Mathematics Shows That Fake News Elected Trump as President
Harold J. Breaux (January 11, 2017 Revision)
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ABSTRACT

The phenomenon of Fake News, aimed at voters in the Presidential Election of 2016, is examined from the standpoint of voting results, demographics of voters usage of social media as source of news, slanting statistics of Fake News on social media platforms and data on voters propensity or inclination to be swayed by Fake News. A mathematical model is derived to estimate how votes were thus swung to both Hillary Clinton and Donald Trump by idealogues and entrepeneurs (and possibly Russia). The model focuses initially on the aggregation of votes needed to swing the Electoral College votes from Michigan, Wisconsin and Pennsylvania but uses a nationwide proportionality analysis for the eventual model. The end result is conclusive. Fake News led to the Electoral College Victory of Donald Trump. A remarkable numerical result from the model is that the percentage of swing votes lost to Clinton (1.07 %), (based on the reported values of 17% of social media readers having a propensity to switch after reading Fake News), when added to her actual popular vote margin of 2.22%, equals a margin of 3.29%. This compares   to the aggregate or average final poll prediction results of 3.3% for Clinton reported by Real Clear Politics [10]. So as not to rely on a single estimate of propensity to switch, a parametric analysis is conducted varying this factor. The analysis shows that this factor can be as low as 2.4% and still be sufficient to switch 379,000 votes nationally, the amount needed proportionally to swing the 39,000 votes in Michigan, Wisconsin and Pennsylvania that gave Trump the Electoral College victory.

Recent developments concern the U.S. sanctions placed on Russia for alleged interference in the 2016 U.S. presidential election. The alleged Russian involvement, along with Fake News from U.S. and other foreign sources, are topics that are intertwined because of their relationship-namely the role each might have played in skewing negative portrayals of Hillary Clinton as opposed to Donald Trump during the election.   Then, of course, one must throw into the mix the negative aspects of the Comey letter on the e-mails found on Anthony Weiner's computer and the inference that the trove contained more Clinton e-mails that had been allegedly erased or otherwise stashed away (which Comey belatedly admitted was not the case). The alleged Russian involvement is in two areas: a.) The hacking of Democratic Party e-mails and the selective leaking of contents that portray Democrats and Clinton supporters in a negative light, and b.) amplifying and accelerating Fake News that portrayed democrats and Clinton negatively. On the margin, all three factors , the Comey Letter, the Russian (twofold) involvement and the skewing of Fake News against Clinton could all have been additive factors in tilting the vote and the Electoral College to electing Donald Trump. Herein we will focus on developing a mathematical metric that will seek to determine whether Fake News alone, independent of any proof of Russian involvement, was sufficient to have swayed the election outcome from Clinton to Trump.

The internet is filled with papers, analyses and commentary on the phenomena of Fake News in the context of its effect on this topic. In particular, the general press has focused on the role of Facebook as the dominant enterprise in the circulation of Fake News . The creator and CEO of Facebook, Mark Zuckerberg, is on record as stating "*I think it was a pretty crazy idea to suggest that Fake News on Facebook helped sway the election*". Despite this denial by Zuckerberg, a concerted effort is underway both by Facebook and Google to develop a procedure that is geared toward minimizing any such effect in the future. Related to this denial or reluctance to conclude any effect on the election, Blake, Washington Post [1] relates how Trump, reacting to the Intelligence Community's report on related Russian activities, claimed in a tweet "*there was absolutely no effect on the outcome of the*

election." Blake noted that what the report did say was *" We did not make an assessment of the impct that Russian activities had on the outcome of the election.".* Trump had earlier stated*:*

> *We ought to get on with our lives because I think that computers have complicated lives very greatly. The whole age of computers has made it where nobody knows exactly what's going on."*

Additionally the news is replete with pundits and public figures expressing the opinion that despite its onerous nature, Fake News did not effect the election outcome.

There is a plethora of articles on the Internet containing various forms of surveys and anecdotes depicting how Fake News was heavily slanted in favor of Donald Trump through negative portrayal of Clinton. Silverman of BuzzFeed [2] performed an analysis of election related top twenty Fake News stories during the three month period preceding the election which generated 8.7 million shares, more than the 7.3 million shares of Mainstream News. BuzzFeed noted how one site , Ending the Fed, was responsible for four of the top ten election stories including: a.) Pope Francis endorsing Donald Trump, b.) Hillary Clinton selling weapons to ISIS, c.) Hillary Clinton being disqualified from holding federal office, and d.) the FBI Director receiving millions from the Clinton Foundation.   Buzz Feed noted that "of the 20 top performing false election stories identified in the analysis all but three were overtly pro-Trump and anti- Hillary Clintion" – a ratio of over five to one.

