# Corporate reputation and social media: a game theory approach

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**Abstract:** Corporate reputation is more and more the most valuable asset for a firm. In this day and age, corporate reputation, although an intangible asset is and will grow as the most essential asset to publicise and also protect. Social media are a formidable tool to publicise a firm's brand and improve its reputation. However, it can also be deadly. Indeed, associated with social media comes the 'buzz', i.e., the means to spread at an unprecedented speed and scale any information being true or false. In this paper, our aim is to propose a game theory approach with both a finite and an infinite horizon. The model presented here helps us evaluate the impact of social media on a firm's reputation. It also highlights the important parameters of a firm's reputation in this new digital era.

**Keywords:** social media; social economics; brand tribalism; corporate reputation.

**Reference** to this paper should be made as follows: Warin, T., de Marcellis-Warin, N., Sanger, W., Nembot, B. and Mirza, V.H. (2015) 'Corporate reputation and social media: a game theory approach', *Int. J. Economics and Business Research*, Vol. 9, No. 1, pp.1–22.

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This paper is a revised and expanded version of a paper entitled 'Corporate reputation and social media: a game theory approach' presented at International Trade and Finance Association Conference, Montréal, Canada, 29 May to 1 June 2013.

## 1 Introduction

Five hundred million messages are sent everyday on Twitter. If one considers a message from a Chinese fortune cookie to be as long as a tweet (140 symbols), then these tweets represent more than 2,500 tons of crispy dough daily. Twitter is just one example and we can add Facebook, Google+, LinkedIn, etc. The multiplication of social networks is at the origin of the often-cited 'buzz'. In this day and age, the exponential replication and amplification of information is of paramount importance for firms. Reputation is and will be the most valuable asset of a firm. Paradoxically, a firm's reputation is defined as an intangible asset as we do not really know how to measure it. In this digital age at once, firms' reputation is more and more important and also more and more exposed through the buzz created on social media (de Marcellis-Warin and Teodoresco, 2012).

Our primary goal in this article is threefold:

1 to highlight the relevant research on building, measuring and managing brand equity in social media times

2 to propose a game theory approach to represent the reputation concept

3 to demonstrate that a high level of reputation awareness is necessary in the new world of social media power.

Indeed, a high level of reputation helps reduce the recovery time after an adverse event hit a company. This is a very important result coming from the game theory framework. Our model highlights the key relationship between the level of reputation and the recovery time after an adverse event occurs for a company.

In this article, we also highlight the twin role played by a high level of reputation:

1 it plays an active protection role: it helps prevent a buzz created by an adverse event

2 it plays a passive protection role: in case of a buzz, it helps reduce the recovery time, limiting the damages made to the firm.

More and more companies are exposed to the judgement of social media. On the one hand, local companies can be criticised by local consumers on media such as Facebook, while on the other hand, global companies can be criticised by consumers anywhere in the world. This is a complicated issue due to the cultural and value systems differences across the world. But global companies can also be criticised for what their partners in their global value chain do or do not do. As a result, more and more companies ask their affiliates to sign corporate social responsibility charters but again it does not protect them from the social media anger. Our game theory model will help demonstrate that, in this day and age of social media power, if a firm – global or local – wants to reduce the recovery time once it has been under a negative buzz on social media, it needs to invest a significant amount of resources in its level of reputation. If a firm cannot do that because it does not have the resources (e.g. a local firm), then it may not recover from a social media attack.

As the important works of Milgrom (1981), Fudenberg and Kreps (1986) and Milgrom and Roberts (1982), economists have well understood the value of brand equity. Before these works though, it was impossible to capture what branding was all about. Branding and reputation were concepts already used extensively in marketing but not in economics. Since then, micro-economists specialising in industrial organisation have built new approaches based on the 1st seminal works aforementioned. Reputation was seen as a barrier to entry or a strategy used by companies to gain some market power.

This is even more interesting in the context of social media. Information can be a true fact or it can be a pure hoax. The nature of the informant has also changed: before only customers would call the company, nowadays even someone on the other side of the globe can post a comment on a company that does not even sell products in his/her country. Beyond the quality of information and the informant, the pace has also changed. Whatever the time of the day or the day of the year, a company's reputation is exposed to any true issue written by a customer in any random country or even to any random hoax that seems funny or that is assumed to be too-big-to-be-wrong and, eventually that becomes viral. The high pace of the information transmission (true or false) has an impact on the company's reputation with an unprecedented magnitude. Needless to say that social media have also become a strategic weapon against competitors. It is no surprise that the terminology 'viral' comes from the virus/anti-virus software industry. With the advent of social media, consumers – and non-consumers – are able to comment on any product, any supplier, or any strategic decision made by a company. The 'buzz' created by social media has an impact on firms' reputation. And when a company is public, a proxy of this impact can be the variation of the stock price right after the buzz. It is thus interesting to use the stock price and its correlation with the buzz to see how deep

the impact was on reputation, how long it will take to recover the initial level of reputation, etc.

Most social media websites offer the option of 'send this to a friend'. For instance, on Facebook and Twitter we have the option of 'share on Facebook' or 'share on Twitter'. YouTube offers 'e-mail this video', as well as the ability to link the video to Facebook, Twitter, Buzz, Myspace, orkut, hi5, tumblr, Bebo, Blogger and StumbleUpon (Veil et al., 2012). Social media and their convolutions create the perfect foundation for any information to go viral. Instead of the old two-step flow from message creator to group members, the transmission model for viral communication is a "networked, distributed flow and via disordered and disorganized yet patterned ways, to combine the communication format, the communication technology and the social contact" (Bennett, 2003).

