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Comment Bruce Mizrach

Introduction

US financial markets began to stabilize in the spring of 2009. Fiscal stimulus, capital injections to banks through the Trouble Asset Relief Program (TARP), near zero short-term interest rates, and quantitative easing by the Federal Reserve have all combined to rally the equity and corporate bond markets and restore positive GDP growth. Even as this process was ongoing, a series of papers in macroeconomics and asset pricing have begun to explore the causes of the crisis and provide a road map to a more stable financial system.

Hyun Shin of Princeton has joined with a series of coauthors, Adrian and Shin (2008, 2010) and Adrian, Moench, and Shin (2010), to explore the role of leverage and risk-based capital requirements. A key message has been the procyclicality of leverage and value at risk (VaR) measures that might encourage excessive risk taking.

The chapter in this volume by Danielsson, Shin, and Zigrand (DSZ) belongs to a second set of papers that explore the asset pricing implications of changing risk appetite. This chapter looks at assets more broadly and builds upon earlier papers by these authors: Danielsson, Shin, and Zigrand (2004) and Danielsson and Zigrand (2008). Related work on other assets includes Adrian, Etula, and Shin (2009), who focus on exchange rates.

The Model

The implicit microfoundation for the VaR criteria is from Adrian and Shin (2008). They show that firms with exponential loss functions will use VaR

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to evaluate their risk exposure. More formally, for every optimal contract, the intermediary maintains just enough capital to keep VaR where the probability of default is a constant.[1]

In a companion paper (DSZ 2011), the authors model risk-neutral traders who choose a dollar investment D_t in the risky equities V_t, with endogenous expected mean and standard deviation (u_t, σ_t) subject to a value at risk constraint,

$$\max rV_t + D_t^T + \alpha\sqrt{D_t^T\sigma_t\sigma_t^T D_t}.$$

Variable r is the risk-free rate, and α is a normalizing constant. The Lagrange multiplier for the VaR constraint,

$$\gamma_t = \frac{\sqrt{(\mu_t - r)^T(\sigma_t\sigma_t^T)^{-1}(\mu_t - r)}}{\alpha},$$

is proportional to the generalized Sharpe ratio. This makes the risk-neutral traders act *as if* they were risk averse with a coefficient of relative risk aversion $\alpha^2\gamma_t$.

In this chapter, DSZ study asset demand functions

$$D_t = \frac{V_t}{\gamma_t}\sum_t^{-1}(\mu - r).$$

The authors obtain, in the single asset case, a closed-form rational expectations equilibrium[2] for the volatility and drift of the risky asset price process,

$$\frac{(\mu_t - r)}{\sigma_t} = \frac{1}{2\alpha\eta\sigma_z}\left\{2\alpha(r^* - r) + \alpha\sigma_t^2 - \eta\sigma_z + (\sigma_t - \eta\sigma_z)[2\alpha^2 r + \frac{\alpha^2\delta}{V_t} - 2]\right\}.$$

Volatility and drift can be expressed as a function of the state variable V_t, which is the author's graph in their figure 2.3 for the parameterization $r = 0.01$, $\alpha = 5$, $\sigma_z = 0.4$, and $c = 10$, where $\eta = 1$ and $\delta = 0.5$ are scaling parameters for the demand functions.

Asset Pricing Implications

The key result is that volatility is nonmonotonic, with a range in which volatility increases in the risky asset holdings. At this intermediate value, there is a positive feedback effect in which rising stock prices lead the trader to hold even more equity. In the multivariate case, they show that return correlation can also rise over the same range. The attractive feature of this model is the endogenous rise in volatility and asset correlations.

My first comment concerns the need to calibrate the model to the mag-

1. While not modeled, one could also motivate the chapter with a regulatory regime like Basel II where capital requirements are risk-based.

