Equilibrium Short Horizons of Investors and Firms

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This paper attempts to explain the often lamented pursuit by investors of short-term capital gains and the selection by firms of short-term investment projects. Our starting point is the observation that, in practice, arbitrage (trading based on knowledge that the price of an asset is different from its fundamental value) is cheaper for assets that cannot stay mispriced for long (short-term assets) than for assets that can (long-term assets). In equilibrium, the net expected return from arbitrage in each asset must be the same. Since arbitrage in long-term assets is more expensive than it is in short-term assets, the former must be more mispriced in equilibrium for net returns to be equal. Thus the rational behavior of arbitrageurs leads to greater mispricing of long-term assets in equilibrium.

Moreover, managers of firms are typically averse to severe underpricing of their equity because they risk getting fired or taken over. They should then avoid investments that raise the cost of arbitrage of their equity. Since mispricing of claims to long-term investment projects can take a long time to disappear, such projects will be avoided. In this way, short horizons of arbitrageurs lead to short horizons of corporate managers.

We stress the distinction between long (short) term investment projects and long (short) term assets. Long (short) term *investment projects* have distant (proximate) cash flows. However, an arbitrageur cares not when an investment project pays off, but rather when the mispricing of the claim to this project disappears, so that he can reap the rewards from his trade. A short-term *asset* is one where mispricing must disappear in the near future, whereas mispricing of a long-term *asset* can persist for a long time. The time to disappearance of mispricing depends on how fast fundamental uncertainty about an asset is resolved, how fast investor misperceptions are corrected, and how rapidly arbitrage drives the price to fundamental value. In general, mispricing of claims to long-term investment projects takes longer to disappear since it takes longer for fundamental uncertainty to be resolved. As a result, long-term assets are typically claims to long-term investment projects. Such association, however, is not automatic.

Examples of short-term assets are options, futures, and other instruments that have a fixed and relatively short expiration time. Examples of long-term assets are stocks and foreign exchange, where mispricing can take a long time to correct. Sometimes even stocks can be short-term assets. For example, an arbitrageur betting on the outcome of a takeover bid, or on an imminent earnings or other public announcement, can expect the mispricing that he is betting against to disappear quite fast. Such an arbitrageur can liquidate his position once the takeover bid fails even if he believes that the stock is still underpriced, and does not need to wait until *that* mispricing is corrected. What matters to the arbitrageur, then, is the horizon of the disappearance of mispricing

In Section I we argue that arbitrage in short-term assets is much cheaper than arbitrage in long-term assets. Section II builds this observation into a model in which long-term assets must be more mispriced in equilibrium than short-term assets. Section III shows how short horizons of smart investors

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translate into short horizons of firm managers averse to underpricing of their equity (see also Jeremy Stein, 1988; 1989). Section IV shows how the flight of smart money to short-term arbitrage can be self-fulfilling.

I. The Relative Costs of Long- and Short-Term Arbitrage

By greater relative cost of long-term arbitrage, we mean that the expected carrying cost of a $1 investment held until the mispricing is eliminated is higher for the long-term arbitrage. This is not just a reflection of the time value of money. An arbitrageur with access to a perfect capital market does not care how long it takes a mispriced security to reach its fundamental price. Suppose that an asset with a fundamental value of $6 trades today for $5. Let the interest rate be 10 percent, which is also the rate of return on the fundamental value of the asset and the arbitrageur's cost of funds in a perfect capital market. In this case, the arbitrageur does not care when the price of the asset catches up with its equilibrium value. If it does so next period, the arbitrageur sells the asset for $6.60, repays $5.50 to his creditors, and gets $1.10 which has the present value of $1. If the price reaches fundamentals two periods from now, the arbitrageur sells the asset for $7.26, repays $6.05 to his creditors, and again ends up with $1 in present value. Moreover, if the price of the asset does not reach its fundamental value early, and the arbitrageur discovers another opportunity in the meantime, he can borrow more and pursue that one as well. There is no opportunity cost of tying up one's funds. The same irrelevance argument holds for short sales, and for the case of uncertainty where the arbitrageur can costlessly issue equity to sell off his risk.

