Policy Analysis
No. 470 February 20, 2003

Empire of the Sun
An Economic Interpretation of Enron's Energy Business

by Christopher L. Culp and Steve H. Hanke

Executive Summary

The collapse of Enron Corporation has been portrayed as the result of accounting fraud and greed. Not everything that Enron did, however, was wrong or fraudulent. Fraud contributed to the timing of Enron's failure but was not the root cause of that failure. In analyzing Enron, it is critically important to distinguish what Enron did wrong from what it did right.

Enron's basic business strategy, known as "asset lite," was legitimate and quite beneficial for the marketplace and consumers. By combining a small investment in a capital-intensive industry such as energy with a derivatives-trading operation and a market-making overlay for that market, Enron was able to transform itself from a small, regional energy market operator into one of America's largest companies.

Enron contributed to the creation of the natural gas derivatives market, and, for a while, it was the sole market maker, entering into price risk management contracts with all other market participants. Its physical market presence, as a wholesale merchant of natural gas and electricity, placed the Houston-based company in an ideal position to discover and transmit to the market relevant knowledge of energy markets and to make those markets more efficient.

When Enron applied that same strategy in other markets in which it had no comparative informational advantage or deviated from the asset-lite strategy, it had to incur significant costs to create the physical market presence required to rectify its relative lack of market information. The absence of a financial market overlay in several of those markets further prevented Enron from recovering its costs. It was at that point that Enron abused accounting and disclosure policies to hide debt and cover up the fact that its business model did not work in those other areas.

For its innovations, Enron should be commended; for their alleged illegal activities, Enron's managers should be prosecuted to the full extent of the law. But under no circumstance should Enron's failure be used as an excuse to enact policies and regulations aimed at eliminating risk taking and economic failure, because unless a firm takes the risk of failure, it will never earn the premium of success. As was demonstrated in the case of Enron, markets—not politicians—are the best judges of success and failure.

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Introduction

By the time the Enron Corporation filed for Chapter 11 bankruptcy protection on December 2, 2001, virtually everyone with a television set knew that things were not as they had once seemed in Houston. How could a company go from a market capitalization of more than $100 billion and being ranked fifth in the *Fortune 500* list to bust within two years? How could a stock that had seen highs of nearly $90 per share become a penny stock in record time? How could the six-time consecutive winner (1996–2001) of *Fortune*'s "most innovative company in the United States" have engineered its own financial destruction? *And more important, what can be done to make sure this never happens again?*

One must be careful, however, when defining "this" in the phrase "make sure this never happens again." Not everything Enron ever did, after all, was illegal, unethical, or even questionable. In fact, what actually caused Enron to fail is still subject to contentious debate. It is clear, however, that Enron did not fail because it was engaged in commercial and merchant commodity businesses.[1] Nor did a "rogue trader" or Enron's use of creative and sometimes-complex financial contracts bring Enron to its knees. Nor, finally, did Enron's corrupt financial activities—concealing its true indebtedness, lining the pockets of select senior managers at the expense of shareholders, hiding major losses, and the like—cause Enron to fail.[2] Enron's financial deception undoubtedly allowed it to remain in business longer than an otherwise similar firm engaged in accurate financial disclosures might have, but that is a question of timing alone and not causality.

This paper argues that Enron's ultimate financial failure most likely occurred for the very same reason that WorldCom, Global Crossing, and many other firms periodically have gone bankrupt or run into trouble. In short, those firms all lacked the ability to identify their true comparative advantage. In some cases that meant Enron overinvested in new markets and technologies that never took off; in other cases it simply meant that the company overestimated the value that it could add. But is *that* something that new policies and regulations should strive to ensure "never happens again"? Or, as argued in this study, is this aspect of Enron's failure simply a testimonial to the fact that competitive markets are effective judges of success and failure?

This study begins with an overview of Enron to stress that it was first and foremost an energy business that employed an innovative "asset-lite" strategy that accounted for many of its genuinely successful years. A discussion of those businesses in which Enron failed follows because it is in those areas where Enron departed from the successful asset-lite strategy employed in the energy business. The next section formally frames Enron's asset-lite strategy in the context of competitive economic theory. Standard "neoclassical" economic models do not explain firms such as Enron, and consequently a more "disequilibrium-oriented," or "neo-Austrian," approach is required. The paper concludes by considering whether Enron's failure *as a business* either offers lessons for other firms or provides a proscriptive case for greater regulation.

Neoclassical vs. Neo-Austrian Economic Theory

In addition to providing an analysis of Enron's business strategy through the lens of economic theory, this study illustrates the limitations of the traditional neoclassical theory of the price system for explaining entrepreneurship and innovation—terms that, despite Enron's illegal and fraudulent activities in some areas, nevertheless do describe that company in other areas. The neoclassical perspective views markets as existing in a stationary state in which the relevant knowledge about demand and supply is known; market prices are static, or given; and data are available to be used by individuals and firms. In this world without change,

there is no need to ask how that stationary state came about. That knowledge simply falls into the category of irrelevant bygones.

Neoclassical economics does, of course, also deal with change. It does so by employing comparative statics. For example, we can conceive of a quasi-stationary state in which changes in the relevant knowledge in a market are few and far between, and analysis of the full repercussions is dealt with by evaluating and comparing the stationary states before and after changes in relevant knowledge occur. In the neoclassical world, prices act as signposts, guiding consumers to substitute goods for one another and producers to learn which lines of production to abandon or toward which to turn. In this neoclassical conception, the price system acts as a network of communication in which relevant knowledge is transmitted at once throughout markets that jump from one stationary state to the next.

In the neo-Austrian, or disequilibrium-oriented, context, by contrast, the market is viewed as a process that is in a constant state of flux.[3] In consequence, there are no stationary or quasi-stationary states. Indeed, expectations about the current and future state of affairs are always changing because the state of relevant knowledge is always changing. And with changing expectations, market prices are also changing. In consequence, the price system functions as a network for communicating all relevant knowledge. It is also a discovery process that is in continuous motion, working toward creating unity and coherence in the economic system. The speed of adjustment and of the dissemination of knowledge in the price system depends on the scope and scale of the markets, however.

As it relates to the discussion here, the full force of market integration is realized when both spot and forward markets exist. Indeed, the function of forward, or derivatives, markets is to spread relevant knowledge now about what market participants think the future will be. Forward markets connect and integrate those expectations about the future with the present in a consistent manner.[4] Although the future will always remain uncertain, it is possible for individuals to acquire information about the expected future and to adjust their plans accordingly. In addition, they can—via forward markets—express their views about the future by either buying or selling forward. Forward markets, then, bring expectations about the future into consistency with each other and also bring forward prices into consistency with spot prices, with the difference being turned into "the basis."

In a neo-Austrian world, relevant knowledge and expectations are in a constant state of flux. And not surprisingly, spot and forward prices, as well as their difference (the basis), are constantly changing, too. Individuals' ever-changing expectations, therefore, keep the market process in motion. In consequence, disequilibrium is a hallmark of the neo-Austrian orientation. While the neo-Austrian market process is in a constant state of flux, it is working toward integrating and making consistent both spot and forward prices.[5]

As the analysis in this paper will demonstrate, the explicit incorporation of neo-Austrian variables such as time, knowledge, and market process into the traditional price-theoretic framework for microeconomic analysis is fundamental to understanding fully the financial and commercial market strategies of a company such as Enron.

Enron's Energy Business

Understanding Enron's business model for its core activities requires a brief explanation of how commodity markets function. The usefulness of many physical commodities to producers (e.g., wheat that can be milled into flour) and consumers (e.g., bread) depends on the "supply chain" through which the commodity is transformed from its raw, natural state into something of practical use. Figure 1 shows a typical supply chain for a variety of commodities.