In recent years, we have witnessed reputation crises, which are the result of viral information – real, or not – spread via social media websites. As an example, we could refer to KFC-Taco Bell rats incident that happened in New York: the story of rats running at the Greenwich restaurant was first reported on early morning TV news by local station WNBC-TV[1]. The related video was uploaded online on 23 February 2007 and according to a Technorati search, more than 1,000 blogs spread the story and thousands discussed the story (Mei et al., 2010). Social media websites bring people together on a platform where they are able to share information and exchange their ideas. In the KFC-Taco Bell incident, the most popular video on YouTube received 2,644 responses sparking comments such as "No more KFC for me" and "When a business allows for such rodents to run freely, the message to us consumers is consumers come last" (Mei et al., 2010). The video of the KFC-Taco Bell incident is still available on the internet. Once information has been uploaded in cyber space, it will stay there for an unlimited period of time, unless the owner chooses to take it down.

Another example illustrating how information can become viral in social media is Nestlé's case which happened on 17 March 2010. The environmental group Greenpeace has long been putting pressure on Nestlé to stop using palm oil. In 2010, for the first time Greenpeace used the social media to attack the giant food company. Greenpeace launched an online campaign accusing Nestlé of buying palm oil for its popular chocolate bar Kit Kat from an Indonesian supplier that clears vast areas of Indonesian forest for its plantations. The consequence of this deforestation is that it destroys the natural habitat of the endangered orang-utans. The campaign included a 60-second video of an office worker enjoying a Kit Kat which, rather than being the popular chocolate bar, appears to be a chocolate-covered ape finger. As the worker eats the treat, it oozes blood over his chin, shocking his co-workers[2]. The video clip ended with a play on Kit Kat's famous slogan: "Have a break? Give orang-utans a break"[3]. Nestlé attempted to censor the video and as a result, the social media attack spread even more on the company's Facebook page which was inundated with negative comments and requests to stop using palm oil. Nestlé's Facebook team responded to their fans' comments by threatening to delete comments left by individuals using modified versions of their corporate logo. This added fuel to the fire[4]. The criticism did not end up on Facebook, it spilled over on Twitter. Negative Twitter comments related to Nestlé's palm oil appeared every 15 minutes. At the end, it was not just social media, also the press picked up the story and publications in *The Economist*, *Guardian* and *Wall Street Journal* appeared. Nestlé's social media crisis

caused the public relations storm, the reputational damage and the financial losses from reduced sales and the fall in its share price[5].

Similar cases are on the rise as social media usage is becoming more popular nowadays. Another example is the Domino's YouTube hoax that happened on April 2009: Domino's pizza employees videotaped their joke which was about contaminating sandwiches and pizza by violating health-code standards and performing unsanitary acts and shared their deed on YouTube. The video went viral and the media picked up the story. The crisis happened for Domino in a short period of time. Social media has an unprecedented ability to create and disseminate hoaxes and rumours (Veil et al., 2012); in fact, hoaxes and rumours are more provoking in cyberspace (Millar and Heath, 2003). For a message to go viral, the content must be provocative enough to engage unpaid receivers to spread the information through their social network (Porter and Golan, 2006). As a 'sick joke', the Domino's YouTube video was provocative enough to go viral (Veil et al., 2012). The crisis resulted in crime charges for the two employees, more than a million disgusted viewers and a major company facing a public relations crisis[6]. Initially, Domino's replied to this reputation crisis by posting an apologetic video on YouTube and addressed the crisis directly via social media.

The big lesson coming from all these examples is that an adverse event occurs and then the social media users (SMU) – individually, i.e., without any coordination – will 'like' it, thus creating a collective 'buzz'. The occurrence of the adverse event can take multiple forms:

1 it can be a true negative event (e.g., mice in a bakery)

2 a hoax (e.g., Domino's Youtube hoax)

3 an adverse event driven by an ideology (e.g., activists caring for a cause).

But then, the adverse event may not become a buzz. It will depend on the mass of SMU who will individually decide to relay the information or not.

## 2 Review of the literature

In what follows, we will review some relevant articles on what constitutes a brand, what determines a firm's reputation and the impact of social media on a firm's reputation. We do not pretend to be exhaustive but we will review the literature that will help us funnel our argument to better understand our research question. Brand and reputation are two related though different concepts. In a nutshell, reputation is an outcome when the brand is a mean that will lead to a certain level of reputation. This distinction is of particular interest for our model. Indeed, branding is here considered as a strategy to change the level of reputation. And branding will be the lever companies can use to respond to social media adverse situations.

## 2.1 Branding

The 'brand' aggregates what is referred to as:

1 product brand

2 corporate brand, according to Knox and Bickerton (2003).

The product brand concept which takes its roots in the marketing field, can be defined as "a product or service, which a customer perceives to have distinctive benefits beyond price and functional performance". Behind the product brand concept, we find the management activities, which lead to the selection of a product brand in order to create some economic value to the company: its corporate brand. The corporate brand concept goes beyond the product itself and it concerns directly the organisation through its different stakeholders. To deepen the definition of corporate brand, Chun (2005) distinguishes the corporate brand concept (also referred to as the image of a company) from the reputation concept (defined in the next section): the brand concept refers to "how others see us" or "simply the impressions or perceptions held by external stakeholders" (Bromley, 1993).

The public's perception of a company makes a difference on a competitive market: a better perception of a company's brand can create a competitive advantage in the long run in order to strengthen or gain some new market shares (Park et al., 1986). Brand enhancement can be achieved through positioning strategies developed during the '60s (Maggard, 1976) such as head-on positioning, or positioning with an idea or positioning for social accountability. Maggard qualifies positioning as a 'warmed-over' version of market segmentation, brand and product differentiation.

