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A NOVEL FINANCIAL MARKET DYNAMICS ANALYTIC FRAMEWORK AGAINST THE BLACK SWANS EFFECT

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Abstract

Inevitably the turbulence of social events, the Black Swans, will impact the economic growth and stability significantly. The polarized media and the populism amplify this impact during the survival period of the social event. To observe the impact of the event, using the leading indices such as the volatility of the financial market is a common approach of reflecting the sensitivity of the event. In the democratic society, the presidential election is the most significant social event that gives the uncertainty of the existing political courses in many perspectives. Arguably, especially when this election occurs in a divided society, the public opinions of the major media collide with the "silent" populism, will magnify the financial turbulence drastically. Mr. Donald Trump has been considered as a black swan since he became the president candidate of the Republicans Party (GOP). Many pessimistic people speculated he would jeopardize the economy if he won the election. This paper examined the poll statistics and the stock indices; not only be this paper able to disclose how the controversial election impacted the financial market, but also to show the deviation between the polls conducted by the major media and the result of the election by rigorous analytical processes. Lastly, the proposed analytic framework can be applied to any critical social events that has financial impact or not.

Keywords: Market Dynamics, Business Analytics, Analytic Framework, Black Swan Effect

1. INTRODUCTION

A ***Black Swan*** event refers to a highly improbable occurrence (Taleb, 2010) (Suárez-Lledó, 2011) with the attributes of: (1) it is subjective and arguable—since the event has not occurred yet, it was usually brought out by a group of "visionary" people, and later on it become a popular saying; (2) it is impossible to predict—too many unknown or hidden factors that tangle together and could hardly prove its existence through rigorous methodology; (3) it carries a massive impact—people perceive there would be significant negative result if that event does occur; (4) its shock value is stunning owing to the ignorance of the event—the shock would impact the society and eventually devastate the economic; and (5) its potential impact is a composite effects of non-linear behaviors—people would change the attitude about the event through time.

To further elaborate the nature of the concept of such a *Black Swan*, the **Figure 1** illustrates how the event is created and later evolved or decade through time. The *Opinion Group* addressed a *Black Swan* event might occur at the beginning. Such an event attracts the attention of *Public Opinion*; based on the receivers' *Personal Interests*, people changes their attitude and take actions to respond the *Perceived Impacts*. The essence of such an event evolves owing to the accumulative effects of actions. The changed event intensifies the *Media Propagation* that also will influence the *Opinion Group* to elaborate the concept and posit the risks further; it also reinforces the acknowledgement to the *Public Opinion*. Either the impact really occurs or more important events flood into the attention, this event will eventually decade anyway. This influence loop demonstrates the non-linearity perfectly; since such an event hardly occurs, therefor it always decades through time.

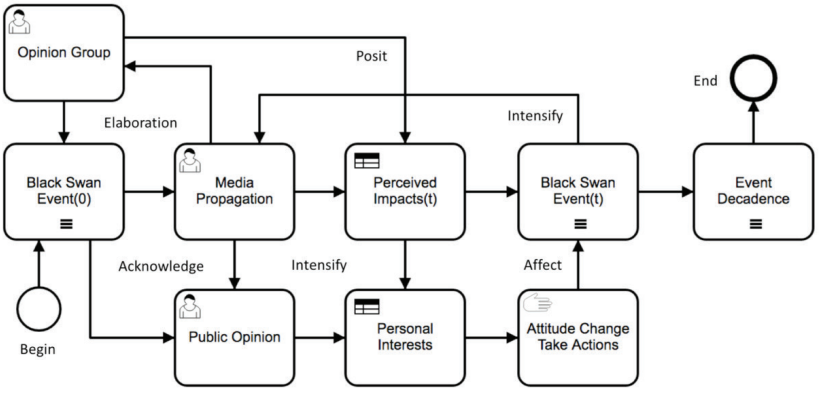

Figure 1. The Black Swan Lifecycle

Mr. Donald Trump has been considered as a black swan since he became the president candidate of the Republicans Party (GOP). Many pessimistic people speculated he would jeopardize the economy, especially the financial market (Taylor & Willams, 2007), if he won the election. This paper proposes a streamlined

analytical framework, using the *Trump Black Swan* (*see next paragraph*) as the example, from identifying the research questions, collecting these datasets, pre-processing these datasets, to correlate the social events and the stock market.

