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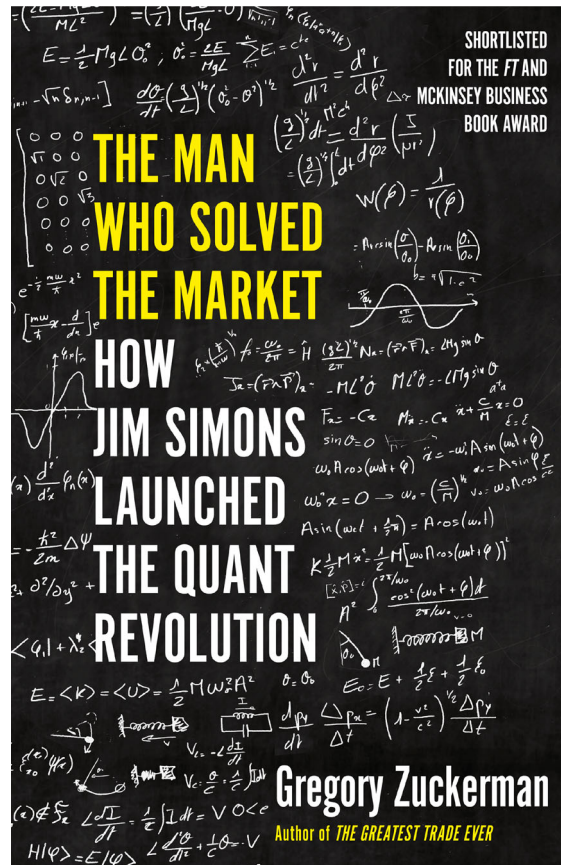# Book review

The Man Who Solved the Market: How Jim Simons Launched the Quant Revolution, by Gregory Zuckerman, Portfolio/Penguin (2019), 384 pp., illustrated, $30. Paperback. ISBN 9780735217980.

> Coffee Cart Man: Hey buddy. You forgot your change.
> Joe Moore: [Takes the change] Makes the world go round.
> Bobby Blane: What's that?
> Joe Moore: Gold.
> Bobby Blane: Some people say love.
> Joe Moore: Well, they're right, too. It is love. Love of gold.
> David Mamet, *Heist*

Gregory Zuckerman wrote a highly entertaining book about consummated love between a man and his money. The book's protagonist is James Simons (JS from now on), a distinguished mathematician, codebreaker, university professor and administrator, venture capitalist, hedge fund manager, and philanthropist. Zuckerman calls him 'the man who solved the market.' This review discusses to what extent this accolade is valid.

Zuckerman boldly dives into the mysterious and fascinating world of hedge funds. Not just the hedge fund world in general described in the American television drama Billions and other fictional narratives. This time, the story has an actual protagonist, JS, the man who built Renaissance Technologies (RT) into one of the most successful money machines in history and captivated the imagination of traders and mathematicians alike. I was one of them, coming to Wall Street in the mid-90s from academia as an established mathematician with a full tenured professorship at the University of Illinois. To me, JS was the legendary figure of a bearded, renowned mathematician who co-authored the celebrated Chern-Simons characteristic classes of 3-manifolds. I thought of him as a somewhat eccentric math genius whose deep insight into stock market dynamics enabled him to become one of the world's richest hedge fund managers. After reading Gregory

Zuckerman's book, I realized that reality is quite different from appearances. Instead of an absent-minded professor, the book portrays a very bright, rather shrewd businessman with a full appreciation for sales and marketing and not above cashing in on his name and mathematical achievements.

