Stock Market Behavior Predicted by Rat Neurons

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We here report for the first time, to the best of our knowledge, rat motor cortex neurons predicting the behavior of the American stock market. We implanted the motor cortex of the brains of rats with silicon electrodes. Using the correlation technique, we monitored the activity of neurons in our rats while simultaneously tracking the activity of stocks in the U.S. stock market.

Background: Hedge Funds

Hedge funds burgeoned in the early 1990's as a popular alternative to the conventional, and more regulated, mutual funds. Hedge funds have often used alternative methods, such as various human social factors, to predict future performance of the stock market. However, we here propose an alternative alternative method.

Figure 1 (top): Behavioral apparatus: rat trained on a brain-machine interface task while stocks simultaneously tracked.

Methods: Correlation Analysis

For nine days, neural activity in the form of firing rates (which are the number of electrical discharges per second) from recorded neurons (n=94) of three rats were averaged each day as

the rats learned to use a brain-machine interface[1] to obtain food pellets.

Mean firing rate data per day were stored using custom software (MATLAB, Mathworks Inc., Natick, MA), along with the closing stock prices for the same day for all corporations listed on NASDAQ, the New York Stock Exchange, and the American Stock Exchange (n=4195). Correlation coefficients were obtained using the *corrcoef* function of MATLAB, and only stocks that had significant coefficients ($p<0.05$, t-test) were labeled "responding" and further analyzed. See Figure 1 for a depiction of the behavioral apparatus.

Methods: Stock Market Prediction

Generalization (prediction) is important for any valid model. Thus, we decided to test our correlations by predicting future stock price. We analyzed a data set containing firing rates from an additional 20 consecutive trading days using a contrarian prediction model.[2] Firing rates obtained on day d (f_d) were used to predict the future closing price on day $d + 1$ using the following rules:

$$f_d > f_{d-1} \longrightarrow a_{short} \quad (1)$$

$$f_d < f_{d-1} \longrightarrow a_{buy} \quad (2)$$

$$f_d \approx f_{d-1} \longrightarrow a_{hold} \quad (3)$$

where f_{d-1} is the firing rate from day d - 1 and a is the action taken, $a = \{buy; short; hold\}$. Stated simply, if the rats' neurons increased firing rates, we would simulate a "short" of the stock; if the firing rates decreased, we would "buy" the stock. If no change occurred (± 1 impulse/s), we did not trade that day (hold). To determine the success of our predictions, the actual value of the stock was observed on day d+1, and we calculated our profits and losses. Brokerage fees were not included in this analysis.

Results

We found that 74 stocks were responsive to the firing rates of our rats. Figure 2 shows an example of one stock (COKE, Coca-Cola Bottling Company Consolidated) that was positively correlated with the rat neurons. Table 1 groups the responsive stocks by sector. Though interesting clusters emerge in the financial and technology industries, the theoretical implications are beyond the scope of this paper.

In our prediction experiments, we found a similar number of stocks that responded to a lag of one day (n=68). Figure 3 shows the output of the stock trading simulation for one exemplar example stock (ASFI, Asta Funding, Inc.). Figure 3A indicates the results of the predictions, while Figure 3B shows our return on investment using the directives provided by the contrarian predictive model.

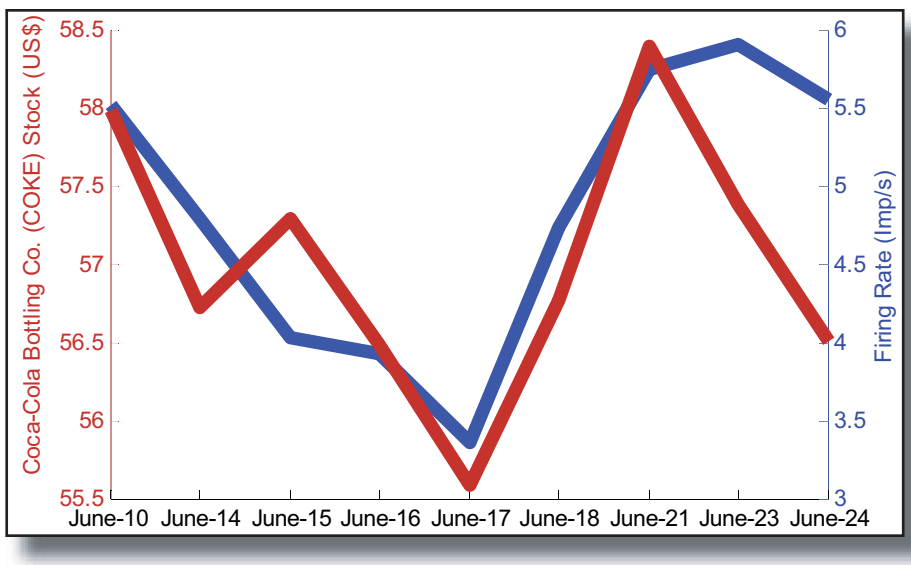

Figure 2: Coca-Cola Stock Price (red) and average firing rates of neurons (blue) from rat motor cortex over 9 days in 2004. Correlation coefficient = 0.704.

