

**WHY CONFUSING ILLUSION WITH
REALITY CAN LEAD TO DISASTER,
ON WALL STREET AND IN LIFE**



**MODELS.
BEHAVING.
BADLY.**

EMANUEL DERMAN

Author of My Life as a Quant: Reflections on Physics and Finance

PRAISE FOR **MODELS.BEHAVING.BADLY.**

"Emanuel Derman has written my kind of book, an elegant combination of memoir, confession, essay on ethics, philosophy of science, and professional practice. He convincingly establishes the difference between model and theory and shows why attempts to model financial markets can never be genuinely scientific. It vindicates those of us who hold that financial modeling is neither practical nor scientific. Exceedingly readable." —**NASSIM N. TALEB, author of *The Black Swan***

"This is a compelling, accessible, and provocative piece of work that forces us to question many of our assumptions. As Derman explains so clearly, models are not 'bad' in themselves; on the contrary, they are crucial for modern society. However, they have been used in a dangerously sloppy and careless way, with sometimes terrible results. Derman explains this clearly and draws heavily on his own lifetime experience—ranging from growing up in apartheid South Africa to working in the scientific field and then as a financial engineer on Wall Street—to provide a moving and fascinating set of illustrations of these principles. The conclusion is unexpectedly optimistic—if people choose to listen."

—**GILLIAN TETT, author of *Fool's Gold***

"An engaging and personal meditation on the limitations of our ability to predict the future, especially—but not only—in the context of financial markets. He is not interested in blame or politics, but in the deeper lessons to be drawn from the financial crisis. As a physicist who was also highly placed in the financial world, he explains clearly the difference between prediction and advice, theory and model, and knowledge and wisdom."

—**LEE SMOLIN, senior researcher at Perimeter Institute for Theoretical Physics; author of *The Trouble with Physics*, *The Life of the Cosmos*, and *Three Roads to Quantum Gravity***

"If you don't want your models to behave badly, you should study carefully these words of wisdom on the philosophy of quantitative modeling. Emanuel Derman has always been one of the most respected quants on Wall Street. Now he has proven that he is also one of the most thoughtful. Though in the sequel he should tell us what happened to the large man over the Sudan!"

—**CLIFFORD S. ASNESS, PHD, managing and founding principal, AQR Capital Management**

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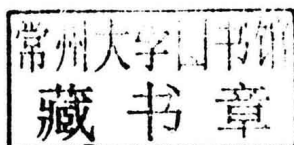
DERMAN



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Can Lead to Disaster, on Wall Street and in Life

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ALSO BY EMANUEL DERMAN

My Life as a Quant: Reflections on Physics and Finance

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MODELS.BEHAVING.BADLY.

I. MODELS

CHAPTER 1

A FOOLISH CONSISTENCY

Models that failed • Capitalism and the great financial crisis • Divining the future via models, theories, and intuition • Time causes desire • Disappointment is inevitable • To be disappointed requires time, desire, and a model • Living under apartheid • Growing up in “the movement” •

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Pragmatism always beats principles. . . . Comedy is what you get when principles bump into reality.

—J. M. Coetzee, *Summertime*

MODELS THAT FAILED I: ECONOMICS

“All that is solid melts into air, all that is holy is profaned, and man is at last compelled to face, with sober senses, his real conditions of life, and his relations with his kind,” wrote Marx and Engels in *The Communist Manifesto* in 1848. They were referring to modern capitalism, a way of life in which all the standards of the past are supposedly subservient to the goal of efficient, timely production.

With the phrase “melts into air” Marx and Engels were evoking sublimation, the chemists’ name for the process by which a solid transmutes directly into a gas without passing through an intermedi-

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ate liquid phase. They used sublimation as a metaphor to describe the way capitalism's endless urge for new sources of profits results in the destruction of traditional values. Solid-to-vapor is an apt summary of the evanescence of value, financial and ethical, that has taken place throughout the great and ongoing financial crisis that commenced in 2007.

The United States, the global evangelist for the benefits of creative destruction, has favored its own church. When governments of emerging markets complained that foreign investors were fearfully yanking capital from their markets during the Asian financial crisis of 1997, liberal democrats in the West told them that this was the way free markets worked. Now we prop up our own markets because it suits us to do so.

The great financial crisis has been marked by the failure of models both qualitative and quantitative. During the past two decades the United States has suffered the decline of manufacturing; the ballooning of the financial sector; that sector's capture of the regulatory system; ceaseless stimulus whenever the economy has wavered; taxpayer-funded bailouts of large capitalist corporations; crony capitalism; private profits and public losses; the redemption of the rich and powerful by the poor and weak; companies that shorted stock for a living being legally protected from the shorting of their own stock; compromised yet unpunished ratings agencies; government policies that tried to cure insolvency by branding it as illiquidity; and, on the quantitative side, the widespread use of obviously poor quantitative security valuation models for the purpose of marketing.

People and models and theories have been behaving badly, and there has been a frantic attempt to prevent loss, to restore the status quo ante at all costs.

THEORIES, MODELS, AND INTUITION

For better or worse, humans worry about what's ahead. Deep inside, everyone recognizes that the purpose of building models and creating theories is divination: foretelling the future, and controlling it.

When I began to study physics at university and first experienced the joy and power of using my mind to understand matter, I was fatally attracted. I spent the first part of my professional life doing research in elementary particle physics, a field whose theories are capable of making predictions so accurate as to defy belief. I spent the second part as a professional analyst and participant in financial markets, a field in which sophisticated but often ill-founded models abound. And all the while I observed myself and the people around me and the assumptions we made in dealing with our lives.

What makes a model or theory good or bad? In physics it's fairly easy to tell the crackpots from the experts by the content of their writings, without having to know their academic pedigrees. In finance it's not easy at all. Sometimes it looks as though anything goes. Anyone who intends to rely on theories or models must first understand how they work and what their limits are. Yet few people have the practical experience to understand those limits or whence they originate. In the wake of the financial crisis naïve extremists want to do away with financial models completely, imagining that humans can proceed on purely empirical grounds. Conversely, naïve idealists pin their faith on the belief that somewhere just offstage there is a model that will capture the nuances of markets, a model that will do away with the need for common sense. The truth is somewhere in between.

In this book I will argue that there are three distinct ways of understanding the world: theories, models, and intuition. This book is

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about these modes and the distinctions and overlaps between them. Widespread shock at the failure of quantitative models in the mortgage crisis of 2007 results from a misunderstanding of the difference between models and theories. Though their syntax is often similar, their semantics is very different.

Theories are attempts to discover the principles that drive the world; they need confirmation, but no justification for their existence. Theories describe and deal with the world on its own terms and must stand on their own two feet. *Models* stand on someone else's feet. They are metaphors that compare the object of their attention to something else that it resembles. Resemblance is always partial, and so models necessarily simplify things and reduce the dimensions of the world. Models try to squeeze the blooming, buzzing confusion into a miniature Joseph Cornell box, and then, if it more or less fits, assume that the box is the world itself. In a nutshell, theories tell you what something is; models tell you merely what something is like.

Intuition is more comprehensive. It unifies the subject with the object, the understander with the understood, the archer with the bow. Intuition isn't easy to come by, but is the result of arduous struggle.

What can we reasonably expect from theories and models, and why? This book explains why some theories behave astonishingly well, while some models behave very badly, and it suggests methods for coping with this bad behavior.

OF TIME AND DESIRE

In "Ducks' Ditty," the little song composed by Rat in Kenneth Grahame's *The Wind in the Willows*, Rat sings of the ducks' carefree pond life:

Everyone for what he likes!
We like to be