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SCREENING STOCKS BASED ON THE RATIONAL APPROACH TO DECISION-MAKING

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ABSTRACT. I propose a rational approach (RA) to decision-making process which, I believe, can be adapted as an alternative methodology for screening stocks. Subject to various constraints (e.g., budget, time horizon, market scope, etc.), the proposed methodology requires the consideration of several alternatives and criteria, assignment of weights of importance, and grading. Undoubtedly, decisions based on the RA ought to be characterized as rationally subjective. Naturally, the degree of rationality ought to be dependent on the capability of the decision maker to legally collect information based on the asset's history, present performance of the issuing firm, and future forecasts; of course, the higher the degree of rationality the more efficient speculator the investor would be. Using a sample of 257 randomly selected stocks I determined their future values by relying on unevenly weighted criteria related to asset's history, present performance of issuing firm, and future forecasts. After each stock was screened, a total score (TS) per stock was calculated; in turn, the stock TS was used as a test variable against future market price performance. Using receiver operating characteristic (ROC) analysis and various tests based on it, I determined the cutoff point of the TS test variable above which it pays to consider stocks favorably for inclusion in a portfolio. The results, although statistically significant at high levels, were characterized as weak and time horizon dependent: they produced an accuracy rate of about 60% for a short time horizon and about 58.5% for a longer time horizon. "Weak" though does not mean valueless: improved evaluation of stocks, shorter or longer time horizon between evaluation time and market testing, sample nature (industry-specific, local, and international) and size of sample may yield higher accuracy. Thus, searching for a cutoff point as proposed in this study is somewhat valuable for the identification of valuable stocks.

JEL codes: H54; R53

Keywords: investments; stocks; decision-making; screening; ROC analysis; statistics

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1. Introduction

Decisions to buy, hold or sell assets are not easy to make. Such decisions are sensitive to time horizon, portfolio allocation, diversifiable risk, un-diversifiable risk, and are based on asset "past," "present" performance of the entity behind the asset, and forecast about the "future" of the asset. How should one screen assets for inclusion in a portfolio? Which assets should be diagnosed (identified) as possible winners? Stock valuation to minimize diversifiable and undiversifiable risk depends, significantly, on information gathered through legal and illegal (i.e., inside information) means. Of course, if the market efficient hypothesis applies (which in its strong form states that stock prices completely reflect all available information, private or inside information as well as public) individual or institutional investors should not be able to speculate; any valuation effort would be nothing more than an exercise in futility. Although it has been demonstrated by various researchers that more established or more developed markets (e.g., US markets) function more efficiently than newly-established or developing markets (e.g., Myanmar), test results on market efficiency, especially when behavioral variables are considered, remain, to this day, inconclusive; see, among other, Chui at al. (2010), Kang et al. (2011), Nisar et al. (2012), Fama et al. (2012), Asness et al. (2013), Pyo et al. (2013), Jaggia et al. (2013), Huehn et al. (2014), and Jiang et al. (2016).

Various stock screening methodologies exist; by and large, they are based on variables ranging from quantitative (such as financial ratios) to qualitative (those associated with behavioral aspects). See Rosenberg (1993), Strong (2009), Fabozzi (1999), Sharpe et al. (1999), Barker (2001), Francis et al. (2002), Vause (2009), Arnold (2010), Jones (2010). Most prominent among these screening methodologies is the so-called "F-Score" by Piotroski (2000) and its many modified versions such as the one by Gray and Carlisle (2013) and Greenblatt (2010). Piotroski (2000) attempts to capture a stock's financial health based on 9 criteria (or signals) divided into 3 groups: profitability, financial leverage/liquidity, and operating efficiency. The F-Score is the sum of the nine binary signals; it measures the overall quality, or strength, of the stock's financial health which may help the investor decide whether to include it in a portfolio. Piotroski computes its F-Score as follows:

F-Score = ROA + ΔROA + CFO + ACCRUAL + ΔMARGIN + ΔTURN + ΔLEVER + ΔLIQUID + EQISS

where,

Profitability

ROA = return on assets (1 point if it is positive in the current year, 0 otherwise);
ΔROA = change in return on assets (1 point if ROA is higher in the current year compared to the previous one, 0 otherwise).

CFO = cash flow from operations (1 point if it is positive in the current year, 0 otherwise);
ACCRUALS = stock current year net income before extraordinary items less cash flow from operations, scaled by beginning of the year total assets. (The use of non-cash accruals is a signal that can contain information about the composition and quality of a firm's earnings.) (1 point if CFO/Total Assets is higher than ROA in the current year, 0 otherwise).

Financial Leverage / Liquidity
ΔLEVER = historical change in the ratio of total long-term debt to average total assets. (It seeks to capture changes in the stock long-term debt levels; he views an increase in financial leverage as a negative signal, and vice versa). (1 point if the ratio is lower this year compared to the previous one, 0 otherwise);
ΔLIQUID = historical change in the stock current ratio between the prior and current year. (1 point if it is higher in the current year compared to the previous one, 0 otherwise);
EQISS = set to one if the stock did not issue common equity in the preceding year, and zero if otherwise.

Operating Efficiency
ΔMARGIN = stock current gross margin ratio (gross margin divided by total sales) less the prior year gross margin ratio (1 point if it is higher in the current year compared to the previous one, 0 otherwise);
ΔTURN = stock current year asset turnover ratio (total sales scaled by beginning of the year total assets) less prior year asset turnover ratio (1 point if it is higher in the current year compared to the previous one, 0 otherwise).

Gray and Carlisle (2013), like Piotroski seek good and inexpensive (or undervalued stock), rather than bad and expensive (overvalued stock) but, despite their many trials on various measures, they end up, like Greenblatt (2010), valuing EV/EBIT (Enterprise Value / Earnings before Interest and Taxes) as the most powerful signal for a stock's value. Thorp (2017) critically describes and ranks the top such screening services out of twenty that one may find on line. According to Thorp, "many financial websites offer some level of screening, but their sophistication, and usefulness, varies. Just as stock screening is necessary to isolate potential investment candidates, this comparison is intended to highlight the 'best' services available to individual investors for fundamental stock screening."

In the rest of the paper, I propose screening of stocks based on the rational approach to decision-making (Section 2), then I deal with maximization of accuracy (Section 3), examine a longer time horizon (Section 4), and conclude and summarize (Section 5).

