

MERTON MILLER'S CONTRIBUTION TO MODERN FINANCE

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Merton Miller was a great economist. He was also a fine warrior. In the 1950s he takes up finance and engineers a stunning campaign that, after a period of years, decisively undermines the Old Guard and installs Modern Finance. That done, he brings his methods to the Real World, and becomes a strategist for Chicago's commodity crowd in their battles with New York's establishment and Washington's power brokers. He does all this with such finesse, such humor, and, above all, such devotion to economic principle that you reluctantly admire him even as he rides past you to victory.

—Fischer Black¹

For the last 30 years, the field of academic finance was new enough that most of its founding fathers were still active and influencing its development. And until his death last spring at the age of 77, Merton Miller stood at the center of these founding fathers. It has been impossible to work in finance without being continually reminded of his contributions and his presence.

Miller's accomplishments were many, but if we were to remember only one of his contributions to the field of finance, which would it be? Most financial economists would cite the famous "M&M" capital structure and dividend irrelevance propositions. But I will argue that although any finance scholar would be thrilled to have produced one of the M&M propositions, Miller's most important contribution to our field went well beyond the propositions themselves.

*This article builds on my keynote address at the annual meeting of the Financial Management Association in Seattle this past October, and differs substantially from the version of that speech that was published as "Merton Miller and Modern Finance" in the Winter 2000 issue of *Financial Management*. I am grateful for Don Chew's considerable editorial assistance, as well as for comments from Steve Buser, Harry DeAngelo, Andrew Karolyi, Lemma Senbet, and Alex Triantis.

1. Foreword to Merton H. Miller, *Financial Innovations & Market Volatility* (Blackwell Publishers, 1991). In the first two sentences, the word "was" originally appeared as "is," since Miller was alive when Black wrote these words in 1991. Fischer Black died in 1995; had he lived three more years, he would have shared the Nobel Prize with Robert Merton and Myron Scholes in 1997.

In making my case, I will start with the first Modigliani and Miller paper, "The Cost of Capital, Corporation Finance and the Theory of Investment," which² was published in the *American Economic Review* in 1958. The main conclusion of that paper is the well-known M&M Proposition I, which states that "the market value of any firm is independent of its capital structure and is given by capitalizing its expected return at the rate...appropriate to its [risk] class."² In other words, changes in companies' leverage ratios should not affect their market values; such values are determined solely by their expected future earnings power or, more technically, by the discounted present value of their expected cash flows. And the companion to Proposition I, the dividend irrelevance proposition, maintains that changes in dividend policy should also have no effect on corporate values.

In the real world, of course, we have all seen dramatic movements in stock prices in response to announcements of dividend changes and leveraged recapitalizations. And in the last 30 years, finance scholars have provided convincing empirical evidence that changes in capital structure and dividends have fairly predictable effects on corporate values. But, as I argue below, the M&M propositions' apparent lack of predictive power in no way diminishes either the validity of their logic or their importance to our current theory of corporate finance. As Miller himself wrote in a 1988 article called "The Modigliani-Miller Propositions Thirty Years Later,"

The view that capital structure is literally irrelevant or that 'nothing matters' in corporate finance, though still sometimes attributed to us...is far from what we ever actually said about the real-world applications of our theoretical propositions. Looking back now, perhaps we should have put more emphasis on the other, upbeat side of the 'nothing matters' coin: showing what doesn't matter can also show, by implication, what does.

"This more constructive approach," as Miller went on to note, "has now become the standard one in teaching corporate finance."³ That is to say, even if the M&M propositions have not been confirmed by

empirical research—and it is unlikely they ever can be—they have nonetheless served as the starting point for virtually all academic research in corporate finance in the last three decades.

What has enabled the M&M propositions to transform modern finance into a serious scholarly undertaking is not their predictive power, but rather the proofs on which the propositions rest—the way of thinking that Miller and Modigliani used in arriving at their conclusions. In the proof of Proposition I, M&M began by making a set of assumptions that, while clearly violated in practice, enable them to produce useful—and in some respects surprising—insights. They started with a set of conditions known as "perfect capital markets" (which Miller himself once referred to as "the economist's frictionless dream world"), in which there are no taxes or transactions (including bankruptcy) costs, reliable information about a company's future performance is freely available to investors, and managers' operating and investment policies are completely unaffected by financing choices. Under such conditions, as M&M demonstrated, changes in capital structure (and dividend policy) cannot affect a company's operating cash flows. And if operating cash flows—that is, the total amount of cash profits to be divided among *all* the firm's security holders—remain unaffected by such changes, then investors continually in quest of profit opportunities can be counted on to eliminate any differences in valuation resulting solely from differences in financial policies.

The mechanism by which investors eliminate the effects of such differences is called "arbitrage." The arbitrageur identifies two assets with identical payoffs that are trading at different prices, and then earns riskless profits by selling the higher-priced asset and buying the lower-priced one. In the words of M&M, arbitrage works as follows:

if Proposition I did not hold [and levered firms sold for, say, higher values than identical unlevered firms], an investor could buy and sell stocks and bonds in such a way as to exchange one income stream for another stream, identical in all relevant respects but selling at a lower price. The exchange would therefore be advantageous to the

2. Franco Modigliani and Merton Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review* Vol. 48 No. 3 (1958).

3. Merton Miller, "The Modigliani-Miller Propositions Thirty Years Later," *Journal of Economic Perspectives* (1988). A somewhat shorter version of this article was published in Volume 2 Number 1 (Spring 1989) of this journal, and all citations of this article in these pages will be from this 1989 *JACF* version of Miller's paper.

investor quite independently of his attitudes toward risk. As investors exploit these arbitrage opportunities, the value of the overpriced shares will fall and that of the underpriced shares will rise, thereby tending to eliminate the discrepancy between the market values of the firms.⁴

In the rest of this article, I argue that it is this concept of arbitrage that is at the center of Merton Miller's career and of his contributions to our field. Fischer Black paid tribute to Miller by calling him a "warrior." The cause for which Miller fought until the end of his life was the social efficacy of financial markets—the idea that financial markets, when allowed to function with minimal interference from regulators and governments, are extraordinarily effective in allocating resources in ways that create social wealth. And the arbitrage mechanism was Miller's guiding principle in thinking about what makes markets so effective. Both his research and his battles with politicians and regulators are testimony to his conviction that any substantial market mispricing of assets that presented arbitrage opportunities for investors would quickly be eliminated because market forces would soon step in to set prices right.

