

## arbitrage and its limits

### Definition

The 'limits of arbitrage' theory of financial markets studies the asset pricing, liquidity and welfare implications of the constraints faced by real-life arbitrageurs such as hedge funds and other financial institutions.

### Abstract

Unlike standard asset pricing theory which assumes frictionless arbitrage, the 'limits of arbitrage' theory of financial markets studies the asset pricing, liquidity and welfare implications of the constraints faced by real-life arbitrageurs such as hedge funds and other financial intermediaries. Among other results, it can explain amplification and cross-market contagion episodes, sudden liquidity dry-ups and liquidity linkages across markets, and offers a useful framework for public policy analysis.

Arbitrage, the simultaneous purchase and sale of assets or portfolios with identical payoffs to exploit a price difference between them, is central to financial economics.

Standard theories assume frictionless arbitrage, implying the 'absence of arbitrage opportunities in equilibrium', the finance incarnation of the LAW OF ONE PRICE. This premise implies the existence of state prices and an equivalent martingale measure. It underlies much of contingent-claims pricing, such as the binomial and Black–Scholes models for pricing options and other financial derivatives (see, e.g., Duffie (2001), for a textbook treatment).

However, the theory is at odds with the observation that assets with near-identical payoffs (e.g., 'Siamese-twin stocks' or 'on- and off-the-run' government bonds) sometimes trade at considerably different prices. Indeed, it predicts that arbitrageurs would exploit these profit opportunities, eliminating them in the process. Nor are standard theories easily reconciled with evidence of return predictability, such as short-run momentum or long-run reversal.

Such challenges have prompted the emergence of 'limits of arbitrage' theories (see Gromb and Vayanos (2010) for a survey). These posit that real-world arbitrageurs such as financial institutions have limited access to funds, due to information or agency problems vis-à-vis their investors. Financial constraints, when binding, inhibit arbitrage, allowing profit opportunities to survive in equilibrium. This

approach has far-reaching implications for asset pricing, liquidity and welfare.

### Asset pricing

To illustrate, suppose that some investors suddenly have to sell large amounts of a given asset. This 'supply shock' can possibly cause the asset's price to drop, offering arbitrageurs a profit opportunity. Unconstrained arbitrageurs would buy the asset, raising any capital needed to do so. Accordingly, even large shocks would have a limited price impact, and arbitrageurs would stabilize prices. If instead arbitrageurs cannot raise funds easily, they may lack the capital necessary to absorb the shock, which can therefore have a substantial and lasting price impact.

In addition, limited arbitrage can amplify a supply shock (e.g., as during financial crises) so its price impact is larger than if there were no arbitrage at all (Shleifer and Vishny, 1997). Assume that the arbitrageurs hold large positions in an asset. A supply shock causing the asset's price to drop implies a capital loss for them. Arbitrageurs may not only fail to absorb the shock, but also have to sell the asset because as their capital shrinks, their financial constraints tighten. This further depresses the asset price. Hence, arbitrageurs can have a destabilizing effect on asset prices.

Limits to arbitrage can further rationalize contagion across markets (Kyle and Xiong, 2001). Following a supply shock for one asset, arbitrageurs' capital may be depleted, forcing them to sell other assets, transmitting the shock from one market to the others.

More generally, this approach links the evolution of arbitrageurs' constraints to the time-series of asset prices and the differing capital amounts required by different trades to the cross-section of asset prices. For instance, it implies that deviations from the law of one price should be more pronounced after arbitrageurs have experienced substantial capital losses, and for assets for which taking a position consumes more capital (e.g., more volatile assets).

### Liquidity

'Limits of arbitrage' theories offer a novel perspective on asset market liquidity, that is, the ease with which supply of an asset meets demand. Inverse measures of liquidity include bid-ask spreads or the price impact of a trade. If supply failed to meet demand – for

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instance because they materialize at different times – potential sellers and buyers would be willing to trade at different prices, presenting arbitrageurs with an inter-temporal profit opportunity. Arbitrageurs can thus be viewed as financial intermediaries (e.g., ‘market makers’) providing liquidity to other market participants.

Under frictionless arbitrage, there are no impediments to arbitrageurs’ liquidity provision, which is therefore perfect. Instead, financial constraints hinder liquidity provision, resulting in imperfect market liquidity (Gromb and Vayanos, 2002). As for profit opportunities, this approach has the potential to explain sudden liquidity dry-ups created, liquidity linkages across markets, the covariance of market liquidity and intermediary capital, as well as liquidity differences across markets.

### Welfare

In standard theory, financial market equilibrium is socially efficient; therefore, public intervention is at best redistributive and at worst inefficient. This result, a version of the ‘fundamental welfare theorems’, captures the idea that in a free market economy, prices adjust so that profit-maximizing agents end up making socially efficient choices.

The ‘limits of arbitrage’ approach offers a more fruitful framework for analysing public policy. Indeed, under limited arbitrage, the welfare theorems do not hold and market equilibrium may be socially inefficient, or ‘constrained inefficient’ (Gromb and Vayanos, 2002). The reason is that the financial health of arbitrageurs affects the functioning of

financial markets but is itself affected by arbitrageurs’ investment decisions. Moreover each arbitrageur’s privately optimal investment decisions are socially suboptimal because, being a price-taker, he fails to internalize a chain of externalities operating through prices (‘pecuniary externalities’): arbitrageurs’ decisions affects asset prices, which affect other arbitrageurs’ financial constraints, affecting their investment decisions.

Since prices do not induce agents to make socially efficient choices, regulation incentivising or forcing arbitrageurs to take less risk could be desirable. Optimal financial market regulation under limits to arbitrage is a fascinating but nascent research area.

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### See also

BANKING INDUSTRY; CAPITAL ASSET PRICING MODEL (CAPM); EFFICIENCY; EFFICIENT MARKET HYPOTHESIS (EMH); EXTERNALITY; LAW OF ONE PRICE; MARKET PRICE; PERFECT COMPETITION; PRICE TAKING; PRINCIPAL-AGENT; RANDOM WALK; REGULATION/DEREGULATION; RISK AND UNCERTAINTY; RISK TAKING

### References

- Duffie, D. 2001. *Dynamic Asset Pricing Theory*. Princeton, NJ: Princeton University Press.
- Gromb, D. and Vayanos, D. 2002. Equilibrium and welfare in markets with constrained arbitrageurs. *Journal of Financial Economics* 66, 361–407.
- Gromb, D. and Vayanos, D. 2010. The limits of arbitrage: the state of the theory. *Annual Review of Financial Economics* 2, 251–275.
- Kyle, A. and Xiong, W. 2001. Contagion as a wealth effect. *Journal of Finance* 56, 1401–1440.
- Shleifer, A. and Vishny, R. 1997. The limits of arbitrage. *Journal of Finance* 52, 35–55.