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Sustainable business model adoption among S&P 500 firms: A longitudinal content analysis study

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Abstract: In this study, we examine the diversity of sustainable business models adopted by the largest global corporations — those listed in the S&P 500 index — over the period 2005–2014. We examine press release communications during this period, which represent public data about business-relevant events. We expect that examining this communication can reveal longitudinal patterns in the adoption of sustainable business activities and models. Empirically, we utilize academic and practitioner expert panels to build a set of keywords across nine sustainable business model archetypes and utilize automated content analysis to examine the breadth and nature of a firm's sustainable business activities and practices. We find evidence of the increasing prominence of different types of sustainable business models over time. In particular, the results show that large capitalized firms have mostly adopted the environmentally-oriented archetypes, and to much lesser extent the societal and organizational ones.

Keywords: Sustainable business models; Sustainability; Content analysis; Large cap; S&P 500

1. Introduction

Publicly listed large firms are known for their pursuit of profit for their shareholders. At the same time, increasing pressures of corporate and business sustainability challenge these same firms (Banerjee, 2008). The larger the firm, the higher the public scrutiny and the potential controversies among profit, people, and the planet (Kolk, 2008). In contrast to small and medium enterprises and new ventures, large cap firms have shown important challenges in the process of transforming their industries toward sustainable development (Hockerts & Wüstenhagen, 2010). Large cap firms react in the face of corporate scandals or stakeholder pressures and adopt responsibility and sustainability as an incremental process (Kolk, 2016). Beyond that, new strategic activities emerge in large firms searching for a win-win situation between corporate responsibility and sustainability and firm performance (Schaltegger et al., 2011).

However, according to Baumgartner and Rauter (2017, p. 81), progress towards sustainable development has been slow, which indicates a need for more concrete guidance for businesses to act strategically and successfully in a sustainable way. To this end, interest has started to turn to the *sustainable business models* utilized by firms (Boons et al., 2013a; Bocken et al., 2014; Schaltegger et al., 2016), and the solutions these business models could offer in response to challenging environmental and social issues. Broman et al. (2017) in the Journal of Cleaner Production Special Issue on "Science in support of systematic leadership towards sustainability" argue that we need to move beyond understanding of 'what is happening and why' to research that is more systemic and cohesive. França et al. (2017) for instance combine a framework for Strategic Sustainable Development with the Business Model Canvas (Osterwalder and Pigneur, 2010). In this paper, we seek to make sense of the diversity of sustainable business model activities of corporations by investigating the emergence of

sustainable activities and practices, acting as a proxy of companies' transition as suggested in the social practice theory (e.g. Shove et al., 2012; Boons, 2016).

The business model literature is interested mostly in business models that create, deliver, and capture economic value (Teece et al., 2010). Recently, the business model literature has also started to include models linked to social and environmental values (e.g., Stubbs & Cocklin, 2008; Boons et al., 2013a, 2013b). Categorizations and typologies of sustainable business models have been created by academics and business practitioners, including e.g. Boons and Lüdeke-Freund (2013), Bocken et al. (2014), Clinton and Whisnant (2015) and Wells (2013). A systematic review by Bocken et al. (2014) demonstrated the broad variety of sustainability-related business models available. This approach suggests that firms can adopt a broad variety of activities that enable the firms to create "shared value" (Porter & Kramer, 2011), combining economic goals with those aligned to social and environmental values.

However, what is missing from the literature is an overarching understanding of the breadth and depth in which global corporations actually pursue business-relevant activities that are not only economically-focused but also address broader social and environmental stakeholders. To bridge this gap, in this study we examine how firms conduct business-relevant activities that touch upon sustainable issues in a broad variety of societal and environmental domains, including the development of new technologies, organizational practices, and socially oriented activities. We adopt the activity-system perspective on business models (Zott & Amit, 2010) to focus the analysis on different activities, which we group under different types of sustainable business model archetypes. This builds on the notion that business model innovation is an iterative process of experimenting, piloting, debriefing and learning, and scaling (Nidumolu et al., 2009; Lüdeke-Freund et al., 2016). The emergent activities and practices (in an organization) contribute to a sustainability transition and contribute to changing the dominant logic of the firm and as result the core business model (Boons, 2016; Loorbach & Wijsman, 2013; Shove et al., 2012). In large global firms (such as in our study), the business models might constitute a myriad of activities, among some of which are more or less sustainable. For this reason, we expect that the approach of examining sustainable business activities as the constituent parts of sustainable business models can provide a feasible overall indicator of the trends of transformation to sustainable business models.