2. The equilibrium is unique up to a constant of integration c.

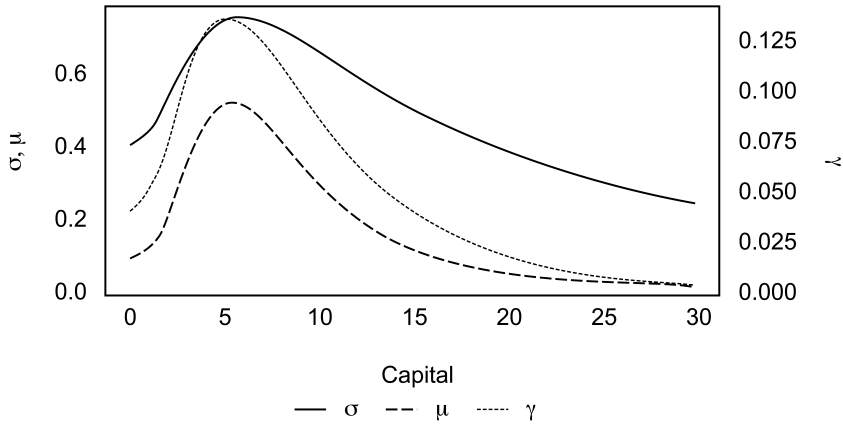

Fig. 2C.1 Mean, volatility, and risk aversion in equilibrium

Note: The figure, from Danielsson, Shin, and Zigrand, graphs the model's equilibrium mean, volatility, and risk aversion for the parameters: $r = 0.01$, $\delta = 0.5$, $\alpha = 5$, $\sigma_z = 0.4$, $\eta = 1$, and $c = 10$.

nitude of the crisis. Is the change from the low volatility to high volatility regime large enough to explain the events of 2007 to 2009?

Policy Implications

Aggregating from a representative firm, the model has important policy implications. Indeed, these market-wide implications are an appealing part of the model. I focus on the case where the economy is on the downward sloping portion of figure 2C.1. If all firms add to their risky asset positions following a positive shock, volatility in this region is actually falling. This loosens the VaR constraint, and leads banks to take on even more leverage. This mechanism for procyclical leverage has been cited by the Committee on the Global Financial System (CFGS 2009) of the Bank for International Settlements as an important source of instability.

In the model's version of a crisis, the firm starts to climb back up the hill in figure 2C.1 as V_t falls. A negative shock leads to rising volatility and can set off a sequence of deleveraging. By most accounts this process is still ongoing.

As I continue with my discussion, I now turn to whether there is evidence in the data for this very appealing model.

Evidence from the US Financial Sector

I begin with a broad view of the US financial sector, looking at both commercial and investment banks. I then develop a case study comparison of two investment banks, Bear Stearns and Goldman Sachs, the first to collapse and the institution that has emerged as perhaps the strongest.

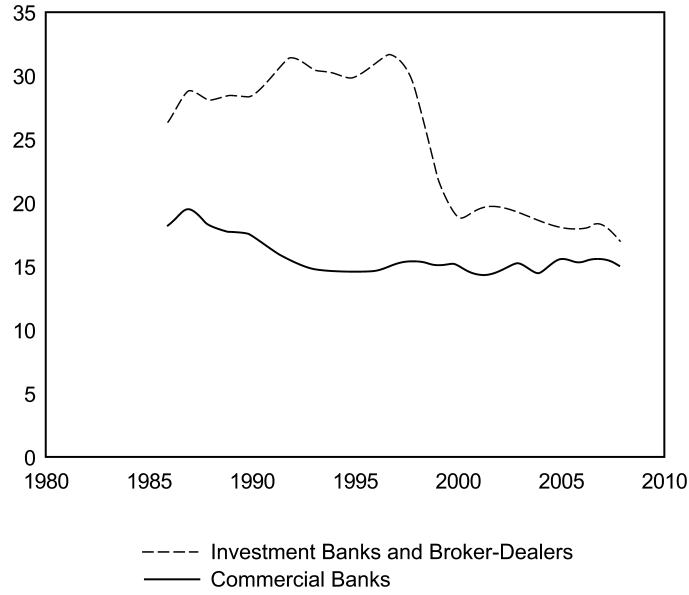

Fig. 2C.2 Leverage in the banking sector
Notes: The data are from Compustat. Leverage is computed as the ratio of assets to shareholder equity (ATQ/SEQQ). The first group is Standard Industrial Classification (SIC) code 6211, which includes investment banks, broker dealers, and flotation companies. The second group is SIC code 6020, which includes commercial banks but not savings institutions. I limit both groups to a minimum of $5 billion in assets and $1 billion in shareholder equity.

Leverage in Commercial and Investment Banks

I graph in figure 2C.2 the leverage ratios, measured as the ratio of assets to shareholder equity, for US investment banks and brokerage firms and commercial banks from 1985 to 2008. If there is any trend in leverage leading into the crisis, it is negative. Indeed, leverage was higher in the 1980s than the 2000s.