The book covers the interconnected story of JS's life and his brainchild – Renaissance Technologies. JS biography is indeed the stuff of legends. He was born in 1938 into a middle-class family in Massachusetts and received a fairly standard upbringing for a boy of his generation. In 1955 JS was admitted to MIT, from which he graduated among the best in his class in 1958. One of the formative mathematical facts he learned at MIT was the celebrated Stokes theorem, a far-reaching generalization of the classical Newton Fundamental Theorem of Calculus. The Stokes theorem combines geometry, calculus, and algebra to produce profound mathematical identities. JS's results, achieved during his brilliant brief career as a creative mathematician, can be viewed as an extension of the Stokes theorem. While the Newton theorem reads, see Rudin (1966), Newton (1669):

$$F(b) - F(a) = \int_a^b F'(x)\,\mathrm{d}x, \qquad (1)$$

the Stokes theorem asserts that the integral of a differential form ω over the boundary of an orientable manifold Ω is equal to the integral of the exterior derivative $d\omega$ over the whole of Ω, see Stokes (1905), Cartan (1945):

$$\int_{\partial\Omega} \omega = \int_\Omega \mathrm{d}\omega. \qquad (2)$$

After spending just two years on his graduate studies under Bertram Kostant, JS obtained his Ph.D. from Berkeley in 1962, and in 1964 he landed a job as a codebreaker at the secretive Institute for Defense Analyses (IDA). At IDA, he met Leonard Baum, a statistician, best known as the co-inventor of the Baum-Welch algorithm. This algorithm is used to this day to estimate the parameters of hidden Markov models. Subsequently, Baum helped Simons to create his famous money machine, which eventually became RT. Interestingly, JS was not ranked exceptionally high as a codebreaker. As his former boss at IDA Neuwirth recalled, 'Lenny (Baum) and some others were definitely higher than Jim in what we in management used to call "lifeboat order."'

While engaging in breaking Russian codes using statistical tools, JS and Baum co-authored a paper, 'Probabilistic Models for and Prediction of Stock Market Behavior,' that proposed a trading method that could generate annual gains of at least 50 percent. Although this paper is still classified, its overall content is known. The authors identified eight states of the market and calculated the corresponding transition probability matrix.

In 1968, at the height of the Vietnam War and ensued social unrest, JS published a letter in the New York Times against the war, which was an absolute anathema for an employee of a government contractor. As a result, he was fired by IDA.

After a short soul-searching period, JS became Chair of the Mathematics Department at SUNY, Stony Brook. He proved to be a highly efficient academic administrator capable of attracting top talent. More importantly for the story, some of the people he met at Stony Brook, such as James Ax and Sandor Straus, formed the backbone of the first incarnation of JS's money machine.

The crowning achievement of his time as a creative mathematician at Stony Brook was the discovery, made jointly with Shing-Shen Chern in 1974, of the Chern-Simons characteristic classes of 3-manifolds. To understand their result, fix a closed oriented 3-manifold X. Let $G = SU(n)$ be the Lie group of unitary $n \times n$ matrices of determinant one for some $n \geq 2$, and $\mathfrak{g}$ be its Lie algebra, which consists of $n \times n$ skew-Hermitian matrices of trace zero. Introduce a connection A on the trivial G-bundle over X, which is a skew-Hermitian matrix of 1-forms with trace zero. Then the now classical Chern-Simons invariant is given by the following formula, see Chern and Simons (1974), Freed (2009):

$$S(A) = \frac{1}{8\pi^2} \int_X Tr\left(A \wedge \mathrm{d}A + \frac{2}{3} A \wedge A \wedge A\right). \qquad (3)$$

Here the wedge products are combined with matrix multiplication. Subsequently, Witten used the Chern-Simons invariant to derive a topological invariant of 3-manifolds by integrating out the variable A, see Witten (1989), Freed (2009):

$$F_k(X) = \int_{\mathcal{F}_X} e^{ikS(A)} \mathrm{d}A, \qquad (4)$$

where k is an integer termed the level of the theory and the integral is taken over a space $\mathcal{F}_X$ of equivalence classes of connections.

For his contributions to geometry and topology, JS became the 1976 recipient of the AMS Oswald Veblen Prize in Geometry. It seemed that JS had reached the peak of his academic career. Yet, he became restless – he started to think about making money, so that in 1978 he resigned his department chair role and founded a money management company called Monemetric, and a hedge fund, Limroy. Since 1978, JS has dedicated his formidable abilities – as a manager, quant, and salesperson – to the objective of making money and more money.