In what follows, I begin by considering how the idea of arbitrage has affected the development of corporate finance theory. I then go on to consider the relationship between arbitrage, market efficiency, and—a relatively new consideration in finance—liquidity, particularly in light of recent events like the failure of Long-Term Capital Management.

ARBITRAGE IN THE HISTORY OF FINANCE

Modigliani and Miller did not invent arbitrage. When their paper was published in 1958, there was already a well-developed arbitrage argument in the economics literature. Both academics and practitioners in the field of international finance knew how to price forward currency contracts based on the interest rate parity theorem (IRPT), a theorem that was proved using arbitrage arguments. The IRPT says, for example, that the value of a position in a U.S. risk-free asset (say, a one-year T-bill) and a forward contract on a foreign currency (a contract to exchange dollars for British pounds in one year) cannot deviate much from the price of the foreign currency

risk-free asset with the same maturity (one-year British treasury stock). The logical appeal of the IRPT is fairly straightforward, relying as it does only on the ability of investors to hedge the exchange rate risk in a foreign bond and so transform it into its domestic currency counterpart. And the predictive power of the IRPT thus depends only on whether or not such risk-free securities really exist and can be purchased without incurring large transactions costs.

The proof of the leverage irrelevance proposition was a much more ambitious undertaking. M&M began by making the assumption that there are many companies in the same risk class. More precisely, these firms are assumed to generate operating cash flows (that is, cash flows before subtracting financing costs) that are perfectly correlated with each other, such that the stocks of these firms can be viewed by investors as perfect substitutes. M&M did not explain why it would be reasonable to assume there would always be enough companies in a given risk class to allow investors to perform this novel kind of arbitrage between risky cash flow streams. Instead, the paper went ahead and attempted to provide empirical support for the irrelevance proposition by examining the leverage ratios and stock returns of a sample of electric utilities. But, as Miller himself wrote 30 years later, "our hopes of settling the empirical issues by that route...have been largely disappointed."⁵

When published in 1958, the first M&M paper generated an avalanche of comments, a number of which were published in the *American Economic Review*. The response that is probably best remembered was by David Durand, then a professor of finance at MIT. Durand's position was that the propositions were logically correct, but only "in their own properly limited theoretical context."⁶ His quarrel was with the realism of the assumptions that made possible the arbitrage proof of Proposition I, particularly those permitting "homemade" leverage and the absence of restrictions on margin buying.

Miller himself never denied the existence of market frictions—although the fact that M&M devised an empirical test of the proposition suggests their belief that it might have some predictive power despite those frictions. But perhaps a more useful way of viewing the M&M irrelevance propositions is this: They tell us what we should expect to see if we

could somehow eliminate the effects on corporate cash flows of real-world frictions like taxes, information costs, and value-reducing managerial behavior. Despite Durand's objections, the key assumptions of M&M have been used over and over in financial research not because they are accurate descriptions of reality, but because they have helped researchers to identify and focus on those variables that are likely to affect the real underlying source of value: the expected cash flows.

Besides providing a foundation for future research in corporate finance, arbitrage arguments of the kind introduced by M&M also prepared the way for other major developments in finance theory—developments that led to the derivatives revolution that has dramatically changed the practice of finance in the last 15 or 20 years. The arbitrage portfolio strategies in the M&M paper are "static" strategies in the sense that once the investor establishes an initial position, there is no need to change it. If a levered firm sells for more than an unlevered firm, investors can make a risk-free profit by selling short the levered firm and buying the unlevered firm, and then just holding that position. But with the discovery of the Black-Scholes option pricing formula and the introduction of "continuous-time" pricing models by Robert Merton in the early 1970s, finance added dynamic arbitrage strategies to its tool box. Such strategies involve continuous changes in the positions held by the arbitrageur and, in so doing, make it possible to create trading strategies that replicate the payoffs of almost any security.

This extension of the arbitrage argument was first made in the context of the option pricing model developed by Fischer Black, Robert Merton, and Myron Scholes in the early 1970s. Remarkably enough, the first sentence of the famous Black-Scholes paper makes an arbitrage argument that is exactly what one would expect from Miller: "If options are correctly priced in the market, it should not be possible to make sure profits by creating portfolios of long and short positions in options and their underlying stocks."⁷

After publication of the Black-Scholes formula, the continuous-time arbitrage approach to pricing

securities quickly showed itself to have considerable predictive power and a broad range of applications. This approach made possible the pricing and hedging of all kinds of new derivatives (not just traded options on stocks), thereby providing tremendous impetus to the growth of derivatives markets. Apart from futures contracts on agricultural commodities, derivatives were virtually unknown when the M&M paper was published in the late '50s. By the end of 1999, the notional value of over-the-counter (OTC) financial derivatives contracts outstanding had almost reached \$90 trillion⁸—an amount that doesn't include the derivatives outstanding on the organized futures and options markets. Such derivatives are now used every day by investors and companies both to make markets more efficient and to manage major price risks.⁹ In addition to their extensive use in corporate risk management, continuous-time arbitrage pricing methods are also now widely used by corporations in *real option* applications such as project valuation and strategic planning.

