

Technology adoption news and corporate reputation: sentiment analysis about the introduction of Bitcoin

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Abstract

Purpose – Evidence from previous literature indicates that adopting a new innovative technology has a positive impact on a company's business performance. Much less work has been carried out into examining whether a technology adoption has impact on corporate reputation. This paper aims to examine the latter topic in a context where social media is the channel used to share news about the introduction of a new technology. The empirical setting of the study consists of five retail companies located in the USA that decided to include Bitcoin as a payment platform.

Design/methodology/approach – Twitter data were used to measure how sharing news about the adoption of new technology could affect the reputation of the companies selected, keeping a clear distinction between the volume of data relating to social media responses and the sentiment expressed in the tweets. A panel vector autoregression model was used to incorporate series of data relating to news items, volume and sentiment.

Findings – The results show that the news about the adoption of a new technology has a positive impact on both the volume of tech-related tweets and the sentiment expressed in the tweets themselves, although the patterns of these two effects are different. The resulting impact decreases after a few days, both in volume and in sentiment.

Research limitations/implications – The analysis has limitations that future research could address by extending and diversifying the examined companies and the social media used as data sources. The research suggests that managers in medium-sized companies can leverage on the introduction of new technologies that have a direct impact on their customers and gain reputational benefits in terms of immediate visibility.

Originality/value – The research introduces an additional dimension of analysis to the current stream of corporate reputation. Although the literature has already covered the dynamics of response to events on Twitter, by focusing on the adoption of the new Bitcoin technology, the paper provides novel insights.

Keywords Vector autoregression, Corporate reputation, Social media analysis, Sentiment analysis, Bitcoin, Technology adoption, Blockchain

Paper type Research paper

Introduction

Corporate reputation refers to the “admiration and respect a person holds of an organization at a point in time” (Dowling, 2016: p. 218). Previous literature agrees in considering it to be a strategic asset for sustaining a company's performance (Fombrun and Shanley, 1990; Benjamin and Podolny, 1999; Deephouse, 2000; Gatzert, 2015; Crespo and Inacio, 2018).

Corporate reputation is seen to contribute positively to a firm's activities through its ability to influence an organization's

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relationships with its stakeholders (Lange *et al.*, 2011; Burrows *et al.*, 2018). In particular, corporate reputation is a key element of brand equity, when it transmits an accurate and positive company image to stakeholders (Caruana and Chircop, 2000; Heinberg *et al.*, 2018; Burke *et al.*, 2018). Brand-related and product-performance indicators, such as loyalty, sales and profit, can in fact all be influenced by corporate reputation (Gray and Balmer, 1998).

Several studies (Carter, 2006; Rindova *et al.*, 2006) have examined the link between corporate reputation and innovation, covering the positive role played by corporate innovation. The main outcome emerging from these studies is the positive correlation found between perceived innovativeness and brand-related performance (Kunz *et al.*, 2011). Technological innovation, however, could also be associated to an increase in customer-perceived risks (Johnson *et al.*, 2008), with negative repercussions on the company's brand image.

A relevant body of literature has investigated the impact of a company adopting a new technology on its business performance (Ahuja and Katila, 2001; Grigoriou and Rothaermel, 2017), but relatively few studies have examined the influence of technology adoption on corporate reputation. The purpose of this work is to provide further insights into such a relationship by examining how a company's reputation is affected when news about a technology adoption is released on social media.

The empirical setting focuses on five companies which decided to introduce Bitcoin as a payment method. Bitcoin is a virtual currency based on blockchain technology and it is predicted to affect the way consumers and brands interact (Boukis, 2019). The interchange between firms and users on the social network "Twitter" was collected and analyzed to evaluate the impact of the announcement of the company's adoption of Bitcoin on its reputation.

A panel vector autoregression (VAR) analysis was performed to investigate the volume and the sentiment of the exchanged messages, "tweets", such as the quantitative and qualitative responses to the Bitcoin news. The results suggest that there is a positive impact on corporate reputation in terms of both volume and positive sentiment of the associated tweets.

This research contributes to the stream of branding literature (Fombrun and Shanley, 1990; Deephouse, 2000; Rindova *et al.*, 2006; Lange *et al.*, 2011; Kunz *et al.*, 2011; Burke *et al.*, 2018) by exploring how spreading the news about technology adoption events can have an impact on different facets of corporate reputation, which in turn is associated with consumer brands and product perception.

In terms of management implications, the results have consequences for brand managers. Executives could leverage on the fact that their company is going to introduce new technologies that impact directly on their customers. Managers could exploit such news releases and gain reputational benefits in the short term.

Research framework

Corporate reputation and technology adoption

The growing literature on corporate reputation (Dowling, 2016; Gürhan-Canli *et al.*, 2018) shows that it is a determinant asset to be established and defended, and that it is connected to several business activity aspects. Corporate reputation does not merely emanate from a company's distinctive capabilities or expertise, but is the result of an intricate interplay with firm's stakeholders (Fombrun and Van Riel, 1997). Several factors can affect a company's reputation, from market strategies to employment policies (Cable and Graham, 2000; Basdeo *et al.*, 2006; Lange *et al.*, 2011; Ravasi *et al.*, 2018).

Because of its complexity as a concept, different authors have presented their own various definitions (Fombrun, 1996; Barnett *et al.*, 2006; Walker, 2010). In essence, corporate reputation can be defined as the "admiration and respect a person holds of an organization at a point in time" (Dowling, 2016, p. 218).

This study follows in the path proposed by Lange *et al.* (2011), for whom the concept of corporate reputation is characterized along three dimensions (Table I). The first dimension refers to the collective perception/awareness of a company or its visibility, i.e. *Being Known*. The second, *Being Known for Something*, relates to the perception of a company's specific outcome or behavior with respect to the beholders' own interests. The third dimension is called *Generalized Favourability* and refers to the perceptions and/or judgments made by those who observe the organization, as an aggregate of company attributes.

From the observer's viewpoint, the construct refers to either a *non-evaluative* or a manifestly *judgmental* perspective. The first case occurs when the observer is aware of the company but does not express an opinion, while the second case occurs when the observer sets out opinions about the whole company or its behavior, or else focuses on one specific trait.

The way third parties perceive a company determines its corporate reputation (Gotsi and Wilson, 2001). In this context, customers are a particular group of stakeholders and their evaluation shapes the company's overall brand image (Lamberti and Lettieri, 2009; Pedeliento and Kavaratzis, 2019). Brand image, in turn, contributes to the construction of the company's brand equity (Kayaman and Arasli, 2007; Davcik *et al.*, 2015; Brexendorf and Keller, 2017). For this reason, any action which can influence the customers' perception of a company in the short-term will have an impact on its corporate reputation in the mid-term. Hence, if customers discern improvements to a company's corporate reputation, their perception will contribute positively to its brand equity (Hur *et al.*, 2014). Enhanced brand equity is then expected to lead to higher performance in sales, market share and loyalty (Cretu and Brodie, 2007; Datta *et al.*, 2017).

Table I Distinguishing among the three dimensions of corporate reputation

Parameters	Being known	Conceptualizations of corporate reputation	
		Being known for something	Generalized favorability
Particular vs Generalized	Generalized	Particular	Generalized
Judgment vs non evaluative	Non-evaluative	Judgment	Judgment

Source: Lange *et al.* (2011)

A company's ability to innovate is considered to be an element of corporate reputation (Clayton and Turner, 2000; Ahuja and Katila, 2001; Brown and Turner, 2012; Safon, 2009; Lange *et al.*, 2011; Padgett and Moura-Leite, 2012; Agarwal *et al.*, 2018) and is a common trait in most of the frequently used qualitative and quantitative methods to assess corporate reputation, such as Fortune's World's Most Admired Companies indicator and the reputation index RepTrak™ (Trotta and Cavallaro, 2012; Fombrun *et al.*, 2000; Ponzi *et al.*, 2011; Fombrun *et al.*, 2015).

Customers' perceptions that relate to innovation, in fact, impact positively on attitudinal and emotional brand loyalty at both corporate and product levels (Kunz *et al.*, 2011) and result in higher clients' satisfaction (Rubera and Kirca, 2017). As technology adoption is inherently an innovation activity (Kim and Chae, 2018), it can potentially deliver a positive effect on corporate reputation.

