FOREWORD BY AARON BROWN

$$E(r_j) = E(r_z)(1-\beta_j) + E(r_M)\beta_j$$

FISCHER BLACK AND THE REVOLUTIONARY IDEA OF FINANCE

$$w(x,t) = xN(d_1) - ce^{-r(t^*-t)}N(d_2)$$

PERRY MEHRLING

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and the

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To
Judy

The true search for knowledge is not like the voyage of Columbus but like that of Ulysses. Man is born abroad, living means seeking your home, and thinking means living. . . .

A cowardly fear of thinking curbs us all; the censorship of public opinion is more oppressive than that of governments. Most writers are no better than they are because they have ideas but no character. . . .

To be original you must listen to the voice of your heart rather than the clamor of the world—and have the courage to teach publicly what you have learned. The source of all genius is sincerity; men would be wiser if they were more moral.

Ludwig Borne (1823), quoted in
Rudolf Flesch, *How to Make Sense* (1954)

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Acknowledgments

This book has been seven years in the making. Along the way I have received help from very many people, in very many forms. My largest debt is to Fischer's family, especially to Cathy Tawes Black, who provided access to Fischer's extensive professional files at MIT as well as student records at Harvard, and to Fischer's parents (now deceased), who welcomed me to their Tampa home and opened the family archives to me. Fischer's siblings Blakeney and Lee, his daughters (especially Alethea), his ex-wife Cynthia Linton and his cousin Stanley Black and aunt Corinne Black all provided invaluable help in understanding issues of character. I am also indebted to Fischer's high school buddies, college and graduate school roommates, friends and housemates, for their insights.

The most important intellectual influences on Fischer were Jack Treynor and Merton Miller, whose help and support were therefore especially valuable and appreciated, especially that of Merton Miller, who took the time to meet with me despite his own failing health. Thanks also to Franco Modigliani, whose passionate advocacy of neo-Keynesian orthodoxy gave Fischer something to respond to, and to Serena Modigliani for access to her husband's papers, which allowed me to trace the origin of Fischer's interest in macroeconomics and monetary theory. Special thanks also to Robert Merton and Myron Scholes, whose lives were from the beginning inextricably intertwined with Fischer's on account of the options formula.

My interest in writing about Fischer Black stemmed originally from an interest in understanding the evolution of twentieth-century American monetary thought, and initially I conceived of the book as providing a window on certain ideas and institutional developments in finance that have transformed both the way banking is done and the way we think about it. The book was supposed to carry into the present the story I had begun to tell in my previous book *The Money Interest and the Public Interest, American Monetary Thought, 1920–1970*. Fischer Black was clearly the best subject on whom to hang such a story since he, more than anyone else of his generation of financial economists, maintained a lifelong engagement with the problems of macroeconomics and monetary theory. In my original conception, the research for the project was to be almost entirely archival. I owe thanks especially to Nora Murphy and Jeffrey Mifflin for their help during a summer spent at the MIT Institute Archives and Special Collections.

My original project survives as Chapters 6 through 8 in the present volume, but the initial research revealed that there was an even larger story that needed to be told, namely the story of the rise of modern finance itself. For this story also, the career of Fischer Black seemed to provide an almost perfect narrative frame, since he spent his life straddling the world of academia and the world of practical business. As I was expanding my sense of the project, Pamela van Giessen at John Wiley & Sons approached me with the suggestion to expand my horizons even more. She urged me to write a book that would not only straddle the worlds in which Fischer lived, both academia and business, but also the personal life that supported the intellectual venture of this unusual mind. I was intrigued by the challenge, but also more than a little intimidated. I thank my agent Susan Rabiner for helping me to discover how concretely to proceed.