2. Screening Based on the Rational Approach to Decision-Making

In this paper, I would like to propose a procedure, motivated by previous examination [see Kantarelis (2017), chapter 2, titled "The Firm as a Decision-Maker"] based on what physical scientists call the scientific approach or, more conventionally, the Rational Approach (RA) to Decision Making which, I believe, can be adapted as an alternative asset screening methodology. Subject to various constraints (e.g., budget, time horizon, market scope, etc.), the RA requires the consideration of several alternatives and criteria, assignment of weights of importance, and grading. Undoubtedly, decisions based on the RA would be characterized as *rationally* subjective. Naturally, the degree of rationality would be dependent on the capability of the decision maker to legally collect information based on the asset's history, present performance of the firm, and future forecasts; of course, the higher the degree of rationality the more efficient speculator the investor would be.

According to Simon (1957, 1959), the rational approach to decision-making is relevant only in non-complex situations or situations with a small number of well-defined alternatives and criteria. Stocks are well-defined alternatives and, in my opinion, portfolios that involve a small number of stocks (in my opinion, 2 to 300 or a portfolio representative of an entire market such as the Dow Jones 30) would be appropriate for the implementation of the proposed procedure. But, in the process of choosing criteria (in terms of both number as well as clarity of definition) and attaching weights to them, we as humans, given our cognitive limitations or bounded rationality, may stumble upon complexity which would render the RA model results obsolete.[1] However, despite such concerns, I believe that the investor can still rely on rationality to minimize the subjectivity problem inherent in the proposed approach: subjective and rational is better than subjective and irrational. Additionally, periodic screenings undertaken by most rational risky investors, will contribute to learning on how to select more valuable alternatives as well as to better define, weight and grade criteria.

As shown in Figure 1, once the need for deciding has been recognized (e.g., to buy or not to buy a stock), the investor must identify constraints and establish criteria. These criteria should then be ranked and weighted according to their relative importance. Next, the investor should identify and collect information about alternatives and then evaluate each one of them, using a grading system, subject to all criteria and their weights. In turn, the alternative that scores highest, the best alternative, is selected. To quantify the process, the decision-maker may form a matrix such as the one in Figure 2.

Figure 1 The Decision-making Process

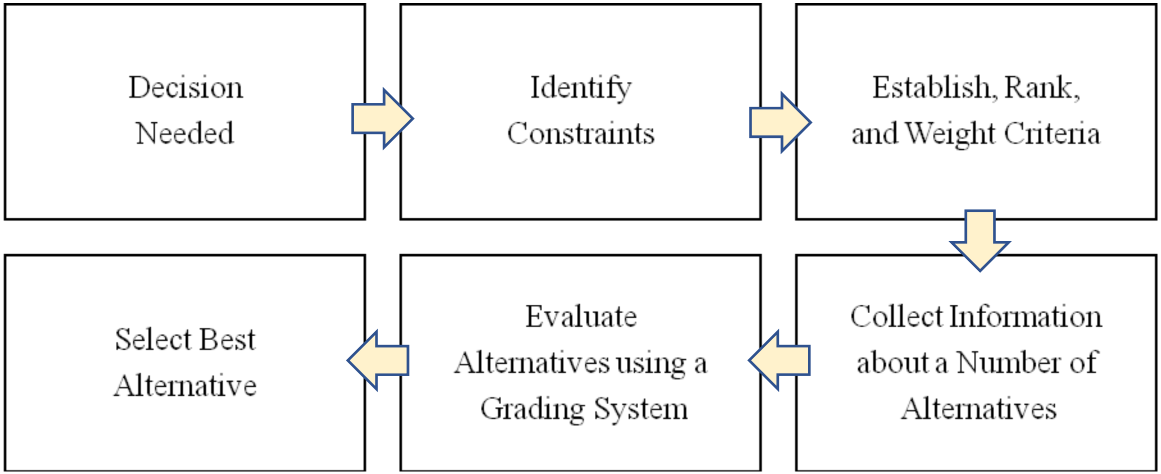


Figure 2 The Decision-making Process in Matrix Form[*]

Weights	w_1	$\cdots$	w_j	T = Total
Criteria / Alternatives	C_1	$\cdots$	C_j	
A_1	w_1G_{11}	$\cdots$	w_jG_{1j}	$TA_1 = w_1G_{11} + \ldots + w_jG_{1j}$
. . .	. . .	$\cdots$	. . .	. . .
A_k	w_1G_{k1}	$\cdots$	w_jG_{kj}	$TA_k = w_1G_{k1} + \ldots + w_jG_{kj}$

[*]A = Alternative, w = Weight of importance ($1 \leq w \leq j$, j = number of criteria), C = Criterion, G = Grade (1 = low, 10 = high), TS = Total Score

Let us consider a hypothetical decision involving stocks IBM and MSFT subject to 5 subjectively chosen criteria grouped into "Past," "Present," and "Future" as displayed in Figure 3: past (historic performance of the stock's market price), present (how well the issuing firm is managed and competes today), and future (how the firm's future is estimated in terms of five-year earnings and forecast projections). The number of criteria considered may be higher or lower but the decision maker must be able to defend the choices made; in other words, the investor is free to subjectively select any criteria for evaluation of stocks but she must be able to rationally defend both the choices made as well as the imposed weights on, and grading of, each choice. Personally, I value signals associated with "future" the most (weight = 5), signals associated with "present" the second most (weight = 4), and signals associated with "past" the least (weight = 1). With different weights but the same number of criteria, TS would vary in the interval $5 \leq TS \leq 250$. Obviously, depending on the grades that I give to each alternative, given the criterion under consideration, the higher the total score (TS) the more valuable the alternative and therefore the better candidate it is for inclusion in a portfolio.

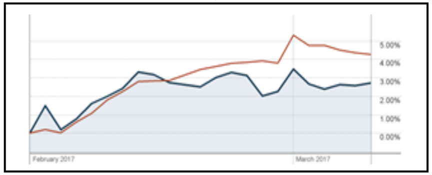
Figure 3 Example

Weights	1	4	4	5	5	
Criteria	Performance	Management	Competition	(t+1) - (t+5)	Forecast	TS
Alternatives	Past	Present		Future		
IBM	1x5=5	4x8=32	4x3=12	5x5=25	5x7=35	109
MSFT	1x7=7	4x8=32	4x9=36	5x8=40	5x8=40	155
.	.	.	.	.	.	.
.	.	.	.	.	.	.

To screen IBM's past performance, I rely on past market price data for 1, 3 and 6 months as well as 1, 3 and 10 years. Figure 4 displays IBM's past market price (blue) versus the DOW index (red). If the blue were above the red throughout the time intervals considered, I would have assigned a high grade for past performance; given the picture I see, IBM, with certainty, does not deserve a 10; in my opinion, 5 is a more appropriate grade.