2. THE TRUMP BLACK SWAN

The major media posited *Donald Trump* as a Black Swan event if he had won the presidential campaign. This paper collected the news, total 21 articles, from the following sources, the **Table 1** illustrates the articles from their news media or magazines.

Table 1.

The Articles about Trump Black Swan Event

Media	Title
News Week	Why Donald Trump's Election Victory Isn't a "Black Swan Event" (Mccabe, 2016)
Washington Times	Donald Trump and the Real Black Swan Event-The Actual Aberration was the Election of Barack Obama (Crowley, 2016)
Politico Magazine	The Black Swan President - Donald Trump Is the Biggest Unknown Ever to Take Control of the White House. What's the Worst-case Scenario? The Best? As the Country Waits to Find out, Politico Magazine Asked 17 Experts to Game out a Trump Presidency. (Politico Magazine, 2016)
Business Insider (UK)	These 13 'Black Swans' Could Cause Market Chaos in 2017 (Martin, 2017)
CNBC	'Black Swan' Author-Nassim Taleb Says: Don't Worry about a Trump Presidency (Wang, 2016)
Yahoo Finance	Nassim Taleb: Donald Trump's Election Win Was No 'Black Swan' (Roche, 2016)
Forbes	Debunking 'Black Swan' Events of 2016 (Kuznetsov, 2017)
The Week	Donald Trump, Black Swan (Millman, 2016)
Live Mint	Why 2016 Was the Year of Black Swans - While Black Swan Events Generally Have a Negative Connotation, Some of them Might Be the Harbinger of More Positive Developments in the Long Run. (Siddhu, 2017)
Rooster Global News Network	Understanding Brexit and Trump as Black Swan Events (Hill, 2016)
Think Advisor	Black Swans, Trump's Victory, DOL Rule: Black Swan Expert Explains-Dr. Renaud Piccinini, A Risk Authority and Black Swan Expert, Discusses Trump's Election, Risk Management and the DOL Fiduciary Rule. (Rusoff, 2016)
Investors	A Trump Win - The Black Swan of 2016? (Socas, 2016)
Psychology Today	Donald Trump Is a Black Swan - The Most Interesting Aspect of Trump's Rise is its Unpredictability. (Dietrich, 2016)
The Federalist	Read More than Wikipedia before Declaring Trump's Election was a Black Swan Event - Donald Trump's Election was no Black Swan Event. The Error Here Lies in the Misunderstanding of Black Swan Probability. (McCubbin, 2016)
Stansberry Churchouse	The Best Hedge for a President Trump Black Swan (Iskyan, 2017)
Global Research (CA)	Trump and the "New Deal" of Modern Politics: Black Swans, White Sharks and Golf Diplomacy (Kampmark, 2016)

Centre for International Governance Innovation	Trump is a Black Swan - The Age of Disruption: A Series about the Risks to Globalization and the Postwar Order as the 45th President of the United States is Inaugurated (Harley, 2017)
Bloomberg	Another Black Swan for Commodities (and Everything Else) (Denning, 2017)
Market Watch	Geopolitical Black Swans are the Stock Market's Biggest Risk - Trump's Unpredictability and Eagerness to upset the Apple Cart Raise the Chance of a Crisis-Induced Swoon (Gold, 2017)
Value Walk	How to Read Trump - 'White Black Swans', 'Walking the Talk', and 'Sober Realism' Scenario (Steinbock, 2017)
Motley Fool	Is a Donald Trump Presidency a Black Swan Event for Pharma Stocks? -Donald Trump Wins! What does this Unexpected Turn of Events Mean for Pharmaceutical Stocks? (Budwell, 2016)

This paper conducted a series of text mining processes against the above articles to: (1) calculate the term frequency; (2) calculate the co-occurrence for each term; (3) extract keywords based on the co-occurrence; and (4) generate a word cloud map, illustrated in **Figure 2**, the font sizes of terms are according to their frequencies.

Figure 2. The Word Cloud about Trump Black Swan

It is obvious that many commentators discussed that *Trump* was a *Black Swan* or not, from those articles; this event could affect the global stock market, being a potential risk factor, even raising a war.