In the end, I interviewed more than a hundred people, some several times. It soon became clear to me that Fischer had the habit—I would go so far as to call it an intellectual strategy—of gravitating to people he thought he could learn from. The key to understanding the evolution of his ideas was therefore to find the people he was interacting with at each stage in his life. In each setting—Arthur D. Little (ADL), Wells Fargo Bank, the University of Chicago, the Massachusetts Institute of Technology, and Goldman Sachs—there was a different group, but in every case I found that group more than willing to share with me their remembrances of interactions with Fischer. The overall intellectual arc of the book would have been largely the same without these interviews, but it would have lacked the texture and detail that make the story of ideas into a human drama. I owe a great debt to all who made time to talk with me, in person or by phone, over the years.

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I have benefited along the way from scholarly feedback in a number of settings, beginning with the invitation by David Colander to lecture on Fischer Black at Middlebury College in April 1999, continuing in a series of presentations to the annual meeting of the History of Economics Society (1999 at the University of North Carolina at Greensboro, 2001 at Wake Forest University, 2003 at Duke University, and 2004 at Victoria College in Toronto), and continuing also in a series of presentations to my Columbia University colleagues at the regular Tuesday Macroeconomics Lunch Group and Thursday Finance Lunch Group. Thanks to Robert Dimand, Franck Jovanovic, Philip Mirowski, Goulven Rubin, and Neil Skaggs, and to Larry Glosten, Gur Huberman, Rick Mishkin, and Steve Zeldes. Thank you to my colleagues at Barnard College, especially Andre Burgstaller, Duncan Foley, and Carl Wennerlind, who read early drafts, to my graduate students Goetz von Peter and Paul Sengmuller, and to Brian Bedner for superior research assistance.

I would also like to thank Warren Samuels for the opportunity to write about Irving Fisher when I needed it as background for the book. Thanks also to the Austrian Economics Colloquium at New York University, to Zvi Bodie for an invitation to talk at the Boston University School of Business, and to Craufurd Goodwin for an invitation to present the 2002 Johnson Distinguished Economist Lecture at Duke University. For valuable opportunities to pull together the broad themes of the book, thanks to Luca Fiorito for arranging a lecture to the Italian Association for the History of Economic Thought (AISPE) in Palermo, Italy, in October 2004; to Michel DeVroey for an invitation to address the History of Macroeconomics conference in Louvain, Belgium, in January 2005; and to Wade Hands for an invitation to address the History of Economics Society in Tacoma, Washington, in June 2005.

In the final stages of the book, I took further advantage of some of my interview contacts to provide comments on draft chapters. I do not claim to have met satisfactorily all of the criticisms I have received, but I do know that I have repeatedly been impelled to deepen and broaden the argument because of them. I thank especially Michael Adler, Peter Bernstein, Emanuel Derman, Benjamin Friedman, Kevin Hoover, Thomas Humphrey, David Laidler, Robert Litterman, James Lorie, John McQuown, Robert Merton, Myron Scholes, William Sharpe, Robert Solow, Jack Treynor, and Richard Zecher.

Finally, I thank my employer, Barnard College, for allowing me a semester Senior Faculty Research Leave in Spring 2002 to get the book started. Thanks to Franco Modigliani for arranging for me to spend that semester at the Sloan School in Cambridge, Massachusetts, and to John Cox and Stewart Myers for making me more than welcome. In the end, I needed a further year and a half leave in order to produce the final manuscript, and I thank Barnard for that as well. But as anyone who has ever written a book knows, free time is only a necessary, not a sufficient, condition. It is my family who have provided the sufficient conditions.

What a writer needs is stability and constancy during the inevitable ups and downs of the writing process, even as the book swells to absorb more and more space, both physical and emotional. A book is like a guest who arrives one day and settles in, increasingly demanding and ill-tempered, with no sign of imminent departure. It takes a very gracious host to find room for such a guest, even while gently moving him day by day closer to the exit. My wife Judy has been that gracious host. It is because of her that I was able to take on a project that I knew would stretch me more anything I have previously done. And it is because of her that I have now been able to bring that project to conclusion. The dedication is only a token of the debt I owe.