Figure 4 Performance (March 2017), IBM (blue) compared to DOW (red)

(Market Price – 1 month)



(Market Price – 1 year)

(Market Price – 3 months)

(Market Price – 3 years)

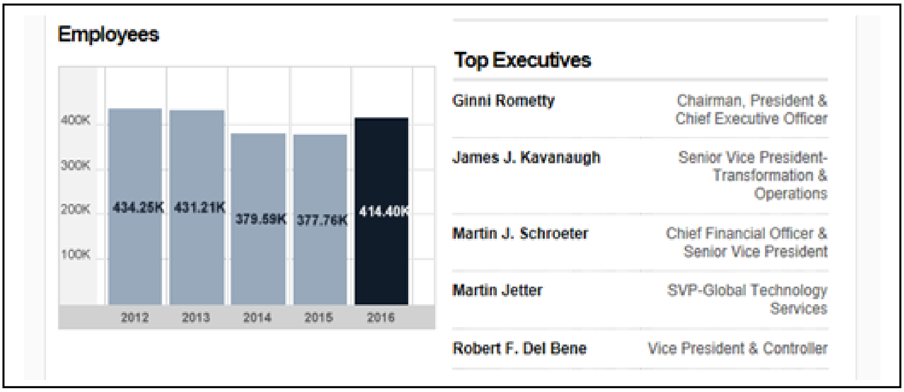
(Market Price – 6 months)

(Market Price – 10 years)

Source: money.cnn.com (charts)

To screen IBM's management, I looked for employment data and checked to see if the company experiences high, top-level, employment turnover. Figure 5 shows employment data for the last 5 years and the names of the top executives. The slight fluctuation in employment data, in my opinion, is not alarming and, given, as reported on line, that the company experiences stability (or no turnover) in top-level management, I decided to assign the grade of 8. If employment were rising, I would have assigned the grade of 9 or 10.

Figure 5 Management (March 2017)



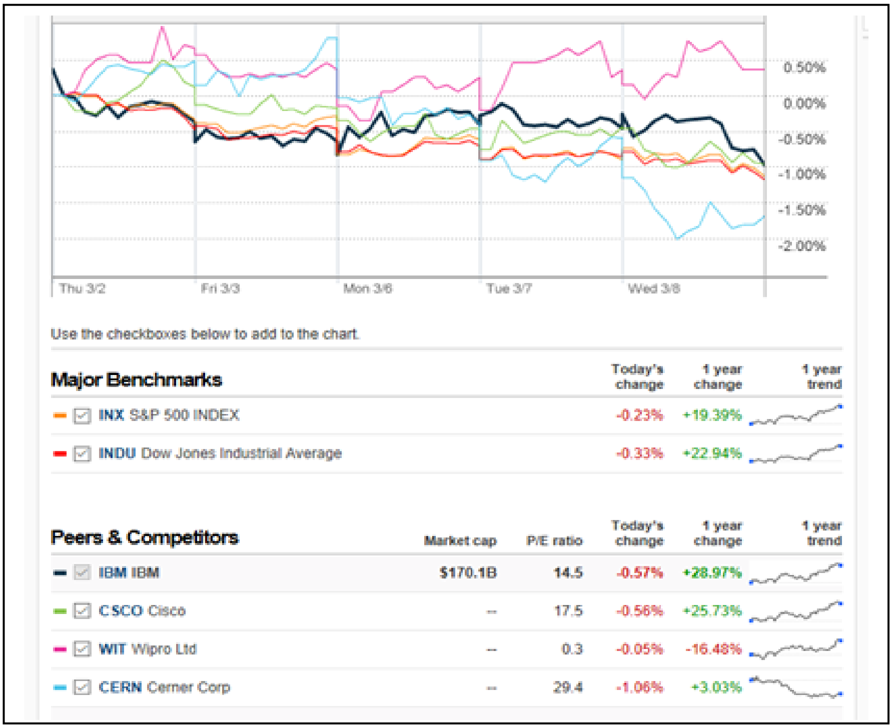
Source: money.cnn.com (profile)

In turn, to screen IBM's current competition environment, I compared the company's performance relative to major benchmarks and peers / competitors. As Figure 6 makes it clear, WIT Wipro Ltd outperforms IBM across time. However, only for some of the time interval considered the company outperforms the benchmarks and two of its competitors. Hence, for competition, I have decided to assign the grade of 3.

Finally, for future I consider earnings growth for the next five years and various forecasts provide by many analysts. See Figure 7. At best, the five-year earnings growth rate is good but not excellent; hence, I assign the grade of 5. The median stock price forecast shows decline but 22 out of 25 analysts recommend "hold" or "buy" and one that the stock will "outperform"; these forecasts compel me to assign the grade of 7.

Similarly, for MSFT. Because MSFT scores higher than IBM, it would be classified as more valuable and therefore it would be viewed as a better candidate for inclusion in a portfolio.

Figure 6 Competitive Environment



Source: money.cnn.com (Competitors)

3. Maximization of Accuracy

Undoubtedly, given the subjectivity involved in considering constraints, selecting stocks, criteria, assigning weights and grades, the results would generate true positives and true negatives but also false positives and false negatives. What total score would maximize the sum of true positives and true negatives (or, the sum of highest sensitivity and highest specificity) otherwise known as accuracy? Such a score may serve as the cutoff point above which stocks would be considered good candidates for inclusion in a portfolio. The cutoff point that generates the highest sensitivity and the highest specificity (the optimal cutoff point) would establish the Criterion Standard Test (or, the Gold Standard Test) for diagnosing the value of a stock.

In the following paragraphs, using Receiver Operating Characteristic (ROC) and Bayesian analyses, I make an attempt to compute the optimal TS cutoff point for 257 randomly selected stocks.

Firstly, in time t_1, I evaluated stocks as shown in the example of Figure 3[2] and recorded their total scores (TS) – second column Appendix 1.

Figure 7 Forecasts

Source: money.cnn.com (Quote, Forecasts)

Secondly, I matched the stock's TS computed in t_1 with the stock's market price / performance (M) in two later times: if the market price in the later time were higher than (or equal to) the market price in t_1, I assigned the number of 1; otherwise I assigned the number of 2.