If *Trump* were a *Black Swan*, the stock market would respond to the potential risk after the polls (in favor of him) had been released. This paper hypothesizes that the stock market would be shy if *Trump* led *Clinton* in the polls. Therefore, this paper collected the quotes of the stock market and the polls history, examined the correlation between these two factors to see if the *Trump*

Black Swan effect did have some influence on the market as those commentators expected before.

3. THE SOURCE AND DERIVED STOCK DATASETS

The source datasets, *S&P500*, *NASDAQ*, and *DJI*, were collected from the Yahoo Finance[1] web site from *2016-01-01* to *2017-05-27*. Each dataset contains the following fields: (1) *Date*—the transaction date; (2) *Open*—the beginning quote; (3) *High*—the highest quote; (4) *Low*—the lowest quote; (5) *Close*—the last quote; (6) *AdjClose*—the quote after closing; and (7) *Volume*—the traded quantity for the date.

The mean quotes of the *S&P500* dataset are in the range from *5207.123* to *5255.360*, the standard deviations are in the range from *466.753* to *479.064*, and **Table 2** illustrates the detail descriptive statistics.

Table 2

The S&P500 Dataset Descriptive Statistics

S&P500	Min	Max	Mean	Std. Dev,	Variance	Skewness	Kurtosis
Open	1833.400	2414.500	2166.071	143.958	20723.890	-0.126	-0.698
High	1847.000	2418.710	2174.447	141.573	20042.865	-0.096	-0.730
Low	1810.100	2412.200	2156.789	147.533	21766.112	-0.177	-0.650
Close	1829.080	2415.820	2166.729	144.354	20837.950	-0.135	-0.692
AdjClose	1829.080	2415.820	2166.729	144.354	20837.950	-0.135	-0.692
Volume	1.58E+09	7.60E+09	3.80E+09	7.28E+08	5.30E+17	1.274	3.520

The mean quotes of the *NASDAQ* dataset are in the range from *5207.123* to *5255.360*, the standard deviations are in the range from *466.753* to *479.064*, and **Table 3** illustrates the detail descriptive statistics.

Table 3.

The NASDAQ Dataset Descriptive Statistics

NASDAQ	Min	Max	Mean	Std. Dev,	Variance	Skewness	Kurtosis
Open	4218.810	6207.040	5231.640	472.475	223233.055	0.205	-0.865
High	4293.220	6217.340	5255.360	466.753	217858.129	0.230	-0.881
Low	4209.760	6196.660	5207.123	479.064	229502.314	0.176	-0.852
Close	4266.840	6210.190	5234.299	473.129	223851.059	0.207	-0.864
AdjClose	4266.840	6210.190	5234.299	473.129	223851.059	0.207	-0.864
Volume	7.68E+08	4.41E+09	1.89E+09	3.37E+08	1.13E+17	2.162	10.920

[1] URL: https://finance.yahoo.com/

The mean quotes of the *DJI* dataset are in the range from *18597.221* to *18747.209*, the standard deviations are in the range from *1429.090* to *1475.412*, and **Table 4** illustrates the detail descriptive statistics.

Table 4.

The DJI Dataset Descriptive Statistics

DJI	Min	Max	Mean	Std. Dev,	Variance	Skewness	Kurtosis
Open	15691.620	21128.910	18673.603	1447.686	2095794.934	0.110	-0.944
High	15897.820	21169.109	18747.209	1429.090	2042298.350	0.134	-0.971
Low	15450.560	21051.410	18597.221	1475.412	2176839.425	0.066	-0.918
Close	15660.180	21115.551	18680.918	1450.573	2104163.047	0.099	-0.946
AdjClose	15660.180	21115.551	18680.918	1450.573	2104163.047	0.099	-0.946
Volume	4.59E+07	5.73E+08	1.71E+08	1.07E+08	1.15E+16	0.909	-0.280

These source datasets require additional derived fields for further analysis, the **Table 5** illustrates the formulae of these derived fields: (1) *Scale*—the discrepancy between the highest and the lowest quote; (2) *Net*—the quote difference between the end and the beginning of the date; (3) *Qty*—the logarithm of the Volume; and (4) *Score*—the hypothetic value, the square root of the summation of *Scale*, *Net*, and *Qty*, taking the spherical distance, will be used to describe the market behavior.