PERRY MEHRLING

Foreword: Unafraid Hard Thinking

The book you hold in your hands (or are viewing on your reading device) is a masterful biography. I can think of no greater praise than to say I knew the subject but never really knew him until I read this book. I have discussed the matter with others who knew Fischer better than I did, including his sister Blakeney and his daughter Alethea, and the ones who have read this book agree that it is the definitive portrait of a complex and eccentric—but most of all a revolutionary—thinker.

The point was brought home even more strongly by the people who had not yet read the book. All expressed puzzlement at some aspect of Fischer's personality or behavior, puzzles that Professor Mehrling has patiently untangled here. To give you an idea of the task he faced, consider Lawrence Weiss's recollection of a lunch with Fischer at MIT over 31 years ago:

> After I sat down facing his desk he went to his lavatory and poured himself six large Styrofoam cups of cold water. When he returned he offered me a cup. When I accepted, he got up from his desk and walked across the room to fetch my cup, leaving his inventory intact. He then pulled from his desk a full bag of Keebler's Pecan Sandies. He ate every one of those cookies, washing them down with copious quantities of prepositioned cold water.

> When he finished the package, he folded it up quite carefully, placed it back in the drawer and then pulled out a fresh package. I don't think he finished the second package.

Or Robert Merton's account of Fischer's most famous talk, his farewell address as American Finance Association president. It is famous because it was short, but also for its blunt dismissal of precision in finance:

> As incoming AFA president, I gave the introduction. Usually, the address lasts 45–60 minutes, and so I thought that at least 3–5 minutes was needed for an appropriately weighted introduction. About 15 or maybe 20 minutes at most into his talk, Fischer paused, and one could hear the proverbial pin drop in the large ballroom. Now those who knew Fischer knew that he would stop sometimes to write down an idea that came to mind before forgetting it (he claimed to have a poor memory), but relatively quickly I realized that he was done. So I started clapping.

My recollection of that talk, by the way, is that several bursts of clapping started and faded before a critical mass decided that the speech was over. The most unusual aspect is that Fischer stood there quietly and inscrutably, giving the audience no clue despite our obvious confusion. This was a familiar look to me; it was the same one he would wear at a seminar after dropping a verbal bombshell, one that was doubly surprising because he was so quiet that presenters often assumed he was not paying attention, or perhaps was even asleep.

It was not only eccentric behavior that puzzled colleagues, but his extraordinary quantity of ideas. I think most would agree with Richard Roll's description of them as "many wrong and others brilliant." I would dissent from the former, some of which Roll lists:

> Some of his other arguments, though, are less well appreciated, such as his contention that one cannot learn anything from studying price/earnings ratios, etc. I think he's absolutely wrong in this case and I told him so at the time.
>
> In terms of macroeconomics, none of his ideas have been accepted, nor should they be. For example, his utterly ridiculous assertion that the rate of growth of the money stock has no impact on inflation. We have a tremendous amount of empirical evidence to the contrary from long histories in many countries. He's also all

> wet about exchange rates. His explanation of business cycles is not simply unaccepted, it's the subject of derision (perhaps somewhat unfairly). Again, I told him at the time that he was heading for trouble, but he persisted in presenting this to a wide range of audiences. I remember macroeconomists asking me, after they heard his talk on macro, whether finance people really held him in such high regard. It was a bit embarrassing.
>
> Fischer had a thick skin. You could tell him flat out that he was full of baloney and he'd just laugh. Shortly before his death, he and his wife came to visit us in California and stayed at our ranch in Ojai. He had not been affected whatsoever by his illness. He was still filled with ideas, many wrong and others brilliant, and he wanted everyone's opinion of them, even my wife's! He was unique, but not always right.

So how did a person so eccentric both personally and intellectually participate in and come to symbolize a revolution? In the words of Meir Statman:

> One of Fischer's great qualities was his ability to place evidence, including everyday observations, next to theory. He was keen at seeing gaps between the two and ready to admit that he does not know how to bridge these gaps. He was also remarkably open to new ideas, his own and others', about bridges between theory and evidence.