Yet, unlike most hedge fund managers at that time (and many in future times to come), several fundamental principles of JS's early days as a money manager set him apart from the rest of the trading community and propelled him to future successes:

(1) Data is the lifeblood of the operation. Straus was instrumental in accumulating enormous amounts of data, which far exceeded what had been achieved by the competition. Data was not used in its raw form; instead, it was carefully cleaned so that spurious inputs, which are not uncommon even today, were carefully purged.

(2) Quantitative trading is teamwork. Not any team, of course. JS never operated in a vacuum and always relied on talented and like-minded partners to help him run his enterprises. His early collaborators were Baum, Ax, Carmona, and Straus.

(3) JS and his partners believed in a souped-up version of technical trading – not surprising, given their technical

background. They viewed with great suspicion, if not outright disdain, the Efficient Market Hypothesis. Statistical relationships, however strange, were welcome. Understanding why they worked was desirable but not necessary.†

(4) Taxes are bad for your business. From the very beginning, JS paid a great deal of attention to minimizing taxes, so Limroy was incorporated in Bermuda. Eventually, the desire to optimize his affairs would put him in the IRS and US Senate crosshairs.

(5) Initially, trading was dealing only with fixed income, currencies, and commodities (FICC), equities being conspicuously absent from the trading mix.

In 1982 Monemetric was renamed Renaissance, and in 1998 Limroy was closed and the hedge fund Medallion launched. After bringing in and subsequently discarding several influential and instrumental partners, including Leonard Baum, James Ax, Elwyn Berlekamp, the equilibrium state was reached at Medallion with Henry Laufer and Nick Patterson leading its hugely successful FICC operations. Yet, JS was continually looking to attract new people capable of bringing new ideas, not least because the Medallion-style FICC trading had reached full capacity by 1992 which prevented the fund from growing further.

These new people came from two different places – Robert Frey from Morgan Stanley's fabled trading group and Robert Mercer and Peter Brown from the IBM Thomas J. Watson Research Center in Westchester, NY. By bringing in a statistical arbitrage expert from a renowned trading shop, and two leading experts on hidden Markov chain speech recognition, Medallion managed to reach a new milestone and become a successful equity trading firm. The effort took about three years, but by 1995, the trio overcame all obstacles, which allowed Medallion to start large-scale equity trading, first domestically and then worldwide, to dramatically increase its size. Eventually, Mercer and Brown became co-CEOs of Medallion in 2010.

The main observations made by Zuckerman regarding Medallion's style are as follows:

(1) In contrast to large-scale trades typical for macro investing, the size of any given position is modest.

(2) The probability of success for a given transaction is slightly above fifty percent.

(3) Trading is done very frequently (although not on the high-frequency timescale).

(4) Every effort is made to reduce slippage, in the form of the bid-ask spread, and keep market impact to an absolute minimum.

(5) The market is viewed holistically so that FICC and equities are described by a UNIFIED model, which enables capturing their correlations correctly.

From the get-go, JS decided to attract the best and the brightest scientists with a solid background in hard sciences but little or no Wall Street experience. Surprisingly, compartmentalization, typical for many hedge funds, was conspicuously absent. On the contrary, the codebase was kept completely transparent and open to any team member to study

and contribute to. However, such openness within RT came at a hefty price: New hires had to sign onerous non-compete and non-disclosure agreements to preserve Medallion's know-how and other intellectual property. Zuckerman shares a colorful story of Belopolsky and Volfbeyn, who did not sign a non-compete document due to a clerical error and tried to launch an operation on their own. JS and his lawyers pursued them with utmost vigor and eventually pushed them out of business.

Interestingly enough, even after expanding its trading worldwide and covering all asset classes, the capacity of Medallion remained limited to ten-billion dollars due to its trading style. Zuckerman did an excellent service to the community by providing two fascinating time series: (a) Medallion's annual returns and (b) its size, shown in Figures 1 (a), (b). We emphasize that since the size of Medallion was kept relatively constant, its positively mouthwatering returns should not be confused with the compound returns produced by some of its hedge-fund competitors. Neither Zuckerman, nor others, who discuss Medallion make this simple fact sufficiently clear.