Table 5.

The Derived Field Formulae for Further Analysis

Derived Field	Formula		
$Scale$	$High - Low$		(1)
Net	$Close - Open$		(2)
Qty	$Log(Volume)$		(3)
$Score$	$\sqrt{\sum_{i=1}^{3}(y_i)^2}$	$y = \{Scale, Net, Qty\}$	(4)
$Normalizer(x_i)$	$\frac{x_i - \min(x)}{\max(x) - \min(x)}$	$x = \left\{ \begin{matrix} Open, High, Low, Close, \\ AdjClose, Volume, \\ Scale, Net, Qty \end{matrix} \right\}$	(5)

Based on the finding of these descriptive statistical figures, apparently, the source datasets have their quote ranges respectively, therefor, to make comparisons among themselves; all quotes must be normalized first. The formula (5) shows the idea of the normalization; after the normalization, each normalized

field has the value between *0* (the minimal value) and *1* (the maximal value). This paper streamlined the above-mentioned calculation, illustrated in **Figure 3**.

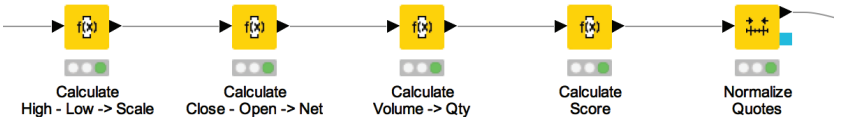

Figure 3. The Derived Fields Calculation Process Flow

After the last step of the calculation, all field values are normalized for further analysis, **Table 6** illustrates the sample result data of *S&P500*.

Table 6.

The Sample Normalized Field Values of S&P500

Date	Open	High	Low	Close	AdjClose	Volume	Scale	Net	Qty	Score
2016-01-04	0.341	0.317	0.321	0.327	0.327	0.398	0.221	0.631	0.607	0.903
2016-01-05	0.352	0.329	0.334	0.321	0.321	0.318	0.210	0.523	0.526	0.771
2016-01-06	0.299	0.298	0.299	0.293	0.293	0.384	0.249	0.687	0.594	0.942
2016-01-07	0.260	0.257	0.241	0.217	0.217	0.490	0.455	0.453	0.687	0.940
2016-01-08	0.253	0.234	0.215	0.194	0.194	0.417	0.481	0.346	0.625	0.861
2016-01-11	0.229	0.203	0.183	0.191	0.191	0.446	0.506	0.492	0.650	0.959
2016-01-12	0.233	0.219	0.205	0.216	0.216	0.379	0.439	0.627	0.588	0.965
2016-01-13	0.245	0.219	0.155	0.133	0.133	0.485	0.973	0.000	0.683	1.188
2016-01-14	0.164	0.186	0.131	0.179	0.179	0.493	0.884	0.849	0.690	1.407
2016-01-15	0.124	0.118	0.106	0.114	0.114	0.563	0.462	0.694	0.744	1.117

Lastly, this paper combined these three datasets into one model, illustrated in **Figure 4**, the process began with the loading these collected datasets, conducted the calculation mentioned above, merged these derived datasets into one result dataset, and save that one dataset for further analysis.

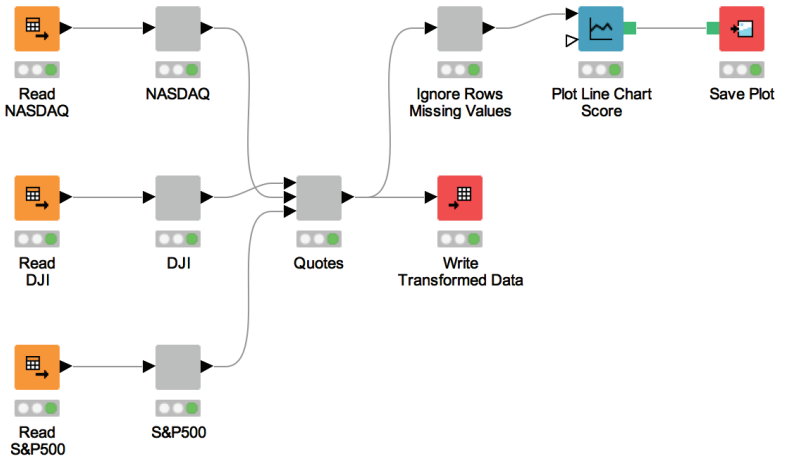

Figure 4. The Source Dataset Preparation Process

To make comparisons against all Score values, the **Figure 5** illustrates the line chart showing the various behaviors respectively. It is worth noting that the maximal *Scores* of *NASDAQ* and *DJI* occurred on the same date, *2016-06-24*.