When a commodity moves from one part

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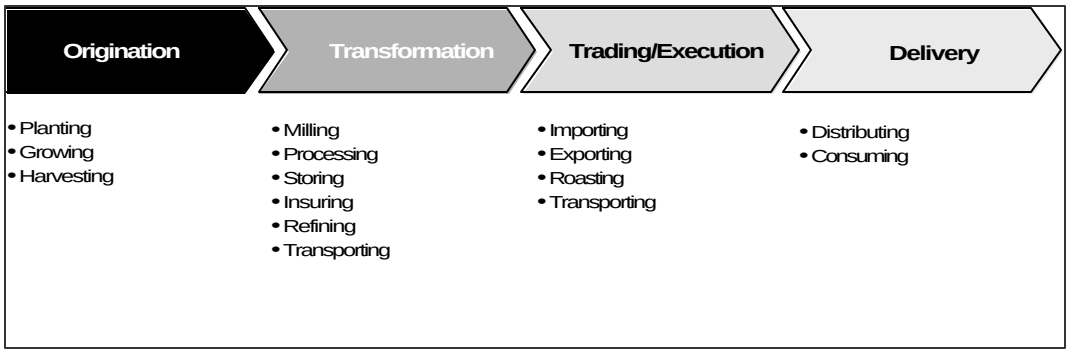
Figure 1
The Supply Chain



of the supply chain to the next, transportation, distribution, and delivery services are almost always involved. Those services are the glue that keeps the supply chain linked. To put it simply, Enron was a firm that specialized in those transportation, distribution, and transformation services—often called "intermediate supply chain," or "midstream," services. Accordingly, Enron acted as a wholesale merchant. It acquired the latest information about alternative sources of supply and set prices for goods in a process that would maximize Enron's turnover. Enron was therefore an ideal vehicle for the discovery and transmission of relevant knowledge.

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In its *2000 Annual Report,* Enron described itself as "a firm that manages efficient, flexible networks to reliably deliver physical products at predictable prices."[6] This involved four core business areas for the firm: wholesale services, energy services, broadband services, and transportation services.

Enron Wholesale Services was by far the largest—and generally the most profitable—operation of Enron Corp. The bulk of that business involved the transportation, transmission, and distribution of natural gas and electricity. On a volume basis, Enron accounted for more than twice the amount of gas and power delivery of its next-largest competitor in the United States.[7] In addition, Enron maintained an active (and, in several cases, growing) market presence in the supply chains for other commodities, including coal, crude oil, liquefied natural gas, metals, steel, and pulp and paper. Enron Wholesale Services' customers were generally other large producers and industrial firms.

Enron Energy Services dealt mainly at the retail end of the energy market supply chains. Enron Wholesale Services' operation might deliver electrical power to a utility, for example, whereas Enron Energy Services might contract directly with a large grocery store chain to supply their power directly.

Enron Broadband was focused on the nonenergy business of broadband services, or the use of fiber optics to transmit audio and video. Capacity on fiber-optic cables is known as "bandwidth." Enron Broadband had three business goals. The first was to deploy the largest open global broadband network in the world, called the Enron Intelligent Network and consisting of 18,000 miles of fiber-optic cable. The second commercial objective in broadband was for Enron to dominate the market for buying and selling bandwidth. Finally, Enron sought to become a dominant provider of premium content, mainly through streaming audio and video over the worldwide web.

Enron's fourth operating division was Enron Transportation Services, formerly the Gas Pipeline Group. Enron Transportation Services concentrated on operating interstate pipelines for the transportation of natural

gas, long a core competency of Enron. Albeit highly specialized and narrowly focused, gas transportation was perhaps the core brick on which the Enron Corp. foundation was laid.

The Houston Natural Gas Production Company was founded in 1953 as a subsidiary of Houston Natural Gas to explore, drill, and transport gas. From 1953 to 1985, the firm underwent a slow but steady expansion, respectably keeping pace with the gradual development of the gas market.

Natural gas was deregulated in the late 1980s and early 1990s. During that time, supplies increased substantially, and prices fell by more than 50 percent from 1985 to 1991 alone. As competition increased, the number of new entrants into various parts of the natural gas supply chain grew dramatically, and many existing firms restructured.

One such restructuring was the acquisition in 1985 of HNG by InterNorth, Inc. The takeover of HNG was largely the brainchild of Kenneth Lay, who had joined HNG as its CEO in 1984. Working closely with Michael Milken, Lay helped structure the InterNorth purchase of HNG as a leveraged buyout relying heavily on junk-bond finance.[8] Lay wrested the position of CEO of the merged firm from InterNorth CEO Samuel Segnar in 1985.

In 1986 InterNorth changed its name to Enron Corporation and incorporated Enron Oil & Gas Company, reflecting its expansion into oil markets to supplement its gas market presence. By then, most firms active in oil markets were also involved in gas—and conversely—given complementarities in exploration, drilling, pumping, distribution, and the like. With the exception of a brief hiatus toward the end, Kenneth Lay remained CEO of Enron Corp. until the firm failed.[9]

In 1985 the Federal Energy Regulatory Commission allowed "open access" to gas pipelines for the first time. In consequence, Enron was able to charge other firms for using Enron pipelines to transport gas, and, similarly, Enron was able to transport gas through other companies' pipelines.

Around that time, Jeffrey Skilling, then a consultant for McKinsey, began working at Enron. He was charged with developing a creative strategy to help Enron—recall, it had just been created through the InterNorth-HNG merger—leverage its presence in the emerging gas market. Skilling argued that the benefits of open access might well be more than offset by the decline in revenues associated with the general decline in prices and margins that greater competition would bring. Add to that Enron's mountain of debt, and Skilling maintained that Enron would not last very long unless a creative solution was identified.

Skilling argued, in particular, that natural gas would never be a serious source of revenues for the firm as long as natural gas was traded exclusively in a "spot" physical market for immediate delivery. Instead, he argued that a key success driver in the coming era of post-deregulation price volatility would be the development of a "derivatives market" in gas in which Enron would provide its customers with various price risk management solutions—forward contracts in which consumers could control their price risk by purchasing gas today at a fixed price for future delivery, and option contracts that allowed customers the right but not obligation to purchase or sell gas at a fixed price in the future.

Viewed from a neo-Austrian perspective, Skilling was functioning as a classic entrepreneur. Once FERC changed the rules of the game and natural gas became deregulated, Skilling spotted an entrepreneurial opportunity, literally, to develop new forward markets. Once forward markets were introduced, individuals could acquire information and knowledge about the future and express their own expectations by either buying or selling forward. Moreover, with both spot and futures prices revealed, "the basis"—the difference between spot and futures prices—could be revealed, and a more unified and coherently integrated natural gas "market" could be created. Although such a new setup would not eliminate risk and uncertainty, it promised to allow much more relevant knowledge to be discovered and disseminated, allowing firms to adjust their expecta-

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tions and plans accordingly and to manage their risk more effectively.[10]

To create that market in natural gas derivatives, Skilling urged Enron set up a "gas bank." Much as traditional banks intermediate funds, Enron's GasBank intermediated gas purchases, sales, and deliveries by entering into long-term, fixed-price delivery and price risk management contracts with customers. Soon thereafter, other natural gas firms began to offer clients similar risk management solutions. And those producers, in turn, also came to Enron for their risk management needs—that is, to "swap" the exposure to falling prices they created by offering fixed-price forwards to customers back into the "natural" exposure to price increases those producers had before offering their customers fixed-price protection.

Enron acted as a classic market maker, standing ready to enter into natural gas derivatives on "both sides of the market"—that is, both buying and selling gas (or, equivalently, buying and selling at both fixed and floating prices or swapping one for the other). Enron thus became the primary supplier of liquidity to the market, earning the spread between bid and offer prices as a fee for providing the market with liquidity. And in a broader sense, Enron was functioning to spread knowledge about what market participants expected prices to be.