Moreover, in order to enhance one's brand, Park et al. (1986) proposed a brand concept management which is structured around sequential steps:

1 selecting a brand concept (product brand)

2 introducing the brand concept in the marketplace

3 elaborating the brand concept (positioning strategies focused mainly on enhancing the value of the brand)

4 fortifying the brand concept by linking it to other products to reinforce it.

It is only through successful brand concepts that a company will be able to strengthen its own corporate brand. However, for a new entrant, whose brand is unknown on a certain market and product quality is similar to the dominant firm's, suggest that the implementation of an associative strategy with a popular brand (co-branding) Dröge et al. (1987) can achieve fast and accurate product positioning.

Brand management is one aspect of companies' concerns toward brand enhancement. The second aspect is the assessment of their brands: how brand equity can be assessed? Keller and Lehmann (2006) mentioned that the brand equity, which refers to the quantification of the benefits attached to the corporate brand, can be observed through three different points of view:

1 customer-based

2 company-based

3 finance-based.

On the customer level, the brand equity can be captured by five criteria: awareness, associations, attitudes (or attraction), attachment and activity (sales). On the company level or product market level, brand equity can be assessed through price differences between the company and its competitors and also through products' sales volumes. Finally, on the financial market level, brand equity can be assessed through financial market performance.

## *2.2 Reputation*

Economists have tried for several decades to capture the concept of reputation. Among them, a quartet formed by Milgrom, Roberts, Kreps and Wilson have developed, in the early '80s, a game theory approach to understand the actions of firms within this context.

According to Milgrom and Roberts (1982) an established firm will target any new entrant in order to build its reputation of a strong incumbent. This leads future entrants to anticipate a predatory strategy from the incumbent. The emergence of reputation could be explained by two reasons: information asymmetries in the market and repeated actions with possibility to observe past behaviours.

In multi-period games, players may decide early in the game to build up their reputation. Adding imperfect information about the players' payoffs to the model developed by Selten (1974), Kreps and Wilson (1981) illustrated the power of reputation in finitely repeated games. Reputation will influence the firms' behaviour. In their work, two models are presented: in the first game, they describe a multi-market monopolist with potential entrants, which are uncertain about the monopolist's payoffs. This *one-sided uncertainty* leads to a unique equilibrium where the entrants nearly elude challenging the monopolist because of the fear of a predatory response. The second model takes into account the uncertainty about the entrant's payoffs. This second game leads to a price war between players as all of them have a reputation to protect.

This seminal work from the four authors (Kreps et al., 1982) confirms the essential role played by imperfect information on reputation. As decisions are impacted by past actions, monopolists and new entrants will be affected by their behaviour. If a monopolist ever declines to fight an entrant, it will be considered as weak. If an entrant ever fails to enter the market, it will be revealed as weak. As a consequence, a strong monopolist always secures its market (by predation), whereas a strong entrant is always able to enter the market.

The authors see reputation as a synonym for predictions of the opponents' future strategies. This concept is used for a dominant firm to ensure its ability to avoid long-term opportunity losses by contracting short-run costs, especially against multiple opponents (Fudenberg and Kreps, 1986).

Following the quartet's work, Mailath (2007) investigates the effect of reputation in repeated games between players. The author describes the *reputation effect* as "the impact upon the set of equilibriums of perturbing [a] game by introducing incomplete information of a particular kind".

However, Chun (2005) has identified the difficulty of clearly defining *reputation*, as a concept used in several disciplines (accounting, economics, marketing, organisational behaviour, sociology, strategy (Fombrun and van Riel, 1997). Her article examines the construct of corporate reputation on the one hand and on the other hand, the construct of image and of identity. She defines *identity* as "how we see ourselves", *image* as "how others see us" and *desired identity* as "how we want others to see ourselves". Corporate reputation is an 'umbrella construct', built upon these three core elements, referring to the 'cumulative impressions of internal and external stakeholders'. This definition is also cited by Brammer and Pavelin (2004) who have linked corporate social responsibility activities of a firm with its reputation. In their article, *Building a Good Reputation*, they enlighten a previous definition of reputation as "a perceptual representation of a company's past actions and future prospects that describe the firm's overall appeal to all its key constituents when compared to other leading rivals"; it also "represent(s) publics' cumulative judgments of firms over time" (Fombrun, 1996).

Reputation has been conceptualised in Game Theory as a signal from a firm. Building on its own reputation, a company has the choice to try new avenues using its brand name in order to convince its customers (Cabral, 2000). He identifies three effects to this decision:

1 a *direct reputation effect* by which the customers will be influenced by the firm's reputation

2 a *feedback reputation effect* by which the new products sales will influence the base traditional products sold by the company

3 a *signalling effect* by which a firm will only stretch its reputation if it is confident enough in its higher quality.

Moreover, reputation is not only a differentiating criterion between companies but can also be seen as strength. Rodrigues et al. (2009) treat reputation as a strategic asset for firms. One can benefit from another's reputation and thus a synergy can emerge through co-branding: shared costs, exposure and risks; market penetration; increasing sales. With a Game Theory approach, they illustrated the concept of co-branding between Apple and Nike through their Nike+ product and how *nerdy* and *sporty* consumers were both successfully reached. With a wider scope, Choi and Jeon (2007) capture co-branding and reputation as a signaling process in order to establish a new firm as a high-quality product player.