ARBITRAGE AND CORPORATE FINANCE

Though arbitrage arguments are now pervasive throughout finance, the more immediate impact of the arbitrage proof of Proposition I was to provide the foundation for modern corporate finance by demonstrating the conditions under which capital structure should not matter—and, by implication, the conditions under which it might. The M&M propositions are often identified as the beginning of modern corporate finance because they represent the first attempt to apply rigorous economic logic to corporate financial decision-making. In so doing, Miller and Modigliani started the transformation of the study of corporate finance from what then amounted to a glorified apprenticeship system into the more systematic and scientific discipline it has since become.

The basic insight of the M&M propositions is that, when viewed from a broad macro perspective, differences in leverage and dividend payout ratios are simply different ways of dividing up the operating cash flows produced by the business and repack-

4. Modigliani and Miller (1958), p. 269.

5. Miller (1989), p. 9.

6. David Durand, "The Cost of Capital, Corporation Finance, and the Theory of Investment: Comment," *American Economic Review* 49 (1959).

7. Fischer Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* Vol. 81 No. 3 (1973).

8. This is the latest estimate of the size of the over-the-counter derivatives market produced by the Bank for International Settlements.

9. In my article, "Rethinking Risk Management" (which appeared in Vol. 9 No. 3 (Fall 1996) of this journal), I argue that the primary source of value added by

corporate risk management is that it enables companies to reduce major price risks they have no comparative advantage in bearing. By transferring such risks to other parties better able or more willing to bear them, risk management effectively allows management to focus more on managing those risks where they do have a comparative advantage.

aging them for (possible) distribution to investors. And as long as "merely financial" decisions do not affect "real" decisions in any systematic way—for example, provided managers make the same investment decisions whether the debt-to-capital ratio is 10% or 90%—financial decisions do not "matter."

As mentioned earlier, the M&M propositions were developed under a restrictive set of conditions, the most important of which are these: (1) there are no taxes paid by companies or their investors; (2) there are no costs associated with bankruptcy or other forms of financial trouble; (3) reliable information about the firm's earnings prospects is freely available to investors (and, thus, what management knows about the future cannot be significantly different from what investors know); and (4) corporate investment and operating decisions are not influenced by financing or dividend choices.

What, then, do the M&M propositions have to say to corporate practitioners? There are really two distinct messages. The first is that there is no "magic" in leverage or dividends. Since the heyday of the conglomerates in the late '60s, investment bankers have been fond of showing their clients the miraculous effect of increasing leverage—whether by issuing new debt or buying back stock—on pro forma earnings per share. The message of Miller and Modigliani is that this EPS effect is an illusion. It is true that if companies issue debt and use the proceeds to retire their shares, their EPS will go up as long as the return on invested capital exceeds the after-tax corporate borrowing rate—hardly an acceptable standard of profitability. The problem with this strategy, as M&M showed, is that as companies take on more financial leverage, the risk of the equity rises commensurately. And as the risk of the equity increases, stockholders raise their *required* rate of return, and the P/E of the firm goes down. The net effect is a wash; overall value remains unchanged. In response to those who claim that investors value companies largely on the basis of dividends, M&M showed that dividends are simply a way of distributing earnings; and as long as the company's earning power remained unaffected, the shareholders' *total* return (dividends plus capital gains) should stay the same.

The second message of M&M can be seen by standing the propositions on their heads. That is,

if changes in corporate financing or dividend policy are going to increase stock prices, they are likely to do so only for the following reasons: (1) they reduce taxes or transactions costs paid by the companies or their investors; (2) they reduce (the present value of) the expected costs of financial distress; (3) they reduce information asymmetries between management and investors; or (4) they provide stronger incentives for management to invest wisely and operate efficiently. It is in this sense that the M&M propositions can be seen as laying the groundwork for the modern theory of corporate finance: they showed future scholars (as well as practitioners) where to look for the *real* effects of financial decisions.

The academic process of exploring these four possible sources of value added by corporate financing decisions was begun by Miller and Modigliani themselves almost 40 years ago. In the so-called "tax-adjusted" M&M proposition presented in a 1963 paper, they argued that the benefits of substituting debt with tax-deductible interest payments for equity with non-deductible (and thus potentially twice-taxed) dividend payments could push the optimal capital structure toward 100% debt.¹⁰ But this result seemed completely at odds with the conservative corporate practices of the time. Faced with corporate debt-equity ratios in the early 1960s "that were not much higher than they were in the low-tax 1920s," Miller recalls,

we seemed to face an unhappy dilemma: either corporate managers did not know (or perhaps care) that they were paying too much in taxes; or something major was being left out of the model... [Our thinking] suggested that the high bond ratings in which the management took so much pride may actually have been a sign of their incompetence; that the managers were leaving too much of their stockholders' money on the table in the form of unnecessary corporate income tax payments.¹¹

The initial way out of this dilemma was to focus on the costs of high leverage—and the most obvious candidate was bankruptcy costs. But the findings of a much-cited study of a sample of bankrupt railroads suggested that the direct, or "out-of-pocket," costs associated with formal bankruptcy proceedings were

much too low—less than 1% of total firm value, on average, for the larger firms—to explain the reluctance of companies to use more leverage.¹² This led finance scholars to explore the "indirect" costs of leverage, those costs (including predictable value-reducing changes in managers' behavior) resulting from the financial troubles of companies in situations much less extreme than bankruptcy.

