speculative bubbles

We maintain that a speculative bubble exists if the market price of an asset differs from its fundamental value – the expected present value of the stream of future dividends attached to the asset. In an economy with a finite sequence of trading dates, the fundamental theorem of asset pricing (see Dybvig and Ross, 1987) guarantees that the equilibrium market price of any asset equals its fundamental value. But in some economies with an infinite sequence of trading dates, this result does not hold, and speculative bubbles may arise. An investor might buy an asset at a price higher than its fundamental value if she expects to sell it later on at a higher price – Harrison and Kreps (1978) call this process 'speculative behaviour'. In general equilibrium models, however, agents take prices as given and trade assets to transfer income across time and states. These models do not contemplate 'speculative behaviour' as it is usually understood. Therefore, the term 'speculative bubble' may seem inappropriate in some theoretical frameworks. Santos and Woodford (1997) talk broadly about 'asset pricing bubbles'.

There have been famous historical examples of sudden asset price increases followed by an abrupt fall as the Dutch 'tulipmania' (1634–7), the 'Mississippi bubble' (1719–20) and the 'South Sea bubble' (1720). Kindleberger (1978) argues that these are examples of bubbles, whereas Garber (2000) provides market-fundamental explanations for these episodes. More recently, we have seen sharp changes in stock and housing markets. The Japanese stock and land prices experienced a sharp rise in the late 1980s and a dramatic fall in the early 1990s. During the 'technology bubble', the Nasdaq Composite Index rose by more than 300 per cent between August 1996 and March 2000, and then fell sharply, reaching the August 1996 level in October 2002. This pattern has been especially intense for the Internet-related sector (Ofek and Richardson, 2003).

There is a vast literature following the variance-bound tests proposed by LeRoy and Porter (1981) and Shiller (1981) that finds significant excess volatility of stock prices (see Gilles and LeRoy, 1991, for a survey). The violation of these variance bounds suggests that asset prices are not determined by fundamental values (see Flood and Hodrick, 1990, and Cochrane, 1992 for a discussion). Various tests have been proposed to detect the presence of rational bubbles in asset prices (see Camerer, 1989, and Cuthbertson, 1996, for a survey). But these tests have important shortcomings. Estimating the fundamental values of an asset is usually a complex task. Hence, rejections of the null hypothesis could be due to an incorrect specification of the fundamental value and not necessarily to the existence of a bubble (Flood and Hodrick, 1990). Even in the most famous apparent bubble episodes, some authors have provided a fundamentalist explanation (see, for example, Donaldson and Kamstra, 1996; Pástor and Veronesi, 2006). To avoid the uncertainty associated with the specification of the fundamental value, Diba and Grossman (1988a) develop a test to detect bubbles based on the investigation of the stationary properties of asset prices and dividends. The main drawback of this test, as Evans (1991) shows, is its limited power to detect periodically collapsing bubbles. Given the severe problems in establishing empirically the existence

G. Jones (ed.), *Banking Crises*

of bubbles, it is of great importance to understand the theoretical conditions under which bubbles may exist.

If all traders are rational, a backward induction argument precludes the existence of bubbles for assets traded at a finite sequence of dates. More specifically, assume that the economy ends at time T, and there is an asset that provides a dividend of d_T at time T. Then the price of the asset at $T–1$ must be equal to the present value of d_T. By backward induction a bubble cannot exist at any point in time t less that T. Hence, a rational bubble begins on the first date of trading. Moreover, in present value terms the size of the bubble must be constant. (This is usually called the martingale property of bubbles.) Diba and Grossman (1988b) argue that negative rational bubbles cannot exist because it would imply that investors expect that the price of the asset will become negative at a finite future date. Tirole (1982) concludes that, in an economy with a finite number of infinitely lived traders, any asset must be valued according to its market fundamental. However, Tirole (1985) shows that under certain circumstances a deterministic overlapping generations economy allows for the existence of bubbles. In infinite-horizon optimization economies, bubbles are not compatible with the transversality condition: the present value of optimal asset holdings must converge to zero. But by definition the discounted price of the asset will converge to the size of the bubble. Hence, either the asset is in zero net supply or the size of the bubble is equal to zero.