Social media and corporate reputation

Although adopting new technology is fundamental for companies operating in innovative and competitive environments, it is only when stakeholders become aware that the innovation is in place that the relative impact on corporate reputation can be identified. The relevant scenario is when a newly adopted technology alters the company's product/service content and/or outcome, as has been pointed out in several studies (Meuter *et al.*, 2000; Son and Han, 2011; Ayers *et al.*, 2009; Yen, 2005; Wu *et al.*, 2013; Rindova *et al.*, 2006; Fleming *et al.*, 2018). In this situation, the impact of adopting a technology emerges when stakeholders learn about the adoption and shift their evaluation of that technology onto the company (Hou *et al.*, 2018).

While studies on how the release of news can influence corporate reputation are found in prior literature (Kioussis *et al.*, 2007; Einwiller *et al.*, 2010; Comyns and Franklin-Johnson, 2018), as yet there has been no research into the specific topic of sharing technology adoption undertakings on social media. This gap in research is surprising, given the role that social media play in corporate reputation and brand performance (Tuškej and Podnar, 2018).

Social media are a major channel for generating and spreading opinions about a company and its corporate quality throughout the public domain (Etter *et al.*, 2019). The reaction on social media to news about an organization can amplify the stakeholders' ability to influence corporate reputation and, potentially, brand equity (Barnett and Pollock, 2012). For such reasons, companies strive to improve the effects of their presence on social media, where user- and firm-generated content are both provided (Kaplan and Haenlein, 2010; Kim and Chae, 2018). Organizations need to develop specific technical and management skills to reap the reputational benefits associated to user-generated content (e.g. flares – Blevins and Ragozzino, 2019) and extract value from these platforms, which are very different from classic advertising channels (Peters *et al.*, 2013).

Scholars have revealed the close link between brand reputation and social media. Social media management entails the systematic monitoring of social media to mitigate any risk to reputational assets (Montalvo, 2011; Hajli and Sims, 2015; He *et al.*, 2017). Moreover, when brand reputation is established through effective media management, it can be a powerful resource for competitive advantage (Deephhouse, 2000; Rindova *et al.*, 2006). Research has also found that focusing on the

preferential channels for electronic word of mouth from customer to customer is a meaningful way to evaluate how external beholders judge and perceive brands online (Xun and Guo, 2017; King *et al.*, 2014). On the contrary, if a company is careless in managing its corporate social media profile, this circumstance can have a direct negative effect on its equity (Yu *et al.*, 2013).

The internet has become a space for expressing opinions on a vast range of topics, and a number of information retrieval techniques are being developed to extrapolate and analyze relevant posts that refer to specific products or brands (Thelwall *et al.*, 2010). A company can apply similar methodologies and evaluate its users'/customers' attitude toward its products and services. The techniques for retrieving information often involve algorithms that can work down to single text elements (Pang and Lee, 2008). The information embedded in social media streams can be investigated through methods that include sentiment analysis, the analysis of trending topics through keywords (*hashtags*) and the automated analysis of shared images combined with machine learning techniques (Tsytssarau *et al.*, 2014; Jensen *et al.*, 2015).

The empirical analyses in this study are based on data gathered from Twitter, one of the world's largest social networks. Sentiment analysis applied to Twitter texts can be used to investigate corporate reputation (Jansen *et al.*, 2009) and a growing number of scientific articles now rely on Twitter data (Castillo *et al.*, 2011; Lerman and Ghosh, 2010; Desmarchelier and Fang, 2016).

Research objectives

Evidence from the previous section indicates three main factors:

- 1 The adoption of an innovative technology can have a significant impact on corporate reputation.
- 2 The impact can relate to the resulting products and/or services, but can also be felt beforehand, when users/customers learn that a company is adopting a new technology, as this awareness can alter peoples' perceptions about innovativeness at corporate level.
- 3 Social networks act as "news accelerators" and key levers that can be used to improve corporate reputation.

The previous evidence paves the way toward setting the objective of this work, which is to evaluate, when users/customers learn that a company is adopting a new technology, how this fact stochastically affects the various dimensions of corporate reputation.

The framework proposed by Lange *et al.* (2011) has been adopted to evaluate the different aspects of corporate reputation and then define the appropriate measures for detecting the aforementioned impact. The framework is based on two parameters that underpin the concept of corporate reputation, i.e. the beholders' attitude (*judgmental* vs. *non-evaluative*) and the kind of relationship they have with the company (*particular* vs. *generalized*). However, it does not include a definition of corporate reputation that matches the desired configuration of *non-evaluative* and *particular* parameters. The required fourth dimension has been, therefore, introduced to cover the entire definitional space and termed as *Being Known for Something* (*non-evaluative*).

Table II sums up the concepts of corporate reputation used in this study. The "generalized" concepts address corporate

Table II Corporate reputation conceptualizations and operationalized drivers in twitter

		Parameters	
Conceptualizations	Particular vs Generalized	Judgment vs Non-evaluative	Driver (Tweets)
Being known	Generalized	Non-evaluative	Tech-unrelated volume
Generalized favorability	Generalized	Judgment	Tech-unrelated sentiment
Being known for something (non-evaluative)	Particular	Non-evaluative	Tech-related volume
Being known for something (judgment)	Particular	Judgment	Tech-related sentiment

reputation in broad terms, and “particular” concepts are specific to the actual technology adopted in the company. “Non-evaluative” measures refer to the volume of tweets, while “judgmental” measures refer to the sentiment expressed in the tweets.

The resulting combinations are the following:

- Being Known (non-evaluative – generalized) is measured through the “tech-unrelated volume” of tweets, which is the number of tweets about a company that do not mention the adopted technology (these tweets can refer to any aspect of the company, other than the adoption of the specific technology).
- Generalized Favourability (judgmental – generalized) represents “tech-unrelated sentiment”, measured by examining the average sentiment of the tweets about the company that do not mention the adopted technology (general sentiment toward the company).
- Being Known for Something (non-evaluative) is an additional concept that analyses the specific “Something” (here, the technology adoption) in terms of volume; “tech-related volume” is the number of tweets that mention both the company and the adopted technology, regardless of the sentiment expressed by the users.
- Being Known for Something (judgmental – particular) is a proxy for “tech-related sentiment” and is the average sentiment of tweets that mention both the company and the specific “Something” which, in this framework, is the adopted technology.

Each configuration of parameters can be associated with a specific driver, as shown in Table II.

The aim of this analysis is to determine, quantitatively, whether there was any impact on the four individual concepts of corporate reputation at the news that the company had adopted a new technology. A positive impact is expected because technology adoption is inherently an innovation activity (Kim and Chae, 2018) and innovation is a key asset of corporate reputation (Ponzi *et al.*, 2011; Kunz *et al.*, 2011; Fombrun *et al.*, 2015). However, the proposed framework makes it possible to provide more fine-grained results. It is also possible to distinguish between:

- whether the effect on reputation is limited to the specific event (“Being Known for Something”, that is, the adopted technology) or whether it encompasses a perception of the company as a whole; and
- whether the sentiment conveyed is significantly positive.

Methodology and data

The aim of this study is to investigate the relationship between the release of news about adopting innovative technology and corporate reputation. The technology adoption in question is the introduction of Bitcoin in five companies, as an additional method of payment. These companies form a useful case study, as they were mentioned in the Twitter timeline before and after the date when their Bitcoin news was released.

Bitcoin as case of technology adoption

The Bitcoin protocol was released in autumn 2009, and from then on, the corresponding cryptocurrency has reshaped electronic payment systems and redefined the idea of money itself (Hughes *et al.*, 2019; Morkunas *et al.*, 2019).

Because it is based on blockchain technology, Bitcoin provides the necessary software tools to implement a completely decentralized infrastructure for the transfer of money. Transaction security is verified through cryptography and the fact that all transactions are recorded in shared electronic public ledgers, the blockchain. The users of this peer-to-peer architecture transact Bitcoins without the need for a trusted third party, such as a bank or any other financial institution. The advantages are associated with enhanced privacy and negligible transaction costs, compared to the current payment methods (credit cards, PayPal or the like). Bitcoin makes micropayments viable on a large scale, even for international transactions.