With a few exceptions, the preponderance of articles shy away from concluding that Fake News and/or Russian hacking and selective leaking tipped the balance of votes toward electing Donald Trump as President. One exception is an article by Max Read [3] of NY Magazine titled "Donald Trump Won Because of Facebook".   His conclusion is subjective based on descriptions of slanted coverage through Fake News with no analysis of statistics on vote switching or other numerics related to Trump's eventual win in the Electoral College.   His primary argument is a description of the reach of Facebook and its dominant role in disseminating Fake News that was heavily slanted against Hillary Clinton. Despite this reticence, statistics on the breath of social media and the nature, content, and skewing of Fake News, leads a discerning   person (this writer in particular) to contrary skepticism. Accordingly, being a mathematician by profession, this skepticism has led to seeking whether mathematics can shed light on the question of: "Did Fake News Tilt the Election to Donald Trump?" The Conclusion from Mathematical analysis (developed herein) is that Fake News did do so.

The Role of the Three Swing States, Michigan, Wisconsin and Pennsylvania (MWP)

It is clear to all that the election turned on the role of the Electoral College and the three swing states of Michigan, Wisconsin and Pennsylvania -all going to Trump by narrow margins despite Clinton having a national vote margin of 2.9 million votes. These results, taken from Wikipedia [4], are shown in Table 1 below. From this table the immediate and very stark conclusion is that an aggregate switching of merely 38,868 votes away from Clinton to Trump, in the three swing states,   (denoted hereafter as MWP) would have (and in effect did) change the course of the election. The combined 46 electoral votes of MWP led to Trump's electoral majority of 306 to 232. Had these three states voted for Clinton, her Electoral College majority would have been 278 to 260.   The fact that switching less than 39,000 votes, potentially by Fake News , could lead to election of a President, thus becomes a topic of paramount importance and has led to this in depth effort to seek whether mathematics can lead to a conclusion, which as noted, most pundits and public officials have been reticent to conclude.

Table 1: Key Vote Statistics From the 2016 U.S. Presidential Election				
	Michigan	Wisconsin	Pennsylvania	United States
Clinton	2,268.839	1,382,536	2,926,451	65,844,954
Trump	2,279,543	1405,284	2,970,733	62,979,879
Margin Trump	10,704	22,748	44,282	
Margin Clinton				2,865,075
Electoral College Delegates	16	10	20	Total MWP Delegates 46
Electoral College Votes for Candidate	Trump 306 Clinton 232			
Swing of the 46 MWP delegates would have resulted in Clinton winning the Electoral College by 278 to 260				
Trump Total Margin in Michigan, Wisconsin and Pennsylvania (MWP) 77,734				
Total Vote swing in MWP needed to swing the election away from Clinton to Trump 38,868 [77,208/2 +1]				
Total Votes in MWP* 13.2 million Total Votes in U.S. 128.8 million *Hereafter MWP represents the three states of Michigan, Wisconsin and Pennsylvania				

What Do We Know About the Fake News Phenomena?

In general the phenomena has three sources:

1. Entrepeneurs without a particular political bias who engage in the area for profit, and slant their Fake News to maximize the "clicks"- namely the number of times their site is accessed.
2.) Idealogues with a political bias who engage in the area to effect their political goal and/or otherwise solidify their beliefs
3.) The Russian (so called bot nets) whose alleged goal was both to weaken the U.S. political system and at the same time elect Donald Trump.

As we seek to develop the math model we will first seek to understand the breadth of the phenomena. This will include the numbers associated with U.S. adults use of social media, which social media platforms dominate, the nature of Fake News stories that were in circulation, how they were skewed in number and readership to each candidate, and the propensity or gullibility of individual voters to be swayed by Fake News. The variables associated with this data, and the data itself, will then be incorporated into a mathematiclal model which logically aggregates the numbers leading to an overall prediction of the number of votes switched nationally by Fake News to each candidate with the aggregate computed by a formula to be developed herein.