The most intuitively appealing analysis of such costs was a 1977 paper by Stewart Myers called "The Determinants of Corporate Borrowing."¹³ After viewing the values of all companies as the sum of two components—tangible "assets in place" and intangible "growth options"—Myers went on to demonstrate why companies whose values stem mainly from assets in place support much higher leverage ratios than firms whose values come mainly from growth options (think of today's Internet firms). The main argument against using debt to finance such growth companies was identified by Myers as the "underinvestment problem." The essence of the argument is straightforward: When faced with a downturn in operating cash flows, debt-financed companies are more likely than their equity-financed counterparts to pass up valuable investment opportunities. And since the potential loss from underinvestment is much greater for growth companies than for mature firms, growth companies have greater reason to avoid debt.¹⁴

To the extent that such expected "costs of financial distress" were assumed to be a major factor in financial decision-making, choice of the firm's leverage ratio could be seen as an attempt to balance such costs against the anticipated tax benefits of higher leverage. But Miller himself remained skeptical about whether distress costs were large enough to resolve the capital structure puzzle, and he proposed a different solution. In his 1976 Presidential Address to the American Finance Association entitled "Debt and Taxes,"¹⁵ Miller pointed out that the tax savings of debt financing from the deductibility of interest (but not dividends) were exaggerated by the failure to account for the taxes paid by the

holders of corporate debt. For individuals, interest on corporate debt is taxed as income while capital gains are taxed at a lower rate and their realization can be postponed. Miller showed that the tax savings from converting equity into debt at the corporate level are at least partly offset by the higher pre-tax promised rate of return that debtholders require as compensation for the taxes they pay on their interest income. And in the somewhat extreme situation where the debtholders' interest is fully taxed while the stockholders' gains go essentially untaxed, the entire tax benefit from debt would disappear. Based on this new development, the leverage irrelevance proposition could hold even in the presence of taxes.

In the late '70s, there was another attempt to take finance theory beyond capital structure irrelevance by exploring the possibility that corporate financing decisions provide "signals" to investors by communicating important "insider" information about the firm's earnings prospects. This theory seemed especially suited to explain the widely noted tendencies of new equity issues to meet with large price drops and of stock buybacks to cause price increases. But, as Miller himself concluded in his 1986 paper on "The Informational Content of Dividends," "none of the signaling models has provided—nor is one likely to provide—a signaling 'equilibrium' in which one dividend or financial policy is clearly superior to another."¹⁶ That is, even though signaling theories offer a plausible explanation of how investors interpret *changes* in corporate leverage and payout ratios, they provide little guidance on the questions of *optimal* capital structure and dividend policy.

By the early 1980s, then, the finance profession had come up with (1) one good reason for some companies (mainly high-growth firms) to avoid debt (namely, to reduce the possibility of underinvestment), (2) one *possible* reason to increase leverage (to reduce corporate taxes), and (3) a third factor—information asymmetries—that would lead most companies to stay away from high leverage (to avoid the "information" costs associated with having to

10. Franco Modigliani and Merton Miller, "Corporate Income Taxes and the Cost of Capital: A Correction," *American Economic Review* (1963).

11. Miller (1989), p. 12.

12. Jerold Warner, "Bankruptcy Costs: Some Evidence," *Journal of Finance*, Vol. 32 (1977).

13. Stewart Myers, "The Determinants of Corporate Borrowing," *Journal of Financial Economics*, Vol. 5 (1976).

14. At the root of this problem, as Myers demonstrated, are conflicts between shareholders and bondholders. If the firm raises funds for investment by selling new shares, the bondholders benefit because their debt becomes less risky. But this increase in the value of the firm's existing debt resulting from an equity issue represents a wealth transfer from the firm's existing shareholders, who accordingly

may choose to bypass the investment rather than incur the costs of a new stock issue. In addition to Myers's discussion of the underinvestment problem, other bondholder-shareholder conflicts arise from incentives of shareholders to make the debt riskier and so less valuable (as pointed by Michael Jensen and William Meckling in their 1976 paper on "agency costs," which I discuss later in this paper).

15. Merton Miller, "Debt and Taxes," *Journal of Finance* (1977).

16. Merton Miller, "The Informational Content of Dividends," in *Macroeconomics and Finance: Essays in Honor of Franco Modigliani* (MIT Press, 1987).

raise new equity). In sum, there was no clear message coming from the academic finance profession about how greater use of debt financing could be expected to add value.

But a new way out of the capital structure dilemma presented itself in the wave of leveraged restructurings in the 1980s. During that period, debt-equity ratios in LBOs and some "public" leveraged recaps achieved levels that Miller described as "far beyond anything we dared to use in our classroom illustrations of the tax advantage." But, as many observers suspected and research later confirmed, tax savings were not the only benefit of high leverage, nor were they probably the most important. As early as 1976, Michael Jensen and William Meckling had pointed to another possible benefit of debt financing in their pioneering paper on "agency costs."¹⁷ Jensen and Meckling demonstrated that, in a world where managers often pursue their own interests at the expense of their shareholders, raising equity capital from outside investors can be costly. The more dispersed the firm's ownership (and the less stock owned by the firm's managers), the greater is this value-reducing conflict of interest between ownership and control. For this reason alone, replacing equity with debt (and perhaps, as in LBOs, increasing managers' stock ownership in the process) could be expected to lead to greater operating efficiency and higher firm value.