Among the negative aspects, financial speculation is a risk, because of its high volatility but, nevertheless, the continuously growing transactions and the constant support of venture capital in Bitcoin-related services suggest that it could play an important role in the future online payment landscape.

The adoption of Bitcoin is an interesting case for several reasons. First, a number of e-commerce companies have implemented this technology platform, and the precise date on which they made the relative announcement is known or can be determined. Since the technology is quite recent, the implementation time frame in each company is narrow and a direct pre and post comparison can be made without too much difficulty. The companies that introduced Bitcoin added an additional payment platform as a plugin to their online shops. The work necessary to set up the technology is not complex but, while it is not a technical issue, it is a strategic, management and behavioral problem, similarly to the e-blog case described by Wu *et al.* (2013). In addition, customers who interact with the new technology are “e-clients”, and hence

they can be reasonably considered in the same category as the people who share their thoughts on Twitter.

Furthermore, there is no uniform opinion about the whole Bitcoin system. Critical comments have been made in the media about the risks of financial speculation and the privacy of the transactions, exposing the fact that the system could be exploited by criminals. The point is interesting, because an a priori negative sentiment in response to the introduction of Bitcoin cannot be excluded.

Twitter as data source

With more than 300 million active users a month, Twitter is one of the most useful social networks for analyzing corporate reputation. As observed by [Jansen et al. \(2009\)](#), when they targeted Twitter corporate accounts, nearly 20 per cent of all branding microblogs contained some expression of sentiment either relating to the company in general or expressing an opinion on one or more specific products. Among the previous studies that analyzed Twitter data to investigate the importance of events and associated sentiment, [Thelwall et al. \(2010\)](#) mentioned the need to be cautious when carrying out sentiment analyses on Twitter because the overall level of sentiment seems to be quite low. Nonetheless, when reporting on facts that generate a surge of tweets, including the launching of new products, the authors considered it reasonable to expect some kind of emotional reaction.

Over a short time, there has been an increase in number of scientific articles that rely on Twitter data. These works investigate platform characteristics ([Naaman et al., 2010](#)), reliability, diffusion and newsworthiness of information ([Castillo et al., 2011](#); [Lerman and Ghosh, 2010](#); [Desmarchelier and Fang, 2016](#)), market efficiency in terms of incorporating information ([Sprenger et al., 2014](#); [Williams and Reade, 2016](#)) and the ability to forecast a specific outcome ([Treme and VanDerPloeg, 2014](#); [Tumasjan et al., 2010](#)).

In this framework, corporate reputation concepts can be measured in terms of number of tweets and corresponding sentiment. Starting from the assumptions set out in [Table I](#), it was possible to translate reputation-type aspects into observable measures linked to the analyses carried out on the Twitter timeline for the selected companies, as shown in [Table II](#).

Sampling process

The five companies were selected through a purposive sampling process (as defined in [Short et al., 2002](#)) to determine whether they satisfied specific requirements. The methodological approach is similar to that presented in the study by [Xun and Guo \(2017\)](#). The aim was to identify a

sample of US companies which adopted Bitcoin as a form of online payment in 2013 and 2014. This was achieved by searching through the Google News repository using the keywords “Bitcoin” and “adopt” (or synonyms and derivations such as “adoption” or “acceptance”) and then screening the results manually.

As mentioned, the five companies analyzed are all based in the USA. The focus on a single market/country provides a coherent framework and reduces any variation in terms of regulations, economic conditions and the kind of Twitter users who potentially interacted with the companies. The US is an ideal choice for this purpose, because of its economic system, access to new technologies and diffusion of Twitter.

Only companies selling online were selected. These companies are particularly suited to the analysis because they expect to receive a relatively high level of attention from social media users and also to engage with them. In addition, internet vendors rely heavily on their reputation ([Kim et al., 2008](#); [Biswas and Biswas, 2004](#); [Caruana and Ewing, 2010](#)). Finally, large corporations were excluded (companies such as Microsoft and Dell or listed on Fortune 500) because there would have been far too many tweets too trawl through, estimated in the millions, but only limited sample accuracy. The preliminary analyses on the retrieved news items and tweets have, in fact, indicated the non-negligible presence of false-positive associations (e.g. frequent cases where “Bitcoin” and “Microsoft” appeared in the same news item/tweet, despite being unrelated). As a consequence, the corresponding volume of traffic made it virtually impossible to carry out the manual consistency check during data processing.

The selection process identified five companies which were among the first to introduce the Bitcoin payment channel as part of their online sales process ([Tables III](#) and [A1](#)). The small size of the sample is a clear limitation of the empirical exercise and, in future research, the analysis could be expanded to a larger set of companies in different countries and different sectors. However, the positive aspect of a small sample is that it gave greater control over the data, as the number of examined records was kept at a level where it was still possible to carry out consistency checks by reading the text fields of the sampled tweets directly, and thereby improve the automated sentiment analysis.

Two sets of data were collected for each company. These were all online news items about the introduction of Bitcoin and all the tweets mentioning the companies. The records in both data sets covered a four-month time frame, centered on the adoption date. The process only covered news items in English and tweets geo-localized in the USA.

Table III Selected companies, main information

Company	Industry	Founded	Turnover (billions USD)	Employees	Bitcoin adoption date	Bitcoin Provider
CheapAir.com	Travel agency	1989	Not available	90	22/11/2013	Coinbase
Intuit	IT services	1983	4.2 (2013)	8,200	25/06/2014	Coinbase
Newegg.com	Retailing (Electronics)	2001	2.7 (2013)	2,600	01/07/2014	BitPay
Overstock.com	Retailing (General)	1997	1.5 (2014)	1,500	09/01/2014	Coinbase
TigerDirect	Retailing (Electronics)	1987	Not available	Not available	23/01/2014	BitPay

The first data set was created by retrieving news items from agencies, blogs and the aggregators available from the Google News repository and contained communications in which customers were told about the adoption of Bitcoin. The second data set contained all the single tweets about the companies, which were provided by The Fool S.r.l., a company with expertise in social media analysis. The tweets collected mentioned either the company's account name (e.g. "@intuit", "@overstock", "@overstockCEO", etc.) or a corresponding hashtag (e.g. "#cheapair", "#tigerdirect", "#overstock", etc.). All tweets posted from the companies' official accounts or by executives and managers were excluded.

A second search was carried out on the contents of the tweets, looking for inherent keywords (e.g. "bitcoin", "BTC", "Coinbase", "BitPay", etc.) to extrapolate the tweets discussing Bitcoin technology. A "sentiment analysis" was then run on each tweet.

Sentiment analysis is a consolidated technique in scientific literature, and its application has soared with the diffusion of the internet and social media (among the several reviews and taxonomies; see Singh and Dubey, 2014; Mäntylä et al., 2018). A "sentiment score" was assigned to each tweet, which was elaborated by combining the results of three different tools: MeaningCloud (<https://www.meaningcloud.com/>), Semantria (<https://www.lexalytics.com>) and SentiStrength (<http://sentistrength.wlv.ac.uk/>). Once all the tweets were processed and a sentiment score assigned by each tool, the results were standardized to deal with the different sentiment scales and define a single measure ranging from -1 to $+1$.

Sentiment analysis is used to process a large amount of data within a reasonable period of time. However, there can be difficulties in how it interprets ironic sentences, jokes, unusual terms or the use of slang (Mostafa, 2013; Bhuta et al., 2014). As an additional accuracy control, the sentiment score of a random sample of tweets was checked, which involved reading more than 10,000 tweets (25 per cent of the sample). The positive and neutral sentiment scores were accurate in 97 per cent and 80 per cent of the cases, respectively. Only 1 per cent of the tweets presumed to express a positive or neutral sentiment were marked-up wrongly and were, in fact, negative. The accuracy was slightly lower for the negative tweets (75 per cent) and, since negative tweets were particularly relevant to the analyses, all the negative tweets were controlled and, when necessary, re-marked correctly.