Did that mean Enron was exposed to *all* of the price risks that its trading counterparties were attempting to avoid? No. Many of the contracts into which Enron entered naturally offset one another. True, a consumer seeking to lock in its future energy purchase price with Enron would create a risk exposure for Enron. If prices rose above the fixed price at which Enron agreed to sell energy to a consumer, Enron could lose big money. But that might be offset by a risk exposure to *falling* prices that Enron would assume by agreeing to *buy* that same asset from a producer at a fixed price, thus allowing the producer to hedge its own price risk.[11] Enron was left only with the *residual* risk across all its customer positions in its GasBank, which, in turn, Enron could manage by using derivatives with other emerging market makers, generally known as "swap dealers," or on organized futures exchanges such as the New York Mercantile Exchange.[12]

For a long time, Enron was not merely a market maker for natural gas derivatives—it was *the* market maker. Having virtually created the market, Enron enjoyed wider spreads, higher margins, and more revenues as the sole real liquidity supplier to the market. But that also meant few counterparties existed with which Enron could hedge its own residual risks.

Here is where Enron's physical market presence comes back into the picture. In addition to allowing Enron to discover and reveal a great deal of "local" knowledge, Enron's presence in the physical market meant that it could control some of the residual price risks from its market-making operations. That could be accomplished because of *offsetting positions in its physical pipeline and gas operations.* Consider, for example, a firm that is buying natural gas in Tulsa, Oklahoma, from a pipeline with a supply source in San Angelo, Texas. If that firm seeks to lock in its future purchase price for gas to protect against unexpected price spikes, it might enter into a forward purchase agreement with Enron, thus leaving Enron to bear the risk of a price increase. But if Enron also *owns the pipeline* and charges a price for distribution proportional to the spot price of gas, then the net effect will be roughly offsetting.

Operating that kind of a gas bank also gave Enron very valuable information about the gas market itself. Knowing from its pipeline operations that congestion was likely to occur at Point A, for example, Enron could anticipate price spikes at delivery points beyond Point A arising from the squeeze in available pipeline capacity. And Enron could very successfully "trade around" such congestion points. Conversely, when prices in derivatives markets signaled surplus or deficit pipeline capacity in the financial market, Enron could stand ready to exploit that information in the physical market.

Gradually, thanks to Enron's role as market maker, the natural gas derivatives market became increasingly standardized and liquid. Accordingly, relevant knowledge was spread more rapidly and the natural gas market became more integrated and coherent. Enron still offered customized solutions to certain consumers and producers, but much of the volume of the market shifted to exchanges like the NYMEX that began to provide standardized gas futures. Nevertheless, Enron's role as dominant market maker left the GasBank well placed to profit from supplying liquidity to those standardized markets, as well as from retaining much of the custom over-the-counter derivatives-dealing business.

The Enron GasBank division eventually became Enron Gas Services, and later Enron Capital and Trade Resources. In 1990 Jeff Skilling left McKinsey to become a full-time Enron employee, and he later became CEO of both EGS and EC&TR. In early 2001 Skilling replaced Lay as CEO of the whole firm, marking the only time in the history of Enron that Lay was not at the helm.

Asset Lite as a More General Business Strategy

When Skilling formally joined Enron in 1990, he maintained that the future success of the firm would be in repeating the GasBank experience in other markets. To accomplish that, Skilling developed a business concept known as "asset lite" in which Enron would combine small investments in capital-intensive commodity markets with a derivatives-trading and market-making "overlay" for those markets. The idea was to begin with a small capital expenditure that was used to acquire portions of assets and establish a presence in the physical market. That allowed Enron to learn the operational features of the market and to collect information about factors that might affect market price dynamics. Then, Enron would create a new financial market overlaid on top of that underlying physical market presence—a market in which Enron would act as market maker and liquidity supplier to meet other firms' risk management needs. As Skilling described it: "[Enron] is a company that makes markets. We create the market, and once it's created, we make the market."[13] Needless to say, that encapsulates the essence of one of the central roles of an Austrian entrepreneur.

One reason for the appeal of asset lite was that it enabled Enron to exploit some presence in the physical market without incurring huge capital expenditures on bulk fixed investments. Enron quickly discovered that this was best accomplished by focusing on investing in *intermediate* assets in commodity supply chains. In natural gas, this meant that Enron could get the biggest bang for its buck in midstream activities such as transportation, pipeline compression, storage, and distribution. In fact, Enron's Transwestern Pipeline Company eventually became the first U.S. pipeline that was exclusively for transportation, neither pumping gas at the wellhead nor selling it to customers.[14]

Other markets in which Enron applied its asset-lite business expansion strategy with a large degree of success included coal, fossil fuels, and, to some extent, pulp and paper. But after its successful experience with gas, Enron remained much more interested in markets that were being deregulated. Electricity thus became a major focus of the firm in the mid-1990s and was a key success driver for Enron.[15]

Oil and Water Do Not Mix

Throughout its history, Enron's consistent financial and market successes occurred in the energy sector. On more than one occasion, however, Enron tried to expand its business outside the energy area, albeit rarely with any success.

Asset Heavy at Enron International

When it became clear that Kenneth Lay was preparing to turn over the reins in the latter half of the 1990s, an extremely contentious struggle for the leadership of Enron ensued.[16]

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That occurred in no small part because of the success of Enron GasBank and the power-marketing operations of EC&TR. When the dust settled, Lay named EC&TR CEO and asset-lite inventor Jeff Skilling as the new CEO of Enron Corp. in February 2001. That Skilling would rise to this level, however, was not at all a foregone conclusion. Right up to the announcement date, debates over whose shoulder Kenneth Lay would tap were popular coffee shop banter. Skilling's chief competitor was Rebecca Mark.

In 1993 Mark prevailed upon Lay to establish Enron International, of which she became the first president. Mark did not adhere to an asset-lite strategy. Instead, she pursued an "asset-heavy" strategy of attempting to acquire or develop large capital-intensive projects *for their own sake*. In other words, there was no financial-trading activity overlay component for most of her initiatives. She tried instead to identify projects whose revenues promised to be sizable based purely on the capital investment component with no need for a market maker component. Unlike asset lite, that did not prove to be an area in which Enron Corp. had much comparative advantage.

Water-Trading Rights

The EI operations delved into the asset-heavy water-supply industry. At least here there was some pretense of eventually developing a "water rights trading market," but that possibility was so far down the road that the firm's water investments have to be regarded as largely self-contained capital projects, the largest of which was Azurix and its Wessex Water initiative.

In 1998 Enron spun off the water company Azurix. Enron retained a major interest in the firm, which focused its efforts on water markets in a single purchase—the British firm Wessex Water, for which Enron paid about $1.9 billion. But in this case, deregulation did not help Enron. There was no market-making function and no trading overlay—there was only a British water company serving a market with plummeting prices. (That experience also underscores the fundamentally correct view that Skilling advanced when he was still at McKinsey—namely, that expanding in a deregulating market makes little sense if you are limited to selling a commodity whose price is falling sharply in the spot markets.)