Thirdly, (a) I used ROC analysis to compute "Sensitivity" and "1-Specificity" (and graphed one against the other) for every TS, the "test variable", and corresponding "M", the "state variable"; (b) then, following Froud and Abel (2014), I chose the point in ROC space that minimizes the sum of squares, MSS = min $[(1\text{-Sensitivity})^2 + (1\text{-Specificity})^2]$. The TS that corresponds to the MSS is the optimum cutoff point (the point that maximizes accuracy) above which stocks would be, rationally, more valuable candidates for possible inclusion in a portfolio.

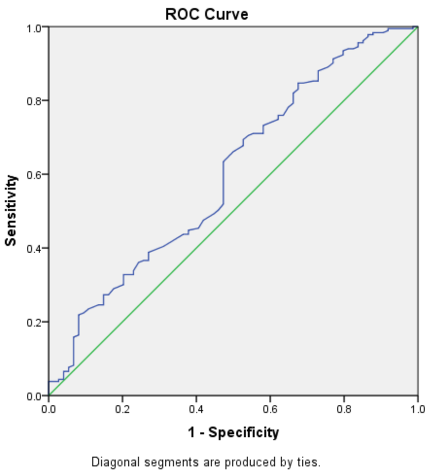
Fourthly, using the Geary test (or Runs test) I tested whether the total scores were randomly mixed about the cutoff point.

Fifthly, based on the MSS and the corresponding TS, Sensitivity and Specificity, I derived a two-way contingency table and tested, using Pearson's Chi Square test, whether the "test" and "state" variables were independent.

Appendix 1 contains names of 257 randomly selected stocks; their corresponding TS values derived January 1 ′17 as in the example of Figure 3; market prices of all stocks on February 10 ′17 (M1) and market prices of all stocks on March 31 ′17 (M2) recorded as “1” or “2” (where “1 indicates higher price relative to January 1 ′17 and “2” lower price relative to January 1 ′17).

ROC analysis, performed on the TS and M1 columns of Appendix 1, generated the ROC curve in Figure 8, the coordinates of the curve and the MSS results. As explained above, the TS that corresponds to the MSS is the optimum cutoff point (the point that maximizes accuracy); hence, at MSS=0.357747, the corresponding TS or cutoff point is 108.5 with a Sensitivity of 0.634, and 1-Specificity of 0.473 or Specificity of 0.527. As stated in the table below the curve, the zero hypothesis that the true area is 0.5 is rejected (P-Value=0.011) in favor of the alternative, indicating that the found accuracy rate of 60.1% (area under the curve) is statistically significant. Undoubtedly, a weak outcome since it is closer to the lowest possible of 50% occurring at the diagonal from southwest to northeast and lower than the highest possible of 100% at the northwest corner. “Weak” though does not mean “worthless”: improved evaluation of stocks, shorter or longer time horizon between evaluation time and market testing, sample nature (industry-specific, local, and international) and size of sample may yield higher accuracy. Thus, searching for a cutoff point as proposed in this study is somewhat valuable for the identification of valuable stocks.

Figure 8 ROC analysis results of TS vs. M1



Area Under the Curve

Test Result Variable(s): TS (Test) vs. Market Price (M1)

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.601	.040	.011	.523	.679

The test result variable(s): TS has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

Coordinates of the Curve

Test Result Variable(s): TS vs. M1

Positive if Greater Than or Equal To[a]	Sen	1 – Spe	MSS
10	1	1	1
16.5	1	0.986	0.972196
23	0.995	0.986	0.972221
25.1	0.995	0.973	0.946754
26.8	0.995	0.959	0.919706
27.7	0.995	0.946	0.894941
28.2	0.995	0.932	0.868649
29	0.995	0.919	0.844586
29.9	0.989	0.919	0.844682
31.1	0.984	0.905	0.819281
32.5	0.984	0.892	0.79592
39	0.984	0.878	0.77114
45.5	0.978	0.878	0.771368
48.5	0.978	0.865	0.748709
51.5	0.973	0.865	0.748954
53	0.962	0.851	0.725645
55.5	0.956	0.851	0.726137
59	0.956	0.838	0.70418
62.5	0.951	0.838	0.704645
64.5	0.945	0.838	0.705269
66.5	0.94	0.824	0.682576
69	0.94	0.811	0.661321
71	0.934	0.797	0.639565
72.5	0.929	0.797	0.64025
73.5	0.923	0.797	0.641138
74.5	0.918	0.784	0.62138
76	0.913	0.77	0.600469
77.5	0.902	0.77	0.602504
79	0.891	0.757	0.58493
80.5	0.885	0.743	0.565274
81.5	0.88	0.73	0.5473
82.5	0.869	0.73	0.550061
84	0.863	0.73	0.551669
85.5	0.858	0.73	0.553064
86.5	0.852	0.73	0.554804
87.5	0.852	0.716	0.53456
88.5	0.847	0.689	0.49813
89.5	0.847	0.676	0.480385
90.5	0.842	0.676	0.48194
91.5	0.831	0.676	0.485537

92.5	0.82	0.662	0.470644	116.5	0.503	0.459	0.45769
93.5	0.809	0.662	0.474725	117.5	0.492	0.446	0.45698
94.5	0.798	0.662	0.479048	118.5	0.475	0.419	0.451186
95.5	0.792	0.662	0.481508	119.5	0.454	0.405	0.462141
96.5	0.781	0.649	0.469162	120.5	0.448	0.378	0.447588
97.5	0.76	0.635	0.460825	121.5	0.437	0.378	0.459853
98.5	0.76	0.622	0.444484	122.5	0.437	0.365	0.450194
99.5	0.749	0.622	0.449885	123.5	0.421	0.338	0.449485
100.5	0.732	0.581	0.409385	124.5	0.404	0.311	0.451937
101.5	0.727	0.581	0.41209	125.5	0.388	0.27	0.447444
102.5	0.71	0.581	0.421661	126.5	0.366	0.27	0.474856
103.5	0.71	0.554	0.391016	127.5	0.366	0.257	0.468005
104.5	0.705	0.541	0.379706	128.5	0.361	0.243	0.46737
105.5	0.694	0.527	0.371365	129.5	0.339	0.23	0.489821
106.5	0.678	0.527	0.381413	130.5	0.328	0.23	0.504484
107.5	0.661	0.5	0.364921	131.5	0.328	0.203	0.492793
108.5	**0.634**	**0.473**	**0.357685**	132.5	0.311	0.203	0.51593
109.5	0.617	0.473	0.370418	133.5	0.301	0.203	0.52981
110.5	0.607	0.473	0.378178	134.5	0.29	0.176	0.535076
111.5	0.585	0.473	0.395954	135.5	0.273	0.162	0.554773
112.5	0.552	0.473	0.424433	137	0.273	0.149	0.55073
113.5	0.536	0.473	0.439025	138.5	0.268	0.149	0.558025
114.5	0.53	0.473	0.444629	139.5	0.262	0.149	0.566845
115.5	0.519	0.473	0.45509	140.5	0.246	0.149	0.590717

