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Fanbots and Corporate Computational Propaganda: The Case of Tesla

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Executive Summary

Since the delivery of the first Roadster in 2008, Tesla has been the vanguard manufacturer leading the modern renaissance in electric vehicles. Although the firm's strategic position in 2022 seems unassailable, the preceding 15 years were characterized by multiple passage points, and the outcome was never as obvious or certain as it appears in retrospect. Looking at the period from the firm's IPO in 2010 to the end of 2020, this paper reports upon one possible contributing factor to Tesla's success: a set of algorithmic Twitter accounts (Fanbots) that generated pro-Tesla content (Corporate Computational Propaganda) which may have buffered the firm against negative news and amplified positive sentiment. The paper describes the extent of the activity of these accounts and the implications of this strategic resource for Tesla and potentially for other firms.

Keywords: Business Model, Case Study, Finance, Promotion, Strategy

1. Introduction

For decades, the electric vehicle has been the "car of tomorrow" but never the car of today [1], [2]. Notwithstanding annual predictions about this year finally being the year of the electric car, recent developments suggest that the automobile industry may truly be on the cusp of electrification. Nearly every automaker from GM to Lamborghini has announced plans to build and market one or more electric automobiles, and numerous startups have entered the electric vehicle market. In this sense, electric vehicle leader Tesla may have accomplished its initial mission statement, "to accelerate the world's transition to sustainable transport," making co-founder Elon Musk one of the wealthiest people alive in the process.

Among the many possible reasons advanced to explain Tesla's success, and resulting valuation, this paper identifies a potentially novel contributing factor: the creation of algorithmic Twitter users that generated pro-Tesla content, totaling as much as one fifth of the volume of tweets about the firm. This computational content may have buffered the Tesla narrative from an emergent group of critics, relieved downward pressure on the Tesla stock price, and amplified pro-Tesla sentiment from the time of the firm's IPO in June 2010 to the end of 2020. To the best of our knowledge, the existence of this computational content has not been previously identified or reported upon.

Proceeding from the concept of narrative and its importance to the way stakeholders – including investors, customers and policymakers – interact with an entrepreneurial firm, this paper argues that the Tesla narrative was both expansive and central to the company's strategic plan. It then explores CEO Elon Musk's use of Twitter to engage followers – who can be drawn from any of the stakeholder groups – in order to sustain and advance this narrative. Alongside the many fans (Fanboys) of Musk and Tesla, the paper identifies a set of algorithmic Twitter accounts (fanbots) that generated pro-Tesla content (Corporate Computational Propaganda) and proposes that this content may have supported the firm's narrative. The conclusion explores the

implications of fanbots and CCP as a new category of strategic resource, which may be adopted by other firms, as well as potential limits to this strategy.

2. The Tesla Narrative

Narratives matter for firm reputation and performance [3]–[5]. For a narrative to work, it must attract believers. Believers of firm narratives are often novice investors, "noise traders" who buy and sell stock based on prevailing sentiments [6]. Of the many "narrative stocks" in the market, Tesla is an anomaly due to the large size of its market capitalization and the high visibility of its central actor, CEO Elon Musk.

2.1. Narratives.

Observers who have followed the trajectory of Tesla have documented multiple, overlapping narratives that supporters of the firm, especially CEO Elon Musk, have deployed to strengthen belief in the firm's ultimate success [7]. Without evaluating the specific claims underlying each narrative, we see each narrative appealing to the preferences and beliefs of different subsets of investors. At various points, these narratives have included:

2.1.1. Environment.

Tesla is an electric vehicle company whose products will help save the world by reducing global emissions of greenhouse gasses associated with the use of traditional, internal combustion-based vehicles.

2.1.2. Software.

Tesla is a software company whose software happens to be embedded in electric vehicles; however, long-term value will be derived from Tesla's identity as a tech company that can (i) experiment with new technology, (ii) update software quickly "over the air," and (iii) outcompete incumbent manufacturers on the basis of Tesla's superior data.

2.1.3. Battery.

Tesla is a battery company whose world-leading battery technology will allow it to (i) rapidly build scale, (ii) dominate the emerging stationary battery market, and (iii) outcompete manufacturers who procure batteries in the open market.

2.1.4. Elon Musk.

Tesla has Elon Musk as its CEO, the most dynamic and visionary business leader of the past decade. Part Steve Jobs, part Henry Ford, Musk's ability to lead the firm will insure its long-term survival and eventual dominance of the EV market.