But the application of Jensen and Meckling's agency cost theory to the events of the 1980s did not come until Jensen's formulation of his "free cash flow" theory of corporate finance. Published in the *American Economic Review* in 1986, Jensen's paper argued that the massive substitution of debt for equity in leveraged takeovers, LBOs, and leveraged stock repurchases was adding value by curbing wasteful reinvestment in mature industries with few promising investment opportunities.¹⁸ In Jensen's view, high leverage exerts a discipline on management that, while potentially costly in high-growth firms, can be a major source of value in large, mature companies with far more capital than growth opportunities.¹⁹ As Miller himself summed up Jensen's

argument: "By accepting such heavy debt-service burdens, the managers are making a binding commitment to themselves and to the other residual equity holders against yielding to the temptations to pour the firm's good money down investment ratholes."²⁰

In the 1990s, the academic finance community furnished supporting evidence for Jensen's argument in the form of study after study documenting significant increases in operating efficiency and value in the LBOs and other leveraged restructurings of the '80s. But, with the collapse of the junk bond market in 1989 and the ensuing wave of defaults and bankruptcies, this was far from the popular view of leverage and financial markets. So, when Merton Miller was awarded the Nobel Prize in Economics at the end of 1990, it was not a complete surprise that he chose "Leverage" as both the title and subject of his Nobel lecture. After briefly noting the "substantial real efficiency gains" accomplished "by LBO entrepreneurs" during the 1980s "by concentrating corporate control and redeploying assets," Miller quickly turned to the main business of the speech—the use of economic logic to combat what he called the "particularly virulent strain of anti-leverage hysteria" then prevailing among U.S. politicians and regulators.

The main thrust of Miller's argument, which can be traced back to the M&M propositions, is the improbability of debt financing *per se* causing significant reductions in the value of corporate America's real assets and future earnings power. This is not to deny the painful losses experienced by many investors and employees of highly leveraged companies during the early '90s. But the main culprit in many of these cases was not debt, but the downturn in the economy (a downturn made worse, as Miller said, by "regulatory overreaction to the S&L crisis" and the adverse effects of new bank capital requirements). If the highly leveraged deals of the '80s had been funded mainly with equity rather than debt, such companies would still have experienced large losses in value; but such losses would then have been borne largely by stockholders instead of being

17. Michael Jensen and William Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," *Journal of Financial Economics* (1976). The view that the firm's capital structure and the ownership of its equity affect managerial behavior is central to the agency literature and started with this seminal paper by Jensen and Meckling.

18. Michael Jensen, "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," Vol. 76 *American Economic Review* (1986).

19. One of my own papers provides a model of optimal leverage in which debt has such a disciplining role. See René Stulz, "Managerial Discretion And Optimal Financing Policies," *Journal of Financial Economics*, 1990, Vol. 26 No. 1.

20. Miller, "The M&M Propositions Thirty Years Later," *JACF*, Vol. 2 No. 1 (1989), p. 14.

Economic historians will conclude that the growth of the '90s, far from being constrained by the high leverage of the '80s, was made possible in large part by the efficiency gains accomplished by the leveraged restructurings of that period.

shared with the debtholders. And even those losses that could correctly be attributed to overleveraging were more likely to represent "private" than "social" costs, since the forgone investment opportunities and laid-off employees were likely to move to other (in some cases new) firms. Hence Miller's skepticism about the popular argument that a cluster of bankruptcies could lead to a general collapse of the economy:

*Neither economics generally nor finance in particular offers much support for this notion of a leverage-induced "bankruptcy multiplier" or contagion effect. Bankrupt firms do not vanish from the earth. They often continue operating pretty much as before, though with different ownership and possibly on a reduced scale. Even when they do liquidate and close down, their inventory, furniture and fixtures, and employees and customers flow to other firms elsewhere in the economy. Profitable investment opportunities that one failing firm passes up will be assumed by others—if not immediately, then later when the economic climate becomes more favorable.*²¹

Given the events of the past ten years, Miller's words now seem prophetic. The remarkable growth of the last decade has laid to rest the concerns about high leverage that were so prevalent in the early 1990s. Eventually, economic historians will conclude that the growth of the '90s, far from being constrained by the high leverage of the '80s, was made possible in large part by the efficiency gains accomplished by the leveraged restructurings of that period.

ARBITRAGE, FINANCIAL MARKETS, AND MARKET EFFICIENCY

Research findings based on arbitrage arguments in perfect markets are relevant only as long as one believes that market forces work. Investors must be able to take sufficient advantage of pricing mistakes that prices will not differ in a systematic way from what they would be if financial markets were perfect.

In Miller's view of the world, financial prices cannot be wrong for long because investors are

always looking for riskless profits from correcting pricing errors. And when regulations or other government interference prevent investors from playing this arbitrage role, the markets tend to find innovative ways around such obstacles—in some cases, by creating new securities. In a 1986 speech to the Western Finance Association,²² Miller argued that many if not most financial innovations are responses to regulatory impediments to the working of market forces. In making this point, he reminded his audience of Milton Friedman's role in the creation of financial futures. In the early 1970s, Friedman wanted to speculate on the British pound by taking a short position; but at that time one could take a short forward position only by going to a bank, and no bank was willing to be his counterparty. (Banks apparently did not want to be seen by their regulators as promoting currency speculation.) This experience led Friedman to advocate the creation of financial futures since futures markets make it just as easy for investors to take a short position as a long one. And the first currency futures began trading on the Chicago Mercantile Exchange in 1972.

Financial economists tend to regard both financial innovation and capital flows in pursuit of investment opportunities as positive forces that make markets more efficient, facilitate risk-sharing, and increase economic growth. But, outside the circle of economists, this view is highly controversial. Politicians and regulators, in particular, are generally inclined to see financial innovation and unfettered capital flows as leading to crashes and general instability. Political and regulatory attacks on financial innovation were particularly fierce in the wake of the stock market crash of 1987 and the junk bond losses in 1989. The same "anti-finance" forces mounted campaigns during the spate of derivatives disasters in the mid-1990s and the emerging-market crises in the second half of the '90s.

Whenever market forces and financial innovations were blamed for problems in financial markets, Merton Miller was there to provide careful economic analysis. For example, when portfolio insurance and index arbitrage were widely blamed for the stock market crash in October 1987, Miller chaired a blue ribbon commission set up by the Chicago exchanges to look into the causes of the crash. And the

21. Merton Miller, "Leverage," Nobel Memorial Prize Lecture delivered December 7, 1990 in Stockholm. The text of the speech was reprinted in this journal, Vol. 4 No. 2 (Summer, 1991), p. 10.