141.5	0.246	0.135	0.586741
142.5	0.235	0.108	0.596889
143.5	0.224	0.095	0.611201
144.5	0.219	0.081	0.616522
146	0.202	0.081	0.643365
147.5	0.186	0.081	0.669157
148.5	0.175	0.081	0.687186
149.5	0.164	0.081	0.705457
150.5	0.158	0.068	0.713588
151.5	0.142	0.068	0.740788
152.5	0.131	0.068	0.759785
153.5	0.12	0.068	0.779024
154.5	0.109	0.068	0.798505
155.5	0.098	0.068	0.818228
156.5	0.093	0.068	0.827273
157.5	0.082	0.068	0.847348
158.5	0.077	0.054	0.854845
159.5	0.071	0.054	0.865957
160.5	0.066	0.054	0.875272
161.5	0.066	0.041	0.874037
162.5	0.06	0.041	0.885281
163.5	0.049	0.041	0.906082
164.5	0.044	0.041	0.915617
165.5	0.044	0.027	0.914665
166.5	0.038	0.027	0.926173
176	0.038	0.014	0.92564
189	0.038	0	0.925444
195	0.033	0	0.935089
198.5	0.027	0	0.946729
203	0.016	0	0.968256
218	0.011	0	0.978121
239	0.005	0	0.990025
249	0	0	1

The test result variable(s): TS has at least one tie between the positive actual state group and the negative actual state group.

a. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values.

In turn, using the Geary (or Runs) test – test and results are reported below in Figure 9, I rejected the zero hypothesis (H_0) that the Total Scores (TS) were randomly mixed about the cutoff point of 108.5 in favor of the alternative (H_1).

Figure 9 Geary Test (Runs Test)

Geary or Runs Test	
	TS
Test Value	108.5
Total Cases	257
Number of Runs	101
Z	-3.168
Asymp. Sig. (2-tailed)	.002

H_0: Total scores (TS) are randomly mixed about the cutoff point of 108.5
H_1: Total scores (TS) are not randomly mixed about the cutoff point of 108.5

Given that the total number of "up" and "down" market prices under M1 of, respectively, 183 and 74, a two-variable contingency table (between "state" and "test") that corresponds to the ROC results, in other words the Criterion Standard Test (or, the Gold Standard Test) results, is reported in Figure 10. With a P-value of 0.018, the zero hypothesis (H_0) that the state and test variables are independent is rejected with a P-Value = 0.018 in favor of the alternative (H_1) indicating, as with the ROC test above, that searching for a cutoff point, as proposed in this study, is somewhat valuable for the identification of valuable stocks.[4] (For details associated with the two-variable contingency table see Appendix 2).

Figure 10 2-Variable Contingency Table (top numbers are frequencies) based on TS vs. M1

		State of Nature		
		U	**D**	
Test (Hypothesis)	**≥ 108.5**	**116** 107.5	**35** 43.5	**151** 151
	< 108.8	**67** 75.5	**39** 30.5	**106** 106
		183 183	**74** 74	**257** 257

H_0: state and test variables are independent
H_1: state and test variables are not independent

With degrees of freedom = 1, Chi-Square statistic (χ^2_{st}) = 5.6297, P-Value = 0.018

4. Longer Time Horizon

To examine the impact of a longer time horizon, I have repeated the above experiment with the data reported in column M2 of Appendix 1. The results were qualitatively the same. Quantitatively, a bit different: higher cutoff point (122.5) with lower Sensitivity (0.516) and higher Specificity (0.674), lower

ROC area (0.585) and higher P-value (0.019), higher P-value for the Gear test (0.030), and lower P-value (0.002) for the Chi-Square statistic (χ^2_{st}) of the corresponding 2-variable contingency table. These results indicate that the longer time horizon has produced slightly weaker outcomes implying that it is more difficult to project stock valuation deep into the future.

Without additional comments, the results of the second experiment, based on TS versus M2, are reported in Figures 11 and 12 of Appendix 3.

5. Summary & Conclusion

In this paper, I have proposed a procedure based on what physical scientists call the scientific approach or, more conventionally, the Rational Approach (RA) to Decision Making which, I believe, can be adapted as asset screening methodology. Subject to various constraints (e.g., budget, time horizon, market scope, etc.), the RA requires the consideration of several alternatives and criteria, assignment of weights of importance, and grading. Undoubtedly, decisions based on the RA ought to be characterized as rationally subjective. Naturally, the degree of rationality is be dependent on the capability of the decision maker to legally collect information based on the asset's history, present performance of the issuing firm, and future forecasts; of course, the higher the degree of rationality the more efficient speculator the investor would be.

Using a sample of 257 randomly selected stocks I tried to determine their future values by relying on unevenly weighted criteria related to asset's history, present performance of issuing firm, and future forecasts. After each stock was screened, a total score (TS) per stock was calculated; in turn, the stock TS was used as a test variable against future market price performance. Using receiver operating characteristic (ROC) analysis and various tests based on it, I determined the cutoff point of the TS test variable above which it pays to consider stocks favorably for inclusion in a portfolio. The results, although statistically significant at high levels, were characterized as weak and time horizon dependent: they produced an accuracy rate of about 60% for a short time horizon and about 58.5% for a longer time horizon. "Weak" though does not mean valueless: improved evaluation of stocks, shorter or longer time horizon between evaluation time and market testing, sample nature (industry-specific, local, and international) and size of sample may yield higher accuracy. Thus, searching for a cutoff point as proposed in this study is somewhat valuable for the identification of valuable stocks.