Discussion

For our analysis, we adopted the standard practice in neurophysiology where researchers will record a population of neurons, say 500, and find 50 that respond to a certain stimulus. The researchers will then decide to focus on the cells that showed responses and subject these to further statistical analysis. Thus, based on the work of our colleagues, we believe our methods are sound.

We found that stocks correlate with the firing rates of motor cortex neurons in rats. We also generalized our model to predict future stock price, and we made $435 from an initial $1000 investment in 20 days by using neuronal firing rates to predict whether to buy, short, or hold shares in Asta Funding, Inc.

Conclusion

Nobel Prize-winning economist Paul Samuelson said in a 1967 declaration to the U.S. Senate that buying a mutual fund is worse than throwing darts at a dartboard. As a consequence, index and hedge funds are now popular. We say that if you are not using a rat motor cortex model of stock price, you might as well be using a mutual fund.

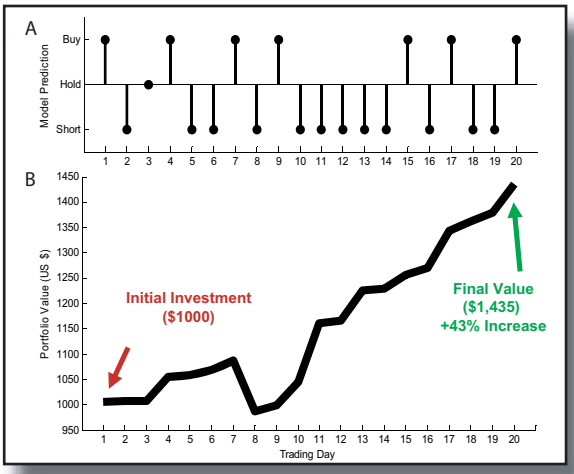

Figure 3: Results of predicting closing stock price of ASFI on day d + 1 from average firing rates on day d. **A**. *Output of contrarian prediction model.* **B**. *Simulation of US $1000 investment using trade information obtained from predictions.*

Appendectal Discussion

We are on the verge of a paradigm shift we call the Gage / Rantze / Marzullo (GRM, or the Generalized Revenue Model) Motor Cortex *Rattus norvegicus* Theory of Societal Urges. The neurons of our rats are in some mysterious way tied to humans' purchase patterns which ultimately manifest as fluctuations in the American Stock Market.

The Gaia hypothesis, proposed by James Lovelock in the 1960's, states the Earth entire is a living organism.[3] The data presented here are consistent with this theory. We are all tied in a great circle of life,[4] where our hopes, dreams, aspirations, triumphs, despairs, boredoms, and loves are inextricably linked to the creatures of the Earth. Research in 1934 proved that the solar cycles of 1929 were correlated to the closing stock prices of the London and New York stock exchanges of the same year.[5] Though we do not have access to rat motor cortex firing rates from 1929[6], our future experiments will do a triple correlation between rat motor cortex firing rates, the American and London Stock Markets, and the 2006 solar radiation flux.

We focused on rats in this study, but we would not be surprised if the stock market was correlated to the behavior of American White House squirrels, Jamaican fruit bats, Tasmanian devils, and New England codfish. As a final note, we wonder what would happen to the stock market should species become extinct. Given Earth's current global biodiversity crash and mass extinction crisis,[7] future human economic success may be neither assumed nor assured.

Notes

Results from the study were previously presented at the 2005 annual Society for Neuroscience meeting in Washington, D.C.

Conflict of Interest Statement: The authors of this study do not personally own any stocks in Asta Funding or Coca-Cola, unless one includes index funds that represent the whole stock market.

References

1. Brain-machine interfaces are devices that are controlled by the self-modulation of brain activity. The rat data presented here were acquired as part of a broad experiment examining brain-machine interface algorithm designs.
"Naive Coadaptive Cortical Control," Gregory J. Gage, Kip A. Ludwig, Kevin J. Otto, Edward I. Ionides, and Daryl R. Kipke, *Journal of Neural Engineering,* vol. 2, no. 2, 2005, pp. 52-63.

2. "Profitability of Short-term Contrarian Strategies: Implications for Market Efficiency," Jennifer Conrad, Mustafa N. Gultekin, and Gautam Kaul, *Journal of Business Economic Statistics*, vol. 15, no. 3, 1997, pp. 379-86.

3. *Gaia: A New Look at Life on Earth*, James Lovelock, Oxford University Press, Oxford, United Kingdom, 1979.

4. *The Lion King*, Walt Disney Pictures, Buena Vista Home Entertainment, 1994.

5. "Solar and Economic Relationships," Carlos Garcia-Mata and Felix Schaffner, *Quarterly Journal of Economics*, vol. 49, no. 1, 1934, pp. 1-51.