At the same time that the falling prices caused by deregulation in Britain were eating away Wessex's margins, Azurix itself was hit with staggering losses on several of its other operations, mainly in Argentina. In light of that failure, as well as the spectacular failure of EI's Dhabhol, India, power plant project, which may have cost Enron as much as $4 billion, Mark resigned as CEO of Enron International in the summer of 2000. Enron eventually sold Wessex in 2002, about three years after financing its acquisition by Azurix, to a Malaysian firm for $777 million, or $1.1 billion less than it paid for the firm.[17]

The Broadband Black Hole

Like its forays into the water industry, Enron's broadband efforts were plagued with problems from the start. In gas and power markets, Enron acquired its physical market presence by investing in assets sold mainly by would-be competing energy companies. It then used those investments to help create and develop a financial market, the growth of which, in turn, helped *increase* the value of Enron's physical investments. But that increase did not come at the expense of Enron's competitors, which in turn were benefiting from the new price risk management market. In broadband technologies, by contrast, Enron's asset-lite effort required the firm to acquire assets not just from competitors but from the *inventors* of the technology. Even then, Enron was paying for a technology that was essentially untested with no guarantee that the "emerging" bandwidth market would bolster asset values. Enron therefore had to pay dearly to acquire a market presence from firms that viewed Enron's effort not as a constructive market-making move but as essentially an intrusive one.

Several other drags on Enron's broadband

expansion efforts contributed to its ultimate failure. One was that demand for the technology failed to materialize as expected. Enron is also alleged to have been using the "bandwidth market" to mislead investors—and possibly certain senior managers and directors—about its losses on underlying broadband technologies. On the one hand, Enron was optimistic about the eventual success of the broadband strategy; it "pointed at" significant trading in the bandwidth market. On the other hand, few other market participants observed any appreciable trading activity, and Enron was openly disclosing millions of dollars of losses on its quarterly and annual reports on its broadband efforts. Much of that "market activity" now seems to have come from Enron's "wash," or "roundtrip," trades or transactions in which Enron was essentially trading with itself.[18] To take a simple example, a purchase and sale of the same contract within a one- or two-minute period of time in which prices have not changed will show up as "volume," but the transactions wash out and amount to no real bottom-line profits.

In addition to apparently using wash trades to exaggerate the state of the market's development, Enron was also alleged to have used some of its bandwidth derivatives for "manufacturing" exaggeratedly high valuations for its technological assets. Specifically, Enron and Qwest are under investigation for engaging in transactions with one another that are alleged to have been designed specifically to create artificial mark-to-market valuations. Enron and Qwest engaged in a $500 million bandwidth swap negotiated just prior to the end of the 2001 third-quarter financial reporting period. Many observers would argue that Enron and Qwest were swapping one worthless thing for another worthless thing, given the lack of a market for bandwidth and the lack of *interest* in bandwidth. Nevertheless, both firms apparently used the swaps to justify having acquired a much more valuable asset than the one of which they were getting rid. With essentially no "market," no market prices were available for evaluating the validity of those claims at the time.

The Economics of Asset Lite and "Basis Trading"

Through its investments in the underlying commodity supply chains, the trading-room "overlay" on the physical markets allowed Enron to generate substantial revenues as a market maker. But that was not the only source of profits associated with the asset-lite strategy of combining physical and financial market positions. Specifically, Enron engaged in significant "basis trading." Understanding what that is and when a company might be able to do it profitably is essential for recognizing the differences between businesses on which Enron "made money" and those on which it did not.

To understand the economics of basis trading (sometimes called spread trading), one must first recognize the important finance proposition that commodity derivatives—contracts for the purchase or sale of a commodity in the future—are economic substitutes for physical market operations.[19] Buying a forward oil purchase contract, for example, is economically equivalent to buying and storing oil.[20] In a competitive equilibrium of the physical and derivatives markets, the forward purchase price—denoted $F(t,T)$ and defined as the fixed price negotiated on date t for the purchase of a commodity to be delivered on later date T—can be expressed using the famed "cost of carry model" as[21]

$$F(t,T) = S(t)[1 + b(t,T)]$$

Where $b(t,T) \equiv r(t,T) + w(t,T) - d(t,T)$

and
- $S(t)$ = time t spot price of the commodity to be delivered at T
- $r(t,T)$ = the interest rate prevailing from t to T
- $w(t,T) \equiv$ the cost of physical storage of the commodity from t to T
- $d(t,T)$ = the benefit of holding the commodity from t to T

such that w and d are expressed as a proportion of $S(t)$ and are denominated in time T dollars.

The term $b(t,T)$—the "basis"— is also often called the "net cost of carry," to convey the

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fact that its three components together make up the cost of "carrying" the commodity across time and space to the delivery location on future date T. The term $d(t,T)$ that reflects the benefit of physical storage is called the "convenience yield," a concept developed by John Maynard Keynes, Nicholas Kaldor, Holbrook Working, Michael J. Brennan, and Lester G. Telser.[22] The convenience yield is driven mainly by what Working calls the "precautionary demand for storage," or concerns by firms that unanticipated shocks to demand or supply could precipitate a costly inventory depletion.[23] Airlines store fuel at different airports, for example, to avoid the huge costs of grounding their local fleets in the case of a jet fuel outage. Gas pipeline owners store gas to help ensure that there is always an adequate supply of gas in the lines to maintain the flow and avoid a shutdown.

Keynes, Working, and others have observed how the "supply of storage" (i.e., the amount of a commodity in physical storage) is related to the convenience yield and, by extension, to the "term structure of futures prices."[24] That relation defines the economic linkage between derivatives, physical asset markets, and the allocation of physical supplies across time. Specifically, the supply of storage is directly related to the premium placed on selling inventory *in the future* relative to selling spot *today*. When inventories are high, the *relative* premium that a commodity commands in the future vis-à-vis the present is reasonably small; plenty of the commodity is on hand today to assure producers and intermediaries that a stock-out will not occur, leading to a very low convenience yield. As current inventories get smaller, however, the convenience yield rises (at an increasing rate) and the spot price rises relative to the futures price in order to induce producers to take physical product out of inventory and sell it in the current spot market. A high spot price *alone* would not do that. But a high spot price *relative* to the futures price signals the market that inventories are tight *today* relative to the future.

A high spot price *relative* to the futures price signals the market that inventories are tight *today* relative to the future.

We can now see more meaningfully where cost-of-carry pricing comes from. Namely, it is the condition that must hold in equilibrium to make market participants indifferent toward physical storage or "synthetic storage" using forwards or other derivatives. Here's how it works. Suppose a firm borrows $S(t)$ in funds at time t and uses the proceeds to buy a commodity worth $S(t)$. At time T, the firm is holding an asset then worth $S(T)$ and repays the money loan. In the interim, the firm incurs physical storage costs w but earns the convenience yield d. Table 1 shows the net effect of this physical storage operation.

In turn, a short position in a forward contract involves no initial outlay and has a time T value of $F(t,T) - S(\mathrm{T})$. From the last line of Table 1, it should be clear that physical storage plus borrowing can be used to hedge the short forward contract (or vice versa). The net of the hedged position is then just $F(t,T) - S(t)[1+r(t,T) + w(t,T) - d(t,T)]$, all of which is known at time t and thus is riskless. If all market participants are price takers and face identical benefits and costs of storage, cost-of-carry futures pricing thus holds purely through the mechanism of arbitrage.

Because not every firm has the same convenience yield or storage costs, however, commodity forward prices are driven to the cost-of-carry expression instead by the dynamics of a competitive equilibrium.[25] To see how it works, suppose the forward purchase price is

$$F^\circ = S(t)[1+b^\circ(t,T)]$$

where $b^\circ(t,\mathrm{T})$ denotes any arbitrary net cost of carry. All firms for which $S(t)[1+b(t,T)] < F^\circ$ can earn positive economic profits by going short the forward and simultaneously buying and storing the commodity. They will continue to do this until the forward price falls and $S(t)[1+b(t,T)] = F^\circ$. As long as any firm can make positive profits from this operation, the selling will continue, until

$$S(t)[1+b(t,T)] = F^*$$

where $F^* = S(t)[1 + b^*(t,T)]$ and where $b^*(t,T)$ denotes the marginal net cost of carry from t

Table 1
Physical Commodity Storage

	t	T
Money loan		
Borrow dollars	$S(t)$	-
Repay dollars and interest	-	$-S(t)[1+r(t,T)]$
Buy and store the asset		
Buy commodity	$-S(t)$	-
Pay storage costs	-	$-S(t)w(t,T)$
Earn convenience yield	-	$S(t)d\ (t,T)$
Still own the commodity	-	$S(T)$
Net	0	$S(T) - S(t)[1+r(t,T) + w(t,T) - d(t,T)]$

to T for the marginal storer. This marginal entrant earns exactly zero economic profits since its own net cost of carry is equal to b*.