### *2.3 Reputation and social media*

Monitoring the social web has become a strategy for firms in order to reach their customers. Stavrakantonakis et al. (2012) have illustrated the approach to adopt in relation to social media monitoring tools. With more than 200 available monitoring tools, it is possible for firms to access the 'real customers' opinions, complaints and questions at real time in a highly scalable way'. They listed and described several commercial tools (such as Alterian-SM2, Brandwatch, Converseon, Cymfony-Maestro, evolve24-Mirror, Meltwater-Buzz, NM Incite-My BuzzMetrics, Radian6, Sysomos, Visible Technologies-Visible Intelligence), but also free available tools (Addict-o-matic, Boardreader, Google Alerts, HyperAlerts, Klout, Netvibes, Twazzup, WhosTalkin and Yahoo Pipes).

Jones et al. (2009) explore the problematic aspects of Web 2.0 from a firm's point of view: *how to best interact with consumers?* As the social web has brought speed, reach and interactivity between firm and stakeholders, a need for some procedure exists in order to take full advantages of the Web 2.0 (and avoid potential threats). The authors identified three ways of managing online reputation: measuring, monitoring and participating in an ongoing process. However, Jones et al. (2009) stated that "[…] positive reputation management results are best achieved once external and internal conditions of transparency […] are satisfied" (p.936), as a firm is highly exposed, results are best achieved with a maximum degree of transparency (internally and externally).

Moreover, the Web 2.0 has given access to new forms of information, through the concept of 'Big Data'. The use of structured and unstructured data has made possible the emergence of a new proxy and new variables to capture complex situations, as well as new ways of measuring risks. Authors have used information posted on social websites in order to invest on the stock markets using Twitter messages (Bollen et al., 2011; Mao et al., 2011). Based on a pure popularity approach, O'Connor (2013) explores the relation between fan counts of popular brands on Facebook and a construct of:

1 consumer following

2 signalling concurrent changes in brand performance

3 valuations of brand companies on the stock markets.

With more exposure comes also a different approach on how to handle a crisis. One simple answer to crisis could be characterised by fast action. Situational crisis communication theory (SCCT) has given a framework to approach this situation (Coombs, 2007). "A crisis is a sudden and unexpected event that threatens to disrupt an organization's operations and poses both a financial and a reputational threat", says the author whereas "crises threaten to damage reputations because a crisis gives people reasons to think badly of the organization". This is especially true in the present social media era. Coombs suggests that three factors shape the reputational threat: the initial crisis responsibility, the crisis history of the company and the prior relational reputation; the last two factors being seen as aggravating or reducing factors to the reputational threat. Dawar and Pillutla (2000) suggested that the way firms can handle a product-harm crisis is determinant in terms of impact on their brand. An ambiguous response could worsen a threat from the public's point of view.

In a publication of the Web Ecology Project (Leavitt et al., 2009), the process of influence on social media, such as Twitter, is to be considered different from traditional media. In fact, the free and unfiltered information flows not only in a one-way direction, but also in a network scheme, giving an individual the opportunity to express herself. As everyone is able to comment, share and publish information, a firm is more than ever exposed to viral content.

Analogy with the biological world can easily express the behaviour of viral marketing. Viruses need hosts to be spread. In fact, an epidemic disease occurs when the number of infected cases exceeds the expected scenarios of endemic behaviour (low and constant propagation). The network connections between subjects contribute to this fast transmission of viruses. *To go viral* occurs when content and information are spread in the same network pattern between users on the internet.

One question that can be addressed is: how and why does content become viral? As part of a viral marketing strategy, several elements have to be taken into account: providing effortless transfer to others, easy scaling from small to large size, use of existing communication networks and taking advantage of others' resources (Wilson, 2000, cited by Jatin et al., 2012). These factors are in fact all common to social media networks, where constant and fast connectivity between users is unavoidable.

Analysing a data set of articles published in the *New York Times*, Berger and Milkman (2009) try to understand how the content of a message can affect its virality. With a psychological approach, they show that content that evokes high-arousal emotions is more likely to be viral (either positive or negative: awe, anger, anxiety). This can be closely linked to the success of *meme* websites: by clustering emotions, users have access to highly addictive content that is generated continuously by the community.

Authors have seen the opportunities that can bring a viral communication strategy. For Moore (2003), the strong benefit of viral marketing is that every user or consumer can be used as an 'involuntary salesperson' (just like hosts for viruses). Examples of how fast Hotmail, Yahoo! or Gmail accounts were opened illustrate this opportunity. More recently, Psy's YouTube video (Gangnam Style) has gained huge exposure, after being seen more than 1.6 billion times in only ten months. Larcker et al. (2012) view social media as an opportunity for firms to directly access their reputational risks. In fact, monitoring the social websites such as Twitter (Jansen et al., 2009), YouTube or Facebook has given signs of effective early warnings: Eli Lilly, Nestlé, Procter & Gamble, Burger King are among the companies that have either approached social media as a monitoring tool or been harmed by scandals spread on these media, highlighting the importance of corporate reputation in a social media era.

## 3 The model

We propose a game theory approach to analyse how reputation has become a very important asset in the new economic environment scrutinised by social media. Based on this model, we will be able to define concepts such as reaction time, recovery time and level of reputation. These concepts will help us understand the specificities of each firm's reputation. We will use these concepts to categorise companies and therefore, we will be able to evaluate the impact of an adverse event on a company's reputation.

Hypothesis 1 There exists a clear relationship between the level of reputation and the recovery time after an adverse event occurs.

