Statement of Research Philosophy

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My present research focuses on the effect of regulatory capital on bank loan portfolios, high-frequency trading and market microstructure, using financial engineering to fund biomedical research, deep neural nets (machine learning) for derivative pricing, energy markets, and energy derivative and project valuation. To analyze the effect of regulatory capital on lending I built a database of FDIC Call Reports (available here). The database contains comprehensive financial information about the 5000+ FDIC-insured institutions in the US, at a quarterly frequency. Using this database I have found evidence that risk-weighting assets causes banks to shift lending away from consumer and real-estate, and towards commercial and industrial lending.

To analyze high-frequency trading I wrote a series of scripts which will translate raw CME messages from FIX/FAST format, and build a full orderbook. This allows me to translate CME market depth data (which is every message sent to and from the exchange) into a full orderbook time-stamped to the millisecond. Using this data I have a research paper which investigates the speed and efficiency of the market reaction to the weekly Natural Gas Storage Report. I also have a paper which models how book liquidity reacts to trades at the millisecond level.

An exciting area where I have two early working papers is in structuring portfolios of compounds used in cancer research in order to attract more money into this research. The problem is phase 1 funding is very hard to attract due to the risk return profile. Each compound costs $200 million to develop, and has only a 5% probability of success. If it succeeds the owner earns $2 billion in years 11 through 20. This is too risky for venture capital investors, so we are trying to structure portfolios of these compounds in order to match typical venture capital investments. You can see more on research on this problem here: http://cancerx.mit.edu/.

Much of my previous research has been in energy finance (electricity, natural gas, and crude oil markets). This was driven by my interesting work at NextEra Energy, where I valued spark spread options. My present research in this area involves estimating the impact of renewable energy generation on electricity price volatility in deregulated networks (NYISO, ISO-NE, PJM, ERCOT, and Europe's Nordpool). I am also interested in how various deregulated market structures affect renewable generation.

In 2014 I published an analysis of the cointegrating relationship between natural gas and crude oil prices in *Energy Economics*. This paper, titled 'The Switching Relationship between Crude Oil and Natural Gas Prices', won the USAEE/IAEE 'Best Working Paper Award for 2012' (there were over 150 competing papers). In the analysis I allow the cointegrating equation to

endogenously switch regimes, which controls for a unit-root in the relative price process. Ultimately the analysis showed there is a strong relative pricing relationship between the two commodities. A following paper determined the causes of the regime switching.

In addition to working in energy finance, I have also focused my empirical work on time series analysis incorporating unobserved variables. Specifically, I have built a collection of self-written code to estimate Markov regime-switching and state-space models. Because I have written the code myself, I have the flexibility to tailor a particular model to the underlying economics of the process.

I have also published research on informed trading prior to mergers and acquisitions. In 2013 I published in *Quantitative Finance* (along with Jeff Madura and Ariel Viale) a mathematical model of informed trading. In 2012 I published papers on informed trading in the *Journal of Economics and Business* and the *Journal of Economic Practice* (with Jeff Madura).

Best regards,

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