Adrian and Shin (2008) have emphasized that risk may have become more concentrated at the large institutions. If I limit the analysis to the five largest firms in each category, there is an upward trend in leverage among the investment banks after 2004.[3] (See fig. 2C.3.)

I do not have any comprehensive data on value at risk, but the CFGS notes that VaR was stable or declining into mid-2006 for the largest banks in the United States, Europe, and Japan.

3. On April 28, 2004, the SEC made amendments to Rule 15c3-1, which established net capital requirements for investment banks. The five largest institutions were allowed to become Consolidated Supervisory Entities, which allowed them to use VaR models for setting capital requirements.

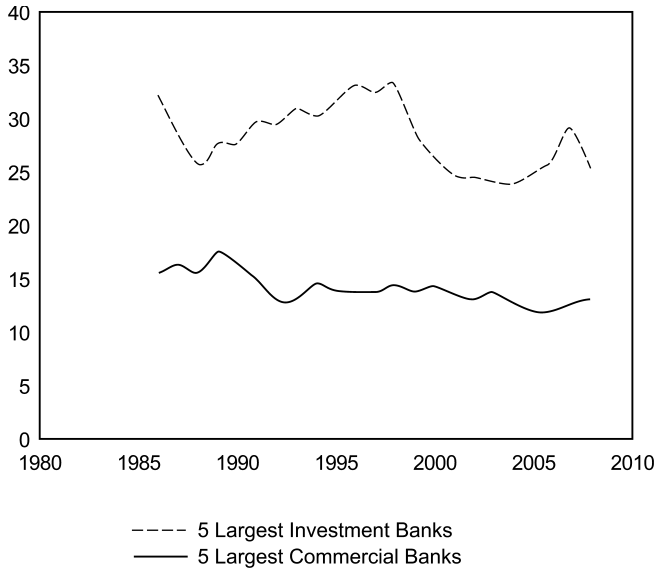

Fig. 2C.3 Leverage at the largest institutions

Notes: The data are from Compustat. Leverage is computed as the ratio of assets to shareholder equity (ATQ/SEQQ). The five investment banks are Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley. The five commercial banks are Bank of America, Citigroup, JP Morgan Chase, Wachovia, and Wells Fargo.

The remainder of this section is a case study of Bear and Goldman. I discuss the commercial banks in a related paper, Mizrach (2011).

Bear Stearns versus Goldman Sachs

Between 1999 and 2004, leverage, graphed in figure 2C.4, was higher at Bear than Goldman, but Goldman closed the gap after 2004. Bear's leverage was falling and dropped below thirty in 2006, the year before their implosion.

There is no trend in value at risk, graphed in figure 2C.5 for the two firms, until the crisis is well under way. Goldman has a slightly higher VaR.

These data are consistent with the model. It seems that the VaR constraint was never binding until Bear Stearns began to shed assets in the summer of 2007. It seems as though I need to go beyond VaR and leverage to understand why Bear Stearns failed.

(Off) Balance Sheets

I will emphasize three things in my discussion: (1) the role of special purpose entities, (2) Level 3 asset valuation, and (3) interruptions in funding liquidity. All three require a careful consideration of balance sheets and regulatory filings.

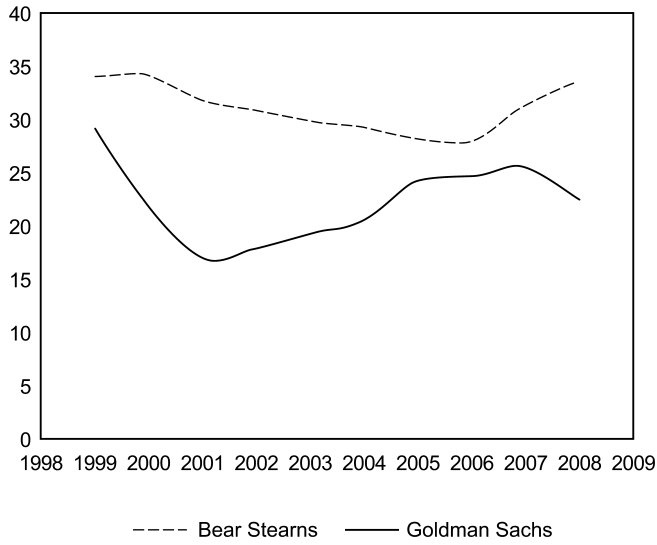

Fig. 2C.4 Leverage at Bear Stearns versus Goldman Sachs

Notes: The data are from Compustat. Leverage is computed as the ratio of assets to shareholder equity (ATQ/SEQQ). I restrict the period here to 1999 to 2008, a time span in which both firms were publicly traded.