Emanuel Derman gave a similar explanation (from which I stole my title):

> Whenever I think of Fischer I think of him as a consummately unsentimental realist, unafraid to see and take the world for what it is. At bottom, he simply liked to think through everything for himself. His approach seemed to me to consist of unafraid hard thinking, intuition, and no great reliance on advanced mathematics.

Fischer Black was very important to my life. Professor W.V. O. Quine introduced us in 1974 when I was a freshman at Harvard and had asked Quine some questions that reminded him of former student Black. Fischer and I saw eye to eye on some issues that were very important to me, and that almost no one else took seriously (much less agreed with). Even more important, he was an inspiring personal example. He tackled hard questions with humility and rigorous logic. He cared nothing about what other people thought. When discussing anything, he gave you the full power of his impressive brain. He never held things back to preserve credit, nor pretended to know more than he did.

Fischer helped me in another way as well. He didn't have students in the normal sense, and I somehow acquired a reputation among practitioners (but not academics) as Fischer's student. It might have been because I explained a lot of his papers to people. This was not hard. It consisted of saying, "Yes, he's serious" and "Read his explanation again; it's clear if you read carefully without preconceptions." This perceived relationship opened some doors for me.

I would be dishonest if I didn't also say that I found the man irritating. He would discuss only things he was interested in, and he shut you out cold if the topic drifted from them. At seminars, his comments were cryptic. They usually were worth figuring out, but he sure wouldn't help anyone do that. He had a full load of unusual and precise personal habits. These were not irritating in themselves, but much as I admire him for not caring what other people thought about ideas, there is something unfriendly about a guy who doesn't care what the person sitting across from him thinks of his personal behavior. A self-deprecating smile or word of explanation could have dispelled the idea that the reason for his unconcern was his low opinion of you.

When Fischer died young in 1995 I was sorry in a conventional sense, and also sincerely sorry to lose a useful intellectual resource. But it was not emotional for me. I didn't know the guy very well. I had no idea of the names of his wife and kids, nor where he lived, nor what he did when he wasn't discussing quantitative analysis. I didn't even know what he thought of me. He had helped me, and I was grateful, but I had helped him, too. And, damn it, he was irritating and everyone was pretending he wasn't. However, not having Fischer's honesty, I allowed myself to get caught up in the outpouring of Fischer Black hagiography that followed. I gave eulogies and participated in commemorative events with unstinted praise and somber politeness.

Ten years later, I was given this book by Professor Mehrling to review for *Publisher's Weekly*. I thought I would finally get to unravel the mysteries of Fischer's life, and maybe put to rest some unresolved feelings. The book did exactly that, but in a totally unexpected way. There was relatively little conventional biographic material and a lot of intellectual analysis. This was the aspect of Fischer I thought I knew, but it assumed a significance that I had never considered.

I went to see Professor Mehrling to ask him why he wrote what he did. He answered by showing me his first book, *The Money Interest and the Public Interest*, which covered American monetary thought from 1920 to 1970, and explained that he started out to write a sequel. Things starting clicking into place then. The conversations Fischer and I had in 1974 and later were a (very small) part of a revolution in monetary thought, one that saw finance dominate traditional macroeconomics. This is a book about that revolution, and Fischer Black is the perfect entry point and organizing character. Astoundingly, that's also the only way to understand Fischer Black.

In a word, the revolutionary idea of finance was *equilibrium*. Earlier economic theory was concerned with equilibrium as well, but in a totally different sense. Equilibrium was conceived as a set of prices and utility functions and constraints at which economic activity would cease because everyone had optimized their consumption given their endowments and tastes. Of course, economic activity does not actually stop. The equilibrium moves around, and due to lags and frictions the economy is always chasing the moving target. But like water running downhill to the ocean, the economy is always moving toward an equilibrium.