The tweets collected were associated to the dimensions of corporate reputation (Table II). For example, a tweet such as "Thanks to @Newegg for handling an issue quickly and

professionally. Always a pleasure doing business with you:)" will increase Newegg.com's tech-unrelated volume, i.e. the dimension of *Being Known*. The same tweet also expresses a positive tech-unrelated sentiment that contributes to *Generalized Favourability*. The message "Bitcoin being accepted by online retailers is a huge deal, especially with major retailers like @Overstock. I can't wait to see how this unfolds" is specific to the technology adoption (*Being Known for Something*) and so positively affects both volume (*non-evaluative*) and sentiment (*judgmental*).

The whole process identified a set of 7,766 news items and 43,497 tweets. Table IV provides some basic statistics on the observations in total and broken down by company.

The two data sets (news items and tweets) were, finally, combined and the data grouped into different time frequencies of 6, 12 and 24 h. It was, therefore, possible to calculate the number of news items and a set of indicators, based on the identified tweets, for each company in any given period. The indicators represent how corporate reputation, as described in the "Research Objectives" section, is expressed operationally. Specifically, they are:

- The number of technology-related tweets (about Bitcoin) defined as tech-related volume, within corporate reputation, it is "*Being Known*" (generalized and non-evaluative).
- The number of other tweets (with no reference to Bitcoin) defined as tech-unrelated volume; within corporate reputation, it is "*Being Known for Something* (non-evaluative)" (particular and non-evaluative).
- The average sentiment score of the Bitcoin-related tweets defined as tech-related sentiment, within corporate reputation, it is "*Being Known for Something* (judgmental)" (particular and judgmental).
- The average sentiment score of all the other tweets defined as tech-unrelated sentiment; within corporate reputation, it is "*Generalized Favourability*" (generalized and judgmental).

The results reported in the next section refer to the analyses carried out with 12-h data points. The other time frequencies showed coherent patterns and are available on request. Table V shows the summary statistics of the examined variables with a 12-h interval.

Vector autoregression models

A "narrative method" based on a set of vector autoregressive (VAR) models was used to evaluate how adopting the Bitcoin technology – proxied by the number of related news items –

Table IV Number of news and tweets, percentage of tweets by sentiment (positive, neutral, negative) and about bitcoin on total tweets. Values provided by company and as total

Company	News	Total tweets	Positive tweets (%)	Neutral tweets (%)	Negative tweets (%)	Tweets About Bitcoin Perc. on Tot. tweets (%)
CheapAir.com	271	1,773	20.6	79.1	0.3	19.5
Intuit	225	6,523	18.8	78.4	2.8	3.2
Newegg.com	584	20,036	17.0	80.2	2.8	18.0
Overstock.com	6,087	9,602	11.2	86.5	2.3	50.5
TigerDirect	599	6,013	9.7	86.2	4.1	40.7
TOTAL	7,766	43,947	15.1	82.1	2.8	26.1

Table V Summary statistics of the variables used in the econometric analyses, when aggregation frequency is 12 h

Variable	Description	Obs.	Mean	Std. Dev.	Min	Max
btc_vol _{i,t}	Number of tweets related to the technology (Bitcoin) for firm <i>i</i> at time <i>t</i>	1,310	8.754	54.988	0	895
rest_vol _{i,t}	Number of tweets un-related to technology for firm <i>i</i> at time <i>t</i>	1,310	24.782	40.399	0	483
news_nr _{i,t}	Number of news related to technology (Bitcoin) for firm <i>i</i> at time <i>t</i>	1,310	5.928	19.548	0	222
btcseanfavg _{i,t}	Average sentiment score of the tweets related to the technology (Bitcoin) for firm <i>i</i> at time <i>t</i>	1,310	0.056	0.185	−1	1
Restseanfavg _{i,t}	Average sentiment score of the tweets un-related to the technology for firm <i>i</i> at time <i>t</i>	1,310	0.105	0.184	−0.66	1

impacts on a company's reputation (for a recent overview, see Ramey, 2016; Favero and Giavazzi, 2012). The models account for the linear interdependencies that occur among data series under specific assumptions related to the causal structure of the examined variables (Fernandez-Villaverde *et al.*, 2007).

Two types of analyses were conducted. The first was carried out on volume drivers, which are the number of tweets that include the two reputational dimensions of *Being Known for Something (non-evaluative)* and *Being Known*, and the second examined the sentiment score of the tweets, measuring both *Being Known for Something (judgmental)* and *Generalized Favourability*. A panel VAR model (Cagala and Glogowsky, 2014) was first applied to the whole sample and the analysis was then repeated on firm-specific subsamples to highlight the presence of different patterns at a company level.

VAR models are commonly applied when there is the need to analyze financial and macroeconomic variables (Blanchard and Perotti, 2002; Perotti, 2011). The first step of the method involves estimating the coefficients in the VAR model, which can be represented as the linear relation of a set of variables, depending on their value in the past, plus an innovation vector (Lütkepohl, 1991; Hamilton, 1994). In the model specification, rather than relying only on past values in the two "tweet" series, the "news" variable was introduced to improve the estimate of future expectations. The combination of tweet sentiment scoring and VAR models is similar to the method used by Xun and Guo (2017) to study company financial performance. Here, the investigation relates to the companies included in the panel VAR model specification. The test was performed using the Stata "xtvar" command developed by Cagala and Glogowsky (2014), which applies a least-squares dummy variable estimator (Canova and Ciccirelli, 2013): the model fits a multivariate panel regression for each dependent variable on lags of itself and on lags of all the other dependent variables.

After having estimated the model, the news variable was shocked at equilibrium and the impulse response on corporate reputation drivers was then evaluated. The impact level was assessed stochastically by applying the Monte Carlo simulation algorithm, with 200 repetitions, to the estimated model (Bachmann *et al.*, 2010) and then by plotting the VAR Impulse Response Functions (IRF).

Various lags were used in the tests, but the results reported are those with lag 2, according to the Schwarz Bayesian Information Criterion associated to the VAR models (further information on the estimation of the panel VAR model can be found in Tables A2, A3, A4, A5 and Figure A5 in the Appendix).

Results

The descriptive results in Table IV show that 2.8 per cent of all tweets expressed a negative sentiment, with small differences across the companies. The largest variations with respect to the sample average refer to TigerDirect (4.1 per cent) and CheapAir.com (0.3 per cent). With respect to the subset of tweets about Bitcoin technology, the share of negative messages was much lower (0.7 per cent).

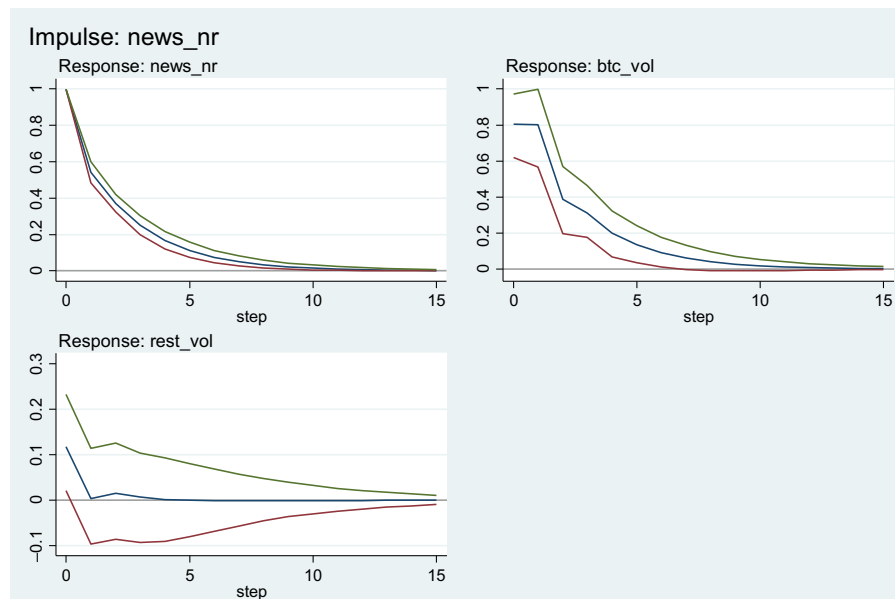
Concerning the econometric analyses, the IRFs of interest are those where the impulse variable consists of the number of news items. The IRFs resulting from the panel VAR are charted in Figure 1 and are calculated with reference to one-unit shocks. The figure plots the effect of the shock (i.e. the announcement of the adoption of Bitcoin) on the number of news items, and the volume of technology-related and -unrelated tweets, respectively.