Santos and Woodford (1997) explore the existence of asset pricing bubbles in an infinite-horizon competitive framework, allowing for potentially incomplete markets, arbitrary borrowing limits and incomplete participation of agents (this framework considers jointly economies with a finite number of infinitely lived households and overlapping generations economies). They show that the price of any asset in positive net supply must be equal to its fundamental value, provided that the present value of aggregate wealth is finite. This latter condition is satisfied empirically (see Abel et al., 1989) since in industrialized economies the aggregate share of income that goes to capital is greater than the investment rate. Loewenstein and Willard (2000) extend these results to a finite horizon economy where assets are negotiated continuously. Some key conditions underlying the negative results of Santos and Woodford (1997) are rational expectations, symmetric information and competitive behaviour.

This analysis has important implications for monetary theory because it precludes the existence of valued fiat money as a store of wealth in a broad class of economies. Santos (2006) extends these results to an economy with liquidity constraints and proves that these constraints must be binding infinitely often for all agents in the economy. Hence, in his simple model the aggregate value of the money supply must be equal to the value of aggregate output infinitely often. This is in the spirit of the quantity theory of money. On a related matter, the absence of rational bubbles guarantees that the initial real value of public debt is equal to the present value of future net public revenues. This is a necessary condition to establish the validity of the 'fiscal theory of the price level' (Sims, 1994; Woodford, 1995).

The presence of bubbles has also been explored in theoretical frameworks with asymmetric information or boundedly rational agents. Allen, Morris and Postlewaite (1993) find necessary conditions for the existence of bubbles in a model with

asymmetric information and a finite sequence of trading dates, and provide examples satisfying these conditions. The existence of a bubble is possible because there is private information which is not common knowledge (all agents know that all agents know, and so on, ad infinitum) that the stock price will fall. Everybody realizes that the stock is overpriced but each agent expects to sell at a higher price before the true value becomes publicly known.

Bubbles may appear in the presence of agency problems associated with short-run optimization behaviour. Allen and Gorton (1993) show that for some compensation schemes a manager may purchase a stock with some prospect of capital gains although with certainty the price will fall below its current level at some point in the future. Allen and Gale (2000) develop a model in which intermediation by the banking sector leads to an agency problem that results in asset bubbles. Investors borrow from banks to buy a risky asset, and they can default in the case of low payoffs. Hence risky assets are more attractive, and therefore investors bid up asset prices.

The behavioural finance literature (see Barberis and Thaler, 2003; Shleifer, 2000 for a survey) often assumes that some agents – called noise traders – are not fully rational. In models in which noise traders and rational agents coexist, the price of an asset can deviate from its fundamental value if rational agents are limited in their capacity to eliminate the mispricing. Shleifer (2000) describes bubbles as the interaction between a significant number of positive feedback investors (who buy securities when prices rise and sell when prices fall), and rational arbitrageurs who anticipate the bursting of bubbles. In this framework, rational arbitragers buy initially after a good-news event to increase the price of the asset and to stimulate the demand of the positive feedback traders; later, they undo their position before the bubble explodes. Abreu and Brunnermeier (2003) develop a model in which noise traders coexist with rational arbitrageurs who become aware of the existence of a bubble sequentially. These rational arbitrageurs would like to exit the market just before the bubble bursts, because before bursting the asset displays high capital gains. The bubble can explode for exogenous reasons, or endogenously when a sufficient number of arbitrageurs decide to abandon the market. In this setting some news could facilitate synchronization and, as a consequence, the bursting of the bubble. Scheinkman and Xiong (2003) develop a model in which overconfidence generates disagreements among agents regarding asset fundamentals. They show that the price of an asset can be above its fundamental value.

In summary, asset prices seem rather volatile – more than their fundamental values. By definition this implies the existence of speculative bubbles. Most empirical exercises to detect the presence of bubbles seem inconclusive. The conditions under which general equilibrium models generate bubbles seem rather fragile, since optimizing agents are unwilling to accumulate arbitrary amounts of wealth. Most recent work has explored the existence of bubbles in economies with limited rationality, asymmetric information and strategic behaviour. The main challenge for these approaches is to explain the mechanisms that lead agents to hold overpriced assets. Specifically, if agents accumulate those assets for arbitrary reasons, then these exercises will not be very enlightening.

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See Also **arbitrage pricing theory; excess volatility tests; noise traders; present value.**

Bibliography

Abel, A.B., Mankiw, N.G., Summers, L.H. and Zeckhauser, R.J. 1989. Assessing dynamic efficiency: theory and evidence. *Review of economic studies* 56, 1–20.

Abreu, D. and Brunnermeier, M.K. 2003. Bubbles and crashes. *Econometrica* 71, 173–204.

