Journal of Financial Economics 115 (2015) 411–428

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Asset pricing with arbitrage activity ☆

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ARTICLE INFO

Article history:
Received 6 November 2013
Received in revised form
10 April 2014
Accepted 6 May 2014
Available online 8 October 2014

JEL classification:
D51
D52
G11
G12

Keywords:
Limits of arbitrage
Rational bubbles
Wealth constraints
Excess volatility
Leverage effect

ABSTRACT

We study an economy populated by three groups of myopic agents: constrained agents subject to a portfolio constraint that limits their risk taking, unconstrained agents subject to a standard nonnegative wealth constraint, and arbitrageurs with access to a credit facility. Such credit is valuable as it allows arbitrageurs to exploit the limited arbitrage opportunities that emerge endogenously in reaction to the demand imbalance generated by the portfolio constraint. The model is solved in closed-form, and we show that, in contrast to existing models with frictions and logarithmic agents, arbitrage activity has an impact on the price level and generates both excess volatility and the leverage effect. We show that these results are due to the fact that arbitrageurs amplify fundamental shocks by levering up in good times and deleveraging in bad times.

1. Introduction

Textbook asset pricing theory asserts that arbitrage opportunities cannot exist in a competitive market because they would be instantly exploited, and thereby eliminated, by arbitrageurs. This basic principle is certainly valid for riskless arbitrage opportunities defined as trades that require no initial investment and whose value can only grow over time.[1] However, there is no reason to believe that it should hold for risky arbitrage opportunities, such as convergence trades, that guarantee a sure profit at some future date but require capital to fund potential losses at interim dates.[2] Indeed, the fact that arbitrageurs have limited capital and are subject to solvency requirements

☆ A previous version of this paper was circulated under the title "Arbitrageurs, bubbles and credit conditions". For helpful comments we thank Hengjie Ai, Rui Albuquerque, Harjoat Bhamra, Pablo Castañeda, Pierre Collin Dufresne, Jérôme Detemple, Bernard Dumas, Phil Dybvig, Zhiguo He, Leonid Kogan, Mark Loewenstein, Marcel Rindisbacher, and seminar participants at the 2013 American Mathematical Society meetings at Boston College, the Bank of Canada, Boston University, the eighth Cowles Conference on "General Equilibrium and its Applications" at Yale University, the 2012 conference of the Financial Intermediation Research Society, the 2014 European Finance Association Annual Meeting, the 2014 North American Meeting of the Econometric Society, Southwestern University of Finance and Economics, the fourth FinanceUC Conference, Universidad Adolfo Ibáñez, University of Geneva, and University of Lugano. Financial support by the NCCR FinRisk Project A5, the Swiss Finance Institute, and Boston University is gratefully acknowledged.

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[1] Such an opportunity arises for example when two assets that carry the same exposure to risk offer different returns. See Gromb and Vayanos (2002) for a model in which such arbitrage opportunities arise due to market segmentation, and Basak and Croitoru (2000) for a model in which they arise due to the fact that securities are subject to different margin constraints.

[2] Examples of such arbitrages include mispricing in equity carve-outs (Lamont and Thaler, 2003a,b), dual class shares (Lamont and Thaler, 2003a) and the simultaneous trading of shares from Siamese twin conglomerates such as Royal Dutch and Shell. See Rosenthal and Young (1990), Lamont and

http://dx.doi.org/10.1016/j.jfineco.2014.10.001
0304-405X/

limits their ability to benefit from such risky arbitrage opportunities and implies that they could subsist in equilibrium. In such cases, the trading activity of arbitrageurs would not suffice to close the arbitrage opportunities but will nonetheless have an impact on the equilibrium, and the goal of this paper is to investigate the effect of this risky arbitrage activity on asset prices, volatilities, risk sharing and welfare.