22. Merton Miller, "Financial Innovation: The Last Twenty Years and the Next," *Journal of Financial and Quantitative Analysis* 21 (1986).

commission contributed a number of important points to the politically charged debate that took place after the crash. For example, critics of the futures markets invariably argued that prices first fell in the stock index futures markets in Chicago, with the effect then spreading to the stock markets in New York. But, as Miller pointed out, this by no means proves that the futures markets *caused* the crash. Noting that many NYSE stocks had delayed openings on October 19, Miller said that a more plausible interpretation of the day's events was that the futures market prices simply *reflected* the true state of the market that was hidden on the NYSE because of the delayed openings. In addition to emphasizing the valuable role of futures markets in "price discovery," Miller also observed that the size of portfolio insurance programs was far too small to account for the volume of selling on October 19.²³

The debate over portfolio insurance was recently reopened with the publication of a book by Bruce Jacobs,²⁴ a professional portfolio manager. The main thesis of Jacobs's book is that portfolio insurance programs caused the crash of 1987 by setting off a "massive liquidation" in response to the price declines before the week of the crash. According to Jacobs, the result of this massive liquidation attempt was "a tremendous explosion—selling, understandable reluctance to buy, prices gapping down, investor panic." As the book explains, "What the participants in these strategies apparently don't realize is that, as their investments become concentrated, so does their need for liquidity. When they need to get out, they find they are stuck in illiquid positions that can be unwound only at steep discounts."

But Miller himself never argued that markets always move continuously, nor did he hold that continuous price movements were a necessary condition for market efficiency. In fact, in May of 1987 (and thus just five months before the crash), he gave a paper at the Mid-America Institute that proved to be remarkably prescient about the possibility of price gaps. In that paper, he pointed out that although greater liquidity in markets makes it possible for individuals separately to withdraw their capital whenever they wish, it is not possible for

society as a whole to withdraw its investment. In normal times, individuals who sell and buy largely balance each other out. But, on occasion, there are imbalances in which many more individuals want to sell than buy. In such situations, there is a possibility that the buffer stocks of the market makers and the resources of liquidity providers will be exhausted. This creates the equivalent of a bank run in which those investors who get to sell first are the lucky winners, while those who come last cannot sell because there are no buyers.

Having acknowledged that possibility, Miller went on to explore its implications for the organization of markets. His main prescription was the importance of putting in place mechanisms that expand the capacity of exchanges to absorb the demand for transactions. But, as he warned in closing, "No economically feasible amount of added capacity will guarantee against any recurrence of market brown-outs, of course; but it can at least make them even rarer events."²⁵

More recently, a number of financial economists have argued that the level and volatility of stock prices experienced in the past few years are clear evidence of a "bubble." The recent debates on the level of the stock market have made extensive use of the findings of a new branch of finance known as "behavioral finance." For example, in a book published in 2000,²⁶ Robert Shiller uses behavioral models based on various forms of investor "irrationality" to explain how investors at times can get carried away by theories supporting high stock prices. According to Shiller, the late 1990s represent the fourth period in the 20th century in which investors have become enthralled by some version of the idea of a "new economy." The first such period was at the turn of the century, the second one led up to the crash of 1929, and the third took place in the 1960s. As Shiller points out, the previous three periods in which dramatic increases in stock prices were fueled by visions of a new economy did not end well.

But if Miller believed that prices might change with dramatic speed because of the limited capacity of financial markets to provide liquidity, he did not think that such price gaps were necessarily evidence of bubbles. In his keynote address to the Pacific-

Basin Finance Association in 1989, he pointed out that stocks are securities with "theoretically infinite durations." This means that, especially in the case of low-dividend stocks, much of their value resides in cash flows that will not be produced until years into the future. And this in turn means that small changes in expectations about growth rates, interest rates, or risk premiums can lead to large changes in prices. To illustrate this point, Miller used an example in which the firm begins with a dividend yield of 3%, a discount rate of 10%, and a growth rate of dividends of 7%. Plugging these assumptions into the Gordon dividend growth model widely used by practitioners, Miller shows that the share price would be worth 33 times the current dividend. He then goes on to show that if the growth rate falls by a half a percentage point to 6.5%, and the discount rate increases by the same amount to 10.5%, the stock price falls to 25 times dividends, a drop of 24%. As Miller's example was meant to suggest, it does not take much of a change in expectations to generate a fall in the stock prices of the magnitude of what took place on October 19, 1987.

In choosing these numbers, Miller made it clear that all he was doing was providing a set of numbers that would be *consistent* with a fundamental explanation of the crash. He did not believe it would be possible for economists to devise empirical tests capable of distinguishing between the two main hypotheses—that the crash represented (1) investor irrationality and the bursting of a bubble or (2) a rational investor response to a sudden shift in fundamentals. In summing up his position, Miller said, "We are faced with competing theories that can seemingly account for the same facts and we have no way of conducting decisive experiments that can distinguish between them."²⁷ And in response to this ambiguity, Miller's recommendations for policymakers concluded with the suggestion that the "wiser and ultimately more conservative policy, even for those who still believe in bubbles, is not to seek to prevent stock market crashes at all costs, but if one does occur, to localize any damage and keep it from spreading to other sectors of the economy."²⁸

In Miller's world, the forces of arbitrage, broadly understood, eventually prevail. If the random or poorly understood actions of a mass of individual investors were to lead them to exit the

markets in a hurry, this should create profit opportunities for other investors; and the act of exploiting such opportunities should move prices back to their proper levels. This mechanism assumes that arbitrageurs will always be there in force to prevent overshooting and systematic biases in prices relative to what they should be based on fundamentals alone.