Special Purpose Entities

The vulnerability of a securities firm to a panic depends upon the structure of their assets and liabilities. The firms that failed (including Bear) had relatively large off-balance sheet exposures. Many of these were organized in the form of special purpose entities (SPEs). There is an academic literature on the purpose of the SPEs, but the impact was nonetheless to make the firm's balance sheet more opaque.

The accounting treatment of securitizations was governed by the Financial Accounting Standard Board (FASB) Statement 140 originally issued in September 2000. The standard defined a Qualifying Special Purpose Entity (QSPE). To determine whether the exposures went off-balance sheet, the asset structure had to be a "true sale" that limited the recourse with respect to the parent. Financial Interpretation No. (FIN) 46, revised substantially in December 2003, defines a related structure called a Variable Interest Entity (VIE).

Figure 2C.6 shows that Bear Stearns relied on these structures to a much larger extent than Goldman.[4] Their exposures nearly triple between February 2005 and May 2007, rising from 3.46 percent to 11.32 percent of assets. Goldman never allowed their exposure to exceed 2 percent. Perhaps more importantly, they began to reduce their exposure in February 2006.

4. As Mizrach (2011) notes, off-balance sheet activity was even more substantial at the large commercial banks where Tier 1 capital was closely monitored.

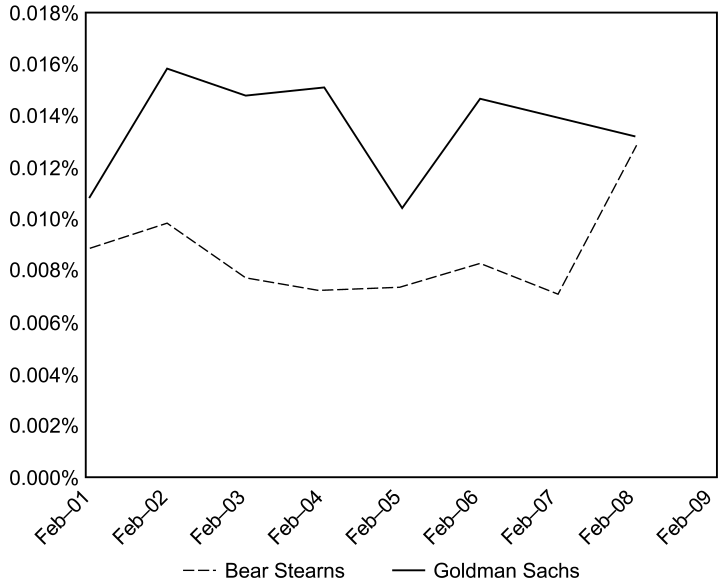

Fig. 2C.5 Daily value at risk at Bear Stearns versus Goldman Sachs

Notes: The data are from the first quarter SEC 10-Q filings of both banks for each year. The value at risk is a one-day 95 percent loss coverage calculation expressed in dollars, which I have converted into a percentage by dividing by total assets.

Illiquid Assets

The most overused word in the crisis has been liquidity. It has many meanings. In the context of asset valuation, it refers to the ability to produce accurate, real time fair market values for a bank's positions. A related point captured by the DSZ model is the potential for losses from having to make a fire sale of these illiquid positions.

In September 2006, the FASB issued Statement 157 on Fair Value Measurements. The standard considers a hierarchy of transparency ranging from Level 1 assets, which have publicly quoted prices, and Level 3 assets, which may often be priced using internal models.

Bear Stearns first reported its Level 3 assets in the first quarter of 2007 Securities and Exchange Commission (SEC) filings. Their exposure was similar to Goldman Sachs, with both firms at around 5 percent of total assets. I compare these levels in quarterly snapshots in table 2C.1.