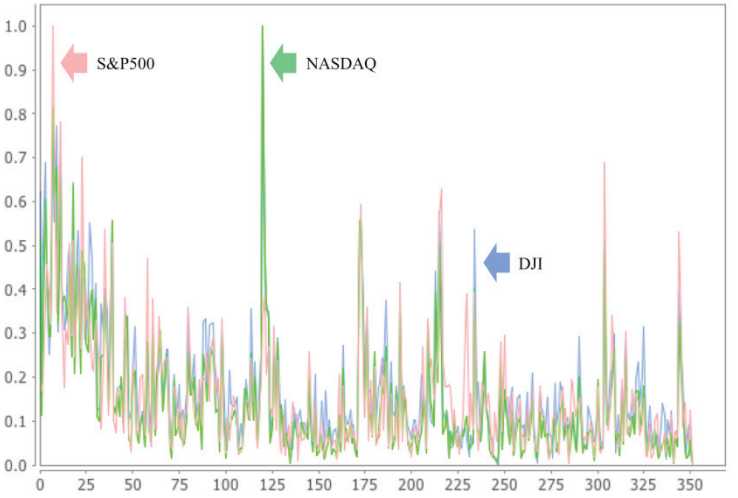

Figure 5. The Line Plot against the Score Values

4. THE POLL DATASET

This paper collected the 2016 USA presidential election poll statistics, *Trump* vs *Clinton*, from *RealClearPolitics*[2], the dataset covered the polls from multiple sources (total 29 sources, illustrated in **Table 6**) over the campaign (from *2016-01-07* to *2016-12-23*, total 259 polls). The dataset consists of the follow fields: (1) Date—the poll released date; (2) *Clinton*—the percentage of favor *Clinton* polls; (3) *Trump*—the percentage of favor *Trump* polls; and (4) *Spread*—the difference between these two polls (*Trump*% - *Clinton*%).

Table 6.

The Poll Sources

ABC News Tracking	CNN/ORC	LA Times/USC	PPP (D)
ABC News/Wash Post	CNN/Opinion Research	LA Times/USC Tracking	Pew Research
ABC/Wash Post Tracking	Economist/YouGov	MSNBC/Telemundo/ Marist	Quinnipiac
Associated Press-GfK	FOX News	McClatchy/Marist	Rasmussen Reports
Bloomberg	GWU/Battleground	Monmouth	Reuters/Ipsos
CBS News	Gravis	NBC News/SM	
CBS News/NY Times	IBD/TIPP	NBC News/Wall St. Jrnl	
CNBC	IBD/TIPP Tracking	NBC/WSJ	

Based on the poll statistics, *Trump* lead 29 polls over the 259 (11.2%); the **Figure 6** illustrates the comparison in a bar chart which consists of two parts, the upper and the lower parts. The upper part shows the polls that *Trump* lead; the lower part is when *Clinton* took lead. The number is the difference between the two polls. It is obvious that *Clinton* lead *Trump* in most of the polls (88.8%).