Arbitrage, however, is often risky and risk cannot be completely sold off in the market. If, for example, an asset is underpriced relative to its fundamental value, and a smart investor buys it, he has to bear the risk that before mispricing is eliminated or reduced the fundamental value actually falls. In this case, his arbitrage trade results in a loss even though it was *ex ante* attractive. In addition to fundamental risk, the smart investor bears the risk that the mispricing gets worse before it is eliminated, called "noise trader risk" by Bradford De Long et al. (1990). If the smart investor has for some reason to liquidate his position when mispricing gets worse, his arbitrage trade results in a loss. Both fundamental and noise trader risk are more important for assets where the elimination of underpricing takes longer, since there is more time for bad news or a wave of pessimism to hit. These risks raise the cost of arbitraging long-term assets relative to short-term assets.

These risks can be perfectly shared in a perfect capital market that is well informed about the arbitrageur's true ability. But in practice, outside investors do not know whether an arbitrageur is smart, and worry that he might take risks with their money without earning an extra return. As a result, they restrict the supply of funds to the arbitrageur (Joseph Stiglitz and Andrew Weiss, 1981). First, his cost of funds exceeds the (risk-adjusted) interest rate at which he would be able to borrow if information was symmetric. Second, he faces a limit on the amount he can borrow. If in our earlier example the return on the fundamental value is 10 percent, but the cost of funds to the arbitrageur is 12 percent, he obviously prefers that mispricing be eliminated sooner.

Credit constraints impose an additional cost of long-term arbitrage relative to short-term arbitrage, namely the opportunity cost of having one's money tied up. When a smart investor dedicates the limited resources that he can get from others to an arbitrage position, he obviously cannot dedicate them to another position. The longer it takes for the price of a mispriced asset to return to its fundamental value, the longer is the period during which the arbitrageur's resources are tied up, and therefore the higher is the opportunity cost of this arbitrage trade.

Since the high cost of funds and the credit constraint reduce the arbitrageur's profits, he will try to convince his lenders that he is indeed smart and can earn abnormal returns, so that they lend him more and at more attractive rates. To do that, he will try to show good performance repeatedly and *fast*, presumably by making multiple short-term

arbitrage trades rather than a single long-term trade. Demonstrating one's talents with long-term trades is expensive and risky by comparison. In this way, not only do the capital market imperfections raise an arbitrageur's cost of funds and so lead to a preference for short-term arbitrage, but the arbitrageur's efforts to reduce these problems and the cost of funds lead to a further bias for short terming.

As feared by Keynes, smart money does not flock to long-term arbitrage: it requires a lot of patience, and patience is costly.

II. A Simple Model

We assume there are three periods: 0, 1, and 2, and two types of investment projects: long and short term. Each firm undertakes a project of one of the two types. Both types of projects have a cash flow only in period 2. The expected period-2 payoff from a short-term project is V_s and the expected payoff from a long-term project is V_l. The true value of a short-term project becomes known in period 1, at which point its mispricing is eliminated. The same happens with a long-term project in period 2. This specification makes clear that arbitrageurs care not when the cash flow of a project is, but when mispricing disappears. All investors are risk neutral. We assume that the market interest rate is 0; the expected payoff from a project is then equal to its fair market value.

There are two types of investors in the model: noise traders and smart money. In period 0, noise traders are either pessimistic or optimistic about the value of each project i (whether long or short term). When noise traders are pessimistic, their combined period-0 demand schedule for the equity of firm i is given by

$$(1) \qquad q(NOISE, i) = [V_i - S_i]/P_i,$$

where $S_i > 0$ is the pessimism shock and P_i is the price. When noise traders are optimistic, the demand curve is the same, except S_i is added rather than subtracted. Whether noise traders are bullish or bearish is known in period 0. We only consider the bearish case; the other case is symmetric. We assume that each stock i is in unit supply. Without a shock to their beliefs, noise traders would hold the whole supply at the fundamental price and there would be no need for arbitrage.