As expected, any additional news items covering the technology adoption has, on average, a positive effect on the number of Bitcoin tweets for each company. This is particularly true for the first interval after the news is released (first 12 h). The effect declines progressively and loses significance after three and a half days (that is, at step 7), with a 95 per cent confidence interval. The effect of the news on the number of tech-unrelated tweets is not significant.

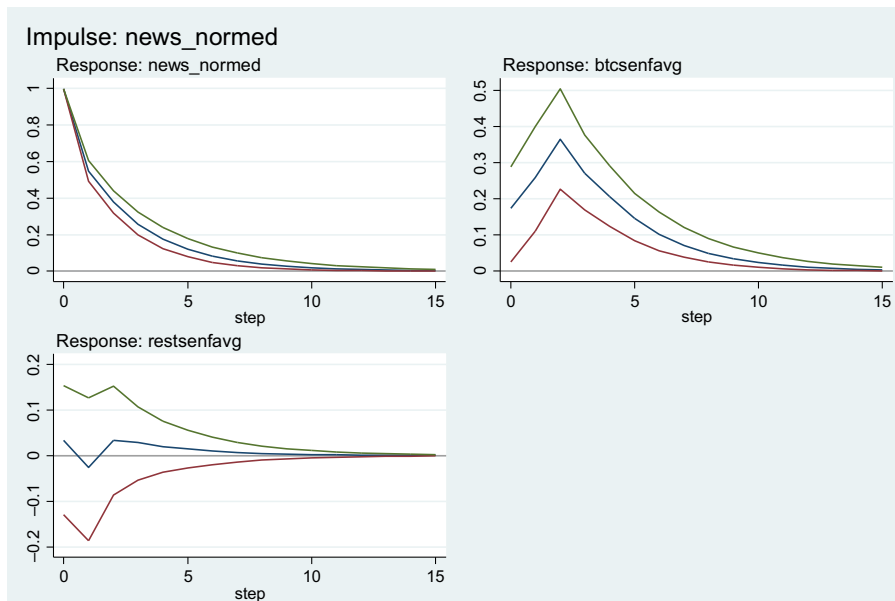
The IRFs of the other impulse variables (number of tech-related and tech-unrelated tweets) are given in the Appendix (Figures A1, A2, A3 and A4). It should be noted that the number of tech-related tweets impacts positively on the number of news items from step 1 onwards, while the effect on the number of tech-unrelated tweets is negative, a fact that suggests a substitute relationship (the Twitter discussion on the company's timeline shifts toward the adoption of Bitcoin).

The same approach is replicated for the sentiment analysis and the results are shown in the following charts. The number of news items was normalized between 0 and 1 to improve the readability of the results. Figure 2 plots the effect on the number of news items and on the average sentiment for the technology-related and -unrelated tweets, respectively. Any additional news about the technology adoption has, on average, a positive effect on the average sentiment of Bitcoin tweets at a company level. The effect increases until Step 3 after the release of the news (the first 36 h) and then declines over the following time intervals (although it is possible to see a small but significant positive effect in step 15). The effect of the news on the average sentiment of tech-unrelated tweets is not significant.

The IRFs of the other impulse variables (average sentiment of tech-related and -unrelated tweets) are given in the Appendix; no significant relationship is found.

Figure 1 IRFs resulting from panel VAR where the impulse is the number of Bitcoin news

Notes: Clockwise from top left: effect on the number of news, on the number of tech-related tweets and on the number of tech-unrelated tweets. Red and green lines represent the 95% lower and upper bounds of percentile confidence interval, respectively

Figure 2 IRFs resulting from panel VAR where the impulse is the number of Bitcoin news

Notes: Clockwise from top left: effect on the number of news, on the average sentiment of tech-related tweets and of tech-unrelated tweets. Red and green lines represent the 95% lower and upper bounds of percentile confidence interval, respectively

Specific VAR models were tested on each company. The IRFs for volume and sentiment drivers are given in the Appendix. The results show some differences in the level of significance and in the pattern of the IRFs, but they are coherent with the

result of the panel VAR, when considering the concept of *Being Known for Something (non-evaluative)* (tech-related volume). One partial exception concerns CheapAir.com, which shows a similar but not significant curve at the 95 per cent confidence

interval. *Being Known for Something (judgmental)* shows similar results across the companies, but those for Intuit and TigerDirect are not significant. When the analyses were carried out on one company at a time, the level of significance for the results concerning the tech-unrelated drivers (both *Being Known* and *Generalized Favourability*) was low.

Discussion and conclusions

Previous works dealing with corporate reputation have focused on understanding the impact of perceived innovativeness on brand-related performance (Kunz *et al.*, 2011). However, no previous study had focused on the role played by a company's decision to adopt a technology as an event that could affect its corporate reputation. The aim of this research was to fill the gap by modeling an empirical experiment based on data collected from Twitter. The social media response experienced by five US-based companies when they introduced the Bitcoin cryptocurrency provided quantitative measures of corporate reputation.

The results show that adopting a Bitcoin payment platform had a positive impact above all on the tech-related aspects of corporate reputation. In particular, as consumers become aware of the news, *Being Known for Something (non-evaluative)* immediately has a high positive impact, which then decreases until it loses significance after about three and a half days. This kind of behavior is consistent with the concept underlying the examined dimension of corporate reputation of being event-triggered and circumscribed. *Being Known for Something (judgmental)* is positively affected, with an increasing response function that peaks after 36 h and then decreases.

The effect on the tech-unrelated drivers is less significant, with only a potential spillover for *Being Known*, which shows an immediate positive response to the news. Global perception with judgment, that is, *Generalized Favourability*, does not seem to register any significant impact as a result of the event.

The analyses were repeated for each company. Coherent results were observed when looking at the tech-related drivers, while the effects on the tech-unrelated drivers showed low significance and different patterns. These differences call for further investigation because they could depend on sector and company specificities (e.g. size, performance, other events that occurred over the timeline in question).

The results suggest that the volume of messages about technology adoptions does not replace the general traffic on social media about the companies, but adds to it favorably. Although the news and the associated phenomenon on social media have a short lifecycle, the analyses found evidence that adopting a new technology has an immediate positive effect on corporate reputation and contributes to the company's brand image.

These findings have potential managerial implications for other companies similar to those examined in this study. With respect to medium-sized companies introducing a new technology that will have a direct effect on customers, management can leverage on the undertaking to the benefit of their corporate reputation, gaining a direct response immediately and an indirect contribution in the longer term. The event could be seen as a trigger for gaining short-term momentum, as well as being a driver for the longer-term goal of building a positive reputation. Companies with a positive

reputation signal their trustworthiness, thereby reducing transaction costs and customer perceived risk (Walsh *et al.*, 2016). The technology adoption can also help them to raise their brand image in the short term and their brand equity in the mid to long term (Ogba and Tan, 2009). The expected effect is not negligible, since perceptions about a company's reputation for non-financial aspects can create more shareholder value in the longer term than perceptions about previous financial performance (Raithel and Schwaiger, 2015).

Given that it has been demonstrated that sharing news on social media about technology adoptions has an impact on corporate reputation – which is, in turn, an antecedent of brand performance – managing public relations correctly when a new technology is introduced onto the market is a fundamental brand building activity. A proactive approach to online brand management is, thus, recommended (Cooper *et al.*, 2019). Although literature shows that the long-term effects of adopting a new technology on reputation are caused by changes to the outcome of products or services that arise from the new technology (Son and Han, 2011; Wu *et al.*, 2013), this study highlights that there is also an immediate effect that is driven by news of an event/undertaking.

The identified dynamics can interest both brand management literature and also corporate communication studies (Ageeva *et al.*, 2018; Dijkmans *et al.*, 2015), which deal with learning about the timing of technology adoption announcements and that of possible communication follow-ups.

