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Final Exam Paper

Complexity in the Financial Market Crisis

In *Complexity*, the economy is described as a fundamental example of a complex adaptive system.[1] In contrast to the neoclassical view of economics as an equilibrium-reaching system, complexity economics emphasizes the important role of positive feedback mechanisms and therefore views the economy and financial market as a continuously adapting and reorganizing system.[2] Studying economics within the complexity framework, which focuses on the new structures and behaviors that emerge at each level of organization, can play a huge role in understanding events that are unexplainable based on more traditional economic theories.[3] The necessity to view the economy as a complex system subject to the effects of dynamic feedback has been emphasized recently by many scholars in explaining the causes of the recent financial crisis and also in determining what tools can be used to identify the next emergent behaviors that will undermine the stability of the system.

I. Endogenous Risk

1 Waldrop, M. Mitchell. *Complexity*. Simon & Schuster, 1992. pg145.

2 Id. at 34.

3 See Id. at 88.

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One important insight complexity theory provides in understanding the processes at work in financial markets is the role of endogenous risk, or risk resulting from participants rather than from outside sources.[4] One group of economists noted how, through the positive feedback-induced growth of risk, crisis episodes often explode more as a result of the actions of investors than from new information being released to the market.[5] Accordingly, accurate measurements of risk, which in turn influence investment decisions, depend on the ability to measure the endogenous sources of risk.[6]

The process of risk growth is described as followed: an episode begins with some new information concerning the economy (for example, macroeconomic data), which changes, often only slightly, investors' views of financial market risk.[7] Using calculations such as "value at risk" (VaR), the investor adjusts his positions to reflect his new view of market risk levels. Other market participants see the investors' changes as reflective of the *correct* level of market risk, which influences their reactions and positions. This, in turn, changes the original investors' view of the correct level of market risk, and VaR

4 Danielsson, Jon et al. "Risk Appetite and Endogenous Risk." London School of Economics. 17 Mar 2009.

5 Id. at 2.

6 Id. at 2-4.

7 Id. at 2.

once again requires an adjustment of his portfolio. This cycle of positive feedback from within the system works until the overall change in risk perceptions is often not at all proportionate to the impact of the original stimulus.[8]

This type of momentum originating from the interconnected decisions of investors often explains much concerning stock price movements. As discussed in *Complexity*, stock bubbles and crashes cannot be explained solely on the basis of the efficient market hypothesis.[9] In an EMH world, investors are assumed to have all the same information (that is, all publicly available information), so adjustments in market prices will be incremental and occur as new information is released.[10] In contrast, in a market with positive feedback, investor views will influence the views of other investors and change prices in a self-fulfilling way.[11] Historical data shows the market functioning more according the complexity theory than the EMH, as the interplay of investor decisions results in bubbles and crashes, or more often, predictable price patterns.[12] Such an example of historical data is described in an article downplaying the importance of the EMH.

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8 Id. at 2-3.

9 Waldrop at 269.

10 Id.

11 Id. at 274.

12 “The Grand Illusion” Buttonwood. The Economist. 5 Mar 2009.

> Take the momentum effect, the practice of buying the stock market's best performers over the previous time period. A study by the London Business School found that, since 1900, buying British stocks with the best momentum would have turned £1 into £1.95m (before costs and tax) by the end of last year; the same sum invested in the worst performers would have grown to just £31. In efficient markets, such an anomaly should be arbitraged away.[13]

II. The Role of Leverage and Financial Booms

Just as the risk management rules guiding investor decisions often exaggerate fluctuations in risk levels, leverage is another factor that increases the positive feedback loop in financial markets.[14] When investors are undercapitalized, their reactions in response changes in market conditions is even larger, resulting a larger or faster feedback effect.[15]

The recent "credit crunch" is an example of this effect on both banks and investors. Economist Hyman Minsky's theories emphasized how market participants exaggerate economic cycles through the type

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13 Id.

14 Danielsson, et al. at 4.

15 Id. at 4.

of positive feedback mechanisms seen in the mortgage and lending crisis.[16] In describing the process of increased borrowing and lending leading to greater market risk, Minsky divided individuals' actions into three phases.[17]

> In the first, investors take on little enough debt that they have no trouble meeting their capital and interest payments. In the second, they stretch their finances so they can only afford the interest. In the third, or Ponzi, phase they take on debt levels that require rising prices to be safely financed…

This last phase is comparable to the recent housing bubble precipitated by homebuyers who often financed their purchases almost completely with debt[18]. Just as Minsky theorized how "a small change in the fundamentals or in investor attitudes can be enough to cause the system to unravel," the recent decline in housing prices in certain parts of the US resulted in a massive deleveraging by consumers.[19] The effects of deleveraging then spread to banks and financial firms across the country, who were forced to write down the capital on their

16 "Minsky's Moment" Buttonwood Column. The Economist. 2 Apr 2009 (quoting Barbera, Robert. "The Cost of Capitalism: Understanding Market Mayhem and Stabilising Our Economic Future" McGraw-Hill, 2009.)