We assume that arbitrageurs have no money of their own, but each can borrow in period 0 up to the amount b at the gross interest rate $R > 1$. The cost of funds to the arbitrageurs in excess of the riskless rate of 0 and the credit constraint reflect the imperfections in the loan market, which we do not model explicitly. In this model, each arbitrageur actually wants to borrow all of b.[1] Since agents are risk neutral, they need not diversify, and we can assume that each arbitrageur invests all of b in the same asset i. If n_i arbitrageurs invest in asset i, their combined demand curve is

$$(2) \qquad q(SMART, i) = n_i b/P_i.$$

Because of the borrowing constraint, arbitrageurs also have unit elastic demand. In period 0, demands for each asset must add up to the unit supply, so,

$$(3) \qquad P_i = V_i - S_i + n_i b.$$

We assume that the total number of arbitrageurs is not sufficient to bring prices of all assets to fundamentals in period 0: $n_i b < S_i$. In this model, the more arbitrageurs that trade in an asset, the closer its price is to the fundamental value and the less attractive it is for each of them to trade in that asset. As a result, arbitrageurs spread themselves out between assets and, in equilibrium, each asset is somewhat mispriced.

In period 1, payoff uncertainty is resolved for short-term assets and prices move to fundamental values. The same happens for long-term assets in period 2. When the price moves to the fundamental value, arbi-

[1] In our simple specification, the opportunity cost of tying up one's funds is not modeled. Introducing it strengthens the results.

trageurs settle their accounts and trading ends.

In equilibrium, returns from arbitrage in each security must be the same. In particular, the number of arbitrageurs investing in each security of a given type is the same, provided that S_i hitting each security of that type is the same. Denote the respective numbers of arbitrageurs by n_s and n_l.

Consider the return from investing in a short-term asset. In period 0, the arbitrageur buys $b/[V_s - S_s + n_s b]$ shares of that asset with borrowed b dollars, receives in expectation V_s for each share in period 1, and must in period 1 repay bR to his lenders. As of period 1, the value of this investment is equal to

$$(4) \qquad b[V_s/[V_s - S_s + n_s b] - R].$$

If the arbitrageur invests in the long-term asset, he buys $b/[V_l - S_l + n_l b]$ shares of that asset in period 0. In period 1, he does nothing and in period 2, he gets the average of V_l per share and repays bR^2. As of period 1, the value of this investment is equal to

$$(5) \qquad b[V_l/(R[V_l - S_l + n_l b]) - R].$$

The difference between (4) and (5) is that, in (5), capital gains are deferred and discounted at the rate R since the arbitrageur is at a borrowing constraint. As R rises, arbitrage in the long-term asset becomes less lucrative and eventually unattractive.

In equilibrium, the returns to arbitrage on the long- and the short-term assets must be equal. Setting (4) equal to (5) we get

$$(6) \qquad \frac{V_l}{V_l - S_l + n_l b} \cdot \frac{1}{R} = \frac{V_s}{V_s - S_s + n_s b}.$$

The fraction on each side of (6) is the ratio of value to price of long- and short-term assets, respectively. Since $R > 1$, (6) says that, in equilibrium, the long-term asset is more underpriced in percentage terms (when the noise shock is negative) than the short-term asset. To induce the marginal arbitrageur to invest in the long-term asset, it must be more underpriced than the short-term asset. This result is independent of the values of noise shocks to the two types of assets, or of the relative attractiveness of long- and short-term projects. If we raise total arbitrage resources (raise the total number of arbitrageurs or b), more of them flow into each asset and the mispricing of each asset is reduced, but the greater relative mispricing of long-term assets continues.[2]

III. The Supply of Assets

The compensation of managers of firms with traded equity typically depends in part on short-term equity performance. Poor equity performance raises the likelihood of replacement, either by the board or through a hostile takeover (see our 1989 paper with Randall Morck). By comparison, increases in managers' incomes from good stock performance are probably small. In this respect, temporary overpricing of the stock is much less of a benefit to managers than temporary underpricing is a cost.

This reasoning suggests that managers will choose short over long-term investment projects, since picking the latter allows their equity to be more mispriced in equilibrium, *ceteris paribus*, and threatens their jobs. If the probability of replacement varies directly with the percentage underpricing, then all managers who are not also large, long-term shareholders would choose short-term investment projects on the margin. In this way, short terming by rational arbitrageurs leads to short terming by the firms. If $V_l > V_s$, managerial short terming is socially inefficient, since the economically more valuable long-term projects are priced less accurately in the stock market and therefore avoided.

