Chapter 31

EXPERIMENTS WITH ARBITRAGE ACROSS ASSETS

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Theoretical finance is essentially the study of inter-temporal arbitrage, but it is often interesting also to analyze relationships between asset prices. Cross-sectional analysis makes it possible to purge both field and laboratory data of unobservable changes in time-varying fundamentals. Also, although backward induction is at the heart of asset-pricing theory, subjects may find its logic dauntingly complex. They may be able to perceive cross-asset arbitrage opportunities much more readily.

Caginalp and Constantine (1995) study two closed-end funds traded on the New York Stock Exchange, consisting of essentially identical portfolios under the same manager. They show that the relevant relative price is statistically significantly different from unity. Using a simple model of market momentum calibrated from their field data, they explain bubbles in experimental asset markets reported in Porter and Smith (1989). O'Brien and Srivastava (1991) use treatments with complex informational where several assets were traded. They found that markets did not aggregate information efficiently, but it is not always possible to detect these inefficiencies using standard statistical tests. In some treatments, two assets' dividends were perfectly negatively correlated, and a simple pricing relationship that was confirmed in the data. Another more subtle connection between two asset prices received some but not overwhelming support in these experiments.

Foreign exchange markets are also environments where arbitrage across assets is salient. Indeed, purchasing power parity, uncovered interest parity, and covered interest parity are all descriptions of arbitrage across currencies, goods, and interest-bearing assets. Since field data on international transactions are among the oldest economic statistics and since scholars as illustrious as Ibn Khaldoun (1375) and David Hume (1752) have written on exchange rates, it is somewhat surprising that the first foreign exchange market experiments were conducted only in this decade.

Fisher and Kelly (2000) explored foreign exchange markets in the laboratory by running sessions based upon the classic treatment of Smith, Suchanek, and Williams (1988). Fisher and Kelly's treatments capture two important aspects of field foreign exchange markets. First, subjects trade blue and red assets for dollars, just as foreign exchange traders use a key currency for most international transactions. Second, there are no goods markets; indeed, only a negligible fraction of foreign exchange transactions in the field is used for imports. The main finding of these experiments is that both the blue and red assets experience significant bubbles, but they are highly correlated.

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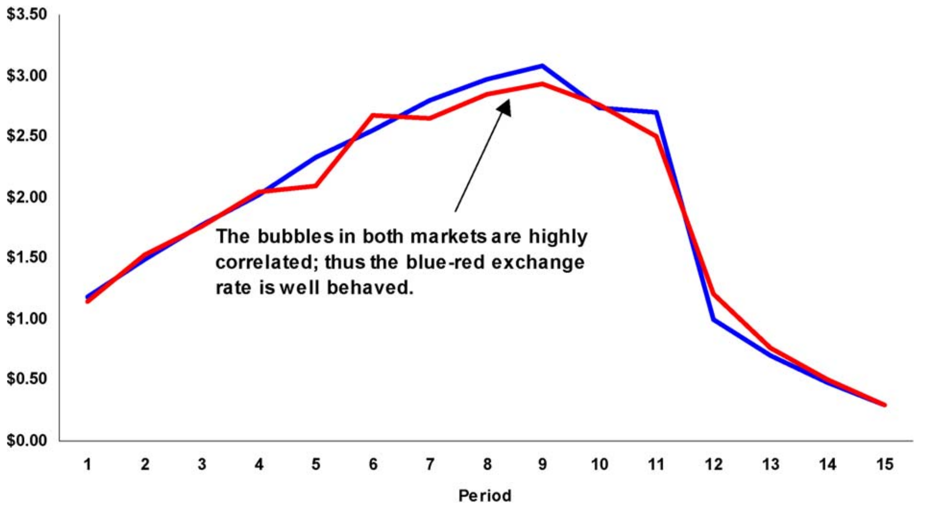

Figure 1. 11 November 1993: actual prices.

Thus a simple theory of cross-asset arbitrage predicts the blue–red exchange rate well, while the dollar price of each asset is quite different from its fundamental. Triangular arbitrage, a fundamental aspect of exchange rate theory, holds in these data, while a simple notion of inter-temporal arbitrage is soundly refuted.