Equilibrium in the capital asset pricing model (CAPM) includes risk explicitly as something that is priced. The economy is not moving toward a single equilibrium but in a (sometimes) stable orbit—more like the entire hydrologic cycle than only water flowing downhill. Actors are anticipating all possible futures and setting prices based not just on the average future outcome but on how wide the range of possible future outcomes is. It is risk that is in equilibrium; economic activity is dynamic. There are four major arguments for the CAPM; the one due to Fischer Black is the purest expression of the equilibrium idea, as it requires no risk-free rate of interest (something that has increased its prominence today) and does not require all investors to hold the same portfolio of risky securities.

Fischer used the idea of equilibrium in virtually every field of finance, typically writing one blazingly original paper in accessible terms in a professional journal and then moving on to other work. Like the CAPM, there are four major arguments for the Black-Scholes-Merton option pricing model, and Fischer's is the one based on equilibrium. Fischer also used the idea in analyzing interest rates, resulting in the Black-Derman-Toy and Black-Karasinski models, and in portfolio construction with the Black-Litterman model. These remain the basic models in those fields.

Risk equilibrium implies that a lot of things economists study don't matter. Instead of the mechanical linkages of traditional macroeconomic models where changing A causes a change in B, unless A changed the risk structure of the economy, any change in A would be offset and the economy would remain in its old equilibrium. And if A did change the risk structure of the economy, the result would be unpredictable, not deterministic.

Even before Fischer got into finance, Franco Modigliani and Merton Miller published their famous irrelevance theorems, claiming that capital structure and dividends—which were two of the most important things studied in finance at the time— don't matter. Fischer was more radical. He claimed money supply and interest rates—which are two of the most important things studied in economics, even today—don't matter. He went on to write the two most important books on these ideas: *Business Cycles and Equilibrium* and *Exploring General Equilibrium*.

The other major implication of the equilibrium view is that a lot of things economists don't study do matter. It's not the signal in the stock market that matters most; it's the noise. In traditional economics, the function of a stock market is to facilitate transactions among investors and provide price discovery for economic decision makers. Stock prices should move only in response to news or changes in investor preferences. If traders do introduce extraneous volatility—as they seem to do—it can only be bad. If people trade without information—as they seem to do—it must be irrational. Fischer's famous talk mentioned earlier is the clearest refutation of that view, the best defense of noise. It was titled, "Noise."

If you are unafraid and willing to do some hard thinking, you have the right book. You will meet and come to understand an exceptional person; you will also learn the historical and intellectual context of some of the most important—and revolutionary—ideas shaping the world today.

AARON BROWN

Preface

Reading this book again, six years after its first publication, it strikes me that it covers a lot more ground than I remembered. Even more, it occurs to me that writing this book was more or less ideal preparation for understanding the global financial crisis that began in August 2007, since the book is essentially about the construction of the world of modern finance, both the ideas and the institutions, that is now undergoing a real-time stress test.

Financial globalization has transformed the modern world, but the mechanisms of regulation, both public and private, lag far behind, designed as they were for a world that no longer exists. Even worse, for lack of a scientific understanding of the evolving relationship between the market and the state, between finance and economics, and between Wall Street and Main Street, the raw anxieties of policy makers and lay observers have been unleashed into public debate. Never have popular (mis)understandings been more divergent; political deadlock is the consequence.

The world is today going through a rough patch, a very rough patch. The crisis of financial globalization was backstopped by the balance sheet of the nation-state, and as a consequence has now morphed into a fiscal crisis of the nation-state itself. At this confused and confusing moment, the story of Fischer Black can help. The best way to understand the current moment in history is to enter the mind of one who saw it coming 40 years ago. Fischer Black's genius was to see the big story before anyone else, and then to find ways to insert himself into that story in key places.