The analyses on the selected sample confirm that perceived innovativeness can increase customer engagement (Henard and Dacin, 2010) and suggest that reputational dimensions follow distinct patterns. The impact of the news about a technology adoption on the particular dimension of reputation is higher than its effect on general aspects. The findings suggest a potential dichotomy between the customers' perception of innovation, at a company level (i.e. stand alone, made before a specific product/service evaluation) and at a product level (i.e. derived from the specific evaluation of a product/service) (Cavazos and Rutherford, 2015).

Previous literature indicates that product/service innovation can introduce paradoxes and ambiguity with regards as to how the brand is perceived (Johnson *et al.*, 2008; Parker and Krause, 2018), caused by, for instance, a certain level of performance ambivalence induced by novelty. This stream of literature has mainly analyzed the “encounter” between customers/consumers and new technology, i.e. product-level perception. Interestingly, other literature has shown that perceived innovativeness (at a corporate level) has a positive impact on both product-level and corporate-level brand performance (Kunz *et al.*, 2011). The results of the present study support the latter view, although they do not encompass the customers' actual “encounter” with technology. It should be noted that recent studies (Pappu and Quester, 2016) put forward the view that actual positive perceived quality, i.e. product-level performance, is a mediator between perceived brand innovativeness and brand loyalty.

This study suffers from some limitations that could be addressed in future research. Other studies could expand the scope and robustness of the analyses and consider a larger number of companies, other technologies and different types of corporate news. They could also introduce a larger data set that

could focus on longer time windows. It would also be useful to examine a wider set of sentiment tools, including any new and more advanced instruments, as this exercise should result in the sentiment scores being more accurate.

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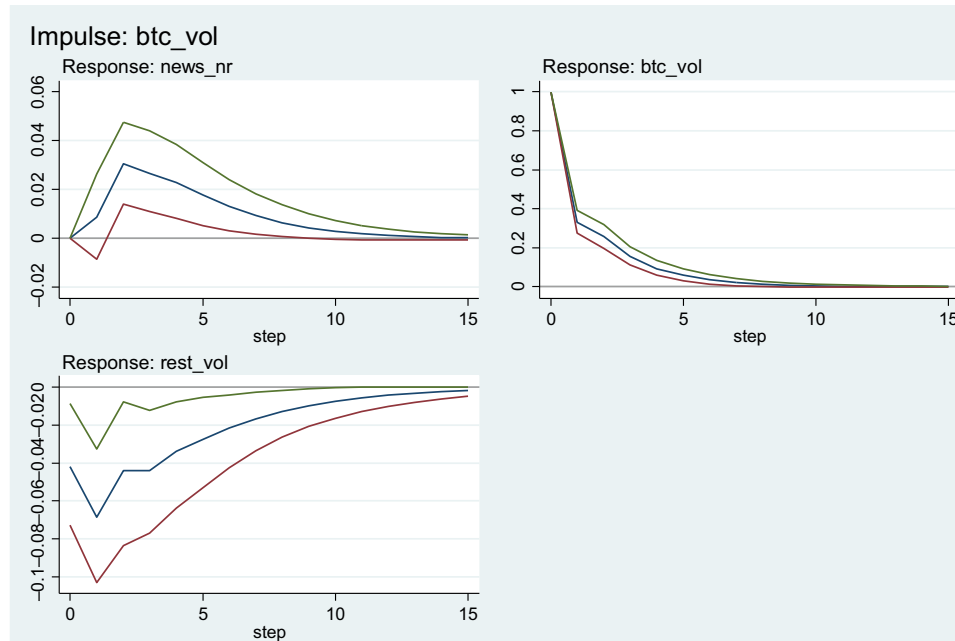
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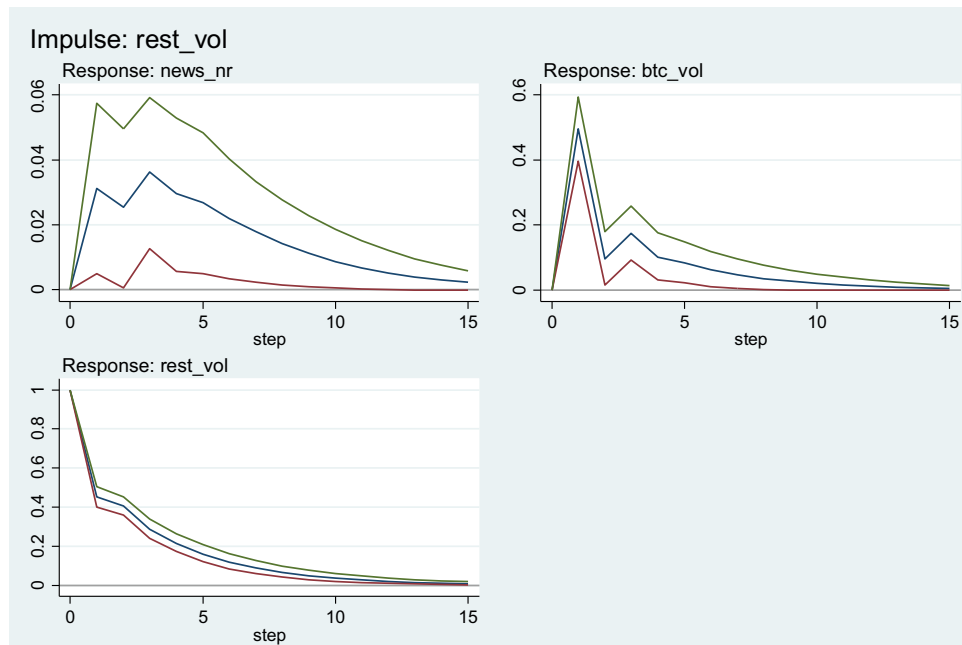
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Appendix

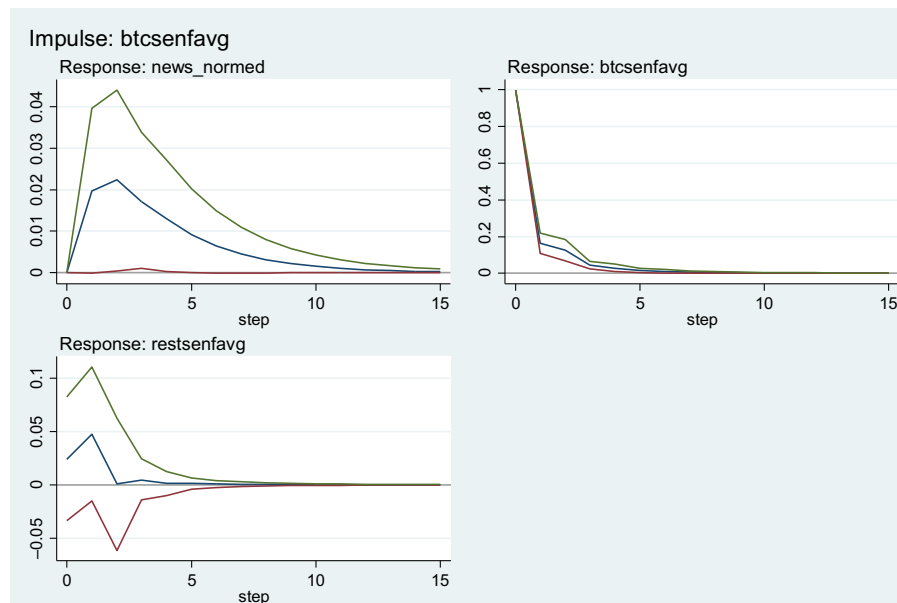
Figure A1 IRFs estimated from the panel VAR where the impulse is the number of tech-related tweets