To address these issues a general equilibrium model must be constructed in which risky arbitrage opportunities exist in the first place. We achieve this by considering a model of an exchange economy similar to those of Basak and Cuoco (1998) and Hugonnier (2012). We start from a continuous-time model that includes a riskless asset in zero net supply, a dividend-paying risky asset in positive supply and two groups of agents with logarithmic preferences. Agents in both groups are subject to a standard nonnegativity constraint on wealth.[3] But, while agents in the first group are unconstrained in their portfolio choice, we assume that agents in the second group are subject to a portfolio constraint that limits their risk taking and, thereby, tilts their demand toward the riskless asset. This portfolio constraint generates excess demand for the riskless asset and captures in a simple way the global imbalance phenomenon pointed out by Caballero (2006), Caballero, Farhi, and Gourinchas (2008) and Caballero and Krishnamurthy (2009), among others. This excess demand naturally implies that the interest rate decreases and the market price of risk increases compared with a frictionless economy. But it also implies that the stock and the riskless asset are overvalued in that their equilibrium prices each include a strictly positive bubble.[4] The intuition is that even though agents of both groups are price takers, the presence of constrained agents places an implicit liquidity provision constraint on unconstrained agents through the market clearing conditions: At times when the portfolio constraint binds, unconstrained agents have to hold the securities that constrained agents cannot, and this is where the mispricing finds its origin. Bubbles arise to incite unconstrained agents to provide a sufficient amount of liquidity, and they persist in equilibrium because the nonnegative wealth constraint prevents them from indefinitely scaling their positions.

To study the impact of arbitrage activity on equilibrium outcomes, we then introduce a third group of agents that we refer to as arbitrageurs. These agents have logarithmic utility and are unconstrained in their portfolio choice, but they differ from unconstrained agents along two important dimensions. First, these agents initially hold no capital and thus would be able to consume only if they can exploit the risky arbitrage opportunities that arise due to the presence of constrained agents. Second, these agents have access to a credit facility that enhances their trading opportunities by allowing them to weather transitory periods of negative wealth. This facility should be thought of as a reduced-form for various types of uncollateralized credit such as unsecured financial commercial paper (see, e.g., Kacperczyk and Schnabl, 2009; Adrian, Kimbrough, and Marchioni, 2010), implicit lines of credit (see, e.g., Sufi, 2009), or loan guarantees.[5] To capture the fact that the availability of arbitrage capital tends to be procyclical (see, e.g., Ang, Gorovyy, and Van Inwegen, 2011; Ben-David, Franzoni, and Moussawi, 2012) we assume that this credit facility is proportional to the market portfolio.

We derive the unique equilibrium in closed form in terms of aggregate consumption and an endogenous state variable that measures the consumption share of constrained agents. Importantly, because the portfolio constraint acts as a partial hedge against bad fundamental shocks, this state variable is negatively correlated with aggregate consumption. The analysis of the equilibrium sheds light on the disruptive role of arbitrageurs in the economy, and reveals that risky arbitrage activity results in an amplification of fundamental shocks that could help explain empirical regularities such as excess volatility and the leverage effect. The main implications can be summarized as follows. First, we show that arbitrage activity brings the equilibrium prices of both securities closer to their fundamental values and simultaneously has a negative impact on the equilibrium stock price level. The latter finding is unique to our setting and stands in stark contrast to what happens in exchange economies with exogenous dividends and logarithmic preferences in which the impact of frictions is entirely captured by the interest rate and market price of risk. See, for example, Detemple and Murthy (1997), Basak and Cuoco (1998) and Basak and Croitoru (2000).

Second, and related, we show that the trading of arbitrageurs pushes the stock volatility above that of the underlying dividend process. This excess volatility is self-generated within the system and comes from the fact that arbitrageurs amplify fundamental shocks by optimally levering up their positions in good times and deleveraging in bad times. The excess volatility component implied by our model is quantitatively significant and increases with both the size of the arbitrageurs' credit facility and the consumption share of constrained agents. Because the latter is negatively correlated with aggregate consumption our model implies that volatility tends to increase when the stock price falls. It follows that risky arbitrage activity

(*footnote continued*)
Thaler (2003a,b), Ashcraft, Gârleanu, and Pedersen (2010), and Gârleanu and Pedersen (2011).

[3] Nonnegativity constraints on wealth were originally proposed by Dybvig and Huang (1988) as a realistic mechanism to preclude doubling strategies. They are widely used, and usually considered innocuous, in continuous-time models but are also introduced in discrete-time, infinite-horizon models. See, for example, Kocherlakota (1992) and Magill and Quinzii (1994), among others.

[4] The bubble on the price of a security is the difference between the market price of the security and its fundamental value defined as the minimal amount of capital that an unconstrained agent needs to hold to replicate the cash flows of the security while maintaining nonnegative wealth. See Santos and Woodford (1997), Loewenstein and Willard (2000), and Hugonnier (2012), and Section 2.5 for a precise definition and a discussion of the basic properties of asset pricing bubbles.

[5] Commercial paper is among the largest source of short term funding for both financial and non-financial institutions. For example, over the period 2010–2013 the average amount of commercial paper outstanding was 1.04 trillion dollars, and about half of that amount is accounted for by unsecured paper issued by financial institutions, see Federal Reserve Economic Data (2014).