2.1.5. Autonomy.

Tesla is an autonomous vehicle company whose market-leading "Full Self Drive" technology will put millions of Tesla "robotaxis" on the roads, providing driverless passenger service as a revenue enhancer for owners of Tesla cars.

2.1.6. First mover advantage.

Because Tesla is the first, successful, new entrant in the electric vehicle market, the company has been able to take maximum advantage of (i) federal loan guarantees intended to stimulate the growth of alternatives to internal combustion, (ii) subsidies for would-be purchasers of Tesla's products, and (iii) investors seeking a

stake in the predicted electrification of the global automobile market. Subsequent entrants will not be able to take advantage of these advantages, will face competition from Tesla, and will therefore experience more limited growth opportunities.

2.1.7. Other.

Additional narratives have stressed the synergies arising from the combination of some of the base narratives identified above, as well as Tesla's promised expansion into related markets such as light duty trucks (Cybertruck), long-haul trucking (Semi), energy generation (Solar Roof) and storage (Powerwall).

2.2. Consequences.

Arguably every equity financed firm raises funds against a narrative about what the firm proposes to do with the funds it is seeking to raise [8]. Often, such narratives come to naught. For example, the now-infamous blood-testing startup Theranos, led by Elizabeth Holmes, effectively used narrative to raise nearly $1B from private investors. In general, new and scaling ventures do not generate the type of standard financial metrics that public investors and analysts use to assess valuations tied to *investment* narratives. Therefore, such firms have no choice but to rely upon broader, less investment-specific narratives to justify valuations. Over our window of observation from IPO in June 2010 to the end of 2020, Tesla Motors (later Tesla) generated negative earnings totaling $5.7B. The company produced losses in all but 10 of the 42 quarters in this period. Yet, over the same period, investor support for Tesla remained strong. Continuing belief in the prospects of Tesla – both in general, *the* narrative, and in specific rationales, the *sub-narratives* – allowed the firm to raise approximately $17B and end 2020 with a market capitalization that neared $670B. The objective drivers and catalysts of the firm's value, as laid out in 2.1.1-2.1.7, may not have justified this market value [9], [10]. Therefore, there may be alternative drivers of valuation in the case of Tesla that are related to the firm's narrative. Though we cannot definitively measure the impact of the multiple narratives on Tesla's valuation, several knowledgeable observers believed that the firm was overvalued based upon estimates of future performance at several points during the study period (see sample valuation estimates in Figure 1).

3. Tesla, Elon Musk and Twitter

Tesla CEO Elon Musk has never behaved like the CEO of an automobile manufacturer or of any publicly-traded company. Among business leaders, Musk stands out for his unique combination of a "mad scientist", genius salesman and impulsive Twitter user. In fact, Musk is the most widely followed business person on Twitter, making the micro-blogging platform a mass-market outlet for marketing his vision and, at times, hosting his antics. Reading between the tweets, Musk's Twitter activity constitutes a novel tool for corporate engagement, mobilization and polarization.

3.1. New communication tool in support of narrative.

Tesla CEO Elon Musk proved particularly adept at attracting followers on Twitter. He further demonstrated the ability to mobilize those followers to act in support of his agenda and thereby insulate the Tesla narrative from critics. In turn, Twitter provided the perfect marketing platform for Musk and Tesla, allowing the firm to directly reach potential customers and shareholders at scale free of charge [11].

3.2. Non-traditional marketing.

Unlike most incumbent automakers who spend approximately 8% of sales on paid advertising, Tesla does not have a traditional marketing budget. Awareness of and interest in the company has accumulated over time via various "free media" such as Twitter followers and news stories about Musk and the company. Musk also combines marketing with other corporate functions, as apparent in new product demonstrations, all of which are aired online. Given Tesla sells its vehicles online, it makes sense to engage consumers and investors

through various digital channels. Across these channels, Musk is able to promote more than electric vehicles; he is empowered to advance the narrative, his grand vision for Tesla. Musk's activities on Twitter constitute Tesla's principal marketing effort.

3.3. Material information.

Among corporate CEOs, Musk pioneered the use of Twitter as a means of communicating directly with corporate stakeholders [12]. Although this behavior sometimes ran afoul of emerging regulatory rules that forbade disclosing material statements via irregular channels, Musk effectively rewrote the rulebook regarding CEO use of social media. He and the company each paid $20 million fines for statements that regulators concluded had misled investors, but in the larger context, this was a small price to pay.