Assumptions and Facts: Initially we will assume that the Fake News campaign did not focus on the three states denoted above as MWP but was uniformly directed at the U.S. voting populace everywhere. From this we conclude that to proportionally change the result in MWP, Fake News would have to have affected an aggregate vote total switched away from Clinton to Trump   (for the entire U.S.) as follows:

(1) Aggregate Votes Switched Away from Clinton to Trump = 38,868 x 128.8/13.2 = 379,257 [Numbers taken from Table 1].

The proportion of 128.8/13.2 is the ratio of total votes cast nationally for Trump and Clinton (128.8 million) to that cast for Trump and Clinton in MWP (13.2 million). This reflects the assumption that if the   Fake News campaign was uniformly effective (in proportion to the vote totals by state, that while

the vote switching needing to be effective in the MWP states would be 38,868 votes, nationwide the needed switched votes would be 379,257 votes. .

The creation of a mathematical metric or model thus focuses on the proportionality factor, demographics of social media, voting statistics, the Fake News stories circulated nationwide, a measure of how they were slanted, and statistics on how the population as a whole were inclined to be swayed by reading Fake News.

The Modus Operandi of Fake News

In addition to Fake News being created by idealogues, another source arises through commercialization which works this way. The entrepreneur creates a web site on which he or she will post Fake News . An arrangement is made with a service (for example Google's AdSense) to host certain ads on the site which can and are to be accessed by clicking on the ad by any individual who accesses the Web site. The sponsor of the ad arranges with the Ad Coordinator to pay the web site provider a certain fee for each time the ad is accessed or so to speak "clicked on" leading to the phrase "pennies per click". The owner of the web site then seeks through social media sites such as Facebook, Instagram, Twitter, Pinterest, or LinkedIn or other means to entice readers to access his/her site and at the same time hopefully click on the ads. As noted commercial entrepeneurs care not who the site portrays in the Fake News - the goal is to seek the maximum readership or to maximize the clicks. One of the most reported on source of commercialization centered on a small town, Veles, Macedonia where a number of teenagerss ran Fake News stories heavily slanted toward Trump. Smith and Banic, NBC, [5] reported how the most successful teen in Veles, Dimitri, *"says he earned at least $60,000 in six months… His main source of cash Supporters of America' president elect …negative posts about Hillary Clinton a big hit".* At a penny a click this amounts to 6 million engagements- 60 million engagements at .1 penny per click.

Key Parameters and Statistics Related to Fake News

Who Accesses Social Media?: According to Pew Research [6], in 2016, 62% of the adult population in the U.S. get news from social media in general which inludes Reddit, Facebook, Twitter with Facebook, as shown in Table 4, being viewed by 68% of the 62%. The model will use this statistic as the Social Media Percentage (SMP) (SMP = 62% or .62)

Gullibility or Propensity to Vote Switching: The only data found on this topic was by Pew Research [7]. They found that only 20% of social media users say the've modified their stance on a social or political issue because of material they saw on social media and 17% say social media has helped to change their views on a specific political candidate with:

"Democrats and Liberal Democrats -are a bit more likely than Republicans saying they have ever modified their views because of something on social media."

This figure of 17 % (.17 as a probability) is the weakest of the various parameters. Hereafter it will be referred to as the G Factor, specifieds by symbols GC (switching away from Clintoin) and GT (switching away from Trump0 in the model. Rather than basing this analysis and the results of this paper on a single figure for this important factor that might be disputed, a parametric analysis will be performed . That analysis , in addition to using .17 as the base, will lower the parameters GC and GT, lower than .17 (in pairs), and determine how low the paired numbers can be -still yielding the result that "Fake News Led to Trump's electoral majority.

Slanting: Mark-Hachman[8] conducted a study on Facebook with Facebook being asked to "recommend pages to follow". He described the submissions to Facebook as posts by Smith versus White. Smith posted anti Trump articles and White posted anti Clinton articles. Hachman concluded his study with the statistic "White saw many, many more posts compared to Smith, 129 versus just 41 , over the course of two and a half days- a ratio of *three to one anti Hillary.* BuzzFeed's analysis [2], led to the observation of a *5 to 1 anti-Clinton slant.* BuzzFeed noted:

