Chapter 42

ASSET PRICING

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1. What the Theory Predicts

A major evolution in the theory of asset pricing took place over the last century.

(a) In 1900, Bachelier suggested the random walk hypothesis: price changes ought not to be predictable from past information (see Bachelier, 1900). In the 1960s and 1970s, this theory became known as the efficient markets hypothesis (Fama, 1970),[1] though some still refer to it as the random walk hypothesis (Malkiel, 1999).

The random walk hypothesis is based on the idea that if price changes were predictable, profit opportunities emerge, and the ensuing speculation would eliminate them. The theory is very pragmatic. It does not specify a trading mechanism. It does not even explain why prices move; it only predicts that, if prices move, the movements ought not to be predictable. The random walk model is dynamic: it characterizes price changes.

(b) Since about the 1950s, equilibrium asset pricing theory has been developing, based on the hypothesis that prices are determined by equilibrating supply and demand. Prices change when supply or demand changes. One distinguishes two (related) canonical models.

(1) The Arrow–Debreu general equilibrium model, where the number of independent securities is assumed to equal the number of states. Implicit in the prices of the traded securities will be state prices: the prices of securities that pay one dollar in one state, and zero everywhere else. The Arrow–Debreu prediction is that the ranking of state security prices for equally likely states will be the inverse of the ranking of the aggregate wealth across those states. This translates into predictions about the pattern of expected returns (expected payoffs divided by prices) across securities.

(2) The capital asset pricing model (CAPM). If quadratic expected utility is the appropriate representation of investors' preferences, then prices should be such that the market portfolio (supply of all risky securities) provides

[1] Fama and others would allow for a positive drift in the random walk, to capture risk aversion. But they did not quantify it and were even willing to allow the drift to vary over time. They did realize that if you were not able to explain why the drift should be there, you could potentially explain away any evidence of predictability.

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maximal reward (expected return) per unit of risk (volatility). This also translates into predictions about the pattern of expected returns across securities. (Expected returns in excess of the risk-free rate should be proportional to covariances with the return on the market portfolio.)

Both are static equilibrium models. They are silent about how markets reach the equilibrium price (and hence, expected return) configuration. This also means that they do not make any prediction about price dynamics. There are multi-period extensions, but these only predict how one period-equilibrium changes to the next one. They are silent about what happens in between.

2. The Empirical Question

Which of these two theories provides the more appropriate view of the workings of financial markets: the relatively agnostic random walk theory or the more stylized equilibrium asset pricing models?

To compare the two theories, one could search for violations of the random walk hypothesis (if any can be found) and prove that these violations can be understood in light of equilibrium asset pricing models.

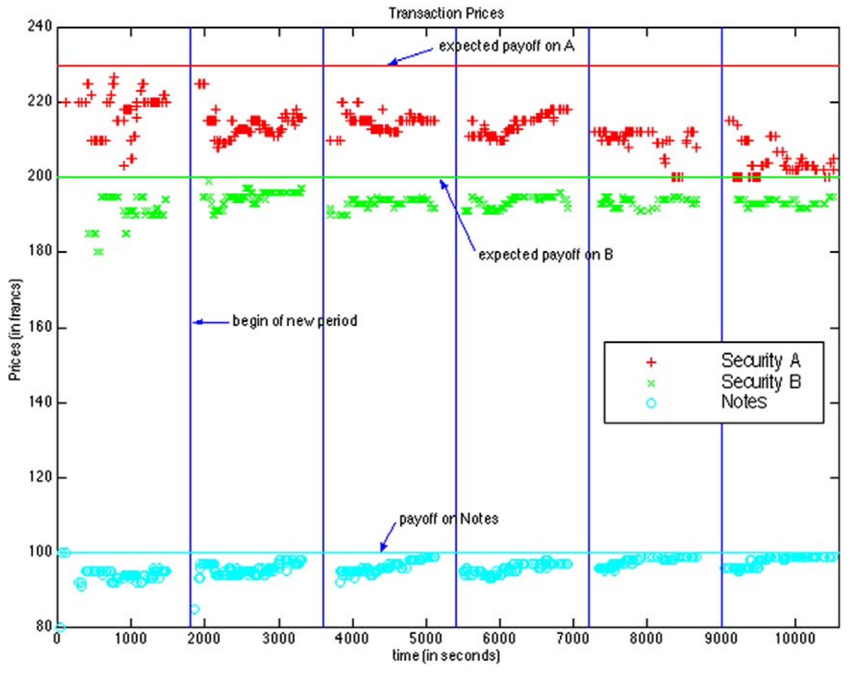
In field studies, it is customary to reject the random walk theory by identifying drift in prices. The drift is to be explained in terms of compensation for risk using some equilibrium asset pricing model. [A well-known example is Debondt and Thaler (1985), who find violations of the random walk hypothesis yet cannot identify them as reward for risk.]