Size limitations had several implications:

(1) JS pushed all outside investors out of Medallion, which effectively became a family office serving JS, his family members, and fund employees.

(2) Search for 'trade optimization' resulted in Medallion engaging in dubious (to put it mildly) shortcuts, see United States Permanent Subcommittee on Investigations (2014). The firm purchased 'basket' options from Deutsche Bank and Barclays. By using these options, Medallion managed to 'magically transform' short-dated gains into long-dated ones, thus saving about 6.7 billion in taxes. Besides, such 'basket' options allowed Medallion to use massive leverage, way outside its leverage limits.

(3) Since the money machine was already running on all cylinders, further capital could be attracted via management and performance fees if the latter were to materialize. Hence, JS decided to capitalize on his reputation and the unparalleled performance of Medallion by launching several hedge funds, such as Renaissance Institutional Equities Fund (RIEF), for outside investors.

In 1997 I published a paper with Tom Hyer and Dmitry Pugachevsky called 'Passport to success;' see Hyer *et al.* (1997). In this paper, we introduced passport options, i.e. options on a trading account, and found a closed-form expression for their prices for zero strikes. The 'basket' options mentioned above seem to be passport options, likely with negative strikes and/or barriers, which would lower their premiums.

The foray into investing for the broader public proved a great disappointment to investors (and a boon to RT). The reasons are obvious – if RT were capable of scaling, they would have done it for themselves. The very fact that RT actively courted investors shows that all the market inefficiencies available to its investment style were exhausted. It turned out that what was left was not so good, regardless of

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† I happen to be of the same persuasion; see Lipton (2016).
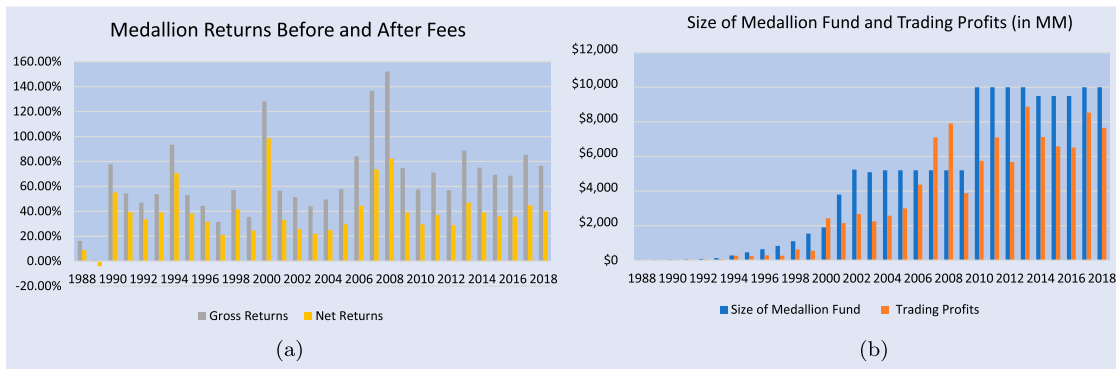
Figure 1. The magnificent Medallion: (a) Medallion returns before and after Fees, (b) the size of the Medallion Fund and its Trading Profits. Source: Zuckerman and own graphics.

how much brain and computer power one could deploy to find long-dated trading strategies.

Investors enthusiastically forgot the inconvenient truth that their investment options were nowhere near what was available to the insiders. T. J. Dunning, quoted by Karl Marx in Das Kapital, put it succinctly: 'With adequate profit, capital is very bold. A certain 10 percent will ensure its employment anywhere; 20 percent certain will produce eagerness; 50 percent, positive audacity . . . ;' see Marx (1867). In Chapter 13, Zuckerman describes a colorful episode, illustrating Dunning's point. The Robert Wood Johnson Foundation's investment team, the largest foundation dedicated to funding public health initiatives, visited RT, prepared to make a significant investment in RIEF. JS entered the room right when a thick, iced vanilla cake was placed in the middle of the table. JS was overwhelmed by an urge to smoke. A secretary brought a pack of his favorite cigarettes. There were no ashtrays in the room, so JS stuck the butt right in the cake upon finishing his smoke. Everyone expected the bemused investors to leave, yet, they duly signed the contract. By using Medallion as a carrot, RT had landed another sizable sale.