Things work in the other direction for any firms for which $S(t)[1 + b(t,T)] > F°$. Those firms will go long the forward and then engage in a commodity repurchase agreement (i.e., lending the commodity at time t and repurchasing it at time T).[26] Again, entry occurs until $F°$ exactly equals $F*$ and reflects the marginal basis of the marginal storer.

In the short run, the basis $b*$ thus reflects the marginal cost of carrying an incremental unit of the commodity over time. In the long run, $b*$ will also correspond to the minimum point on a traditional U-shaped long-run average-cost curve.[27] Suppose all firms have $b*$ below this minimum long-run average cost. In this case, at least one firm will expand output until the marginal cost rises to the minimum average cost and equals the marginal price of the cost of carry and the new $b*$ will also be reflected in the forward price.

The process by which commodity derivatives and the underlying asset market simultaneously grope toward a competitive equilibrium helps illustrate an important point: namely, the relation between forward and spot prices—the "basis"—is really a "third market" implied by the prices of the two explicit ones.[28] In the example above, the two explicit markets are the spot and forward markets, and the relation between the two implicitly defines *the price of physical storage*. Such "third markets" are also called "basis" or "spread" relations. The implicit market for storage over time is called the "calendar basis or spread," the implicit market for transportation is called the "transportation basis or spread," and so on.

Firms can also use derivatives *based* on *different assets* in order to conduct spread trades to synthesize a third market. Going short crude oil and simultaneously long heating oil and gasoline, for example, is called trading the "crack spread" and is economically equivalent in equilibrium to synthetic refining. Short soybeans and long bean oil and meal are likewise "synthetic crushing." And trading the "spark spread" through a short position in natural gas and a long position in electricity is called "synthetic generation" because the derivatives positions replicate the economic exposure of a gas-fired electric turbine.

Firms can use derivatives based on different assets in order to conduct spread trades to synthesize a third market.

A Neo-Austrian Explanation for Basis Trading

Armed with an understanding of how commodity derivatives are priced in equilib-

The cost of carry reflected in the forward price may or may not be the optimal cost of carry for any given firm at any given time.

rium, we want now to consider the economic rationale for why Enron and firms like it sometimes dedicate substantial resources to "basis trading." We want to recognize what can happen out of *equilibrium*—a state of affairs that typically prevails. Indeed, expectations and relevant knowledge (data) are in a constant state of flux. Accordingly, a neoclassical stationary state—one that treats the data as constant—is of limited use in explaining the market process.[29]

We have seen how equilibrium emerges from the interactions of numerous firms competing to drive prices to their marginal cost. Specifically, suppose b^* reflects the marginal net cost of carry reflected in the prevailing natural gas forward price. This is the price of transportation and delivery in equilibrium. The net cost of carry b^* may only conform to the actual physical and capital costs of carry less the convenience yield for one firm—the marginal entrant into the gas transportation market. Or b^* may be shared by all firms in the short run, but aggregate output may need to adjust in the long run if b^* does not also reflect the minimum average long-run cost of carry. The point is this: the cost of carry reflected in the forward price may or may not be the optimal cost of carry for any given firm at any given time. As is standard in neoclassical microeconomic theory, the price that "clears the market" in the long run will equal the short-run marginal cost for any given firm only by pure coincidence.

Suppose we begin in a situation where b^* is the cost of carry reflected in the forward price and is equal to the short-run marginal costs of all market participants at their production optima. Now consider a new entrant into the market and suppose that new entrant is Enron with its large amount of pipelines and strong economies of scale that lead to a cost of distributing and transporting natural gas at some point in time of $b^e < b^*$, where b^e is Enron's marginal cost of carry. In this case, Enron can physically move gas across time and space at a lower cost than gas can be moved "synthetically" using derivatives.

By going short or selling gas for future delivery using forwards, or futures, Enron is selling gas at an implied net cost of carry of b^*. But its own net cost of carry—a cost that is quite relevant to Enron's ability to move the gas across time and space in order to honor its own future sale obligation created by the forward contract—is less. Accordingly, in *disequilibrium*—or, more properly, on the way to equilibrium—Enron can make a profit equal to the difference between its own net cost of storage and the cost reflected in the market.

The reason that that profit is a short-run profit inconsistent with a long-run equilibrium is that Enron's sale of the forward contract drives the b^* reflected in forward prices closer to b^e. If Enron is the lowest-cost producer and other firms can replicate its production techniques (i.e., Enron owns no unique resources), ultimately b^* will become b^e, which will also eventually approach the long-run minimum average cost of carry. Enron's capacity to earn supranormal profits will vanish in this new equilibrium—in fact, zero economic profits earned by every producer is basically the very meaning of a long-run equilibrium.

Because markets are constantly adjusting to new information, new trading activity, and new entrants, however, it is quite hard to determine when a market actually is in some kind of "final equilibrium resting state," as opposed to when it is adjusting from one state to another. The inevitability of a long-run competitive equilibrium in which profits are not possible thus must be considered relative to the inability of market participants to identify slippery concepts such as "long-run" and "in equilibrium." Strictly speaking, a market is "in equilibrium" as long as supply equals demand. But the term is used here in a more subtle fashion, where "equilibrium" refers to the steady state in which firms earn zero supranormal economic profits in the long run. Accordingly, firms may engage in basis trading to try and exploit the differences in prices reflected in derivatives and their own ability to conduct physical market "pseudoarbitrage" operations that are economically

equivalent to those derivatives transactions.[30]

Now consider a situation in which the market is *always* adjusting and never reaches a long-run competitive equilibrium.[31] In this situation, the tendency is still toward the archetypical neoclassical long-run competitive equilibrium, but we never quite get there. Why not? Certainly economic agents are responding in the manner here described, and their behavior should ultimately lead to a steady-state long-run equilibrium. The only reason it does not is, quite simply, that too much is happening at any given moment to make the leap from "short run" to "long run."

In that situation, all firms are always, by definition, inframarginal in some sense of the term. The kind of "pseudoarbitrage" between physical and synthetic storage described above thus can be expected to occur *quite regularly*. And at least some firms will earn supranormal profits quite regularly. Those profits are not riskless, but at least some firms are sure to be right at least some of the time.

Does that mean that physical and synthetic storage are not really equivalent? Technically, it does. But it was never said otherwise. It was only claimed that the two are equivalent *in equilibrium*. When a market is in disequilibrium, what you actually pay to store a commodity physically may well differ from what you actually pay to store it synthetically. But that is not important.

What is important is that, even if new information and other market activities drive a wedge between $b°$ and $b*$, maximizing decisions by firms *always* lead *toward* the convergence of the two prices of storage. Conversely, the price mechanism *never* sends a signal that will lead maximizing firms to engage in physical or derivatives transactions that drive $b°$ and $b*$ further apart. The very fact that maximizing firms are constantly seeking to exploit differences between $b°$ and $b*$ itself is what gives the theory meaning. That the two might never end up exactly equal is not very relevant because, as explained below, information changes before the long-run equilibrium is ever reached.