As aforementioned, reputation is an outcome. Firms will be able to design strategies to adjust to the buzz created on social media and these strategies will rely on the concept of branding. This is why the notion of branding is very relevant in our model. It is a response firms can use when their reputation is hit. The game theory approach will thus help us design the best strategic responses to an adverse event and the timing of the responses. The model is a signalling model specifically designed to fit the social media context. The model is built with two players: the firm and the SMU (consumers or people who believe they are stakeholders). The firm will send signals about its activities and the SMU will respond or not to these signals. We are able to devise multiple equilibriums

and a Pareto-optimal solution depending on the reaction time of the company and its initial level of reputation.

### *3.1 The structural equation*

Based on the previous definitions, there is a relationship between the concept of reputation and the concept of brand. In particular, this relationship will depend on three sub-definitions of brand:

1 brand positioning

2 brand re-positioning

3 brand de-positioning (Maggard, 1976).

Reputation will thus be defined considering these three subtleties. We also add another important dimension: reputation has a temporal aspect, whereas branding is assessed in a relative way. Branding is indeed defined relatively to the other brands in the same industry. This is where the three aforementioned definitions of positioning, re-positioning and de-positioning are much relevant. They provide a dynamic perspective, considering the strategies within an industry and we capture the impact on the concept of reputation of this dynamics by introducing a temporal dimension. We also assume positioning/re-positioning/de-positioning are relative concepts, inherently linked to the dynamics of the industry, thus we consider the difference in the change of the brand level for each company.

Let us define the structural equation, assuming two firms in the industry, represented by the subscripts *a* and *b*:

$$r_{a,t} - r_{a,t-1} = \alpha_{a,t} \times \left(\Delta b_{a,t} - \Delta b_{b,t}\right) + \varepsilon_{a,t} \left\| \{a, b\} \right| a = 1, 2 \left| b = 1, 2 \right| a^1 b \tag{1}$$

where $\Delta r$ represents the change in reputation. Reputation is thus assumed to have a temporal dimension. This is a key in order to be able to relate the notion of reputation to the recovery time when an adverse event occurs and is popularised on social media. $\Delta b$ represents the change in brand perception and is considered here relatively to the industry. $\varepsilon_{a,t}$ represents an external event impacting the firm's reputation.

We have three possibilities in our information set for the dynamics of reputation:

$$I_t = \left\{ E_1 = \left(\Delta b_{a,t} - \Delta b_{b,t} = 0\right), E_2 = \left(\Delta b_{a,t} - \Delta b_{b,t} > 0\right), E_3 = \left(\Delta b_{a,t} - \Delta b_{b,t} < 0\right) \right\} \tag{2}$$

With *E* representing the three different events.

### *3.2 The players*

The game will be played between two types of players: a firm and the SMU. The payoff for the firm increases with a higher reputation and decreases with de-positioning ($I_t = E_3$) vis-à-vis the competition in the industry. The SMU receive a payoff every time they promote their opinion or relay someone else's opinion. Among the SMU, there will be 'regular' people as well as activists (Baron and Diermeier, 2007; Lenox and Eesley, 2009). In the following model, we will focus only on the 'regular' SMU. We assume then a linear relationship between their payoff and their opinion. We also assume zero cost,

considering they are already connected to the internet and the various social media. In our view, the activists play certainly a big role in initiating attacks against big corporations, but what will transform an attack into a buzz will be the responsibility of the more regular SMU. Indeed, an attack consists in a negative message against a company. The message can rely on scientific evidence or be driven by an ideology. Activists alone cannot create the buzz, they can initiate the message but then the buzz exists (or not) depending on the decision by the regular SMU to relay the message or not. To summarise, an activist creates an initial message and a regular SMU creates the buzz based on the initial message.

The payment function for the firm will be represented by the following profit function which will be defined as the sum of the tangible $T_n$ and intangible values $r_{n,t}$:

$$\Pi_{n,t} = T_{n,t} + r_{n,t} \tag{3}$$

As the goal of this article is to assess the impact of an adverse event on a firm's reputation, we will focus on the loss in intangible value of the firm following a buzz in social media. We do not look at the direct costs on the tangible assets. We will thus consider one of the sub-games specifically capturing the loss in intangible value, i.e., when $\beta < 0$ with $\beta = f(\varepsilon)$.

The loss in the intangible value is:

$$\Lambda_{firm,t} = \left(\rho_{firm,t}\right)^2 + \chi \cdot \left(\beta + \phi \cdot \left(\rho_{smu,t} - \rho_{firm,t}\right)\right)^2 \tag{4}$$

where $\rho_{firm,t}$ represents the response of the firm impacted by the adverse event and $\rho_{smu,t}$ represents the response from the SMU through social media/buzz.

### *3.3 The strategies*

For each player, there will be two strategies $s \subseteq S$ in this sub-game:

$$s \subseteq S \left| S = \begin{Bmatrix} S_1 = \left(s_{1,firm,t} \cup s_{1,smu,t}\right), S_2 = \left(s_{1,firm,t} \cup s_{2,smu,t}\right), \\ S_3 = \left(s_{2,firm,t} \cup s_{1,smu,t}\right), S_4 = \left(s_{2,firm,t} \cup s_{2,smu,t}\right) \end{Bmatrix} \right. \tag{5}$$

For the firm, there will be two strategies: coordination and non-coordination. With $n = \{firm, smu\}$, the first strategy $s_{1,n,t}$ corresponds to coordination. The second strategy $s_{2,n,t}$ corresponds to non-coordination. Coordination means that when an adverse event happens, the SMU and the firm do not make a big fuss about it. In other words, the SMU have a high level of confidence in the firm's management and communication about the adverse event. Non-coordination means that:

1 the SMU do not trust the firm and as a consequence, do not believe in the firm's response, or decide to augment the buzz

2 the firm, when it plays non-coordination, does not trust the SMU. For instance, in the context of the Nestlé's earlier example, SMU have relayed the message from Greenpeace.