3.4. Mobilization.

Among business leaders, Musk is a standout figure on social media with access to more than 40 million twitter followers (as of December 31, 2020, the end of our sample period; that number has since increased to ~79 million as of March 23, 2022). During the study period, no other CEO had anywhere near as many Twitter followers as Musk. Many of these followers are supporters of Tesla and Elon Musk, who frequently corresponded via Twitter about topics ranging from vehicle design (e.g., Cybertruck) and rocket science (e.g., Falcon 9) to cryptocurrency (e.g., Dogecoin) and Covid-19 (e.g., Fremont lockdown). The degree to which Musk engages with followers is uncommon in business communication, as is the style of this communication, which often included humor (e.g., S3XY EV model naming acronym), innuendo (e.g., stock price surpassing $420.69) and avoidance (e.g., never acknowledging critics directly). Sample tweets depicting these topics and styles are included in Figure 2. This engagement enhances the follower experience, turning them into "fanboys", who mobilize in support of the firm and CEO.[1]

3.5. Polarization.

While Musk's deft use of Twitter delighted and engaged the fanboys, the techniques he employed also mobilized a subset of Twitter users to challenge and oppose Musk, leading to polarization. In fact, the very actions that delighted the fanboys were often the same ones that aggravated and inflamed the critics. For example, when Tesla fanboys outed ("doxxed") the anonymous Twitter user @MontanaSkeptic, who argued the "bear" case for the firm based upon fundamental financial analysis, Musk threatened to sue him and his employer, effectively silencing one of his most vocal critics [13]. While Musk pleased the fanboys, his attack on @MontanaSkeptic and taunting of critics in general (e.g., sending "short shorts" to institutional short sellers) generated a sharp response from other critics, prompting more to join the critics' conversations. For tractability, we have identified the critics' conversation as operating under the hashtag and cashtag TSLAQ, with the fanboys operating under TSLA [14].

4. Fanbots and Corporate Computational Propaganda (CCP)

Among the considerable volume of Twitter content related to Tesla that was posted under the various hashtags (#TSLA/#TSLAQ) and cashtags ($TSLA/$TSLAQ), a subset of tweets appeared to have been generated by algorithms, not human users. The existence of the bot users that posted this content raised several further challenges. These included distinguishing human users from bot users and estimating the relative importance of fanbot content within the overall corpus of tweets relating to Tesla. Compared to algorithmic Twitter content about other prominent tech firms, Tesla fanbots are more active, suggesting that supporters of the Tesla narrative may have felt that supporting the Tesla narrative on Twitter was more central to the success of Tesla

[1] The "fanboy" or "fanboi" label had attached to admirers of Apple and its charismatic CEO Steve Jobs. In the years since Jobs' death in 2011, Elon Musk emerged in surveys as the most admired tech CEO. The website techopedia defines a fanboi as "someone who is unusually attracted or devoted to a particular technology or tech company."

than for other companies. However, we do not conclusively demonstrate that the price of Tesla stock was influenced by the fanbots.

4.1. Identification of fanbots.[2]

The presence of bot content in the Tesla twitter collection was indicated by the observation of a particular anomaly. Among the set of most active accounts, a subset of users had been created in close proximity both to each other and to negative news about Tesla. On the evening of November 7, 2013 – following a steep drop in the price of Tesla shares and amid general reporting about fires associated with Tesla's Model S sedan – eight Twitter accounts were created within a span of 75 minutes (see Table 1). These accounts would post almost 25,000 $TSLA and over 5,000 #TSLA tweets over the ensuing 7 years. The nature and timing of these tweets did not resemble those of a human user as they were cyclical throughout a 24-hour day (see Figure 3). To identify fanbots, user names were evaluated using an off-the-shelf IS platform known as Botometer [15], [16]. This tool processes the language, timing, frequency and other aspects of a user's tweets to generate a score between zero (likely human user) and 5.0 (likely programmed user). For example, the Twitter account of one of the authors of this paper, David Kirsch, has a Botometer score of 0.4 (likely human) whereas the account of Tesla's central actor, Elon Musk, has a Botometer score of 1.4 (also likely human). For this study, any user with a Botometer score equal to or greater than 4.0 is treated as a programmed account, or fanbot. Within the 400 most active $TSLA and #TSLA Twitter accounts by volume of tweets generated over the study period, there were 95 and 143 fanbots, respectively, with an overlap of 24 accounts. Of these fanbots, 81 and 126, respectively, were created following the IPO of Tesla, with an overlap of 21 accounts. In total, 186 unique, post-IPO fanbots were identified among the most active $TSLA and #TSLA Twitter accounts (see Figure 4).