An alternative would be to view drift as evidence that equilibration forces are at work, verify whether the drift points in the direction of a given asset pricing equilibrium, and whether it eventually leads markets to this equilibrium. In the experiments discussed below, the data can best be understood in this fashion.

3. What the Field Data Teach Us

There is plenty of evidence that it is hard to predict asset price changes, in support of the random walk theory. Still, there are well-documented violations (a number of them are reported in Lo and MacKinlay, 1999). Granted, the amount of predictability that is present in the field data is small, but they do not seem to be compensation for risk in any way equilibrium asset pricing models predict. Best known is the finding in Fama and French (1992) that the historical drift in prices across U.S. common stock cannot be explained in terms of differences in covariances with the market portfolio (as predicted by the CAPM).

While it is easy to verify the random walk hypothesis on field data, it is far more difficult to explain violations in terms of equilibrium models of asset pricing, because



Note: Each observation corresponds to a transaction in one of the three securities; the price of the non-trading securities is taken to be the previous transaction price.

Figure 1.

these models require information that is hard to come by in the field (e.g., what is the aggregate wealth? What is the market portfolio? What are the expected returns? What did the market believe to be the covariances? What states did it perceive to be equally likely? Do investors have quadratic utility?).

4. What the Experiments Teach Us

Experiments make it easier to identify the forces of equilibrium asset pricing theory, because almost all parameters can be controlled (e.g., aggregate wealth, market portfolio, expectations).[2]

Figure 1 displays the evolution of transaction prices in a typical asset pricing experiment. Subjects were allocated three securities, two of which were risky. The payoff on these securities was determined by randomly drawing one out of three possible states.

[2] Quadratic utility can be assumed, as an approximation, provided risk is not too large and subjects have well-behaved preferences.

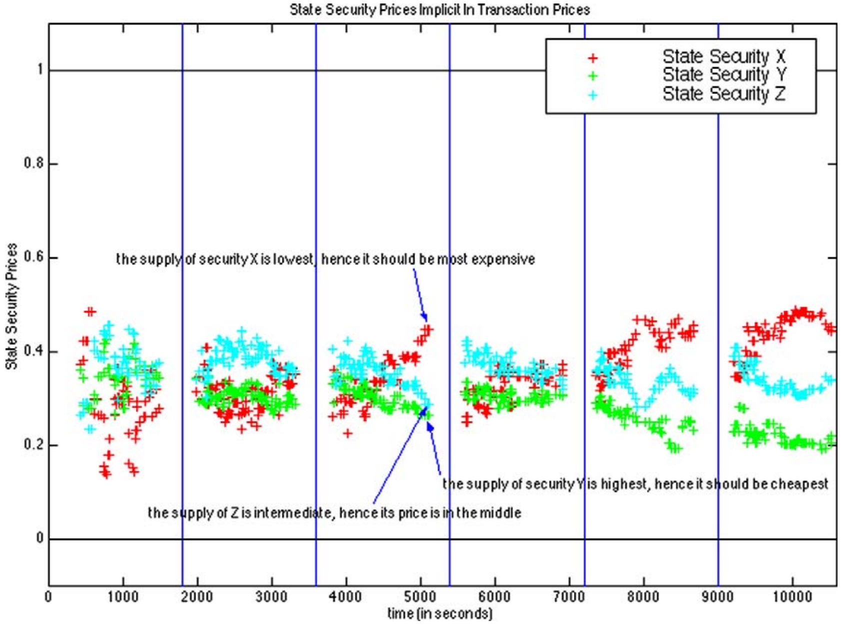


Figure 2.

Subjects could trade the securities over the Internet (using an anonymous open book trading mechanism) for about 25 minutes, after which payoffs were determined and distributed. Subjects were then given a fresh allocation of securities and a new period started. See Bossaerts and Plott (2004).

The prices of the risky securities in Figure 1 are below their expected payoff during the entire experiment, indicating the presence of risk aversion. The price of the risk-free security often starts below its payoff in a period; in equilibrium, its price should be 100 because of the presence of cash. This phenomenon emerges because of a cash-in-advance constraint: subjects need cash if they want to bid on the risky securities.