As the crisis unfolded, it appears that Goldman was able to reduce or limit their exposure while Bear Stearn's kept rising right up until their collapse. In determining the fate of the two companies, it appears that the type of Level 3 assets held matters more than the level. In the case of Bear Stearns, there has been more (eventual) disclosure; a portion of their illiquid assets wound up in a special purpose entity created by the Federal Reserve Bank of New

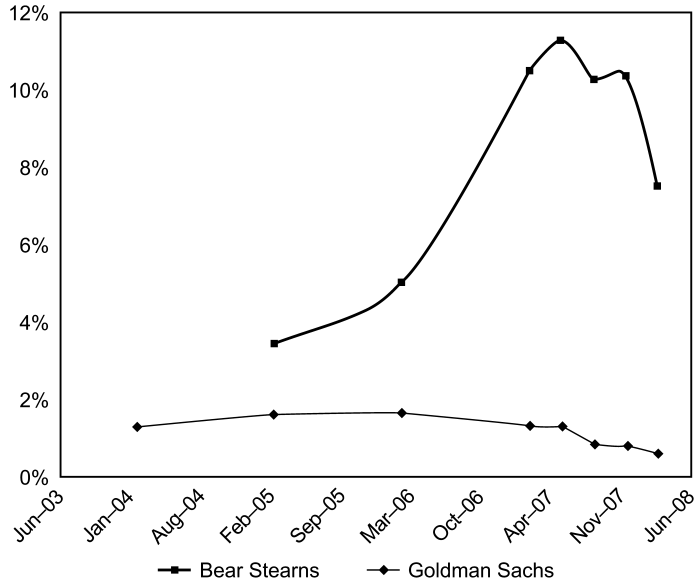

Fig. 2C.6 Special purpose and variable interest entities as a percent of total assets
Notes: The data are from the SEC 10-Q and 10-K filings of both banks for each year. I report the consolidated assets of the Qualified Special Purpose Entities (QSPEs) and Variable Interest Entities (VIEs) of both firms as a percentage of total assets.

Table 2C.1 Bear Stearns versus Goldman Sachs Level 3 assets

	Bear		Goldman	
Date	$bn	% of assets	$bn	% of assets
2-1-2007	19.0	4.81	47.6	5.22
5-1-2007	18.0	4.26	54.1	5.74
8-3-2007	20.3	5.10	72.0	6.89
11-1-2007	23.9	6.05	54.7	4.89
2-28-2008	37.4	9.36	82.3	6.92

Note: The data are from the SEC 10-Q and 10-K filings of both banks for each year.

York called Maiden Lane 1. Using the Maiden Lane financial statement,[5] I estimate that 56 percent of the portfolio was in commercial (48 percent) and residential (8 percent) mortgage-backed securities. Maiden Lane had an unrealized capital loss of more than $4 billion on the Level 3 portfolio in the eight months after its acquisition.

The type of assets also mattered a great deal once their counterparties began to demand more collateral.

5. http://www.newyorkfed.org/aboutthefed/annual/annual08/MaidenLanefinstmt2009.pdf

Bear's Collapse

Bear Stearns operated two hedge funds with leveraged exposure to the subprime mortgage market,[6] largely through collateralized debt obligations (CDOs). High Grade Structured Credit Strategies Fund (SCSF) had $925 million in capital employed at six times leverage. It was three years old and had forty straight months without a loss, producing a cumulative 50 percent return. High Grade Structured Credit Enhanced Leverage Fund (SELF) was started in August 2006. It invested $638 million in investor capital at ten times leverage.

The SCSF reported its first ever loss in March 2007. In late April, Goldman, as a counterparty to some of the trades, marked down subprime assets to $0.55. When Bear questioned the marks, which ranged between $0.80 to $0.98 from other parties, Goldman offered to sell their own subprime assets to Bear at their mark. Bear did not bite.

Bear posted a –19 percent decline in SCSF for April. Redemptions followed, Merrill Lynch pulled collateral in June, and both funds collapsed at the end of July 2007. Bear took the remaining assets in both funds and put them on their own balance sheet.

As subprime assets continued to deteriorate,[7] Bear's SPEs are marked down. In their final quarterly financial statement, February 29, 2008, the value of the special purpose entities falls by –32.5 percent to $26.74 billion.

Turn Off the Lights: Funding Liquidity

Gorton and Metrick (2009) have emphasized that in the final stages of the investment bank's collapse, there was a modern version of a bank panic that they call the "run on the repo." Repo refers to the lending of securities as a source of day-to-day funding liquidity, a mechanism that has also been emphasized by Brunnermeier and Pedersen (2009). As Bear's positions soured, they prudently began to raise cash, which rises from 3.8 to 8.9 percent of the balance sheet, shown in table 2C.2, between February 2007 and February 2008.