4.2. Magnitude of fanbot content.

During the study period, there were nearly 4.2 million tweets containing $TSLA. Of these tweets, approximately 1.4 million (or 33%) were posted by the top 400 $TSLA accounts and more than 400,000 (or 10%) by fanbots identified within these top accounts. Over the same time, there were approximately 157,000 tweets containing #TSLA. Of these tweets, nearly 66,000 (or 42%) were posted by the top 400 #TSLA accounts and 36,000 (or 23%) by fanbots within these top accounts. As shown in Figure 5, the magnitude of content generated by fanbots is considerable in $TSLA and more so in #TSLA.

4.3. Prevalence of Tesla fanbots relative to other, prominent tech firms.

For purposes of comparison, tweets containing the tags $/#AAPL (Apple) and $/#AMZN (Amazon) were also collected (for the year 2010 only). Fanbots were observed in all four cases; however, due to the limited number of Apple and Amazon tweets using the hashtag, the cashtag tweets were used to conduct similar analyses of prominent accounts. Among the top 100 most active accounts in $AAPL and $AMZN, there were 29 and 35 fanbots, respectively. For 2010, Apple fanbots were responsible for 32% of the total tweets posted using $AAPL, though over half of these tweets came from a single source (@applenewswatch, a fanbot designed to constantly share news about the company). For $AMZN, 23% of tweets were generated by fanbots. With 123K tweets, $AAPL had nearly seven times the volume as $AMZN. Meanwhile, $TSLA had only 2.5K tweets in 2010, significantly lower than both $AAPL and $AMZN. However, 16% of this volume came from early fanbots within the top 100 accounts.[3] Histograms of the Botometer scores for the top 100 accounts in each collection are shown in Figure 6 and distributions of tweet volume by category of user (fanbots within top users, non-fanbots within top users and other accounts) are depicted in Figure 7. At the end of 2010, Tesla's market capitalization was just above $2.5B, less than 1% of that of Apple's $297B and nearly 3% of Amazon's $81B, underscoring the extent to which Twitter activity in general, and fanbot activity in particular, was overrepresented in the TSLA tweet collections relative to those of other tech firms.

[2] Twitter data (including tweet content and metadata) were collected using Twitter Academic API.
[3] Because Tesla became a public company in June 2010, the $TSLA cashtag only came into use in the second half of the year.

4.3.1. Differences in CCP.

Based upon preliminary analysis, fanbot tweets about AAPL and AMZN contain generic, pro-market content, whereas the TSLA fanbot content is more specific to Tesla. This difference suggests that fanbot content about Tesla was generated for different purposes than that for other tech firms and further suggests that Tesla fanbot content was intended to bolster support for Tesla in particular, rather than encourage pro-market beliefs more generally.

4.4. CCP as a new resource.

A clear difference between the pro-Tesla (#/$TSLA) and Tesla-critical (#/$TSLAQ) conversations on Twitter is that the former contained computational content (CCP), while the interactions among Tesla critics included almost no bot content (see Figure 8). To the extent that fanbot activity increased the *availability* of pro-Tesla content or *amplified* existing pro-Tesla sentiment, the existence of the fanbots and their dissemination of CCP can be interpreted as an extra, strategic resource that was used only by the pro-Tesla Twitter community. Prior research on social movement mobilization has underscored the importance of resources: For example, gun rights activists have succeeded, in part, because their movement has had access to greater material resources to promote, organize and amplify their message [17]. In this light, the creation of fanbots and the CCP they generated may have had a similarly material impact upon the fate of the Tesla narrative, and by inference, the performance of Tesla's stock in the public market. This paper does not test specific mechanisms through which these effects may have played out though several possible mechanisms are proposed in the conclusion.

5. Conclusion

This paper identifies algorithmic Twitter accounts (fanbots) as a source of Corporate Computational Propaganda (CCP), a new category of corporate communication that was particularly prevalent within the pro-Tesla Twitter conversation. CCP was observed in each of the corporate tweet collections examined. Beyond noting the existence of this new strategic resource, the paper makes no statement about the source of CCP, and the research team remains agnostic in this regard. Many IT firms offer services that include the generation of computational content for clients. However, creating fanbots and having them generate CCP is not costless. Therefore, the fact that fanbots exist and the extent of their contribution to the overall corpus of tweets about Tesla suggests that whoever was responsible for these actions believed that deploying these resources – to influence the conversation about Tesla on Twitter – would help bolster the Tesla narrative and thereby support the price of Tesla stock.