Often Fischer was wrong about the details—it is part of his theory that it is impossible to be right about the details—but he was more right than anyone else about the big picture. Way back at the beginning, when he was consulting for Wells Fargo, he anticipated the innovations on which the future of the financial industry would be based—index funds, hedge funds, global funds, automated trading—and also, most important, the intertwining of capital markets and money markets that is the defining feature of our modern financial system. At a time when everyone else viewed Treasury debt as the riskless anchor of the financial system, Fischer showed how the capital asset pricing model (CAPM) made sense even without a riskless asset, an insight especially relevant today. At a time when everyone else was extrapolating from the most recent past into the infinite future, Fischer adopted a higher point of view in which nothing is forever. The only constant is change, and our goal, therefore, both as individuals and as societies, must be to find ways to endure volatility with equanimity, to find personal stability in an ever-changing world.

But Fischer didn't see everything. One of the details that he missed was the liquidity factor, which has played such a key role in the global financial crisis. Committed to seeing the world through the lens of equilibrium, in his early thinking Fischer largely abstracted from liquidity. Only when he came to Wall Street, and started to think systematically about what traders do, did he begin thinking about how to bring the liquidity factor into his theory, and he was still thinking about that when he died prematurely in 1995. As a scientist, he would have been absolutely fascinated by the global financial crisis of 2007, most of all for the myriad recalcitrant data points it offers as entry points for revision, and improvement, of our theoretical understanding.

In Fischer's mature conception, equilibrium is about value, while the liquidity factor is about price.

Fischer's friend Jack Treynor was the first important influence in his thinking about how liquidity causes price to deviate from value. Treynor's idea was that market liquidity depends in the first place on the ability and willingness of dealers to absorb temporary imbalances in the flow of supply and demand by using inventories on their own balance sheets as a buffer. But the ultimate source of liquidity is the value investor who is willing to take those inventories off the hands of the dealer when price moves far enough away from value. The wide "outside spread" set by the value investor is one reason that price can deviate so far from value. Price has to move away from value in order to attract buyers and sellers.

When Fischer was thinking about the 1987 crash, he downplayed the liquidity factor and put the emphasis instead on a kind of systematic error in valuation. The widespread adoption of dynamic trading strategies such as portfolio insurance had led those who adopted the strategies to become more tolerant of risk, but without appreciating that the very same widespread adoption had changed the equilibrium behavior of the system. The 1987 crash came when people figured it out and prices adjusted. Liquidity factors kicked in to cause a temporary overshoot, but they were not fundamental to understanding the crash.

In my April 2009 Foreword to John Wiley & Sons' reissue of Fischer's book *Business Cycles and Equilibrium*, I used Fischer's analysis of the 1987 crash as a template for understanding the current crisis. This time the innovation was the technology of credit risk transfer, including credit default swaps, and once again people failed to appreciate how widespread adoption of an innovation had changed the equilibrium behavior of the system. The result was gross mispricing of risk for a while, and then a correction, along with liquidity factor overshooting. That was my guess two years ago about what Fischer would say about the current crisis, but today (September 2011) I think he might also say more.

With two more years of data, it seems clear that what is new in the current crisis is the much greater prominence of the liquidity factor, not just in driving the price of assets away from value but also, even more, in disrupting the funding of asset positions. It is the liquidity factor that drove the shadow banking system onto the balance sheet of the government, and it is the liquidity factor that is keeping it there.

To understand the crisis, therefore, we need to bring Treynor's account of market liquidity more centrally into the picture, but we also need to augment and integrate Treynor's account with an account of "funding liquidity." Treynor was absolutely right that market liquidity depends on dealers, and on the value investors who step in when price deviates from value. But what the current crisis shows is that the ability of dealers to provide market liquidity also depends crucially on access to funding liquidity, since dealer inventories need to be financed. Even more, what the current crisis shows is that the ultimate source of funding liquidity is the central bank, because only the central bank can fund inventories by issuing money.

Fischer Black famously imagined a world without money, which meant also a world without central banking. For 40 years that vision of a possible future helped him to understand, and to urge along, the construction of the world of modern finance. Today, as a consequence of crisis, we are living in a world of only central banking. I think Fischer would have drawn the conclusion that it is time to bring money back in; to him that would have meant integrating an understanding of liquidity into his idealized world without money. (Interested readers will find my own account of the role of the liquidity factor in the crisis in my book *The New Lombard Street: How the Fed Became the Dealer of Last Resort*, 2011.)