Asymmetric Information

Now suppose that the net cost of storage is a random variable about which some firms are better informed than others—for example, the impact of supply or demand shocks on particular locational prices, the impact of pipeline congestion on the transportation basis, and the like. Suppose further that we assume a competitive long-run equilibrium *does* hold. Because of the information asymmetry, a rational expectations equilibrium (REE) in which expected supranormal profits are zero in the long run will result. But *expected by whom?*

In that case, firms such as Enron may engage in basis, or spread, trading in an effort to exploit a perceived comparative informational advantage. If a firm owns physical pipelines, for example, it may have a superior capability for forecasting congestion or regional supply-and-demand shocks. That creates a situation quite similar to a market that is out of or on the way to equilibrium—that is, the net cost of carry that the *firm* observes may be *different* from the net cost of carry market participants expect, given the different information on which the two numbers are based. Just as in the disequilibrium case, firms may engage in basis trading to exploit those differences.

In a traditional REE that type of behavior is akin to inframarginal firms attempting to exploit their storage cost advantage relative to the marginal price of storage reflected in forward markets. And as noted, that cannot go on for very long, because the trading actions of the lower-cost firm eventually lead it to become the marginal entrant, thus driving $b*$ to $b°$ for that firm. The same is true in a REE, where trading *itself* is informative. Every time a well-informed trader attempts to exploit its superior information through a transaction, it reveals that superior information to the market. So, the paradox for the firm with better information is that the firm must either *not trade* based on that information in order to preserve its informational advantage, or it must *give away* its informational advantage while simultaneously trying to exploit it in the short run through trading.

Firms such as Enron may engage in basis, or spread, trading in an effort to exploit a perceived comparative informational advantage.

In a study written with the late Nobel laureate economist Merton H. Miller, one of this paper's authors argues,[32] however, that that sort of classic equilibrium assumes that the trading activities of the better-informed firm are, indeed, informative. But what if other market participants cannot *see* all the firm's trades? And what if the trades are occurring in highly opaque, bilateral markets rather than on an exchange? In this case, better-informed firms can profit from their superior information without necessarily having all of their valuable information reflected in the new marginal price. Anecdotal evidence certainly seems to support this in the case of Enron, given how heavily the firm focused on less-liquid and less-transparent markets.

Why Not Speculate Outright?

Trading to exploit disequilibrium, market imperfections, or asymmetric information is hardly riskless. On the contrary, it can be quite risky. That helps explain why many firms engaged in such trading do so with *relative*, or *spread*, positions in third markets rather than take outright positions in one of the two explicit markets. Suppose, for example, that a firm perceives the "true" net cost of storage of gas to be b* (which is equal to the firm's own net cost of carry) but that the current net cost of carry reflected in listed gas futures prices is b' > b*. It is a good bet that b' will fall toward b*. In that case, an outright short position in forward contracts would make sense. But that is *extremely risky*.

A position that exploits the same information asymmetry without the high degree of risk is to go short futures and *simultaneously* buy and hold gas. In this manner, the firm is protected from wild short-term price swings and instead is expressing a view solely on the *relative* prices of storage as reflected in the futures market and storage by the firm itself.

In essence, asset lite is a basis-trading or "third-market" trading strategy in which physical assets are traded vis-à-vis derivatives positions. A physical market combined with the *residual risk* of a market-making function is essentially one big spread trade.

Enron was hardly the first firm to leverage its physical market presence into financial- and basis-trading opportunities.

Putting Enron in Context

Reading the marketing and business materials of Enron's energy business lines is eerily similar to reading an example of a firm putting all the theories of basis trading just discussed into practice. And in that sense, Enron was hardly the first firm to leverage its physical market presence into financial- and basis-trading opportunities. Perhaps the best-known example of a firm engaged in the same practice is Cargill.[33] Cargill is the largest private company in the world, with $50 billion in annual sales and 97,000 employees deployed in 59 countries. For 137 years, Cargill has employed an asset-lite strategy that has allowed it to basis trade and manage risks for a wide variety of agricultural commodities, among other things. For the commodities it deals in, Cargill is involved in every link of the supply chains. As a result of its commodity trading, processing, freight shipping, and futures businesses, Cargill has been able to develop an effective intelligence network that generates valuable information. Indeed, via its people on the ground, Cargill knows where every ship and rail car hauling commodities is in real time and what that implies about prospective prices over time and space. By being able to ferret out valuable local information, Cargill has been able to obtain an edge, one that accounts for much of its success.[34]

Basis trading can make economic sense to a firm *ex ante* without making profits *ex post*. The key driver underlying most basis traders' behavior is the *perception* that they have some comparative informational advantage about some basis relation. But perception need not be reality. Markets are, after all, relatively efficient. Indeed, most of the inefficiencies that give rise to profitable trading opportunities can be linked to taxes, regulations, and other institutional frictions that essentially prevent markets from reflecting all available information at all times.

Enron did indeed attempt to focus its efforts on markets riddled with inefficien-

cies, often created by overregulation, poorly defined property rights, or a slow deregulation process. But that did not mean Enron had a comparative informational advantage in all of those markets.

Structural inefficiencies that prevent prices from fully reflecting all available information are only part of what it takes to run a successful basis-trading operation. The other requisite component is for a firm to perceive itself as (and, it is hoped, actually be) *better informed*. In oil and power, Enron achieved that informational superiority like many other firms do in their own industries—by dominating the financial market. That allowed Enron to develop informationally rich customer relationships that in turn could be extrapolated into superior knowledge of firm-specific supply-and-demand considerations, congestion points along the supply chain, and other important factors.

Now consider, by contrast, a market such as broadband in which Enron was *not* the primary inventor of the technology, *not* the primary buyer or seller of the supply chain infrastructure, and *not* a regular player in the consumer telecommunications arena. The mere existence of market frictions in broadband attracted Enron, but without the requisite information, Enron could not achieve the market dominance required to make asset lite in that market profitable.

Buying Time and the End of Enron

As Culp and Miller explain,[35] firms best suited to the asset-lite kind of strategy that Enron pursued typically require fairly significant amounts of capital—not invested capital assets necessarily but *equity capital* in a financial market sense. Equity capital is a necessary component of successful basis trading and the asset-lite strategy for several reasons. First, equity is required to absorb the occasional loss inevitably arising from the volatility that basis trading can bring to cash flows. Second, maintaining a strong market-making and financial-market presence requires at least the perception by other participants of financial integrity and credit worthiness. Especially in long-dated, credit-sensitive over-the-counter (OTC) derivatives, financial capital is essential to support the credit requirements that other OTC derivatives users and dealers demand.[36]

Unfortunately, Enron's cash management skills were no match for its apparent trading savvy. Despite being "asset lite," Enron's expenditures on intermediate supply chain assets were still not cheap. Add to this EI's asset-heavy investment programs *and* a corporate culture under Skilling and Lay that emphasized high and stable *earnings* often at the expense of high and stable *cash flows*,[37] and the net result was financial trouble for the firm.[38]

Enron's Deceptions

Much of the public controversy about Enron focuses on how Enron abused accounting and disclosure policies. In short, Enron's abuses in those areas included the following:

- Using inappropriate or aggressive accounting and disclosure policies to conceal assets owned and debt incurred by Enron through special purpose entities (SPEs);[39]
- Using inadequately capitalized subsidiaries and SPEs for "hedges" that reduced Enron's earnings volatility on paper, despite in many cases being dysfunctional or nonperforming in practice;[40] and
- Allegedly engaging in "wash trades" with undisclosed subsidiaries designed to increase trading revenues or mark-to-market valuations artificially.[41]

At first, Enron's abuses of those structures seem to have been driven more by a desire to manage earnings than by anything else. But as time passed, Enron used aggressive accounting and disclosure policies to "buy time" for itself. Especially as Enron moved into new markets in which its comparative advantage was more questionable (e.g., broadband) or in which Enron's success depended strongly on the rate of government deregulation (e.g., water), Enron's financial shenanigans amounted to "robbing Peter to pay

Most of the inefficiencies that give rise to profitable trading opportunities can be linked to taxes, regulations, and other institutional frictions.