Allen, F. and Gale, D. 2000. Bubbles and crises. *Economic Journal* 110, 236–55.

Allen, F. and Gorton, G. 1993. Churning bubbles. *Review of Economic Studies* 60, 813–36.

Allen, F. Morris, S. and Postlewaite, A. 1993. Finite bubbles with short sale constraints and asymmetric information. *Journal of Economic Theory* 61, 206–29.

Barberis, N. and Thaler, R. 2003. A survey of behavioral finance. In *Handbook of the Economics of Finance*, vol. 1, ed. G.M. Constantinides, M. Harris and R.M. Stulz. Amsterdam: North-Holland.

Camerer, C. 1989. Bubbles and fads in asset prices. *Journal of Economic Surveys* 3, 3–41.

Cuthbertson, K. 1996. *Quantitative Financial Economics: Stocks, Bonds and Foreign Exchange*. Chichester: Wiley & Sons Ltd.

Cochrane, J. 1992. Explaining the variance of price dividend ratios. *Review of Financial Studies* 5, 243–80.

Diba, B.T. and Grossman, H.I. 1988a. Explosive rational bubbles in stock prices. *American Economic Review* 78, 520–30.

Diba, B.T. and Grossman, H.I. 1988b. The theory of rational bubbles in stock prices. *Economic Journal* 98, 746–54.

Donaldson, R.G. and Kamstra, M. 1996. A new dividend forecasting procedure that rejects bubbles in asset prices: the case of 1929's stock crash. *Review of Financial Studies* 9, 333–83.

Dybvig, P.H. and Ross, S.A. 1987. Arbitrage. In *The New Palgrave: A Dictionary of Economics*, vol. 1, ed. J. Eatwell, M. Milgate and P. Newman. London: Macmillan.

Evans, G.W. 1991. Pitfalls in testing for explosive bubbles in asset prices. *American Economic Review* 81, 922–30.

Flood, R.P. and Hodrick, R.J. 1990. On testing for speculative bubbles. *Journal of Economic Perspectives* 4(2), 85–101.

Garber, P.M. 2000. *Famous First Bubbles*. Cambridge, MA: MIT Press.

Gilles, C. and LeRoy, S. 1991. Econometric aspects of the variance-bounds tests: a survey. *Review of Financial Studies* 4, 753–91.

Harrison, J.M. and Kreps, D.M. 1978. Speculative investor behavior in a stock market with heterogeneous expectations. *Quarterly Journal of Economics* 92, 323–36.

Kindleberger, C.P. 1978. *Manias, Panics and Crashes: A History of Financial Crises*. New York: Basic Books.

LeRoy, S.F. and Porter, R.D. 1981. The present value relation: test based on implied variance bounds. *Econometrica* 49, 555–74.

Loewenstein, M. and Willard, G.A. 2000. Rational equilibrium asset-pricing bubbles in continuous trading markets. *Journal of Economic Theory* 91, 17–58.

Ofek, E. and Richardson, M. 2003. DotCom mania: the rise and fall of internet stock prices. *Journal of Finance* 58, 1113–37.

Pástor, L. and Veronesi, P. 2006. Was there a Nasdaq bubble in the late 1990s? *Journal of Financial Economics* 81, 61–100.

Santos, M.S. 2006. The value of money in a dynamic equilibrium model. *Economic Theory* 27, 39–58.

Santos, M.S. and Woodford, M. 1997. Rational asset pricing bubbles. *Econometrica* 65, 16–57.

Scheinkman, J.A. and Xiong, W. 2003. Overconfidence and speculative bubbles. *Journal of Political Economy* 11, 1183–219.

Shiller, R.J. 1981. Do stock prices move too much to be justified by subsequent changes in dividends? *American Economic Review* 71, 421–36.

Shleifer, A. 2000. *Inefficient Markets: An Introduction to Behavioral Finance*. Oxford: Oxford University Press.

Sims, C.A. 1994. A simple model of the determination of the price level and the interaction of monetary and fiscal policy. *Economic Theory* 4, 381–99.

Tirole, J. 1982. On the possibility of speculation under rational expectations. *Econometrica* 50, 1163–81.

Tirole, J. 1985. Asset bubbles and overlapping generations. *Econometrica* 53, 1499–528.

Woodford, M. 1995. Price level determinacy without control of a monetary aggregate. *Carnegie-Rochester Conference Series on Public Policy* 43, 1–46.