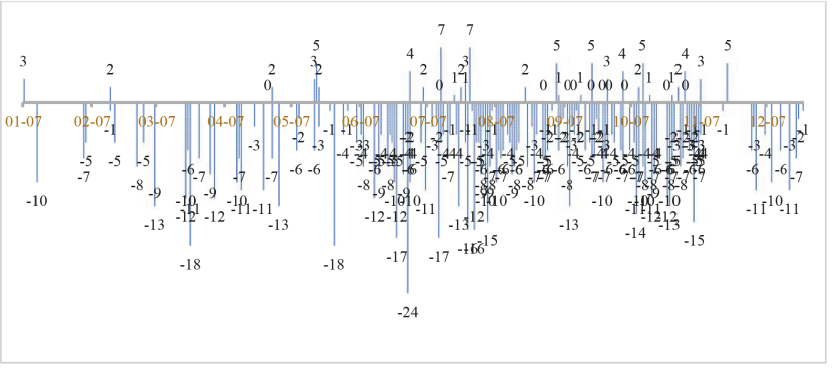

Figure 6. The Polls of Trump vs Clinton

[2] URL: http://www.realclearpolitics.com/epolls/2016/president/us/general_election_trump_vs_clinton-5491.html - polls

5. THE CORRELATION OF TRUMP BLACK SWANS

This paper hypothesizes that the stock market would reflect the trades negatively if *Trump* lead the polls next to the transaction date (mostly was tomorrow or the following business day). To analyze the correlation between the *Quotes* and the *Polls* favor *Trump* datasets, joining these two datasets according to their dates (the poll date and the next trading date) is essential, the **Figure 7** illustrates the analytic process. The process applied the co-relation among the *Scores* and conducted the polynomial regression analysis to find the appropriate power of the endogenous variables, the *Scores*. The reason why this paper chose the polynomial approach instead of the general linear one is because the stock quotes behaves sinusoidal.

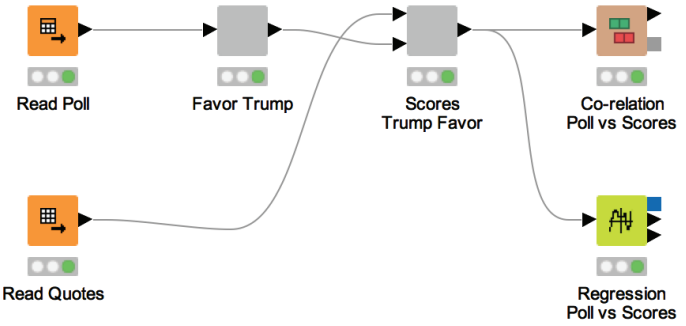

Figure 7. The Analytic Process for Correlation

The *Spread* values are all negative; it means the stock market reflected otherwise when *Trump's* polls took lead but were not significantly correlated. The **Table 8** illustrates the model statistics of the correlation.

Table 8.

The Co-relation Model Statistics

	DJI	NASDAQ	S&P500	Spread
DJI	1	0.968	0.906	-0.108
NASDAQ	0.968	1	0.944	-0.099
S&P500	0.906	0.944	1	-0.116
Spread	-0.108	-0.099	-0.116	1

To further investigate this correlation behavior, this paper conducted the regression tests and got the following model statistics, illustrated in **Table 9**. The polynomial exponent of 2 seems having better fitness according to the $P > |t|$ values. The coefficients show the opposite directions of these two exponents; certainly, the exponent of 1 model is linear regression which coincides with the above co-relation. In exponent of 2 model, *DJI* and *S&P500* were favor in *Trump*'s poll lead, but *NASDAQ* was not.

Table 9.

The Polynomial Regression Model Statistics

Variables		Exponent	Coeff.	Std. Err.	*t*-value	P > |*t*|
Score	DJI	1	-12.134	25.785	-0.471	0.642
	NASDAQ	1	27.059	25.209	1.073	0.292
	S&P500	1	-4.786	12.896	-0.371	0.713
Score	DJI	2	27.573	77.855	0.354	0.726
	NASDAQ	2	-51.534	67.623	-0.762	0.452
	S&P500	2	0.797	26.977	0.030	0.977
Intercept			1.758	1.149	1.530	0.137

If take exponent of 2 as the reference model, there is a concaved regression line of the *NASDAQ* and *DJI* respectively. The pivot points of these concaved lines show the opposite behaviors but at near the same timing, the **Figure 8** illustrates these behaviors. *DJI* was pro-Clinton and *NASDAQ* was not before the pivot points; but after that, they switched the favors. The coefficient of *S&P500* is too small to consider the significance.