The payoff function is the result of the strategies played by the players, with $\Lambda_{firm,t} = f(S)$.

In this strategic context, equation (4) can be rewritten as:

$$\Lambda_{firm,t} = \left(\rho_{firm,t}\right)^2 + \chi \cdot \left(\beta + \phi \cdot \left(\rho_{smu,t} - \rho_{firm,t}\right)\right)^2 \quad (6)$$

We only consider the payment function of the firm as we assume the SMU's payment function is a simple linear transformation.

Hypothesis 2 Coordination is in fact the best strategy for a firm if it wants to reduce its response costs when facing an adverse event popularised on social media.

As aforementioned, a brand will be impacted by an adverse event, leading to a decrease in reputation (based on some conditions as seen before), but then a firm can decide to re-position itself for instance in order to adjust to the consequences of this adverse event. In the context of this model, branding is also a response or a tool the firm can use. In the context of the earlier examples, Domino's pizza responded to the crisis by tackling the issue, while trying to re-position itself as a company that is unapologetic. The hard-line strategy was chosen.

## 4 Strategies in the context of a repeated game with a finite horizon

In what follows, we will define the sub-optimal equilibrium and the Pareto-optimal equilibrium.

Hypothesis 3 If a firm does not have a long-term horizon, then investing in reputation is not an optimal strategy.

Hypothesis 3.1 A high level of reputation is an 'active protection' and helps a firm convince the SMU to choose the coordination strategy, resulting in the Pareto-optimal equilibrium.

### *4.1 The model under $S_1$*

Let us first start with the information set defined as $S_1$. In this context, both players will play a strategy of coordination, meaning $\rho_{firm,t} = \rho_{smu,t}$. We will also assume that $\rho_{firm,t} = \rho_{smu,t} = 0$. It simplifies the model without changing anything to the interpretation of the results. Equation (6) can be rewritten as:

$$\Lambda_{n,t} = \chi \cdot \beta^2 \quad (7)$$

### *4.2 The model under $S_4$*

Let us now move to the information set $S_4$. In this context, the firm will want to minimise its loss, without considering the other player. The firm will play discretionarily and the SMU know it. The way the firm will respond to an adverse event will depend on $\beta$ (a function of the adverse event), but also on the level of awareness of the firm vis-à-vis its reputation (captured by $\chi$ and $\phi$).

Equation (6) can be minimised:

$$\frac{\partial \Lambda_{firm,t}}{\partial \rho_{firm,t}} = \frac{\partial \left( \left( \rho_{firm,t} \right)^2 + \chi \cdot \left( \beta + \phi \cdot \left( \rho_{smu,t} - \rho_{firm,t} \right) \right)^2 \right)}{\partial \rho_{firm,t}} = 0 \tag{8}$$

Leading to:

$$\rho_{firm,t} = \frac{\chi \cdot \phi \cdot \left( \beta + \phi \cdot \rho_{smu,t} \right)}{1 + \chi \cdot \phi^2} \tag{9}$$

To solve this function and considering the information set in which we are, we assume that the SMU are well aware of this minimisation programme and thus will anticipate:

$$\rho_{smu,t} = \frac{\chi \cdot \phi \cdot \left( \beta + \phi \cdot \rho_{firm,t} \right)}{1 + \chi \cdot \phi^2}. \tag{10}$$

As a result:

$$\rho_{firm,t} = \rho_{smu,t} = \chi \cdot \phi \cdot \beta \tag{11}$$

By substituting equation (11) into equation (6), the loss function for the firm is then:

$$\Lambda_{firm,t} = \beta^2 \cdot \left( \chi + \chi^2 \cdot \phi^2 \right) \tag{12}$$

### *4.3 The model under $S_2$, $S_3$*

These payoffs ($S_2$ and $S_3$) correspond to the situation where one player plays coordination and the other one plays non-coordination $\{S_2 = (s_{1,firm,t} \cup s_{2,smu,t}), S_3 = (s_{2,firm,t} \cup s_{1,smu,t})\}$.

The loss function becomes:

$$\Lambda_{firm,t} = \left( \rho_{firm,t} \right)^2 + \chi \cdot \left( \beta + \phi \cdot \left( -\rho_{firm,t} \right) \right)^2 \tag{13}$$

It can be minimised, leading to:

$$\rho_{firm,t} = \frac{\chi \cdot \phi \cdot \beta}{1 + \chi \cdot \phi^2} \tag{14}$$

By substituting equation (14) into equation (13), we obtain:

$$\Lambda_{firm,t} = \frac{\chi \cdot \beta^2}{1 + \chi \cdot \phi^2}. \tag{15}$$

The solution of the game is thus a Nash equilibrium captured by $S_4$, although the Pareto-optimal equilibrium is $S_1$ $\left( S_1 \succ S_4 \right)$. In this sub-game with a finite horizon, a high reputation of transparency and honesty of a firm may play a triggering effect leading to $S_1$. Hypothesis 2 is thus validated. Considering the costs incurred in the sub-optimal equilibrium, coordination should be preferred to get to the Nash equilibrium. In this regard, a high level of reputation can be considered as an 'active protection', meaning it can reassure SMU and make them choose the coordination strategy. Hypothesis 3.1 is thus validated. But the time horizon plays obviously a role.

With a finite horizon, Rosenthal's (1981) paradox may apply depending on the time horizon. If we consider a short period, then each player will play the sub-optimal strategy. But, if the time horizon is long enough, then the folk theorem may apply leading to the Nash equilibrium in some periods. Ultimately, the sub-optimal strategies will be chosen. This result highlights the fact that investing in reputation may not be very efficient if the time horizon of a firm is short (and conversely). Hypothesis 3 is thus validated.