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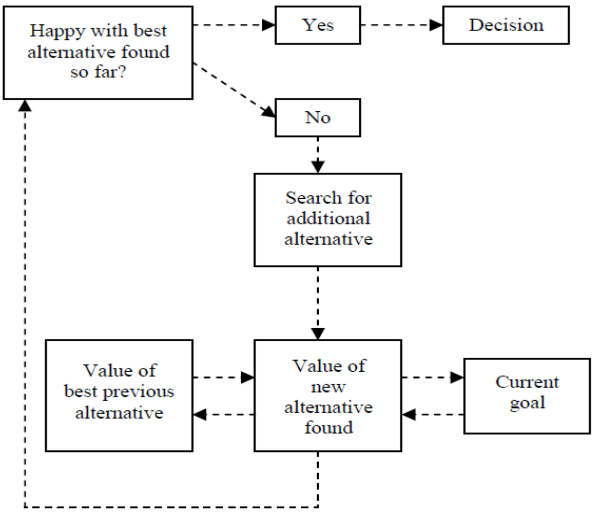
NOTES

1. In this case, we ought to rely on *satisficing*. According to Simon (1957, 1959), the rational approach to decision-making is relevant only in non-complex situations or situations with a small number of well-defined alternatives and criteria. Complexity, prevalent in most business decisions, renders the rational model obsolete because decision-makers are human which makes them subject to cognitive limitations or *bounded rationality*. Simon's model is based on the following four assumptions for decision-makers: (a) there are limitations to their knowledge of alternatives and criteria; (b) they act on the basis of a simplified, ill-structured, mental abstraction of the real world, subject to personal perceptions, biases, and so forth; (c) they do not attempt to optimize (or select the best possible alternative) but will select the first alternative which satisfies their current level of aspiration (in other words, they will experiment until a pleasing, minimum standard satisfying, alternative is found – a practice referred to as *satisficing*); (d) their level of aspirations concerning a decision fluctuates relative to the alternatives most recently selected. The flow chart below describes the satisficing approach to decision-making. [A similar flow chart appears in March and Simon (1958, p. 49)]. Given a complex choice set, satisficing may go as follows: the decision-maker defines a goal (level of aspiration) and considers several alternatives; if one of them is good enough, a decision is made in favor of that alternative; otherwise, given the same goal, the decision-maker searches for a new alternative. If the decision-maker is happy with the current choice but the goal changes, then a search for a new alternative is needed and so forth. In other words, the value of a new alternative depends on how it compares to the value of the previous alternative and, simultaneously, on how well it satisfies the latest goal. Hence, by satisficing, the decision-maker selects the alternative that meets the minimum contentment criteria and makes no real effort to optimize. Obviously, successive satisficing (such as periodic screenings undertaken by most rational risky investors) will contribute to learning on how to select more valuable alternatives as well as to better define, weight and grade criteria.



2. I am grateful to all students in the spring 2017 Investment Theory course, at Assumption College, who helped me evaluate most of the stocks based on the proposed approach; alphabetically, by last name, they are: J. Alley-Tarter, V. A. Beaulieu, V. A. Beaupre, T. P. Brengel, M. R. Carpentier, Y. Chen, J. T. Clutter, J. R. Coffin, C. S. Colby, D. I. Davies, T. W. Drohan, J. R. Dube, T. C. James, T. J. Knight, M. A. Lundstrom, T. J. McNicholas, R. L. Morgis, A. A. Pastore, M. S. Petty, S. J. Picard, B. S. Pickett, A. M. Rauf, M. S. Richard, A. A. Richardson, C. A. Smith, A. C. St. Germain, J. V. Virga, C. M. Waung, R. K. Wolff, Y. Zheng.

3. As it has been shown by Kantarelis and Kantarelis (2017), the P-Value of the χ^2_{st} associated with the Criterion Standard Test (or, the Gold Standard Test) is the lowest possible. In other words, the lowest MSS gives rise to the most statistically significant cutoff point possible.

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Appendix 1

Stock	Total Score Jan 27, '17 (TS)	Market Price Feb 10, '17 (M1)	Market Price March 31, '17 (M2)
AAN	98	2	2
AAP	80	2	2
ABM	125	2	1
ADBE	153	1	1
AEIS	130	1	1
AEL	112	1	2
AEO	135	1	2
AIG	128	2	2
AIRM	140	1	1
AKRX	126	1	1
AKS	115	1	2
ALK	156	1	2
AMP	142	1	1
AMT	153	1	1
AMZN	185	2	1
ANF	72	1	2
AOI	68	2	2
ATVI	108	1	1
AXP	124	1	1
BA	206	1	1
BABY	142	2	1
BAS	51	1	2
BBBY	88	1	2
BBRY	52	1	1
BBY	117	1	1
BCO	163	1	1
BEAV	107	1	1
BEN	82	1	2
BGFV	99	1	2
BIG	107	1	2
BIO	163	1	1
BKS	126	1	2
BMRN	149	1	2
BPFH	162	1	2
BRKB	148	1	1
BRKS	197	1	1
BSX	248	1	2
BXP	193	1	2
CAA	119	2	1
CAG	111	1	1
CAH	119	1	1
CAKE	119	1	1

COG	93	1	1	EXPE	159	1	1
COST	145	1	1	EZPW	92	2	2
CSCO	129	1	1	FALC	32	2	2
CVS	142	1	1	FB	154	1	1
CVX	120	2	2	FDX	142	2	1
DAL	143	2	2	FE	96	1	1
DDS	121	1	2	FFIV	133	1	1
DGX	124	1	1	FII	144	2	2
DIS	136	2	1	FINL	112	1	2
DISH	125	1	1	FIS	166	1	2
DKS	164	1	2	FN	160	1	2
DLTR	157	1	1	GAIN	125	1	2
DNKN	133	1	2	GALT	73	1	1
DPS	143	1	1	GBL	64	1	2
DPZ	152	1	2	GD	131	2	1
DVD	104	1	2	GLPI	80	1	1
DYN	161	2	2	GME	97	1	2
EBAY	94	1	2	GOOGL	165	2	1
EFII	147	1	1	GPS	81	1	2
EHTH	103	2	1	GRMN	82	1	1
EL	140	1	1	GST	85	1	1
ESRX	91	1	2	HAFC	81	2	2
ETN	119	1	2	HAR	132	1	1
EXAR	117	2	1	HBHC	108	2	2

HBI	167	2	1	JNPR	96	1	2
HBIO	147	1	2	JNS	120	1	2
HE	65	1	2	JPM	154	1	2
HGR	108	1	2	K	97	1	2
HHS	52	1	2	KCG	109	1	1
HOG	78	2	1	KEY	107	2	2
ICPT	102	1	2	KFY	113	1	1
IBM	109	1	1	KHC	132	1	1
IDTI	135	2	2	KLAC	100	1	1
INSM	97	1	2	KLIC	134	1	1
INTC	107	2	1	KMG	127	2	1
INTU	118	1	2	KO	103	2	1
INVA	93	1	1	KR	117	1	2
IONS	109	1	2	KSS	91	1	2
IRM	115	1	2	KWR	92	1	1
ITT	129	1	2	LDR	111	1	2
IVR	125	1	1	LEA	123	1	1
JBLU	151	1	2	LL	97	1	2
JCI	147	1	1	LLL	150	1	1
JCP	112	1	1	LMT	135	1	1
JIVE	65	2	2	LOGI	75	1	2
JKHY	108	1	2	LOW	139	1	2
JMP	111	1	1	LPNT	105	1	2
JNJ	100	1	2	LSTR	112	1	2