6. Curiously, 1929 was also the year that Hans Berger published the first recordings of human brain activity in his research attempting to understand the physiology of a youthful telepathic experience with his sister.

7. "Declines of Biomes and Biotas and the Future of Evolution," David S. Woodruff, *Proceedings of the National Academy of Sciences of the United States of America*, vol. 98, no. 10, 2001, pp. 5471-6.

Market Sector	mean Corr. Coeff.	n	% of total n
Basic Materials	0.03	2	3%
Consumer Goods	0.23	3	4%
Financial	0.31	24	32%
Healthcare	-0.59	10	14%
Industrial Goods	-0.19	3	4%
International	0.83	2	3%
Services	-0.41	9	12%
Technology	-0.18	16	22%
Utilities	0.72	1	1%
Not Specified	0.37	4	5%

Table 1: Market Sectors and the mean Pearson's correlation coefficients of responding stocks.

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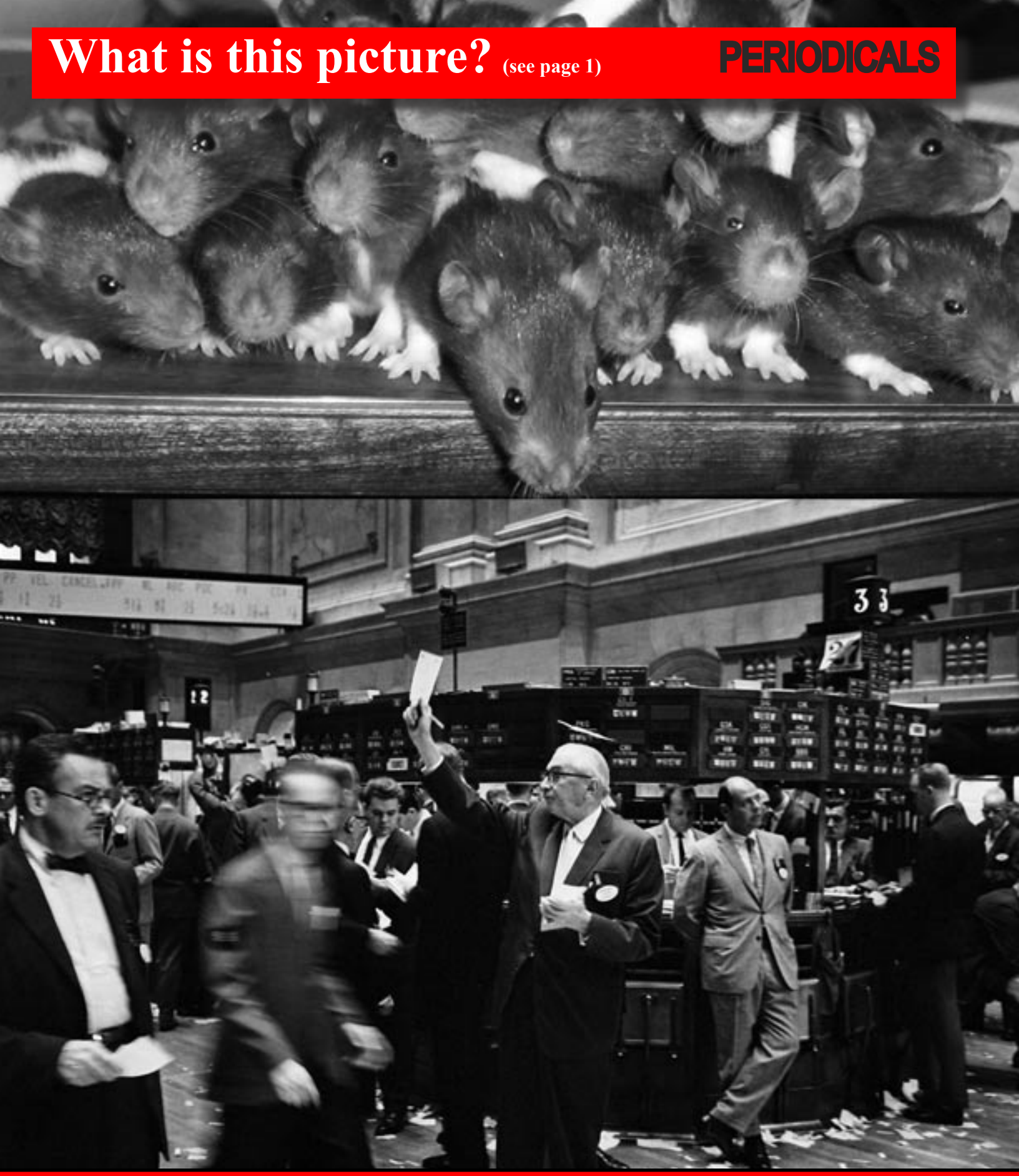

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