One reason the book covers so much ground is that Fischer Black himself covered so much ground, in macroeconomics as well as finance. But another reason is the task I set myself to put each and every one of his contributions in its proper context, both in terms of Fischer's own intellectual development and in terms of developments in the outside world. I wanted to write a self-contained book that did not assume a lot of prior knowledge, and that meant that I had to provide all the necessary prior knowledge myself.

But I was also determined to limit myself to three hundred pages, and that required me to think hard about what prior knowledge was necessary, and what could be left out. In effect, that meant I had to construct a history of macroeconomics and finance as the setting for Fischer Black's own intellectual journey. Most reviewers, however, have focused on the central narrative of the book, the story of Fischer Black, and so have missed the background narrative about the rise of modern finance and its transformative impact on macroeconomics.

As a signal to readers about this broader narrative, the "revolutionary idea of finance" to which the title refers is not the Black-Scholes option pricing formula that made Black famous. It is rather the capital asset pricing model (CAPM) that first captured Fischer's imagination, and subsequently provided the "pre-scientific vision" (as Joseph Schumpeter called it) that guided Black's scientific quest for the rest of his life. It was 1965 when Fischer Black learned about CAPM and imagined a possible future world very different from the world of 1965. As I was writing the book, it seemed to me that Black's idiosyncratic vision had largely become present reality, and I therefore conceived of the book as using Black's life and work to tell the larger story about the construction of our present reality.

The big story was about the rise of financial globalization, and the consequence of that rise for national economic policy. But there were also a lot of subsidiary stories that had to be told along the way, to clear away the brush that was hiding the larger contours of the land. For most of these smaller stories there was a lot of folk wisdom, passed down from teacher to student, but hardly any proper historical work to check on the accuracy of that wisdom. I could have spent a lifetime generating individual papers that developed each of these subsidiary stories in detail, but then I would never have finished the book. Instead, these subsidiary stories appear for the first time in the book, but as subsidiary stories—about specific people and places, about the origins of CAPM and Black-Scholes and the efficient markets hypothesis, about the Keynesian-monetarist brouhaha, about the CFA and CRSP, ERISA and FASB, the role of econometrics and Bretton Woods. In each of these stories, I have tried to state clearly how I read the historical evidence, hoping to inspire and provoke a next generation of scholars to dig deeper.

The range of Fischer's interests, and of the institutional settings in which he did his work, made it possible to use his life and work as an organizing principle for knitting all of the smaller stories together into a larger narrative. But it wasn't easy going. The biggest writing challenge came from the fact that Fischer pursued each of his myriad interests simultaneously, and continuously, over the course of his entire career. Each interest has its own story, stretching across decades. As a consequence, a doggedly chronological narrative would quickly devolve into a yearly list of updates on each project, and so lose sight of the internal logic driving each of them. But the alternative, a strictly thematic organization, would involve far too much boring repetition of the basic milestones and turning points of his life.

My solution to the writing challenge was to associate each of the major themes with a particular period in Fischer's life, the period when he made the most substantial progress on the theme in question, and then to use flashback and foreshadowing to tell the story of how Fischer came to be interested in that theme and where that interest ultimately took him. The goal was to make each chapter into a more or less self-contained unit, focused on the story of a single dimension of Black's larger project. (Teachers considering classroom adoption take note. You don't have to assign the whole book. If you just want to cut to the big idea, or if you want to regain your understanding of that big idea after drinking from the fire hose that is the rest of the book, I suggest pages 93 to 98 where the essentials of Fischer's interpretation of CAPM are laid out, and pages 286 to 291 on the deeper philosophical bases of that interpretation.)