Bloomberg recently published actual returns for RIEF. We illustrate SPX and RIEF returns in Figure 2(a). Several times, RIEF did significantly worse than the index. Figure 2(b) shows that, as of now, an outside investor would be better off by investing in SPX rather than RIEF every year since RIEF inception. Investors' reaction to RIEF's losses in 2020 was severe, not least because Medallion did very well for itself and brought in another 2.6 billion dollars. Bloomberg's

headlines speak for themselves: 'Jim Simons Makes Billions While Renaissance Investors Fume at Losses,' 'Renaissance Clients Exit After Firm's Anemic Run of Results,' to mention but two. It is clear to me that smaller investors should stick with indices, while larger ones, such as sovereign funds, should do their homework and invest themselves rather than hiring hedge funds to do so.

Zuckerman spent the last few chapters of his book on the political controversies, which embroiled several senior employees working for RT, particularly its co-CEO Robert Mercer. Eventually, JS decided that Mercer had to become a regular employee for RT's greater good, making Brown the sole CEO.

Far from being a professor focused on all things intellectual, JS has accumulated the classic billionaire's trappings: a 50-million-dollar apartment on 5th Avenue, a 220- foot yacht, called the Archimedes, a Gulfstream G450 jet, to mention but a few material possessions. However throughout his career, he has been actively engaged in philanthropy. In 1994, he co-founded the Simons Foundation, and in 2004 founded Math for America with an inaugural pledge of $25 million from the Simons Foundation. He also gave money to several prominent universities, including Berkeley, MIT and Stony Brook, as well as the National Museum of Mathematics (MoMath).

In summary, Zuckerman has written a well-researched book describing JS and his *modus operandi*. I believe that the book's title is somewhat misleading because JS worked more as a builder and an impresario of the firm that collectively solved the market rather than a scientific giant who solved it
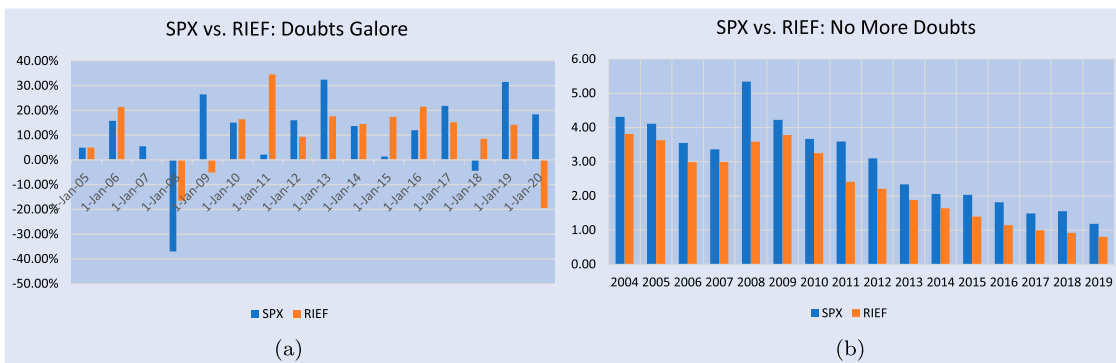

Figure 2. The mediocre RIEF: (a) SPX and RIEF net returns, (b) Investing in SPX beats investing in RIEF for every year since RIEF's inception. For example, a dollar invested in SPX and RIEF at the beginning of 2008 was worth 5.34 and 3.59 dollars, respectively, at the end of 2020. Source: Bloomberg. Author's calculations and graphics.

alone. But does this matter? Given the complexity of the problem JS tasked himself with, organizing victory is arguably more critical than achieving it on one's own. Like Lazare Nicolas Marguerite, Count Carnot, JS should be known as the 'Organizer of Victory' rather than as just the victor. Reading this book will be useful for both JS's admirers and his detractors, providing food for thought for all.

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