But how can we be sure that the free fall of October 19, 1987 stopped just where it should have? How can we know that the collapses of emerging markets, or the recent drop in the value of the Nasdaq, were not excessive? Perhaps we will never know. Such drops or gaps in markets will turn out to be consistent with market efficiency only if there are enough investors who do not succumb to panic to step in and start buying. This means that such investors must have enough capital at their disposal.

IS THERE ENOUGH CAPITAL FOR ARBITRAGE?: THE CASE OF LTCM

Investors can now make trades more quickly, and with lower transactions costs, than ever before. Although this increase in liquidity is unquestionably a great benefit for both investors and the companies in whose shares they trade, it also creates the potential for investors to herd in ways that were not possible before. We have seen dramatic reversals in investor sentiment in the last few years. For instance, capital flows to East Asian countries experienced a swing of more than \$100 billion from 1996 to 1997. When such events take place, trades by a group of investors can end up destabilizing markets unless Miller's arbitrageurs stand up to the herd and profit from their behavior. But while more arbitrage capital may now be needed to allow other investors to exit from the markets at a moment's notice, developments in the last few years suggest that we may actually have less of such capital—or at least not enough.

Among recent events that seem to indicate the limitations of the arbitrage mechanism, the fall of Long-Term Capital Management (LTCM) in the fall of 1998 stands out. LTCM was mostly engaged in transactions that would qualify as M&M-type arbitrage transactions. A typical example of such a transaction was to go long in an agency bond

23. Reports showed that sales of stocks unrelated to portfolio insurance were three to five times as great as the sales driven by portfolio insurance.

24. Bruce Jacobs, *Capital Ideas and Market Realities* (Blackwell Publishers, 1999).

25. Miller (1991), cited in note 1, p. 48.

26. Robert Shiller, *Irrational Exuberance* (Princeton University Press, 2000).

27. Miller, *Financial Innovation and Market Volatility* (1991), cited earlier, p. 103.

28. *Ibid.*, p. 106.

Miller argued that the problems of the Japanese economy (still very much in evidence today) stem from the same fundamental source as those afflicting the countries in Southeast Asia—namely, excessive reliance on bank financing and failure to develop well-functioning capital markets.

and go short in a similar Treasury bond. Although bonds issued by government agencies typically have yields fairly close to those of Treasury bonds of the same maturity, there are times when the yield of agency bonds is considerably higher. And since the coupon payments of the agency bond exceed those of the bonds held short, a long position in an agency bond trading at par and a short position in a comparable Treasury bond will earn a positive cash flow provided (1) the federal guarantee to the agencies is strong enough that there is no default risk on the agency bonds and (2) the positions are held to maturity.

In the real world, there are three difficulties with this arbitrage transaction. First, there might be some default risk on the agency bond, although this problem could be eliminated by using a credit derivative to construct a default-free synthetic agency bond. (In this fashion, financial engineering has removed one obstacle to arbitrage.) A second difficulty is transactions costs that increase the yield differential between agency and Treasury bonds at which an arbitrage trade becomes profitable. Such costs would be increased by any restrictions on full use of the proceeds on short sales, which would force the investor to use some of his own capital to implement the trade. Third, and most important, this would be a true arbitrage trade only if it were certain that the position could be held to the bonds' maturity, at which time the values of the long position and the short position *must* converge (since both bonds are at par). To see why this condition is important, consider what happens if one month after the trade is put in place, the yield on agency bonds increases sharply relative to the yield on Treasury bonds. In that case, the value of the position becomes negative because the price of the bond held long falls by more than the increase in the value of the bond held short. And if the investor *could for some reason* be forced to liquidate the position after its value has fallen, then the arbitrage is no longer riskless—and hence it is no longer arbitrage.

The situation of LTCM in August of 1998 is well represented by this simple example of an arbitrage

trade. LTCM had positions that were generating positive cash flows with a high degree of certainty, but changes in yield spreads had sharply reduced the net worth of those positions through their effect on prices. In terms of our above example, the difference between the yield spreads on agency bonds and those on more liquid Treasuries, which was large enough to attract investors like LTCM in the first place, suddenly became even larger, reflecting investors' heightened desire for liquidity. And as a result of this marketwide preference for liquidity, the values of the securities LTCM was holding long fell by more than the values of the more liquid securities they were shorting, causing a drop in the net worth of their combined positions.

Arbitrageurs with sufficient capital to allow them to hold positions for long periods of time can close the gaps created by increases in the premium for liquidity. In fact, one of the important economic functions of arbitrageurs is to provide liquidity to the markets. But, in August of 1998, many if not most such arbitrageurs stayed on the sidelines. Although still puzzling in some ways, perhaps the most important cause of the failure of arbitrage on this occasion was the major constraints faced by many of the firms and investors capable of playing such an arbitrage role. Financial institutions that could have provided liquidity and thereby earned arbitrage profits are subject to regulations that can discourage them from so doing. A good example of such regulation is the new capital requirements for the trading activities of commercial banks that were put in place at the beginning of 1998. That change in regulation created a situation in which any significant increase in volatility in global capital markets would force banks to choose between increasing the capital used to back their trading activities and cutting back the scope of those activities.

And in August of 1998, the extreme volatility of global financial markets prompted many firms that normally function as market makers to *reduce* their positions instead of providing liquidity.²⁹ As a result, LTCM was in fact unable to satisfy the all-important

third condition of arbitrage: *the ability to hold the combined positions to maturity*. As LTCM's net worth plummeted, it found itself unable to continue financing its positions (even though many of them would still have been profitable arbitrages if carried to maturity). The fact that Warren Buffett, arguably the world's most famous arbitrageur, teamed up with Goldman and AIG to offer to buy the fund for \$250 million (as well as committing \$3 billion of Berkshire Hathaway's capital to stabilize the fund after the acquisition) suggests that even when the net worth of the fund was plummeting, outsiders continued to see value in the portfolio. But Buffett's offer was not accepted and, with some prompting from the New York Fed, a consortium of commercial and investment banks provided LTCM with enough new capital to continue the operation. The banks ended up making a modest profit—about 10%—on their investments when LTCM was liquidated early in 2000.