Groups of chapters then function to bring major dimensions of the larger story into focus. Chapters 2 to 5, which cover Fischer's life before he became an academic, are about the core ideas of modern finance. Chapters 9 to 11, which cover Fischer's life after he left academia, are about the core institutional changes of modern finance. Together these sections tell a story of coevolution, of ideas and institutions, that transformed the world. Chapters 6 to 8, which cover Fischer's academic years, are about how that transformation challenged traditional ideas and institutions, themselves a product of the traumatic years of Depression and World War. These middle chapters are about the challenge that finance posed to economics, and in particular to macroeconomics, a challenge that continues to this day.

Perry Mehrling

■ Prologue ■

THE PRICE OF RISK

Preferring a search for objective reality over revelation is another way of satisfying religious hunger. . . . It aims to save the spirit, not by surrender but by liberation of the human mind. Its central tenet, as Einstein knew, is the unification of knowledge. When we have unified enough certain knowledge, we will understand who we are and why we are here.

Edward O. Wilson, *Consilience* (1998, p. 7)

On Wednesday, September 24, 1997, Jack Treynor flew into Boston on the red-eye from California, where he ran his own small money management business. The weather was sunny but only in the 50s, and a gusty northwest wind made it feel colder. Treynor's destination that morning was the annual conference of the International Association of Financial Engineers (IAFE), already under way downtown at the Park Plaza Hotel, just a block from the Boston Common. He was flying in for the day to give a talk at lunch about his old friend Fischer Black, who had died two years before (only 57 years old) shortly after receiving the association's highest honor, Financial Engineer of the Year.

Unbeknownst to Treynor, Paul Samuelson, the Nobel Prize–winning economist from the Massachusetts Institute of Technology (MIT) across the river in Cambridge, had been the featured speaker at the Monday dinner that opened the conference. In anticipation of the October announcement of that year's Nobel Prize, Samuelson had offered his own "Hall of Fame of Theoretical Finance," in which he suggested that the time was overdue for recognition of the work of Fischer Black, Myron

Scholes, and especially his own student Robert Merton. He planned to conclude with the words: "If the modern corpus of financial engineering came into existence in any one instant, by my vote that instant was when Merton constructed the boundary-value solutions to the partial-differential equations of continuously diffusing Bachelier probabilities."[1] The reference was to Merton's 1973 paper "Theory of Rational Option Pricing," published in the same year as "The Pricing of Options and Corporate Liabilities" by Black and Scholes. Both papers contained the option pricing formula that everyone in the industry had come to know colloquially as "Black-Scholes."

But Samuelson got only halfway through his speech before there was an interruption from the floor. He had been listing names on a flip chart, starting with Louis Bachelier, an obscure turn-of-the-century French mathematician who had anticipated the line that Merton would later follow, but including along the way other greats whose contributions had followed different lines. The talk was going fine until he reached 1964 and wrote "John Lintner and William Sharpe: independent innovators." The innovation in question was the capital asset pricing model (CAPM), for which Sharpe had been awarded the Nobel Prize in 1990. Samuelson's next entry would have been for Black, Scholes, and Merton, but there was a voice from the audience. "What about Treynor? You forgot Treynor!"

It was Franco Modigliani, Samuelson's Nobel-winning colleague at MIT, rising unsteadily to his feet to spoil the punch line, and he was rising from Samuelson's own chair! He had come in after Samuelson was already under way and sat in the only empty place he could find. Hard of hearing as he was, and having forgotten his hearing aid, he could well have mistaken what Samuelson was saying. But there could be no mistake about what Samuelson had written on the flip chart, and Modigliani had good reason to be sensitive about it. He knew that Treynor had developed his own version of the capital asset pricing model, and even before Sharpe or Lintner, because Treynor had shown it to him. At the time, Modigliani had not recognized its importance because it seemed to him too simple. But in retrospect Treynor had been right, and forever after Modigliani felt badly that he had not encouraged Treynor more strongly.

Suddenly the after-dinner entertainment got very interesting. Here were two Nobelists, both well past normal retirement age, going at it