17 Id.

18 Id.

19 Id.

balance sheets when individuals starting defaulting on their loans.[20] Similar to the investor adjusting his risk level, the banks were required to shed assets to meet the capital constraints on their new equity levels.[21]

A related point is the role that periods financial of financial prosperity play in this buildup of leverage. As economist Danielsson explains, favorable economic conditions result in greater ability to assume risk, so the longer the period of prosperity and resulting higher risk appetite, "the larger the vulnerabilities that build up and therefore the larger the resulting instabilities."[22]

III. **Model Risk**

Just as risk measurements need capture the potential impact of endogenous sources of risk, or the risk component created by market participants themselves, trading models need to be dynamic enough to capture what happens when the models are successful and, consequently, the use of a particular model proliferates enough to impact the function of the model itself. This need to incorporate "model risk" more fully and accurately into financial decision-making is

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20 Danielsson, et al. at 8.

21 Id.

22 Id.

not a necessity that investors have only recently identified.

Economists studying the stock market crash of 1987 have emphasized the large role that the portfolio insurance models played in that financial episode.[23] Portfolio insurance is a dynamic trading strategy where a computerized portfolio manager is programmed to sell equities when their prices fall and buy equities when their prices rise in order to ensure that the individual portfolio never loses more then a certain amount of money.[24] These computer programs, however, did not have an alternative embedded into their algorithms to respond to a situation where large numbers of portfolio insurers were trading based on the same criteria. Automated selling by portfolio insurers triggered a price drop that resulted in more selling by similar automated insurers, which then spread to other investors who, aware of the "trading rules" of the insurance programs, also sold their assets in anticipation of even more automated selling and a further decline in prices.[25] Essentially, investors' failure to equip the trading model with the tools to react to, essentially, use of the model resulted in an uncontrollable sell-off, and the DOW Jones Industrial Average lost one-third its value in one week.[26]

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23 Report of the Presidential Taskforce on Market Mechanisms – 1988. pg15.

24 Id.

25 Report of the Presidential Taskforce on Market Mechanisms -1988. pg15.

26 Id.

Recently, this same type of model risk has surfaced with the widespread use of quantitative-based finance, which involves using computer programs to locate what their programmers determined were overpriced shares.[27] As investors began making money with the programmed trading and computing power increased, more investors developed their own algorithms and adopted similar models, until quant-based traders developed into the large market force they are today, making millions of trades every millisecond and effectively setting the price for certain securities.[28] Furthermore, increased competition resulted in traders leveraging their positions, which, as discussed, intensifies the deleveraging process in a downturn.[29] When equity prices dropped last year, many investors (who studied the portfolio insurance debacle of 1987) refused to change their positions in those interests in order to avoid a loss on the sale.[30] However, the investors' high leverage required them to sell *something*, so liquid quant-based positions were sold off and prices started falling.[31]

> Those [quant-based funds] that were leveraged were naturally forced to reduce their positions as well. These waves of selling

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27 "Heart of Darkness." Buttonwood. The Economist. 27 Oct. 2007.

28 Id.

29 Id.

30 Id.

31 Id.

> played havoc with the models. Quant investors thought they were aware of the risks of their strategy and had built diversified portfolios to avoid it. But the parts of the portfolio that were previously uncorrelated suddenly fell in tandem.

Again, although the model may work for individuals, the traders failed to account for the dynamic feedback when everyone starts adopting the model.

IV. **Regulatory Considerations**

As economists and policy makers come to better understand how complexity theory affects financial markets, more can be accomplished to regulate participants and ensure a functionally stable system. In a recent conference focused on stabilizing the world financial markets, various notable economists and finance experts drafted a report highlighting the shortfalls of the current regulatory framework and suggesting some alternative approaches to better reflect the way financial markets operate and evolve.[32] Although the proposals are focused most specifically on the banking industry, the ideas presented are some examples of approaches, similarly applicable to other market

32 Brunnermeier, Marc et al. “The Fundamental Principles of Financial Regulation.” Geneva Reports on the World Economy – Preliminary Conference Draft pg11.

participants, that can be considered in regulating the complex financial system.