They sold off and/or wrote down financial instruments and the structured entities on the balance sheet. They were squeezed (perhaps rationally) by their counterparties, however: securities pledged as collateral rose to 5.7 percent of assets, and it also appears that firms were slow to pledge collateral in return, as this fell to less than 4 percent of assets.

6. Despite claiming only 6 percent exposure to subprime, the funds' exposures were actually closer to 60 percent.

7. Marklt's ABX index of subprime CDS is a reasonable proxy (see, e.g., Gorton 2008 or Mizrach 2012).

Table 2C.2 **Bear Stearns consolidated assets**

Assets $mn	2-28-2007	%	5-31-2007	%	8-31-2007	%	11-30-2007	%	2-29-2008	%
Cash	5,891	1.5	11,178	2.6	18,143	4.6	21,406	5.4	20,786	5.2
Cash segregated	9,126	2.3	4,653	1.1	13,460	3.4	12,890	3.3	14,910	3.7
Securities rcvd. as collateral	21,227	5.4	18,948	4.5	18,301	4.6	15,599	4.0	15,371	3.9
Securities to resell	37,248	9.4	42,272	10.0	32,144	8.1	27,878	7.1	26,888	6.7
Securities borrowed	84,015	21.3	92,050	21.8	80,039	20.2	82,245	20.8	87,143	21.8
Receivables	40,730	10.3	46,984	11.1	43,320	10.9	53,522	13.5	53,332	13.4
Financial instruments	134,410	34.1	136,411	32.2	126,870	32.0	122,518	31.0	118,201	29.6
Pledged as collateral	12,754	3.2	12,265	2.9	15,004	3.8	15,724	4.0	22,903	5.7
Assets of VIEs and QSPEs	41,483	10.5	49,985	11.8	41,045	10.3	33,553	8.5	29,991	7.5
Property and equipment	508	0.1	547	0.1	586	0.2	605	0.2	608	0.2
Other	7,119	1.8	8,011	1.9	8,180	2.1	9,422	2.4	8,862	2.2
Total	394,512		423,304		397,091		395,362		398,995	

Note: The data are from the SEC 10-Q and 10-K filings.

The $18 billion in cash that Bear Stearns possessed[8] on Monday, March 17, 2008, only managed to last until the weekend's emergency merger with JP Morgan Chase.

Conclusion

Leverage can be a problematic measure, but it seems as though leverage was not excessive compared to prior noncrisis episodes. The VaR was held relatively constant, and the level does not have much predictive value in the crisis.

Back in the superficially calm days of January 2007, with the Chicago Board Options Exchange (CBOE) volatility index below 10, the markets may have been in the right-hand side of DSZ's figure 2.1. As firms like Bear sold assets, volatility rose and asset prices fell, leading to additional selling. What the model and many economists are still struggling to explain is why the hill was so steep given the relatively small size of the subprime sector.

My discussion tries to sketch out a more comprehensive theory. The components of this model would have to incorporate: (1) balance sheet transparency (SPE, VIEs, etc.); (2) the complexity of assets in the portfolio (Level 3 assets like synthetic CDOs); (3) how crowded the trades are—Adrian and Brunnermeier's (2009) concept of a distressed bank's value at risk, called CoVar, may prove useful here; and (4) seizures in funding liquidity.

This chapter is still an important first step, and it will be on my syllabus next semester.

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8. Kelly (2009) reports that the cash cushion was cut in half in just three days. Bear Stearns needed a short-term loan from the Federal Reserve, via JP Morgan, on Friday, March 21, 2008, just to make it to the weekend.

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Comment

Terence C. Burnham

Introduction: Consilience and Economics

> He who understands baboon would do more towards metaphysics than Locke.
> —Charles Darwin (1838) *The M Notebook*

Economists should pay more attention to baboons and less to mathematics. The chapter by Danielsson, Shin, and Zigrand (hereafter, DSZ) explores "anomalous" behavior in financial markets. An anomaly is actual human behavior that differs from behavior predicted by standard neoclassical theory.

Economic efforts to reconcile neoclassical theory with anomalies involve relaxing one of more of the standard assumptions and showing that some stylized features of actual behavior are consistent with the modified assumptions. This approach is now common in many behavioral papers on topics such as other-regarding preferences (Bolton 1991) and intertemporal decisions (Laibson 1997).

E. O. Wilson advocates a radically different approach in his book *Consilience* (Wilson 1998). He has long advocated that social scientists ground their work in the natural sciences (Wilson 1978). Consilience is the "jumping

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