## 5 Strategies in the context of a repeated game with an infinite horizon

In what follows, we will define the equilibrium in the context of a repeated game with an infinite horizon. We use the usual convention in game theory by introducing a discount factor. The following analysis builds on a variant of Solow's labour market model (Solow, 1990). More precisely, this is another illustration of a repeated game as one can found in Vranceanu and Warin (2001).

Hypothesis 3.2 Even if a firm faces a buzz following an adverse event, a high level of reputation will help it reduce the recovery time. A high level of reputation plays a 'passive protection' role.

### *5.1 Dynamics of the game*

Here is the sequencing of the decision process:

Step 1 Initially, the players begin with $\rho_{firm,t} = \rho_{smu,t} = 0$ hence $\Lambda_{firm,t} = \chi \cdot \beta^2$.

Step 2 Then, an adverse effect occurs. The firm decides to play non-coordination: $\rho_{firm,t} = \chi \cdot \phi \cdot \beta / 1 + \chi \cdot \phi^2$. During the first period, the firm will then benefit:

$$\left\{\left(\Lambda_{firm,t} \left| S_1\right.\right) - \left(\Lambda_{firm,t} \left| S_2\right.\right)\right\} = \chi \cdot \beta^2 - \frac{\chi \cdot \beta^2}{1 + \chi \cdot \phi^2} = \frac{\chi^2 \cdot \phi^2 \cdot \beta^2}{1 + \chi \cdot \phi^2} \tag{16}$$

Step 3 But then, the SMU will change their strategy and play $S_2$ leading to the creation of a buzz. Therefore, $\rho_{firm,t} = \rho_{smu,t} = \chi \cdot \phi \beta > 0$, leading to:

$$\left\{\left(\Lambda_{firm,t} \left| S_4\right.\right) - \left(\Lambda_{firm,t} \left| S_1\right.\right)\right\} = \beta^2 \cdot \left(\chi + \chi^2 \cdot \phi^2\right) - \chi \cdot \beta^2 = \chi^2 \cdot \phi^2 \cdot \beta^2 \tag{17}$$

Step 4 This case of non-coordination will last for $T$ periods, after which the Pareto-optimal equilibrium will be played again.

### *5.2 Conditions for coordination*

A firm will want to invest in its reputation so long as:

$$\left\{\left(\Lambda_{firm,t} \left| S_1\right.\right) - \left(\Lambda_{firm,t} \left| S_2\right.\right)\right\} < \sum_{t=1}^{T} \delta^t \cdot \left\{\left(\Lambda_{firm,t} \left| S_4\right.\right) - \left(\Lambda_{firm,t} \left| S_1\right.\right)\right\} \tag{18}$$

where $\delta = (1 + R)^{-1} < 1$ is the discount factor. It captures the time preference of the firm. This is a critical assumption and also a very interesting one for it captures the complexity of each situation. Indeed, a firm may not have a long horizon in one remote market for instance. This variable will capture this kind of practical consideration. The higher the reputation of the firm, the lower the discount factor. Equation (18) can be rewritten:

$$\frac{\chi^2 \cdot \phi^2 \cdot \beta^2}{1+\chi \cdot \phi^2} < \sum_{t=1}^{T} \delta^t \cdot \chi^2 \cdot \phi^2 \cdot \beta^2 \tag{19}$$

therefore:

$$\frac{1}{1+\chi \cdot \phi^2} < \frac{\delta \cdot \left(1-\delta^T\right)}{1-\delta} \tag{20}$$

Let us define $k(T, \delta) = \delta \cdot (1 - \delta^T)/1 - \delta$ with $k(1, \delta) = \delta$ and $\{\partial k / \partial T > 0; \partial k / \partial \delta > 0\}$. Thus, equation (20) becomes:

$$\frac{1}{1+\chi \cdot \phi^2} < k\left(T, \delta\right) \tag{21}$$

### 5.3 *Implications for the role of reputation and the strategies to develop in case of an adverse event*

There is $\hat{T}$ representing the duration for which a firm is indifferent between coordination and non-coordination. This duration is represented by:

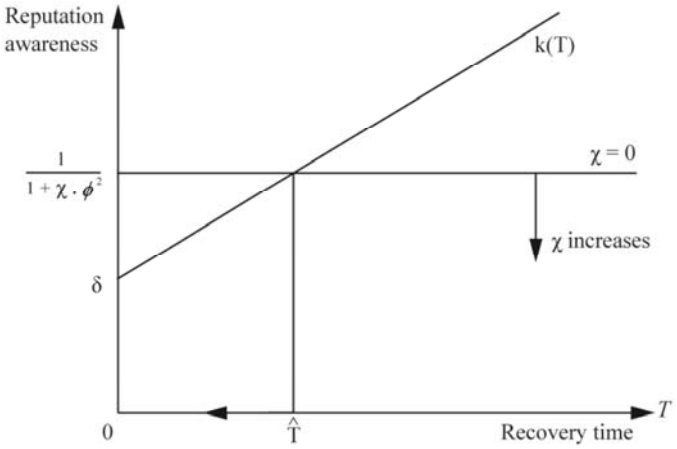
$$\frac{1}{1+\chi \cdot \phi^2} = k\left(\hat{T}, \delta\right) \tag{22}$$

- with $\forall T > \hat{T}$, the discounted loss is greater than the benefit from choosing $S_2$ or $S_3$, therefore the coordination strategy will be chosen by a rational firm.
- or with $\forall T > \hat{T}$, the discounted loss is lower than the benefit from choosing $S_2$ or $S_3$, therefore the coordination strategy will not be chosen by a rational firm.