Alternatively, if the actors responsible for fanbots did not believe they would be value creating for Tesla (or in the immediate interests of the actors), they may have believed that CCP would insulate the Tesla narrative against downward pressure arising from various critics. In this scenario, an investment in fanbots may be thought of as a buffer, an insurance policy, against negative information. Whether the Tesla narrative (and stock) would have thrived, or even survived, in the absence of fanbots and the CCP they generated, is a question for future research. For now, the existence of fanbots suggests that someone believed they would be value creating for the firm.

In practice, both mechanisms may be operative. The working hypothesis informing this analysis is that the value creation mechanisms work through buffering negative information and amplifying positive information, thereby strengthening the narrative associated with the firm. In this light, further research may provide insights on several additional questions:

5.1 Valuation.

If CCP supports valuation, what are the specific pathways by which this content influences the behavior of market participants? One possible pathway is through human observation and action, whereby a retail investor views CCP content and decides to trade or otherwise transact based upon that information. The classic

structure of Twitter, where tweets scroll past and users only see the most recent postings, may heighten the impact of CCP that keeps retweeting positive content about a given actor or firm. As a result, investors may be subject to a recency bias or a frequency effect. Another possible pathway would work through trading algorithms that respond to Twitter content. In this scenario, fanbots generate positive content that triggers algorithmic trading rules. In this algorithm to algorithm interaction, no human intervention would be necessary in order to support a valuation narrative.

5.2. Disclosure.

The use of CCP to support a firm's narrative suggests that coordinated, non-market activity may have influenced market outcomes. To date, no one associated with Tesla or its supporters have admitted any role in creating the fanbots that produced the pro-narrative CCP reported upon above. Regardless, should firms that use CCP as a strategic communication resource be required to disclose their activities in the same way they disclose their lobbying efforts? How should the use of CCP be regulated within the larger context of investor protection?

5.3. Ethics.

Regardless of the legality of CCP, is it ethical to use algorithmic means to influence investor behavior? Tesla is one case in which CCP was used to support the narrative of a new entrant firm in a re-emerging industry. If CCP can be used more broadly to support firm or industry narratives, are there any ethical issues associated with such use? For example, if such content is untrue, how would it be controlled so as to minimize the misguidance of viewers? Clearly, CCP is an opportunity for firms and individuals to capitalize on their narratives. How will such capitalization be controlled and/or monitored?

5.4. Competition.

So far, we have observed CCP as a resource to support a positive firm narrative. However, CCP may also be used to criticize narratives, especially between competing firms and industries. Such "weaponizing" of CCP is commonly observed in the political sphere, as in the case of 97 "bot-like" Twitter accounts spreading misinformation on the whereabouts of Peng Shuai, a popular Chinese tennis player, after she accused Zheng Gaoli, China's former Vice Premier, of sexual assault [18]. If corporations and industries also begin to "weaponize" CCP, how might that affect competition? Are policy efforts required to account for such effects?

5.5. Generalizability.

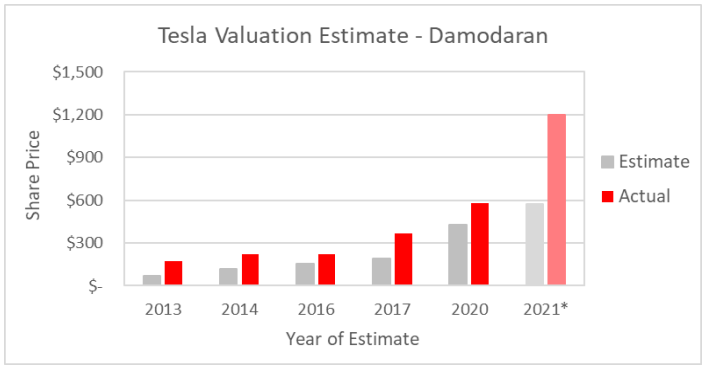
The analysis thus far has assumed that any firm can take advantage of CCP. However, as noted, Elon Musk is a singular figure on Twitter. His Twitter status allows him to use the platform as an engagement tool, possibly enhancing the effects of CCP. It is not clear if this strategy could be replicated by other firms seeking to use CCP to support their own firm narrative, in the absence of a central actor. In this light, what are the boundary conditions within which CCP may be an effective strategic resource? Under which conditions is CCP likely to be most effective?