LZB	155	1	2	OMNT	119	1	2
MATX	11	2	2	ORLY	123	1	1
MAA	102	1	1	OSK	97	2	2
MAR	113	1	1	OWCP	46	2	1
MCD	200	1	1	OXM	124	1	1
MCO	114	1	1	PBCT	124	2	2
MNST	126	1	1	PCLN	157	1	1
MRK	200	1	1	PCYG	140	1	2
MS	116	1	2	PEP	123	1	1
MSFT	155	1	1	PETS	92	1	2
MSI	74	2	1	PLKI	128	1	1
NBIX	138	1	2	PNC	135	1	2
NBTB	116	2	2	PRU	106	1	2
NEE	132	1	1	PSA	112	1	2
NEOG	129	1	2	PZZA	144	1	2
NFLX	152	1	1	Q	78	1	1
NOV	86	1	1	QADA	150	2	2
NTAP	121	1	1	QEP	100	2	2
NTGR	125	2	2	QNST	88	2	2
NYT	99	1	2	QSII	77	1	2
OCN	83	1	2	QTM	101	1	1
ODFL	116	1	2	QUAD	122	2	2
ODP	70	1	2	RCII	45	1	1
OHAI	111	1	2	RCL	116	1	2

RGC	125	2	2	VISI	118	1	2
RL	89	2	2	VLY	123	2	2
RMD	112	1	1	VMC	151	1	2
RMTI	108	1	1	VOYA	134	1	2
RST	100	2	1	VR	118	2	2
RT	75	2	1	VZ	141	2	1
RTN	113	1	1	WCG	126	1	2
RTRX	110	1	1	WFC	151	1	2
SAM	77	1	2	WM	105	1	1
TGT	108	1	2	WMT	149	1	1
THG	70	2	2	WST	129	2	2
TM	74	1	2	WTS	118	1	2
TRIP	94	1	2	WTW	145	1	1
TROW	61	1	2	WWE	134	2	1
TRV	230	1	1	WWW	27.4	2	1
TSLA	90	1	1	XBKS	30.2	2	2
TUP	107	1	1	XEL	28	2	2
TWX	108	2	1	XIN	28.4	2	1
TXN	96	2	1	XL	30.2	1	1
TZOO	134	2	1	XMSR	87	2	2
VAR	148	1	1	XOM	29.6	1	2
VGR	100	2	2	XOXO	33	2	1
VHC	102	1	2	XPO	24	2	2
VIAB	123	2	1	XRX	26.2	2	1

XTLY	22	1	1
XUE	118	2	2
YELP	158	1	2
YHOO	124	2	1
YNDX	120	2	2
YORW	158	2	2
YRCW	52	2	2
YTEN	130	1	2
YUM	57	2	2
YUMA	145	1	2
YY	104	2	1
YZC	105	2	2
Z	88	2	2
ZAGG	131	2	1
ZBH	129	1	1
ZBRA	95	1	1
ZEUS	78	1	1
ZGNX	110	1	2
ZIXI	143	1	2
ZLTQ	54	1	1
ZN	100	1	2
ZNGA	106	1	1
ZUMZ	106	1	2

Appendix 2

State of Nature

		U	D	RMT
Hypothesis	**≥ TS**	**a (T+)**	**c (F+)**	**a+c**
	< TS	**b (F-)**	**d (T-)**	**b+d**
	CMT	**a+b**	**c+d**	**a+b+c+d**

Where P=Probability

U = Price Up
D = Price Down
≥ **TS** (valuable stocks)
< **TS** (less valuable stocks)
RMT = Row Marginal Total
CMT = Column Marginal Total
Total = N = a+b+c+d
a = True-Positive = T+ = Hit
b = False-Negative = F- = Miss
c = False-Positive = F+ = False Alarm
d = True-Negative = T- = Correct non-event

P(T+) = a|(a+c) = Positive Predictive Value=PPV
P(F+ given D) = c|(c+d)
P(F+ given "+") = a|(a+c) = P("+" wrong)
P(T-) = d|(b+d) = Negative Predictive Value = NPV
P(F- given U) = b|(a+b)
P(F- given "-") = b|(b+d) = P("-" wrong)
Prevalence = (a+b)|Total
Sensitivity = a|(a+b)
Specificity = d|(c+d)
P(Overall Accuracy) = (a+d)|Total

Among other tests, the Chi-Square statistic (χ^2_{st}) may be used, when expected frequencies are greater than 5, to examine whether the zero hypothesis H_0 (the state of nature variable and the hypothesis variable are independent) is rejected in favor of the alternative hypothesis H_1 (the state of nature variable and the hypothesis variable are not independent). Expressing the above table as follows,

	U	D	RMT
+	A_{ij}	…	TR_1
−	…	…	…
CMT	TC_1	…	N

the χ^2_{st}, with degrees of freedom (k−1)(m−1) (k = row and m = column), is

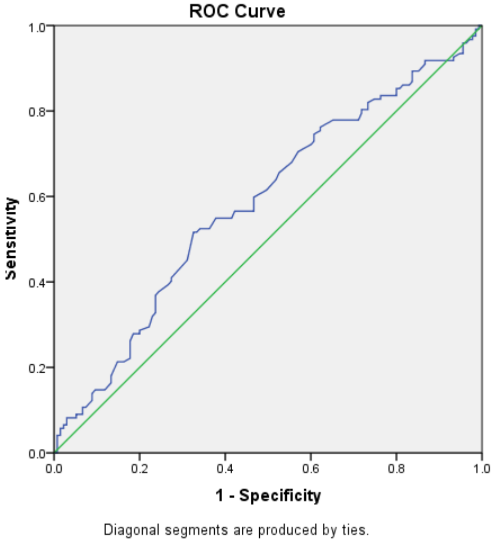
$$\chi^2_{st} = \sum_{i=1}^{k}\sum_{j=1}^{m}\frac{(A_{ij} - E_{ij})^2}{E_{ij}}, \qquad \text{where} \quad E_{ij} = \frac{(TR_1)(TC_1)}{N};$$

E_{ij} = expected frequency in the i-th row j-th column.