"*Of the 20 top performing false election stories identified in the analysis, all but three were overtly pro-Donald Trump or anti-Hillary Clinton. Two of the biggest false hits were a story claiming Clinton sold weapons to ISIS and a hoax claiming the Pope endorsed Trump. The only viral false stories during the final three months that were arguably aginst Trump's interests were a false quote from Mike Pence about Michelle Obama that Ireland was accepting American refugees fleeing Trump and a hoax claiming RuPaul said he ws groped by Trump.*"

Heavy News [9] , referencing a late October BuzzFeed study stated: *"hyper partisan news sites, that is sites taking a strong and obvious slant toward one candidate -38 percent of stories generated by right-wing , pro Trump sites were false … on left-leaning wing sites , … 19 percent were false "*

In the math model we will use this latter finding (a ratio of 2 to 1 anti-Clinton) as the slant namely (ST= .19, SC =.38). This is conservative in favor of Trump.

Table 2: Summary Listing and Sourcing of Parameters in the Mathematical Model				
		Symbol Used in Model	Value Used in Model	Source of values used in the Model
Total Votes	Trump Component	VT	62,980,000	Table 1 Wikipedia [3]
	Clinton Component	VC	65,845,000	Table 1 Wikipedia [3]
% of U.S. adults Getting News From Social Media	Social Media Perentage	SMP	.62	Pew Research [6]
Propensity/Gullibility Factor Fraction of Voters Claiming to be swayed to a particular candidate by Fake News	Trump Component	GT	.17	Pew Research [7]
	Clinton Component	GC	.17	
Slanting Factor	Trump Component	ST	.19	Heavy [8]
	Clinton Component	SC	.38	

The Mathematical Model and its Prediction Results

The model is essentially based on the theory of compound probability which states that if a phenomenon is dependent on a collection of independent events, each event having a specified probability, then the compound or overall probability is the product of the individual probabilities. First the probabilities of a candidate's voters switching due to Fake news is observed to be proportional to that candidates number of votes times the fraction of the population that reads Fake News. If we define VCS and VCT as votes switched away from Clinton and Trump respectively then:

VCS is proportional to VC x SMP and VCT is proportional to VT x SMP

where VC is the number of votes for Clinton , VT is the number of votes for Trump and SMP is the fraction of voters who read Fake News. To this proportionality (for each candidate) one must attach as multipliers the Gullibility Factors GC and GT and the two probabilities (in this case ratios) of how the Fake News are slanted, namely SC and ST. The overall estimate of vote switching is given by

(1)   VCS = VC x SMP x GC x SC   [Votes switched away from Clinton]   and

(2) VTS = VT x SMP X GT x ST   [Votes switched away from Trump]

The aggregate votes switched away from Clinton minus the votes switched to Clinton (or away from Trump) is given by AGVSC, namely

(3) AGVSC = VCS – VTS = VC x SMP x GC x SC   - VT x SMP x GT x ST

Using these formulas with the parameters listed in Table 2 above and the parametric values for GC and GT leads to the results in Table 3.

From thse results one observes that the Gullibility Factor can be as low as 4.6% for each of Clinton and Trump's voters and the Electoral College would still be swayed to Trump. From Table 3 one also observes that if no votes at all were switched from Trump to Clinton (GT =0), assuming no Fake News against Trump, a gullibility factor of 2.4% (GC = .024) of Fake News aimed at Clinton would have switched the Electoral College vote.

Another interesting observation is the following. Clinton's popular vote margin was 2.22 % (100x 2.87/128.8). If one focuses on GC= GT = .17 (the base number reported by Pew Research) the aggregate vote switching estimated by the math model is   100x 1.375/128.8 = 1.07 %. If one adds this latter percentage to Clinton's actual vote margin of 2.22% one gets a victory percentage of 3.29% (by adding the model prediction of the votes lost due to Fake News). Real Clear Politics [10], lists the Final Results of the RCP average from aggregating many polls taken during the period 11/2 to 11/7 2016 as 3.3%. **This is a remarkable validation of the predictive power of the mathematical model and suggests that GC and GT were in reality more likely to be in that range rather than the lower figures analysed parametrically in Table 3.**

Table 3: Parametric Results Showing Aggregate Number of Votes Switched Away From Clinton (AGVCS) as a Function of the Gullibility Factors GC and GV				
Required Votes Needing to be Switched Nationally to Tilt the Electoral College Away From Clinton to Trump 379, 257				
GC	GT	VCS	VTS	AGVCS
.17	.17	2,637,224	1,261,237	1,375,986
.17	.08	2,637,224	593,523	2,043,700
.08	.08	1,241,047	593,523	647,523
.06	.05	930,785	370,952	559,833
.05	.04	775,654	296,762	478,892
.04686	.04686	726,886	347,629	379,257
.02445	0	379,257	0	379.257