5.6. Electrification by fanbots.

Finally, to bring this back to the electrification story, what if CCP turns out to have been the crux of the transition to electric vehicles? It is a difficult counterfactual scenario to evaluate, but electrification has been promised for decades, and all would agree that the success of Tesla has accelerated the acceptance of electric vehicles. If fanbots accelerated this success, in so far as they supported the firm's narrative since IPO, then everyone benefiting from the re-emergence of the contemporary electric vehicle has Tesla's fanbots to thank.

6. Figures

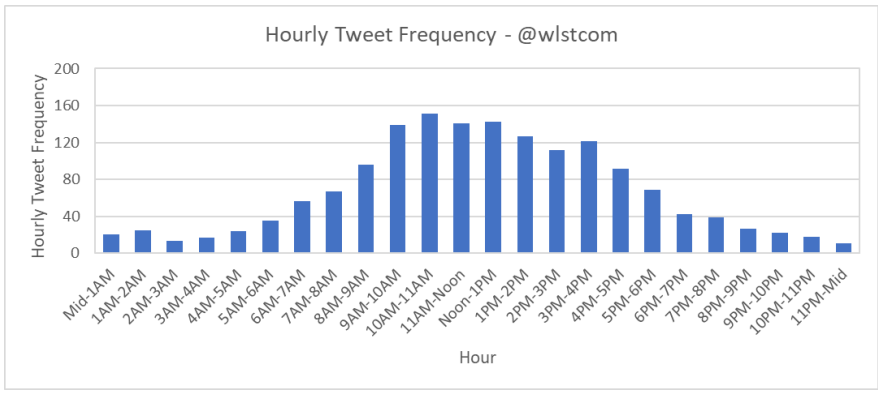
Figure 1. Sample expert Tesla valuation estimate over time (A. Damodaran, NYU Stern School of Business).



*With adjustment of 5-for-1 stock split on August 31, 2020. Source: Damodaran, 2021.

Figure 2. Sample tweets demonstrating corporate communication by Tesla CEO Elon Musk.

Figure 3. Daily Twitter activity pattern of several Fanbot accounts.



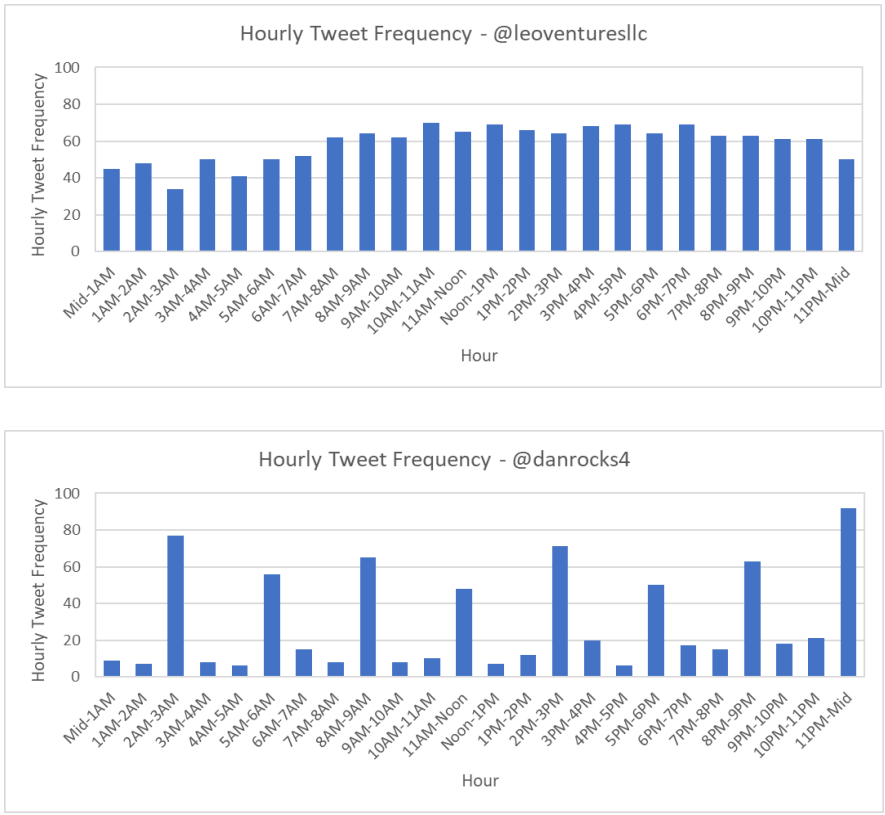


Figure 4. Number of fanbots active in $TSLA and #TSLA, created between June 2010 and December 2020.