The H_0 is rejected, in favor of the alternative, when the P-Value is less than 0.05.

Appendix 3

Figure 11 ROC analysis results of TS vs. M2



Area Under the Curve

Test Result Variable(s): TS (Test) vs. Market Price (M2)

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.585	.036	.019	.515	.654

The test result variable(s): TS has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

Coordinates of the Curve
Test Result Variable(s):TS vs. M2

Positive if Greater Than or Equal To[a]	Sen	1 – Spe	MSS
10	1	1	1
16.5	1	0.993	0.986049
23	0.992	0.993	0.986113
25.1	0.992	0.985	0.970289
26.8	0.984	0.985	0.970481
27.7	0.975	0.985	0.97085
28.2	0.975	0.978	0.957109
29	0.967	0.978	0.957573
29.9	0.967	0.97	0.941989
31.1	0.959	0.963	0.92905
32.5	0.959	0.956	0.915617
39	0.951	0.956	0.916337
45.5	0.943	0.956	0.917185
48.5	0.934	0.956	0.918292
51.5	0.934	0.948	0.90306
53	0.926	0.933	0.875965
55.5	0.918	0.933	0.877213
59	0.918	0.926	0.8642
62.5	0.918	0.919	0.851285
64.5	0.918	0.911	0.836645
66.5	0.918	0.896	0.80954
69	0.918	0.889	0.797045
71	0.918	0.874	0.7706
72.5	0.918	0.867	0.758413
73.5	0.91	0.867	0.759789
74.5	0.902	0.859	0.747485
76	0.893	0.852	0.737353
77.5	0.893	0.837	0.712018
79	0.869	0.837	0.71773
80.5	0.861	0.83	0.708221
81.5	0.861	0.815	0.683546
82.5	0.852	0.807	0.673153
84	0.852	0.8	0.661904
85.5	0.844	0.8	0.664336
86.5	0.836	0.8	0.666896
87.5	0.836	0.793	0.655745
88.5	0.836	0.77	0.619796
89.5	0.836	0.763	0.609065
90.5	0.828	0.763	0.611753
91.5	0.828	0.748	0.589088

92.5	0.82	0.733	0.569689
93.5	0.803	0.733	0.576098
94.5	0.803	0.719	0.55577
95.5	0.795	0.719	0.558986
96.5	0.779	0.711	0.554362
97.5	0.779	0.674	0.503117
98.5	0.779	0.667	0.49373
99.5	0.779	0.652	0.473945
100.5	0.762	0.622	0.443528
101.5	0.754	0.622	0.4474
102.5	0.746	0.607	0.432965
103.5	0.73	0.607	0.441349
104.5	0.721	0.6	0.437841
105.5	0.713	0.585	0.424594
106.5	0.705	0.57	0.411925
107.5	0.68	0.556	0.411536
108.5	0.656	0.526	0.395012
109.5	0.639	0.519	0.399682
110.5	0.631	0.511	0.397282
111.5	0.615	0.496	0.394241
112.5	0.598	0.467	0.379693
113.5	0.574	0.467	0.399565
114.5	0.566	0.467	0.406445
115.5	0.566	0.452	0.39266
116.5	0.566	0.422	0.36644
117.5	0.549	0.415	0.375626
118.5	0.549	0.378	0.346285
119.5	0.525	0.363	0.357394
120.5	0.525	0.341	0.341906
121.5	0.516	0.333	0.345145
122.5	**0.516**	**0.326**	**0.340532**
123.5	0.484	0.319	0.368017
124.5	0.451	0.311	0.398122
125.5	0.426	0.289	0.412997
126.5	0.41	0.274	0.423176
127.5	0.402	0.274	0.43268
128.5	0.393	0.267	0.439738
129.5	0.377	0.244	0.447665
130.5	0.369	0.237	0.45433
131.5	0.352	0.237	0.476073
132.5	0.328	0.237	0.507753
133.5	0.32	0.23	0.5153
134.5	0.295	0.222	0.546309
135.5	0.287	0.2	0.548369
137	0.279	0.2	0.559841
138.5	0.279	0.193	0.55709
139.5	0.279	0.185	0.554066
140.5	0.262	0.178	0.576328

141.5	0.254	0.178	0.5882
142.5	0.221	0.178	0.638525
143.5	0.213	0.163	0.645938
144.5	0.213	0.148	0.641273
146	0.197	0.141	0.66469
147.5	0.18	0.133	0.690089
148.5	0.164	0.133	0.716585
149.5	0.156	0.126	0.728212
150.5	0.148	0.119	0.740065
151.5	0.148	0.096	0.73512
152.5	0.139	0.089	0.749242
153.5	0.123	0.089	0.77705
154.5	0.115	0.081	0.789786
155.5	0.107	0.074	0.802925
156.5	0.107	0.067	0.801938
157.5	0.09	0.067	0.832589
158.5	0.09	0.052	0.830804
159.5	0.082	0.052	0.845428
160.5	0.082	0.044	0.84466
161.5	0.082	0.037	0.844093
162.5	0.082	0.03	0.843624
163.5	0.066	0.03	0.873256
164.5	0.066	0.022	0.87284
165.5	0.057	0.022	0.889733
166.5	0.057	0.015	0.889474
176	0.049	0.015	0.904626
189	0.041	0.015	0.919906
195	0.041	0.007	0.91973
198.5	0.033	0.007	0.935138
203	0.016	0.007	0.968305
218	0.008	0.007	0.984113
239	0	0.007	1.000049
249	0	0	1

The test result variable(s): TS has at least one tie between the positive actual state group and the negative actual state group.

a. The smallest cutoff value is the minimum observed test value minus 1, and the largest cutoff value is the maximum observed test value plus 1. All the other cutoff values are the averages of two consecutive ordered observed test values.

Figure 12 2-Variable Contingency Table (top numbers are frequencies) based on TS vs. M2

State of Nature

Test (Hypothesis)		**U**	**D**	
	≥ 122.5	**63** 50.8	**44** 56.2	**107** 107
	< 122.5	**59** 71.2	**91** 78.8	**150** 150
		122 122	**135** 135	**257** 257

H_0: state and test variables are independent
H_1: state and test variables are not independent

With degrees of freedom = 1, Chi-Square statistic (χ^2_{st}) = 9.5674, P-Value = 0.002