Could Facebook Alone Have Tipped the Balance to Trump?:To answer this question one observes that the mathematical model to Facebook involves changing the Social Media percentage (SMP). As shown in Table 4, of the 62% of U.S. adults who get their news from Social Media, 68% (of the 62%) use Facebook as their primary source according to Pew Research [6]. The model adjustment for Facebook alone would thus multiply the parameter SMP (. 62 for Social Media in general) to a value of .4216 obtained by multiplying .62 by ,68.   The parametric analysis for Faceboo alone is shown in Table 5.

Table 4: Distribution of the 62% of U.S. adults who get news on social media in 2016 Source Pew Research [6]	
Platform	% of Adult Users
Facebook	68%
Instagram	28%
LinkedIn	25%
Twitter	21%

Table 5: Parametric Results Showing Aggregate Number of Votes Switched Away From Clinton as a Function of the Gullibility Factors GC and GT for Readers of Facebook Alone (SMP = .4216)				
Required Votes Needing to be Switched Nationally to Tilt the Electoral College Away From Clinton to Trump 379, 257				
GC	GT	VCS	VTS	AGVCS
.17	.17	1,793,312	857,641	935,671
.17	.08	1,793,312	403,596	1,389,716
.1	.1	1,054,890	504.495	550,395
.06	.05	632,933	252,248	380,686
.06891	.06891	726,886	347,629	379,257
.035952	.0	379,257	0	379,257

From Table 5 one sees that G factors greater than 6.9% for both Clinton and Trump supporters would be sufficient to have switched the Electoral College vote to Trump. Also a G factor as low as 3.6% for Clinton, if Trump supporters had no propensity to switch (namely a G factor GT = 0), that percentage also would have been sufficient to have switched the Electoral College to Trump.

Overall Conclsions and Observations: Any effort to apply mathematics to social and political phenomena is fraught with difficulty. Unlike Physics and Mathematics there are no (or few) accepted theories or fields to which agreed upon formulas can be attached. This writer was fully aware of this at the outset but proceeded as noted in the full light of the paper's effort. The reasononing was that the current (as of Jan 6, 2017) hearings on the Intelligence Briefings regarding Russian involvement in the election plus related discussions on any potential effect on the election by Fake News have been met with most officials (when testifying or opining) following with one or the other caveats:

a,) there is no evidence that the Russians and/or Fake News generallyhad any effect on election results
b.) no analysis or conclusion was made with respect to social media and/or the Russians having an effect on the election results

I disagree with a,) above. What I agree with is the following: It is difficult to put numbers to determine how voters are/were influenced by information and points of view, in particular, information that is purposely false and whose falsity was designed so as to create a point of view which would lead the viewer/reader to favor or disfavor a candidate. As a result, most pundits or officials, who have no facileness with mathematics or analytic analysis shy away from making the claim of the factors cited as having any effect on the election.

This writer has had the following experience in scientific circles: A scientist, delving in a new area of endeavor, writes an early, perhaps first paper, on a topic and subjects it to peer review and publishes the paper in the general and open literature. Any aspect of the writers claim , perhaps a new theory or finding, is thus free to be examined, critiqued and possibly found to be partly or totally in error. This is all to the good because in the end, such a paper, advances the state of knowledge and in particular works toward defining the degree to which there is a measure of agreement or certainty on the specified topic. And finally one should note that if that scientist, who wrote the first paper on the topic, had shyed away from doing so for fear of criticism and possibly being wrong, then the subject of the topic would either remain obscure or too long be subject to conjecture..

It is clear that the broad and extensive reach of Social Media was harnessed by creation and circulation of Fake News toward a corrupt end in the election of 2016 and is a huge current and future threat to our democracy. The CEO and founder of Facebook, Mark Zuckerberg, denying that Facebook had any effect on the election result, further exacerbates this concern. So my call to individuals who may agree or disagree with the essence of my paper I say " please have at it- critique my methodology and/or results with your best shot but please do it with logic, analysis and reasoning. " Also please document and provide your analysis in a web accessible forum so that the collegiality (and state of understanding and acceptance) I described above for the scientific process can occur and be furthered.

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