Enron's financial shenanigans amounted to "robbing Peter to pay Paul."

Paul." In other words, as Enron's cash balances got lower and lower, concealing its true financial condition was the only way that Enron could sustain itself long enough to hope that its next big investment program would pay off. That might have worked had Enron stuck to markets in which its success with asset lite was more assured. Unfortunately, as has been argued, the firm's end became inevitable once it decided to start moving into areas that deviated from its core business strategy.

There is also the question of whom Enron was actually deceiving with its accounting and disclosure policies. Over the course of many years, one could argue that Enron seduced investors, monitors (e.g., rating agencies and accounting firms), creditors, and even its own employees into believing that the firm was stronger financially than it actually was through a mixture of aggressive marketing, cultural arrogance, and, in some cases, outright deception. But especially as the end of Enron neared, many institutions had begun to view the company with deepening suspicion.[42] By the time Enron failed, a surprisingly large number of firms dealing with Enron commercially had come to fear that the worst for Enron might lie ahead.[43] In the end, those who seem to have been the most deceived—and for the longest time—were Enron's own employees, who, unlike other firms dealing with Enron, had more cause to be inherently optimistic and were doubtless taken almost completely off-guard.

Conclusion

Enron's main business was asset lite—exploiting the synergies between a small physical market presence, a market-making function on derivatives, and a basis-trading operation to "arbitrage" the first two. Many observers have questioned the wisdom of Enron's asset-lite strategy. Most of the criticisms are hard to address without getting into deeper details of Enron's financial situation. In short, people argue that although asset lite did not require a lot of capital *expenditures* and investments in fixed capital, the strategy *did* require Enron to have a fairly large chunk of equity capital—enough to convince its numerous financial counterparties that it was creditworthy. If indeed Enron was camouflaging its capital structure to hide a massive amount of debt, then Enron probably *was* undercapitalized to exploit asset lite effectively. But that is not a criticism of asset lite—it is a criticism of Enron.

In fact, asset lite has become a very common practice for many firms engaged in energy market activities, especially at intermediate points along the various physical supply chains—transmission and distribution of power and midstream transportation and distribution of oil and gas, to name two. One firm that has been consistently successful at playing the asset-lite game, for example, is Kinder Morgan, founded by Enron's former president Richard Kinder when he left Enron in 1996. Kinder Morgan was started in part by Kinder's successful acquisition from Enron of Enron Gas Liquids, for which he outbid six other firms, including Mobil Oil.[44]

In nonenergy markets, firms such as Cargill have also long practiced their version of asset lite, often going the way of Enron in electricity and becoming asset heavy over time. The key common denominators are two: the use of a physical market presence to acquire specific information about the underlying market and the use of a financial-trading operation to make markets and engage in basis trading to leverage off that underlying asset infrastructure.

Unfortunately, there is no exact answer to the question of when asset lite and basis trading might work for a firm versus when they might fail dismally. The comparative informational advantage that allows some firms to earn positive economic profits is exceedingly hard to analyze or identify except through trial and error. That process of trial and error is what Austrian economist Joseph Schumpeter meant by the "creative destruction" of capitalism, and great economists such as Frank H. Knight and Keynes went on to emphasize further that the success or failure of a given firm cannot ever really be predicted. "Animal spirits," as Keynes put it, ultimately dictate the success or failure of a busi-

ness as much as any other variable.

Economists are uneasy with that notion. As noted earlier, the neoclassical model postulates that markets tend to be "in equilibrium," whereas the neo-Austrian perspective merely argues that markets "lean in that direction." To be in equilibrium implies some steady state of profits resting on an identifiable cost advantage or structural informational asymmetry. But concepts such as "information asymmetry" are completely nontestable. That makes theoretical economists nervous because it means that the success or failure of a firm cannot be related to a defined set of assumptions and parameters *ex ante*. And empirical economists get even more disgruntled because the success or failure of a firm cannot be explained *ex post*.

Nevertheless, that is the state of affairs. Economic theory merely says that firms will strive to exploit perceived comparative informational advantages in disequilibrium situations where prices do not reflect every market participant's information equally. Theory says nothing about firms being correct in their perceived advantages, nor does theory help us pinpoint precisely what those advantages are. Those things are what *the market* is for.

Can Enron's experience be generalized to suggest a "failure" of the theory underlying basis trading? In fact, Enron cannot be generalized at *all*. Looking purely at the firm's *legitimate* business activities, Enron perceived a comparative informational advantage, pursued it, and was wrong. That does not make the underlying economic model wrong, nor even Enron's managers and shareholders. If we could generalize the economic factors that explain why one firm succeeds and another fails, then competition in the open market would serve no purpose. Instead, competition and the market are both judge and jury to a company's perceived informational advantage. And unless a firm takes the risk of failure, it will never earn the premium of success.[45]

There can be little doubt that Enron did a lot wrong. Indeed, where it deviated from its asset-lite strategy, Enron tended to engage in businesses that were unprofitable. In addition, many of the firm's senior managers were basically unethical. But amid all those legitimate criticisms of Enron, we must be careful not to indict everything the firm did. In some instances, Enron got it right. And at a minimum, the firm moved entrepreneurially into new areas and put itself to the ultimate test of the market. Finally, Enron failed that test, but we must at least tip our hats to that part of Enron that was willing to try. Without that spirit of innovation, the process of capitalism would grind to a screeching halt.

Notes

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1. See *Corporate Aftershock: The Public Policy Lessons from the Collapse of Enron and Other Major Corporations*, ed. Christopher L. Culp and William A. Niskanen (New York: John Wiley and Sons, forthcoming 2003), part I.

2. See ibid., part II.

3. The Austrian school of economics was developed in the 19th and 20th centuries by a group of principally Austrian economists in response to several noted shortcomings in the neoclassical theory of the price system. The approach adopted here, however, is more properly called *neo*-Austrian. Following Sir John Hicks's use of the term, a neo-Austrian approach recognizes some of the deficiencies of the neoclassical school and seeks to address those problems from a more Austrian perspective. We do not consider, as some do, the pure Austrian school to be a viable standalone theory of the price system. Rather than forcing a choice of theories in either/or fashion, the neo-Austrian approach recognizes instead that a little bit of Austrian insight can go a long way toward salvaging the neoclassical paradigm. For an example of this theoretical approach, see John R. Hicks, *Capital and Time: A Neo-Austrian Theory* (1973; reprint, Oxford: Oxford University Press, 2001).

4. That does not require that forward prices always be unbiased expectations of future spot prices, although they frequently are, especially for physical commodities. But even if forward prices are not

Competition and the market are both judge and jury to a company's perceived informational advantage. And unless a firm takes the risk of failure, it will never earn the premium of success.

unbiased predictors of future spot prices, as in some currency markets, there is still a strong and consistent relation between spot and forward prices—just not an unbiased one. For further discussion of this issue, see Christopher L. Culp, *Risk Transfer: Derivatives in Theory and Practice* (New York: John Wiley and Sons, forthcoming 2003).

5. For a full elaboration of these concepts, see Ludwig M. Lachmann, *Capital and Its Structure* (Kansas City, Mo.: Sheed Andrews and McMeel, 1978).

6. See Enron Corporation, *2000 Annual Report*, 2001, cover page.

7. Ibid., p. 9.

8. A typical use of junk bonds during this period was providing funds to companies with otherwise questionable access to capital, given their credit risk. Highly leveraged transactions like leveraged buyouts were thus a natural candidate for junk-bond financing.

