymakers during the recent financial crisis (e.g., [Beber and Pagano, 2013](#)). Moreover, short-sale bans preserve the countercyclicality of volatilities, decrease market prices of risk and increase interest rates. However, the effect of these constraints on asset prices and volatilities is small, in line with the empirical studies on short-sale bans during the 2007–2009 crisis (e.g., [Beber and Pagano, 2013](#); [Boehmer et al., 2013](#)).

Finally, to isolate the pure effects of constraints, the paper considers an economy where both investors are identical except that one of them faces a limited participation constraint, that is, invests only a small fraction of wealth in stocks. This constraint is typical for pension funds, retail investors, and some mutual fund families. The main finding is that when the substitution effect dominates, the model generates countercyclical market prices of risk and stock return volatilities, procyclical interest rates and price-dividend ratios, excess volatility, and a negative correlation between risk premia and price-dividend ratios, consistent with the empirical literature. The effects on market prices of risk and interest rates are similar to those for borrowing constraints.

The paper offers a new tractable characterization of equilibrium for comparing the effects of different constraints. This characterization does not rely on a restrictive assumption of logarithmic constrained investors, as commonly employed in the literature. The derivation of equilibrium proceeds in two steps. First, all processes are derived in terms of the shadow costs of constraints from the first order conditions for consumption. Then, the shadow costs are found from the Kuhn–Tucker conditions of optimality. Finding the equilibrium reduces to solving a system of ordinary differential equations (ODEs) for investors' W/C ratios. In the unconstrained benchmark, the paper provides a new closed-form solution of the model.

There is a large body of literature on economies with constrained logarithmic investors. The results in the current paper on whether constraints increase or decrease market prices of risk and interest rates do not strongly depend on preferences and are consistent with this literature. Nevertheless, the results on the spiky non-monotone dynamics of interest rates and volatilities and the analysis of the cyclicalities of P/D ratios and volatilities are new even for economies with logarithmic investors. Moreover, as shown in this paper, models with general preferences and models with logarithmic preferences may have opposite predictions regarding the effects of constraints on P/D ratios and stock return volatilities.

Below, we review the most closely related works. [Detemple and Murthy \(1997\)](#) and [Basak and Croitoru \(2000, 2006\)](#) study economies with various constraints where all investors are logarithmic. [Coen-Pirani \(2005\)](#) studies margin requirements in an economy with Epstein–Zin investors who have $EIS = 1$. In those papers, constraints do not affect stock prices because income and substitution effects cancel each other when investors have $EIS = 1$. [Pavlova and Rigobon \(2008\)](#) study a three-country economy with constrained logarithmic investors, but they use home bias as the source of investor heterogeneity.

[Kogan et al. \(2007\)](#) consider a model with one unconstrained CRRA investor and one logarithmic investor who cannot borrow. Their processes are deterministic, and there is no excess volatility. [Gallmeyer and Hollifield \(2008\)](#) study short-sale bans in a model with heterogeneous preferences and beliefs and a logarithmic constrained investor. They find that constraints increase (decrease) volatilities when the unconstrained investor has $EIS > 1$ ($EIS < 1$). In contrast to the above papers, this paper handles looser constraints and non-logarithmic preferences, and the volatility can go either way for any fixed EIS, depending on the constrained investor's consumption share.

[Basak and Cuoco \(1998\)](#) study market prices of risk and interest rates in an economy with limited participation and a logarithmic constrained investor. [Hugonnier \(2012\)](#) studies endogenous bubbles in the model of [Basak and Cuoco \(1998\)](#).

² When the investment opportunities worsen, the substitution effect induces investors to consume more and save less because of the lower opportunity cost of consumption. The income effect induces them to do the opposite in order to have higher consumption in the future. For CRRA preferences with risk aversion γ , $EIS = 1/\gamma$. The substitution effect dominates for $EIS > 1$, and the income effect dominates for $EIS < 1$.

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