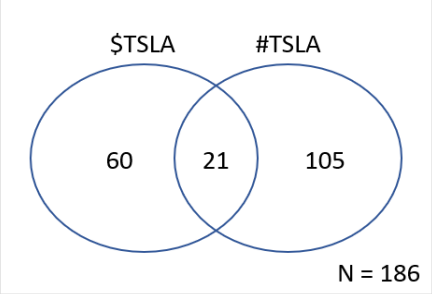
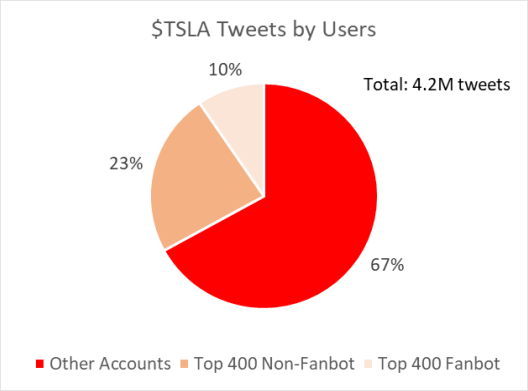


Figure 5. Distribution of $TSLA and #TSLA tweets by category of users.



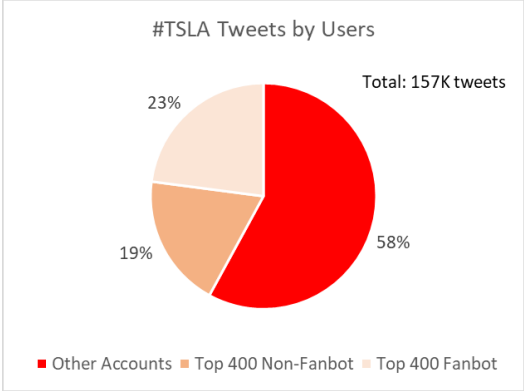


Figure 6. Botometer score histograms for top 100 accounts under $AAPL, $AMZN and $TSLA in 2010.