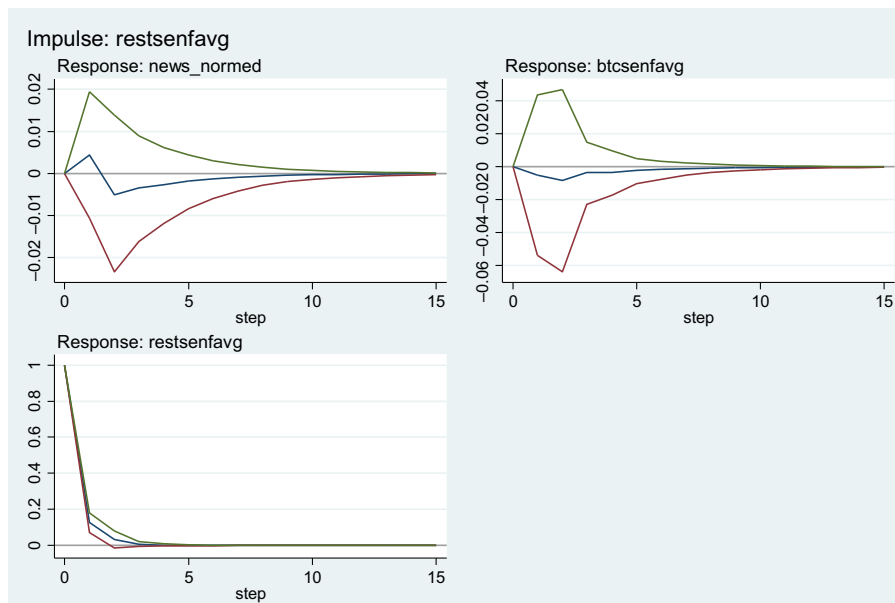
Notes: Clockwise from top left: effect on the number of news, on the number of tech-related tweets and on the number of tech-unrelated tweets. Red and green lines represent the 95% lower and upper bounds of percentile confidence interval, respectively

Figure A2 IRFs estimated from the panel VAR where the impulse is the number of tech-related tweets

Notes: Clockwise from top left: effect on the number of news, on the number of tech-related tweets and on the number of tech-unrelated tweets. Red and green lines represent the 95% lower and upper bounds of percentile confidence interval, respectively

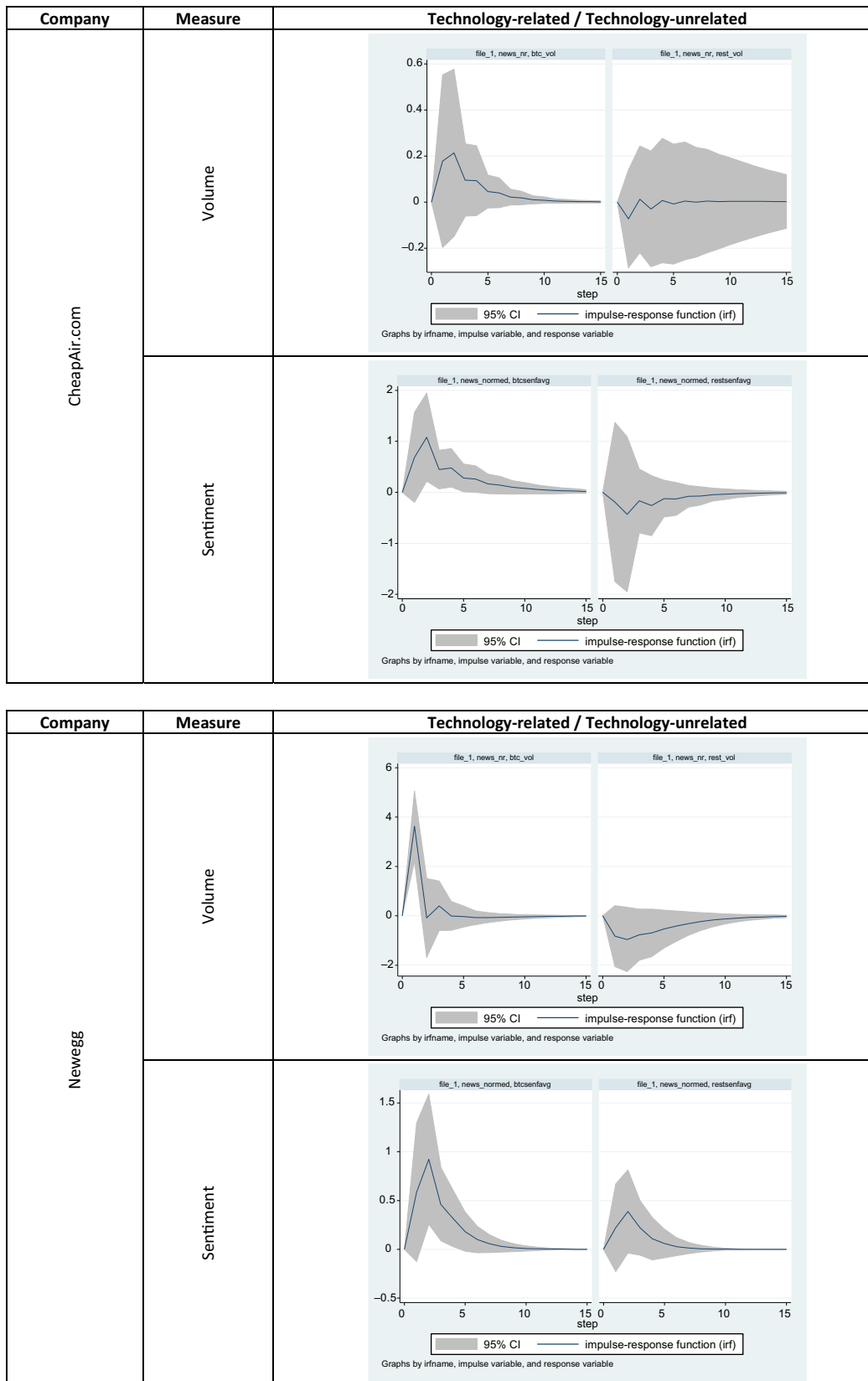
Figure A3 IRFs estimated from the panel VAR on sentiment drivers where the impulse is the average sentiment of tech-related tweets

Notes: Clockwise from top left: effect on the number of news, on the average sentiment of tech-related tweets and of tech-unrelated tweets. Red and green lines represent the 95% lower and upper bounds of percentile confidence interval, respectively

Figure A4 IRFs estimated from the panel VAR on sentiment drivers where the impulse is the average sentiment of tech-related tweets