Figure 1 allows us to easily visualise equation (22) and this condition. We have represented a straight line $k(T, \delta)$ when $T = 0$, then $\delta$ captures the initial level of reputation awareness.

Then, the immediate benefit from the non-coordination strategy for the firm is by definition, time invariant (independent from T) and is captured by a horizontal line $y = \frac{1}{1+\chi \cdot \phi^2}$, $\forall \chi \in [0, \infty] \Leftrightarrow y \in [1, 0[$.

**Figure 1** Best strategic responses




The interpretation of Figure 1 is interesting in terms of the best strategic responses based on the initial conditions of the firm:

1 If the duration of the non-coordination strategies is long enough and beyond a certain limit, then the coordination strategy is preferred. In a nutshell, a high level of reputation is always desirable. This is the mathematical proof of why reputation – the intangible value of the firm – is one of its best assets. It shows that if the costs incurred by the buzz can be big, then firms realise it is in their best interest to play coordination. But they also need to convince the SMU that they are credible at playing the coordination strategy.

2 The non-coordination solution $S_4$ could be chosen, but only when the duration of the game is very short, for instance in the finite horizon game.

3 The minimal duration of the non-coordination strategies $(\hat{T})$ is a decreasing function of $\chi$.

4 There exists a critical value of $\chi$ beyond which coordination is preferred even in the short term. More precisely,

$$\forall \chi > R/\phi^2, \left\{\left(\Lambda_{firm,t} \left| S_1 \right.\right) - \left(\Lambda_{firm,t} \left| S_2 \right.\right)\right\} < \sum_{t=1}^{T} \delta^t \cdot \left\{\left(\Lambda_{firm,t} \left| S_4 \right.\right) - \left(\Lambda_{firm,t} \left| S_1 \right.\right)\right\} \left| T = 1. \right.$$

5 *Ceteris paribus*, the duration of the non-coordination strategies increases when the discount factor $\delta$ decreases.

In short, in most cases, it is preferable for a firm to develop a high-level reputation. It will help it be credible vis-à-vis the SMU when it comes to choosing the coordination strategy. But even if a firm faces a buzz following an adverse event, a high level of reputation helps reduce its recovery time. It serves as a 'passive protection' Hypothesis 3.2 is thus validated.

## 6 Conclusions

This model and discussion around it is a first attempt to put together different definitions such as reputation and branding, as well as highlight the relationship between these two concepts. It is important to realise how branding may translate into reputation and how brand strategies can play a role in adjusting to social media anger.

It is also a first attempt to model and represent mathematically what the concept of reputation entails. Indeed, the notion of reputation is often defined as an intangible asset for firms. Intangible implies that we cannot measure it. However, the financial impact of a good (bad) reputation is real, but also difficult to measure. In a firm's accounting books, we find all the tangible assets, whereas the intangible assets – and reputation for that matter – are approximated by the financial world and embodied in the stock price when the company is public. The volatility of the stock price is often related to perceptions from the financial market and reputation is an important aspect of this volatility. In short, what we have in this article is an attempt to model and thus capture in a tangible way what reputation means.

This is even more interesting in the context of social media. Indeed, social media have changed the customer's loyalty paradigm. As aforementioned, information can be

1 a true fact

2 a pure hoax

and on top of that, the nature of the informant has also changed: a brand can be attacked by a foreign citizen who does not even have access to the firm's product or service.

The possibility of facing a buzz on top of the direct consequences of an adverse effect leads to the idea that a firm should always try to prevent the buzz and put together a communication system that will respond to the buzz. Here, the buzz is proven to be a dominant strategy, thus highly credible. To our knowledge, this is the first time that there is a formal demonstration of the relationship between the level of reputation and the recovery time once an adverse event occurs. It is interesting to note that the best responses from a firm may actually prevent the buzz (sometimes) but even in the case of a buzz, a high-level reputation firm will face a shorter recovery time.

Coordination is in fact the spontaneous strategy for a firm if it wants to prevent a buzz or to reduce its response costs when facing an adverse event. In other words, it is always profitable for a firm to invest in a high-level reputation. Otherwise, when a firm does not give too much attention to its reputation (low level of reputation awareness), then $\delta$ is low. In this situation, in case of an adverse event, the recovery time to the initial level of reputation will be greater.

From a management perspective, this model helps us advocate in favour of a strategy that consists in investing a lot of resources in brand building. As aforementioned, branding is always relative to other companies in the same market. It seems to us that brand building strategies are an efficient investment. It may prevent a buzz in case of an adverse event by convincing SMU that they should play the coordination strategy. But even in the case of a buzz, having a high level of reputation as a result of brand building strategies help reduce the recovery time. In short, brand building strategies are either an 'active protection' (preventing the creation of a buzz) or a 'passive protection' (an insurance policy reducing the consequences of the buzz by shortening its duration).

For further research, we hope this article opens the door to more questions and approaches. It would be interesting to extend this theoretical framework to capture even more complex situations. For instance, it would be interesting to design a model for the demand side (the SMU) in addition to the supply side (the firm or the industry). Indeed, on the demand side, it would be interesting to have two kinds of players: the regular SMU and the activists. It would also be interesting to include a variable capturing more characteristics about a buzz (magnitude, duration, etc.).

## Acknowledgements

The authors would like to thank CIRANO, the GMT Lab (Polytechnique Montréal) and SSHRC for their support. They would also like to thank two anonymous referees and the International Trade and Finance Association participants to the Montréal conference in 2013. The usual caveats apply.

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