9. EOG continued for two decades to spearhead all of Enron Corp.'s exploration and production activities in oil and gas. In 1999, EOG exchanged the shares in EOG held by Enron for its operations in India and China. In so doing, EOG became independent of Enron Corp. and, in fact, changed its name the same year to EOG Resources, Inc. This firm still exists today.

10. See Lachmann.

11. For more discussion of these different types of contracts, see Andrea M. P. Neves, "Wholesale Electricity Markets and Products after Enron," in *Corporate Aftershock;* and Barbara T. Kavanagh, "An Introduction to the Business of Structure Finance," in *Corporate Aftershock*.

12. In the huge interest rate swap market, dealers did essentially the same thing as the Enron GasBank—they used other swaps and futures contracts to manage the *residual* risks of running a dealing portfolio, called a "swap warehouse."

13. Quoted in Joel Kurtzman and Glenn Rifkin, *Radical E: From GE to Enron—Lessons on How to Rule the Web* (New York: John Wiley & Sons, 2001), p. 47.

14. See Ronnie J. Clayton, William Scroggins, and Christopher Westley, "Enron: Market Exploitation and Correction," *Financial Decisions* (Spring 2002): 1–16.

15. See Neves.

16. See Peter C. Fusaro and Ross M. Miller, *What Went Wrong at Enron?* (New York: John Wiley & Sons, 2002).

17. Ibid.

18. This can be accomplished in various ways. For examples, see Andrea S. Kramer, Paul J. Pantano, and Doron F. Ezickson, "Regulation of Electricity Trading after Enron," in *Corporate Aftershock;* and Paul Palmer, "The Market for Complex Credit Risk," in *Corporate Aftershock*.

19. Early discussions of the economic rationale for basis, or spread, trading can be found in L. Leland Johnson, "The Theory of Hedging and Speculation in Commodity Futures," *Review of Economic Studies* 27, no. 3 (1960): 139–51; Holbrook Working, "Theory of the Inverse Carrying Charge in Futures Markets," *Journal of Farm Economics* 30 (1948): 1–28; Holbrook Working, "The Theory of Price of Storage," *American Economic Review* 39 (1949): 1254–62; and Holbrook Working, "New Concepts Concerning Futures Markets and Prices," *American Economic Review* 52 (1962): 432–59.

20. See, for example, Jeffrey B. Williams, *The Economic Function of Futures Markets* (New York: Cambridge University Press, 1986); Culp, *Risk Transfer;* and Steve H. Hanke, "Backwardation Revisited," *Friedberg's Commodity and Currency Comments* 8, no. 11 (December 20, 1987).

21. Alternative versions of this rely on different types of discounting and compounding assumptions, as well as allowing certain variables in the equation to be stochastic (i.e., subject to random variation). But the spirit of all versions of the model is well captured by the representation here. See Culp, *Risk Transfer,* for more detail.

22. See John Maynard Keynes, *The Theory of Money*, vol. II, *The Applied Theory of Money* (London: Macmillan, 1930); Nicholas Kaldor, "Speculation and Economic Stability," *Review of Economic Studies* 7 (1939): 1–27; Working, "Theory of the Inverse Carrying Charge in Futures Markets"; Working, "The Theory of Price of Storage"; Michael J. Brennan, "The Supply of Storage," *American Economic Review* 48 (1958): 50–72; and Lester G. Telser, "Futures Trading and the Storage of Cotton and Wheat," *Journal of Political Economy* 66 (1958): 233–55.

23. See Working, "New Concepts Concerning Futures Markets and Storage."

24. See Keynes; Working, "The Theory of Price of Storage"; Culp, *Risk Transfer;* and Hanke.

25. Cost-of-carry pricing for forwards on financial assets, by contrast, is enforced by direct "cash-and-carry" arbitrage because financial assets pay *observable* and *explicit* dividends that are the same regardless who holds the asset. See Culp, *Risk Transfer.*

26. Commodity lending does occur, so this example is in no way unrealistic. See Williams.

27. The classical U-shape is consistent with a production technology that demonstrates increasing returns to scale up to b^* and diminishing returns thereafter.

28. See Williams.

29. For a more general discussion, see John H. Cochrane and Christopher L. Culp, "Equilibrium Asset Pricing: Implications for Risk Management," in *The Growth of Risk Management: A History* (London: Risk Books, 2002).

30. This is pseudoarbitrage because it has the flavor of an arbitrage transaction but is far from riskless.

31. This seems heretical in the neoclassical microeconomic paradigm, but is typical of the notion of "equilibrium" developed by economists in the "Austrian" and "neo-Austrian" tradition, such as Carl Menger, *Principles of Economics* (1871; reprint, Grove City, Pa.: Libertarian Press, 1974); F. A. Hayek, "Economics and Knowledge," *Economica* 4 (1937): 33–54; F. A. Hayek, "The Use of Knowledge in Society," *American Economic Review* 35, no. 4 (1945): 519–30; F. A. Hayek, "The Meaning of Competition," in *Individualism and Economic Order* (1948; reprint, London: Routledge and Kegan Paul, 1978), pp. 92–107; F. A. Hayek, "Competition as a Discovery Procedure," in *New Studies in Philosophy, Politics, Economics, and the History of Ideas* (Chicago: University of Chicago Press, 1978), pp. 179–91; F. A. Hayek, "The New Confusion about 'Planning,'" in *New Studies in Philosophy, Politics, Economics, and the History of Ideas*, pp. 232–49; Hicks; and Lachmann.

32. See Christopher L. Culp and Merton H. Miller, "Hedging in the Theory of Corporate Finance," *Journal of Applied Corporate Finance* 8, no. 1 (Spring 1995): 121–27.

33. See, for example, Wayne G. Broehl Jr., *Cargill: Trading the World's Grains* (Hanover, N.H.: University Press of New England, 1992).

34 See, for example, Neil Weinberg and Brandon Copple, "Going against the Grain," *Forbes*, November 25, 2002, pp. 158–68.

35. See Culp and Miller, "Hedging in the Theory of Corporate Finance"; Christopher L. Culp and Merton H. Miller, "Metallgesellschaft and the Economics of Synthetic Storage," *Journal of Applied Corporate Finance* 7, no. 4 (Winter 1995): 62–76; and Christopher L. Culp and Merton H. Miller, "Introduction: Why a Firm Hedges Affects How a Firm Should Hedge," in *Corporate Hedging in Theory and Practice: Lessons from Metallgesellschaft*, ed. Christopher L. Culp and Merton H. Miller (London: Risk Books, 1999).

36. See David Mengle, "Do Swaps Need More Regulation?" in *Corporate Aftershock;* and Christopher L. Culp, "Credit Risk Management Lessons from Enron," in *Corporate Aftershock*.

37. See Richard Bassett and Mark Storrie, "Accounting at Energy Firms after Enron: Is the 'Cure' Worse than the Disease?" in *Corporate Aftershock*.

38. Cash flow mismanagement was not always the norm at Enron. Jeffrey Skilling's predecessor Richard Kinder was actually known for being a cash flow "tightwad" and kept the firm's financial health relatively strong during his tenure at the operational helm of Enron.

39. See Bassett and Storrie; Kavanagh; and Keith A. Bockus, W. Dana Northcut, and Mark E. Zmijewski, "Accounting and Disclosure Issues in Structured Finance," in *Corporate Aftershock*.

40. See Bassett and Storrie; and Kavanagh.

41. See ibid.; Neves; Kramer, Pantano, and Ezickson; John Herron, "Online Trading and Clearing after Enron," in *Corporate Aftershock;* and Bockus, Northcut, and Zmijewski.

42. See Bassett and Storrie.

43. See Culp, *Risk Transfer*.

44. See Fusaro and Miller.

45. See Frank H. Knight, *Risk, Uncertainty, and Profit* (Boston: Houghton Mifflin, 1933).

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