Building Liquidity into the Model

Given its role in the collapse of LTCM and the failure of portfolio insurance during the crash of '87, liquidity may well prove to be the Achilles heel of a theory of finance built on perfect market assumptions. Nevertheless, as Miller himself showed us, liquidity can be studied. In a paper published in the *Journal of Finance* in 1988,³⁰ Miller and Sanford Grossman offered an explanation for why liquidity can suddenly disappear even in an efficient market. They hypothesized that if many investors suddenly want to sell a security because they experience a "liquidity event"—some unanticipated need to raise cash—the price of that security will drop to attract buyers even though the underlying expected cash flows of the security are unchanged. This temporarily low price should make it attractive for other investors to step in and buy the security, causing its price to return to its previous level. Thus, in markets with a large supply of capital, a large number of investors selling for liquidity reasons would have little or no impact on price. But, as Miller and Grossman also showed in their model, if the suppliers of liquidity have limited capital, or their actions

are restricted by regulations, then market makers—particularly when hit with a series of liquidity events—may exhaust their ability to provide liquidity, leading to a free fall in prices.³¹

Miller was acutely aware of the importance of liquidity in markets. But, in all his writings on the subject, his main concern was to ensure that excessive regulation not reduce liquidity, and that financial markets be allowed to perform their role of directing capital to its best uses. He always took a dim view of arguments suggesting that regulators or bureaucrats could allocate capital more effectively than the private sector under the discipline of financial markets.

What's more, he saw a fairly limited role for commercial banks in the capital allocation process. During the 1980s, when Japanese industrial companies seemed to be outperforming their U.S. and European counterparts, some financial economists began to develop theoretical models that purported to explain why bank-financed economies like Japan and Germany function more efficiently than market-based systems like the U.S. and U.K. But Miller remained squarely in the camp of those who argued that the U.S.-U.K. model of market capitalism is the most reliable way of producing consistent economic growth.

In an article published in this journal in the wake of the Asian crisis,³² Miller argued that the problems of the Japanese economy (still very much in evidence today) stem from the same fundamental source as those afflicting the countries in Southeast Asia—namely, excessive reliance on bank financing and failure to develop well-functioning capital markets. He went on to say that banking "is not only basically 19th-century technology, but disaster-prone technology," and that "in the summer of 1997 a banking-driven disaster struck in East Asia, just as it had struck so many times before in U.S. history." In the 20th century, as Miller pointed out, the U.S. economy steadily reduced its dependence on banks by developing "dispersed and decentralized" financial markets and institutions. By so doing, it has significantly reduced its vulnerability to credit crunches (for example, non-bank sources of capital were an important reason why the U.S. recession of

29. Another problem facing publicly traded financial institutions with significant trading operations are the difficulties in communicating the reliability of trading profits to the investment community. For instance, in the middle of 1998, Salomon Smith Barney decided to sharply limit its proprietary trading operations at a time when it was contemplating the integration of its operations with the rest of the new Citigroup. The apparent reason for taking this step was that the volatility of the profits expected from such operations would be difficult to explain not only

to stock analysts and the bank's regulators, but also to customers (like depositors and purchasers of insurance products) concerned about the bank's financial stability. And for this reason, as well as the regulatory problem mentioned above, a number of economists have suggested that publicly traded financial institutions are likely to be supplanted in this arbitrage role by private, unregulated investors, popularly known as "hedge funds."

30. Sanford Grossman and Merton Miller, "Liquidity and Market Structure," *Journal of Finance*, Vol. 43 (1988).

31. Indeed, yield spreads today on non-investment grade bonds are considerably wider today than in August of 1998, a puzzling phenomenon that has been attributed partly to the absence of market making by U.S. financial institutions.

32. Merton Miller, "Financial Markets and Economic Growth," *Journal of Applied Corporate Finance*, Vol. 11 No. 3 (Fall 1998).

1990 was so mild and short-lived) while at the same time dramatically increasing the efficiency of the U.S. capital allocation process. In closing, Miller urged the developing countries in Southeast Asia and elsewhere not to imitate the Japanese example, but to

follow the model of the U.S. in shrinking the banking industry itself, and steadily expanding the number and variety of market alternatives to bank loans... If the current crises have done nothing more than to discredit the Japanese and Korean models of bank-driven economic development, then perhaps the whole episode, painful as it has been, and still is to live through, has nevertheless been worthwhile.

In sum, Miller was always ahead of the crowd in identifying important issues and using the logic of economics to come up with solutions. And, having thought the issues through, he had no equal in presenting those solutions in ways that would not only affect the thinking of his profession, but also appeal to a much broader audience. In the closing

sentences of his Nobel lecture, Miller urged his colleagues to do the same:

Many in academic finance have viewed the ill-founded attacks on our financial markets, particularly the newer markets, with some dismay. But they have, for the most part, stood aside from the controversies. Unlike some of the older fields of economics, the focus in finance has not been on issues of public policy. We have emphasized positive economics rather than normative economics, striving for solid empirical research built on foundations of simple, but powerful organizing theories. Now that our field has officially come of age, as it were, perhaps my colleagues in finance can be persuaded to take their noses out of their data bases from time to time and to bring insights of our field, and especially the public policy insights, to the attention of a wider audience.³³

In this undertaking Merton Miller had no peers, only students, and it seems safe to say that his influence on financial economists and his contribution to the field of finance will not be matched.

33. Miller, Nobel Prize Lecture, *JACF* (1991), p. 12.

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