If a manager does undertake a long-term project and his firm becomes underpriced, a

[2]Similar results obtain if arbitrageurs are risk averse and long-term arbitrage is more risky than short-term arbitrage.

hostile acquirer can profit by changing the firm's investment policy. A hostile acquirer *must* make a change to profit from his acquisition fast, for otherwise an acquisition is the same as long-term arbitrage and there is no reason to buy the whole firm at a premium. The changes that a hostile acquirer can make are of two sorts. He can remove the reason that some investors do not like the firm. For example, if the stock market does not like conglomerates, he can bust up the firm and sell off the pieces. More in the spirit of our model, the hostile acquirer can shift the firm's cash flow toward the present by cutting investment, raising dividends, and selling some of the divisions. Because these changes reduce uncertainty and the likely duration of mispricing, they attract more arbitrageurs and reduce underpricing, even if the underlying noise trader pessimism about the firm remains. After the acquirer makes these changes, he can sell the firm to the public at a higher price since underpricing caused by noise is now less significant.

Of course, this is precisely what some hostile acquirers as well as leveraged buyout specialists do. They first effectively reduce the duration of the firm's assets by cutting investment and selling off divisions, and then sell the firm to the public. Michael Jensen (1986) enthusiastically interprets such evidence as pointing to elimination of inefficient investment pursued by corporate managers dedicated to growth. Our model suggests, in contrast, that some of the investment cuts eliminate good long-term projects that have previously been responsible for greater stock market underpricing.

In this way, takeovers substitute for long-term arbitrage. With long-term arbitrage, the smart investor must wait until the elimination of mispricing to realize the returns on his trade. When a firm pursues a long-term investment project, the wait can be long. With a hostile takeover, in contrast, the smart investor can gain control and turn a long-term asset into a shorter-term asset that is less mispriced by the market. It is sometimes said that smart money, unless they are willing to wait a long time to profit from an investment, must be ready to take over the firm. Our model explains how this is so.

IV. Self-Fulfilling Short-Term Arbitrage

We have assumed throughout that participation of each arbitrageur brings the period-0 prices closer to their fundamental values, but has no effect on whether prices return to fundamentals in period 1 or period 2. As a result, participation by each arbitrageur reduces the returns from arbitrage to others. However, participation by each arbitrageur can also *raise* the attractiveness of arbitrage to others by bringing prices to fundamental values *faster*, and so reducing the time it takes others to profit from their own detection of mispricing. If the price returns to fundamentals not through a public news event but through the work of arbitrage, then each arbitrageur will trade more aggressively on a piece of information when he knows that other arbitrageurs will later detect the same mispricing and eliminate it more rapidly. Conversely, it does not pay to trade in an asset which no one else follows and which can therefore remain mispriced forever.

In addition, participation by more arbitrageurs reduces noise trader risk, since each smart trader knows that if noise traders become even more biased in the future, more smart traders will lean against them. Since price fluctuations in the asset are smaller when more traders participate, arbitrage is less risky for each of them. To be sure, it does not pay to be in a market with so many arbitrageurs that no mispricing occurs, but at the same time countering the mispricing of a security by oneself might be too risky.

These arguments provide a further reason why arbitrage will focus on short-term assets. When a lot of traders are arbitraging away price discrepancies in short-term assets, arbitrage in them becomes both faster and less risky. This presumably makes the attractiveness of arbitrage to each trader even greater. In contrast, because few traders arbitrage the mispricing in long-term assets, such mispricing might take even longer to correct as the forces bringing prices to fundamentals are weak. Moreover, the arbitrage in the long-term assets will be very risky, since so few traders will be countering future waves of noise trader sentiment. With posi-

tive externalities between arbitrageurs, the greater mispricing of long-term assets relative to short-term assets can be self-fulfilling. Almost all arbitrageurs will focus on the same assets and events, such as takeover or earnings announcements, and few will commit time and resources to long-term arbitrage.

V. Conclusion

Arbitrage generally serves the useful social function of bringing asset prices closer to fundamental values. Arbitrage itself, however, is guided by maximization of arbitrage profits. We have shown that the private costs and benefits of arbitrage lead to its clustering on the trading of short-term assets. This clustering in turn leads to systematically more accurate pricing of short-term assets than of long-term assets, even though efficient capital allocation and managerial evaluation might be better served by the opposite bias.

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