In choosing an appropriate regulatory regime, emphasis must first be placed on the fact that, because of the effect that participants can have on the larger system, there is often a tension between focusing on protecting an individual and focusing on protecting the economy.[33] As discussed earlier, traders may shed certain assets to maintain the value of their individual portfolios and, as a result, cause asset prices to dive in a way that hurts all of them. Similarly, regulation may make individual banks safer but result in behavior that "collectively undermines stability of the system."[34] Of course, principles of capitalism and free market benefits often appropriately tip the regulatory scale in favor of individual freedom over public wellbeing. However, the banking industry does complicate the inquiry to the extent that the prosperity of the industry has such a large effect on the functionality of other participants. As described in one article, "In conventional industries, the demise of companies leads to "creative destruction" with capital being reallocated to more productive areas. But in banking and finance, a crisis leads to "deflationary destruction"

33 Id. at 8.

34 Id.

as capital is eliminated."[35] Thus regulators need to be aware of which party or collective parties receive the most benefit from the rules.

This discussion of public benefits leads directly into one regulatory option: the use of counter-cyclical regulations. Because leverage intensifies the effects market adjustments, greater restrictions on risk buildup during market expansions would help ensure that the fall of asset prices is not so intense in an economic downturn.[36] Many counter-cyclical proposals focus on changing the way bank capital requirements are calculated, so that there are not, as occurred last year, drops in bank equity that result in huge capitalization shortfalls.

Commentators emphasize the way capital requirements are often not aligned with risk and therefore misappropriated. For example, credit ratings play a large role in calculating required capital, but higher credit ratings are not often indicative of underlying risk. In contrast:

> Regulatory capital is meant to be held against unexpected loss, and not against *expected* loss, which should be met by a higher interest spread. The rating (should) measure the expected probability of default, whereas what matters is the likelihood of

35 "Minsky's Moment."

36 Brunnermeier et al. at 29.

> migration (downwards) of the rating, and the loss of value that should occur.[37]

Capital requirements are also determined based on assets that are held, and some important asset characteristics that largely influence its riskiness are often overlooked. Accordingly, it has been suggested that more attention is paid to how an asset is funded, in addition to the characteristics of the individual asset- a measure which would take into account, as complexity theory seems to necessitate, some risk that is attributable to interactions between participants rather than an outside measure of the asset itself.[38] The basic idea is that, even though two banks are holding the same asset, one bank is exposed to substantially more risk if it has funded the asset using a liability with a different time frame.[39] This is an especially important issue in times of market expansion, as an upward-sloping yield curve (often occurs in boom market) means that short-term funding is cheaper than long-term funding; accordingly, more banks with choose to fund longer term assets with shorter term funding and thereby expose themselves to the risk that necessary refinancing will bring.[40] More capital can therefore be required in these situations to ensure against this type of risk.[41]

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37 Id. at 20.

38 Id. at 39.

39 Id.

40 Id.

41 Id.

Finally, the use of counter-cyclical regulations does not need to be focused only on the banking industry. The Federal Reserve, who determines the supply of money available to the over-extending banks and financial firms, can also incorporate more "good times risk" into their monetary policy determinations. For example, one commentator has suggested that the FED build into its money supply model a variable based on the current corporate bond spread, which measures the difference between interest rates on corporate bonds and US Treasury Bills.[42] Low spreads mean that investors are willing to accept relatively low returns on riskier corporate bonds, indicating that risk appetites are high. Because leveraging and potential risk builds up during periods of increased risk tolerance (as discussed above), the corporate bond spread variable would signal to the FED that they should tighten the money supply to counterbalance this tendency.[43] Conversely, when spreads are high and investors are de-leveraging, monetary policy should be eased to support prices and liquidity.[44]

Complexity theory says that, as a result of constant reorganization and feedback loops, seemingly stable systems are

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42 "Minsky's Moment"

43 Id.

44 Id.

always vulnerable to small changes or uncertainties that grow into chaos. As illustrated with the events of the recent financial crisis and the insight that complexity can provide into those episodes, viewing the economy as a complex adaptive system can help regulators and participants understand and earlier identify both feedback loops at work in the financial markets and the resulting new emergent behaviors. By focusing on the large effect that participants play in changing the system from within, economists and public policy-makers will be more effective at finding the optimal balance between dynamic innovation and stability.