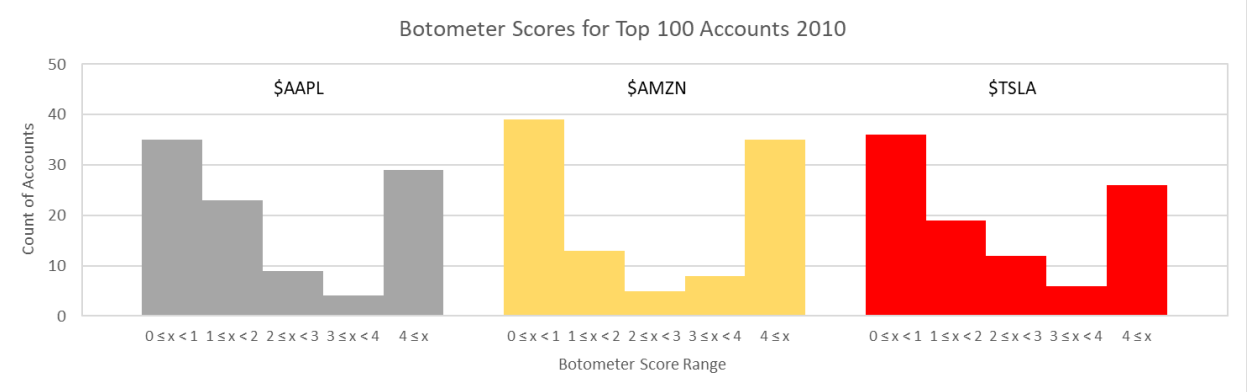
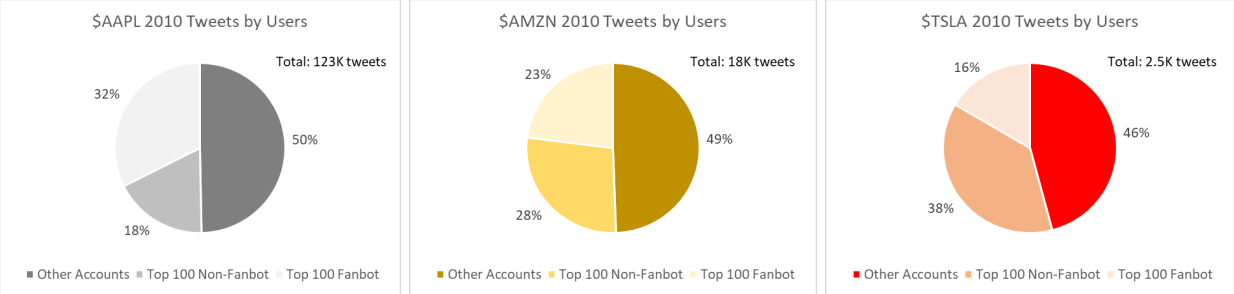
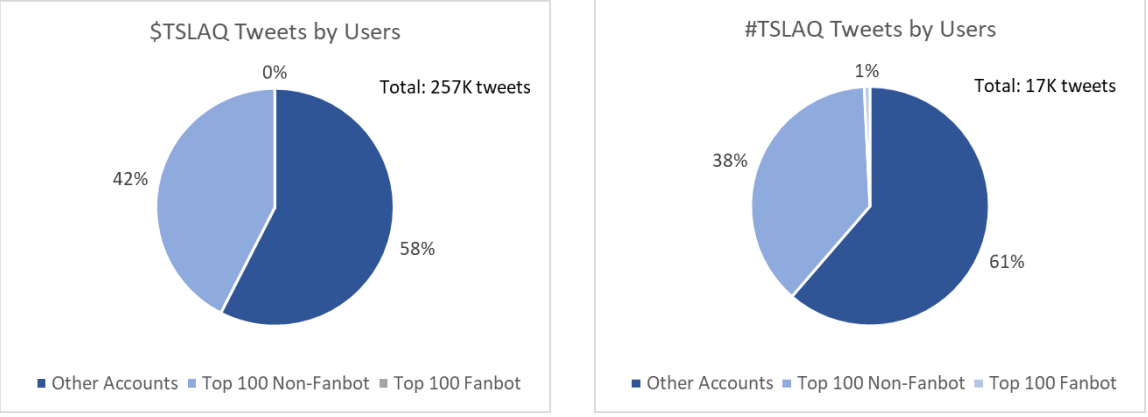


Figure 7. Distribution of $AAPL, $AMZN and $TSLA tweets in 2010 by category of users.



Note: $TSLA has considerably lower Twitter volume in 2010. The company went public in June of 2010 and Twitter volume accelerated in the following years.

Figure 8. Distribution of $TSLAQ and #TSLAQ tweets by category of users.



7. Tables

Table 1. Eight $/#TSLA accounts created within 75 minutes on November 7, 2013 (with Botometer scores).

1	Author_Tweet_Count	Author_Username	Author_Creation_Time_EST	Author_Botometer_Score
106	3386	danrocks4	2013-11-07 22:41:39	4.6
114	3258	lookn4wins	2013-11-07 21:59:26	4.6
119	3194	leahanneta	2013-11-07 22:29:09	4.8
128	3036	Jake132013	2013-11-07 21:42:49	4.8
136	2956	clayton_dd	2013-11-07 21:53:01	4.6
143	2852	Jim5011	2013-11-07 22:07:43	4.6
145	2850	Stock_Tracker1	2013-11-07 22:17:00	4.4
149	2807	Emylers	2013-11-07 22:50:04	4.9

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10. Presenter Biographies

David A. Kirsch is Associate Professor at the Robert H. Smith School of Business at the University of Maryland, College Park. His research focuses on the intersection of problems of innovation and entrepreneurship, technological and business failure, and industry emergence and evolution. Kirsch has written about the history of alternatives to internal combustion (*The Electric Vehicle and the Burden of History* (Rutgers, 2000)) and the general problem of speculation around technology in financial markets (*Bubbles and Crashes: The Boom and Bust of Technological Innovation,* with Brent Goldfarb (Stanford, 2019)).

Mohsen A. Chowdhury is an independent scholar interested in topics of strategy, innovation and entrepreneurship, with a focus on the diffusion of physical and digital technologies across markets. He received an undergraduate degree in mining engineering from the University of British Columbia and an MBA from York University. He was previously a field engineer in the global mining industry and a credit analyst covering the energy and utilities sectors. Mohsen will be pursuing doctoral studies in strategy starting Fall 2022.