Inspection of Figure 1 reveals little predictability in changes in the prices of the risky securities. The price of one of the securities (A) seems to have a negative drift, but this is statistically insignificant. So, it appears as if the random walk hypothesis holds.

But there is more than meets the eye. Figure 2 displays the evolution of the state security prices (normalized to add up to one) implicit in the transaction prices of the traded securities. The aggregate payoff (wealth) was lowest in state X, followed by state Z and Y. Which means that the price of state security X should be highest; that of state security Y cheapest; and that of state security Z in the middle. Figure 2 reveals a clear tendency for state security prices to move in this direction. Confirming the visual impression, statistical tests confidently reject the random walk model in favor of a model where state security prices tend to re-arrange in accordance with the theory.

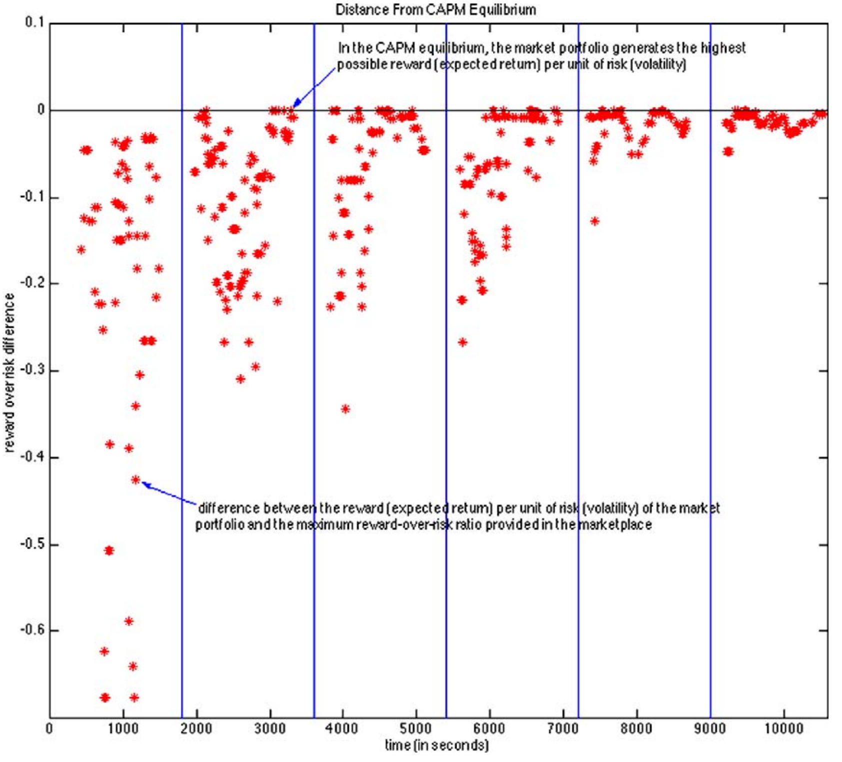


Figure 3.

Figure 3 summarizes the information in the prices in another way. It displays the difference between the reward (expected return) per unit of risk on the market portfolio and the maximum possible reward/risk ratio for any portfolio that investors could hold. In the CAPM equilibrium, this difference is zero. The question is: do prices change so that the difference disappears? Figure 3 demonstrates that there is this tendency, both within periods and over the duration of the experiment. Statistical tests confirm this: one can predict that transaction prices move in the direction of the CAPM (and hence, one can reject the random walk model).

Why can not we implement these prediction models in field data? Why can not we imply state security prices and predict where they are going as we can in the laboratory? Why can not we use the difference in reward/risk ratio between the market portfolio and the best portfolio and predict where prices will move next? Because unlike in the laboratory, we (the empiricists) know even less than investors.

Like investors, we do not know what the market portfolio or aggregate wealth is. Worse, we do not even know what investors' beliefs are. In the laboratory, we determine the nature of uncertainty, and hence, control subjects' beliefs. We know more than the subjects: we set the supplies, so we know aggregate wealth and the market portfolio. If we come down to the level of information of the subjects, or even below this level, as in field research, we cannot predict prices (Figure 1); if we use information that we do not have in field research, we can, as we can see in Figure 2 (using aggregate wealth in each state) and Figure 3 (knowing the market portfolio).

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