Figure 1 shows the data from a typical session. Each experiment had twelve subjects with heterogeneous endowments of blue assets, red assets, and initial cash on hand. In this session, the blue dividend was an independent and identically distributed multinomial random variable with support {\$0.00, \$0.08, \$0.28, \$0.60}; each element occurred with probability $1/4$. The red dividend was an identical random variable, independent of its blue analog. Since each asset has an expected dividend of \$0.24 per period, both assets have the same fundamental, a line with intercept \$3.60 and slope $-$\$0.24. (This line is not shown to keep the figure uncluttered.) Since the two assets are identical, the natural prediction is that the blue-red exchange rate is unity. Figure 1 shows this is true, even in the initial periods.

Investigating the origins of these bubbles is still an active area of research. Lei, Noussair, and Plott (2001) show that bubbles occur even when there is no possibility of making profits from anticipated capital gains. In a fascinating exploration of the "active participation hypothesis," they construct a treatment where a static market and a dynamic asset market are open simultaneously. The data in the static market conform to theoretical predictions, but the asset market still experiences bubbles, albeit with attenuated volume.

Building on Morris (1996), Fisher (1998) posits that the subjects are Bayesians who have heterogeneous prior beliefs about the assets' dividends. Even though each experiment's instructions spend a good deal of time describing the true processes, Fisher

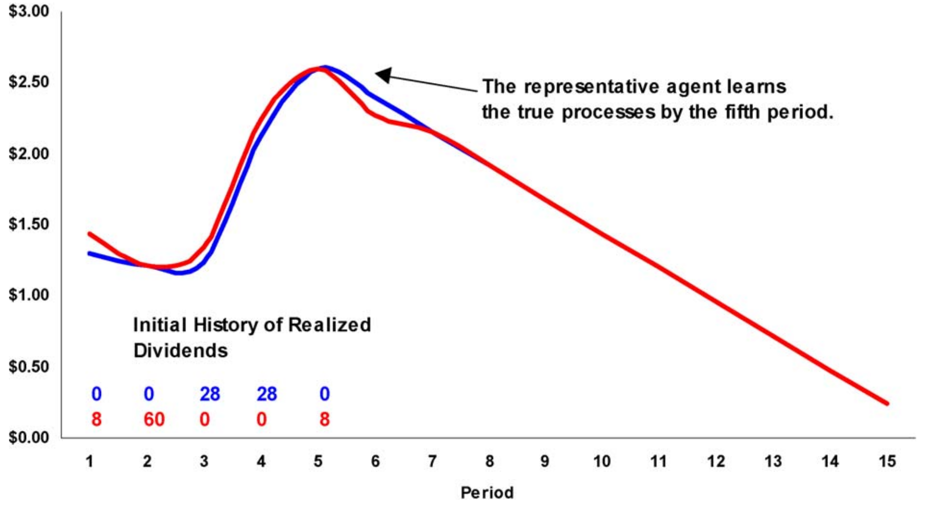

Figure 2. 11 November 1993: predicted prices.

(1998) argues that the subjects may not initially believe the directions, though agents typically do learn the truth. Figure 2 shows the predictions for the data from the session shown before; it is derived from a calibration akin to a minimum distance estimator. In this case, there is one representative agent participating in both the blue and red asset markets. It is apparent that the agent learns the true processes by about the fifth period. Also, this person's prior beliefs are sufficiently pessimistic so that the calibrations fit the data well in the initial periods.

Even though bubbles are ubiquitous in the laboratory, subjects often get cross-asset prices right. Why is this? Two reasons seem salient. First, cross-asset arbitrage may be a simpler cognitive task than inter-temporal arbitrage. This conjecture is supported by the fact that the exchange rates are uniformly accurate in Fisher and Kelly's treatments with two identical assets; in other cases, where the predicted exchange rate is one-half, the data are more variable. Second, after the bubbles burst, usually about two-thirds of the way through a session, the assets are priced according to their fundamental values and then the data predict the exchange rate almost perfectly.

Why does a model with Bayesian updating predict the asset price ratios well? Again two reasons stand out. First, the calibrated priors are often highly correlated across the two markets; thus the initial predictions for the blue and red assets are close, and the exchange rate is predicted well in the early periods. Second, most posterior beliefs converge to the truth. Thereafter the model fits the exchange rate perfectly, although it usually predicts convergence to fundamental values earlier than in the data.

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