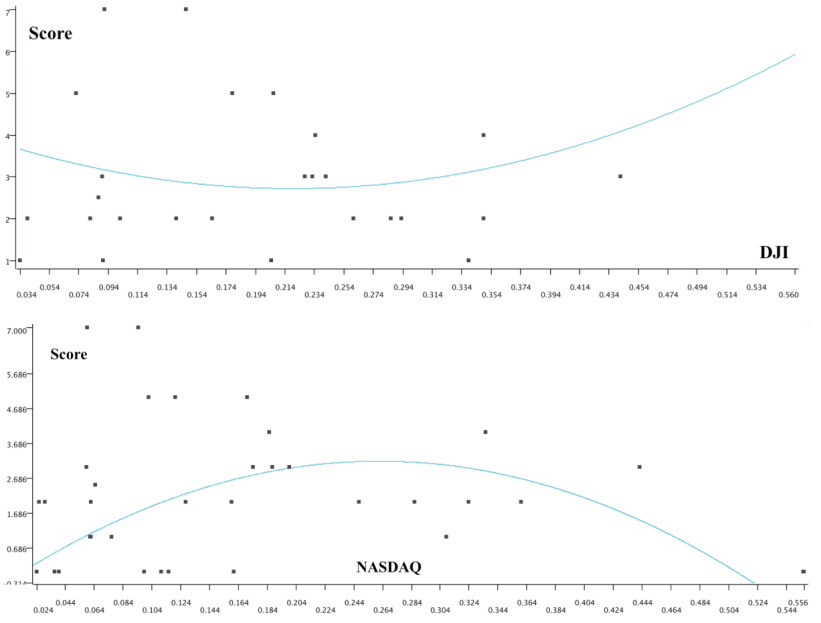

Figure 8. The Polynomial Regression against Scores

6. THE STOCK MARKET BEHAVIOR AFTER THE ELECTION

To understand whether the *Trump Black Swan* effect affected the stock market or not, this paper filtered the datasets limited the trading dates after *2016-11-08* (the election completed date) but within the same November. From the line chart below, illustrated in **Figure 9**, the *Score* behavior of all the selected stocks were nearly the same for this period.

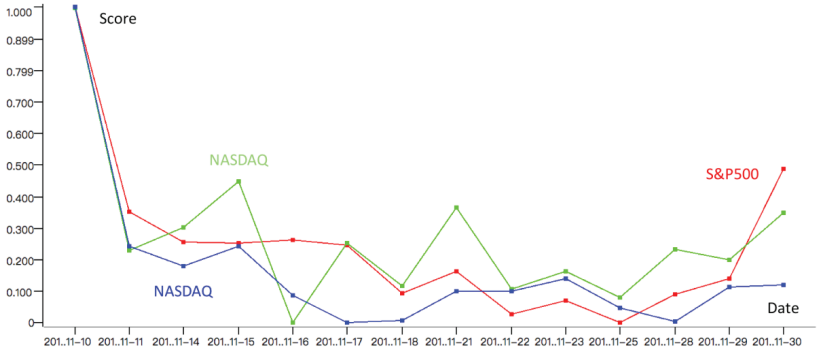

Figure 9. The Stock Market Behavior after the Election

The **Table 10** shows the correlation statistics among the *Scores*; which substantiates the *Score* behaviors were almost the same.

Table 10.

The Polynomial Regression Model Statistics

	S&P500	NASDAQ	DJI
S&P500	1	0.865	0.883
NASDAQ	0.865	1	0.891
DJI	0.883	0.891	1

7. CONCLUSION

Many *Black Swans* were brought out by the media but few could give the convincing evidence to prove whether the perceived impacts were true or not. For the *Trump Black Swan* case, the financial market did not respond as pessimistic as previously expected. A further research question should be asked; will the political populism di-route or affect the economic course? Maybe not as solid as the perception; more substantial empirical evidences are required to prove the theory. This paper discloses a feasible and operable framework to investigate the correlation between the event and the measurable impact. However, the behavior of stock market is driven by optimistic and the

pessimistic forces; many of them are unknown. The presidential election is a significant event; the stock market might have the same behavior right after the election and yet awaiting to prove.

On the other hand, this paper did not consider the velocity (how fast the *Scores* changed) and the momentum (how fast that *Scores* velocity changed). These should disclose more insights and sensitivity about the event. But this will be the extended research direction of this paper.

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