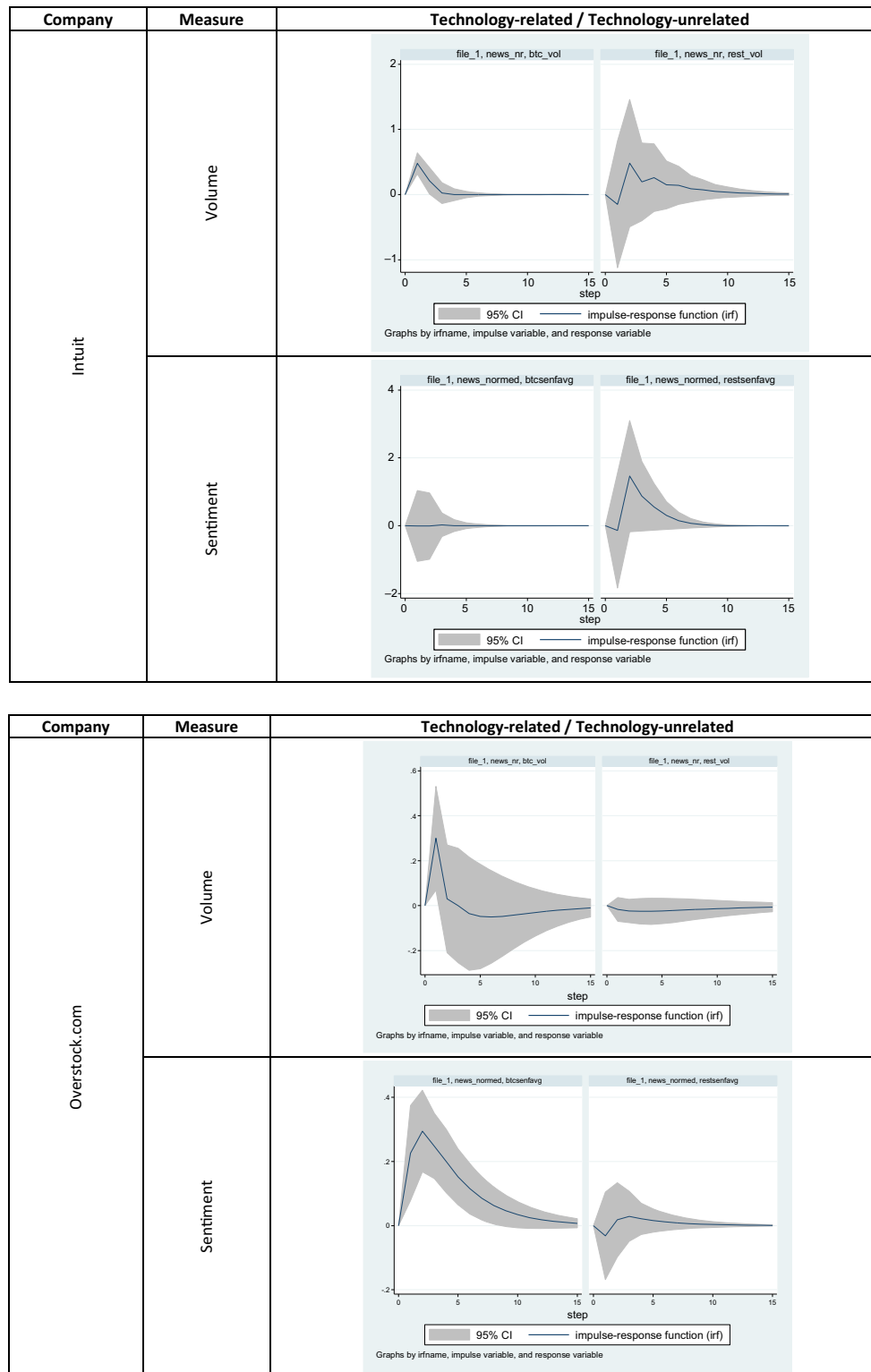
Notes: Clockwise from top left: effect on the number of news, on the average sentiment of tech-related tweets and of tech-unrelated tweets. Red and green lines represent the 95% lower and upper bounds of percentile confidence interval, respectively

Figure A5 IRFs resulting from VAR models limited to each company



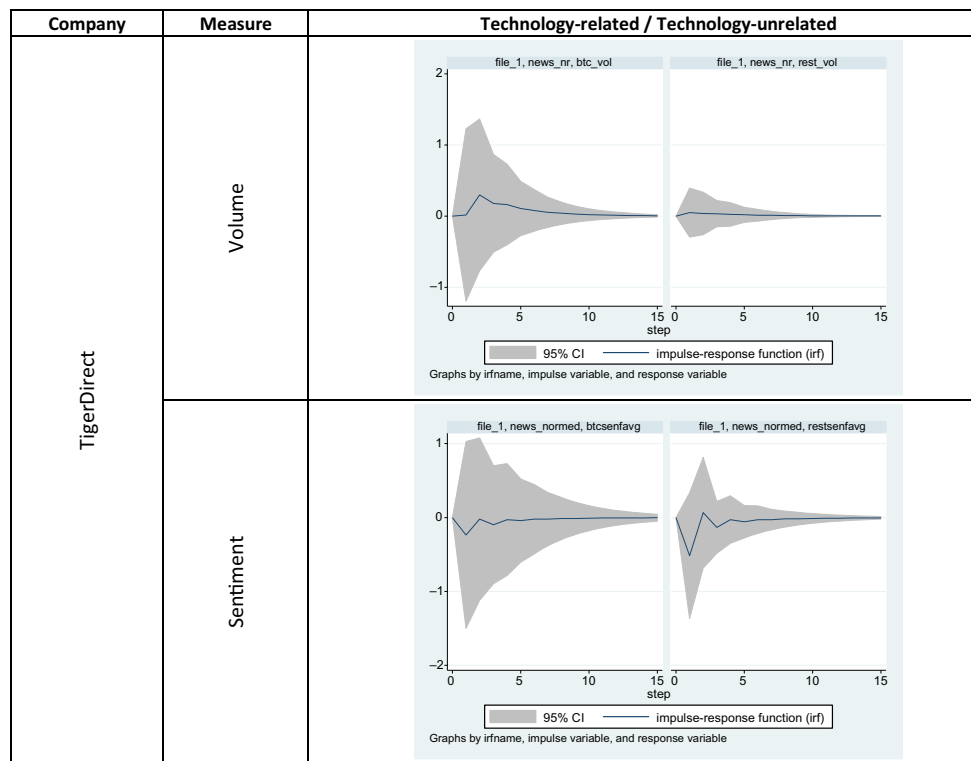
(continued)

Figure A5



(continued)

Figure A5



Notes: The impulse is the number of Bitcoin news. The plotted effects are respectively on the number of tech-related and -unrelated tweets (“Volume” rows) and on the average sentiment of tech-related and -unrelated tweets (“Sentiment” rows)

Table AI Selected companies, main information

Company	Founded
CheapAir.com	Californian online travel agency founded in 1989. A proprietary algorithmic engine provides the cheapest travel solution available online. CheapAir's online service offers a search interface that makes also possible to purchase flights and accommodation On November 22nd, 2013, CheapAir announced to be the first travel agency in the world to accept Bitcoin. In 2014, the company announced to have surpassed \$1.5m sales in bitcoin
Intuit	Californian software company founded in 1983. Intuit provides financial software for corporate accounting, income tax preparation, personal finance and expense tracking. Intuit services have reached more than 45 million customers, with an annual turnover exceeding \$4bn billion. The company is publicly traded on the NASDAQ Stock Market (INTU) On June 25th, 2013, the company integrated bitcoin payments into one of its main accounting software (QuickBooks): since then merchants can convert and receive payments in bitcoin
Newegg.com	Newegg Inc. is a Californian leading online retailer, founded in 2001. The typical products sold in Newegg's website are computer hardware, software, peripherals, gaming and mass electronics On June 1, 2014, Newegg announced to have integrated Bitcoin as a form of payment, in response to the increasing demand from customers
Overstock.com	Overstock is a publicly listed company on NASDAQ. Overstock was launched in 1999, quickly becoming an online market leader in the e-commerce space, counting over one million products in its catalog, with product categories varying from home accessories to furniture, health & beauty, electronics and garden tools The company started accepting bitcoin on January 9th, 2014. In August 2014, the CEO declared that about 0.25% Overstock's sales were in bitcoins
TigerDirect	TigerDirect was founded in 1987. It started as a software developer then turned to online retailer of electronics, computer hardware and software. The company was acquired in 2015, closed the online sales but the website was relaunched in 2016 TigerDirect announced the bitcoin adoption during the end of January 2014, together with a tutorial about the cryptocurrency and some incentives for GPU card buyers in order to start mining bitcoins with their own devices. Bitcoin transactions were limited to online purchases and not accepted inside the physical stores. 18 months later, TigerDirect reported that orders purchased with bitcoins were 30% larger than the expected order value

Table AII Results of the panel VAR model concerning volumes

Equation	Parms	RMSE	R-sq	F	P > F
News	11	13.943	0.499	128.549	0.000
Bitcoin related tweets	11	46.416	0.298	86.406	0.000
Other tweets	11	28.090	0.523	124.570	0.000

Table AIII Panel VAR model on volumes: contemporary coefficients

Contemporary coefficients	News	Bitcoin related tweets	Other tweets
News	1	0	0
Bitcoin related tweets	0.806	1	0
Other tweets	0.118	-0.042	1

Table AIV Results of the panel VAR model concerning sentiment

Equation	Parms	RMSE	R-sq	F	P > F
News	11	0.063	0.493	124.871	0.000
Bitcoin related tweets	11	0.175	0.116	19.675	0.000
Other tweets	11	0.178	0.079	4.210	0.000

Table AV Panel VAR model on sentiment: contemporary coefficients

Contemporary coefficients	News	Bitcoin related tweets	Other tweets
News	1	0	0
Bitcoin related tweets	0.174	1	0
Other tweets	0.033	0.024	1

About the authors

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