We focus on Standard and Poor (S&P) 500 firms over the period 2005–2014, and using big data research design and automated content analysis (see e.g. Lee et al., 2008, 2009), we examine the patterns of adoption of sustainable business models by large cap corporations over time. Based on automated content data analytics of the press releases of the firms in the sample, we evaluate business activities based on a taxonomy of technological, social, and organizational activities oriented toward creating sustainable value. Methodologically, the present study goes beyond the more traditional analyses of corporate social responsibility (Dahlsrud, 2008), and even beyond studying sustainability reporting, as we focus directly on the corporate communication directed at stakeholders. Given the high public scrutiny S&P 500 firms face, we expect that this data source provides feasible access to potential sustainable business activities.

By utilizing existing literature, and especially a further developed systematic review-based sustainable business model taxonomy by Bocken et al. (2014), this study provides interesting evidence of how the relative emphasis on different sustainable business models and activities has changed over time in global corporations. The results provide implications for research but

also for the methodology of studying sustainable business models in a large-scale, big data research design.

Next, we discuss the links between large global corporations and sustainable development, and the motives and challenges faced in their efforts to integrate sustainability issues with competitive strategies. This is followed by a discussion of sustainable business models (SBMs). Then, based on the conceptual foundations, we describe the methodology and results for SBM analysis of S&P 500 firms between 2005 and 2014. Finally, we discuss the theoretical and practical implications of the findings, as well as address the limitations and future research directions.

2. Setting the scene: (Lack of) business sustainability in global corporations

2.1. The corporate sustainability journey

Large corporations have been criticized due to the lack of trust in their ethical, social, and environmental behavior (Banerjee, 2008; Carroll & Shabana, 2010). This criticism is based on the premise that corporations are mostly guided by self-interest, leading to the pursuit of economic profits over social and environmental concerns (Banerjee, 2010). This is linked to the classic Friedman claim (1970) that the main responsibility of business is only to increase economic profits for shareholders in contrast to other social concerns. However, recently we have seen how societal pressures and the negative consequences of globalization have forced corporations to focus on social and environmental concerns in core business activities. First, corporations have been pressured to reduce the negative impacts of their operations on consumers or suppliers, and even local communities are adopting corporate social responsibility practices and new dialogues with societal stakeholders (Freeman, 1984; Carroll, 1999; Garriga & Mele, 2004). Second, corporations have also been forced to react to the new global environmental challenges by promoting new sustainable practices and the greening of their processes (Gladwin et al., 1995; Hart, 1995; Shrivastava, 1995). Third, global companies have increasingly outsourced activities to supply chain partners, shifting the domain of corporate responsibility from that of an individual corporation to the level of the whole supply chain (Seuring & Müller, 2008). Thus, large corporations are also held responsible for the impacts caused by their partners (Paulraj et al., 2015).

As a consequence, corporate social responsibility (CSR) and sustainability have become important dimensions that affect the reputation and strategy of large cap corporations (Hoffman and Bansal, 2012; Kolk, 2008, 2016). Currently, most corporations report their economic, social, and environmental impacts (Kolk, 2008; Perego & Kolk, 2012) assuming the principles of the triple bottom line (Elkington, 1997). Corporations have also adopted CSR and environmental strategies (McWilliams & Siegel, 2001) and included them as drivers of competitive advantages in the markets (Porter & Kramer, 2006). Some corporations have also gone through important changes by greening their operations and assuming new arguments for how sustainability creates new economic, social, and environmental value (McWilliams & Siegel, 2010). Friedman's approach to social responsibility has been largely moved forward with the emergence of public discussions on the role of business in society (Carroll, 1999). Beyond that, stakeholder management and dialogue have emerged as a core dimension of business responsibility and sustainability (Freeman, 1984, Freeman & Evans, 1999). The analysis of how corporations affect and are affected by internal and external stakeholders has changed the way companies create new value in markets, solve societal and environmental challenges, and include multiple stakeholders in the process of value creation (Freeman, 2010; Garcia-Castro & Aguilera, 2015; Bocken et al., 2013; Tantalo & Priem, 2016).

We have seen different waves of how businesses have approached social and sustainability issues (Hoffman & Bansal, 2012; Carroll, 1999). The first wave in the early 1970s was based on the recognition that corporate social responsibility and environmental issues could become an important problem for corporate reputation. During that period, corporations mostly reacted to environmental and social crises (e.g., the Bhopal accident) by adopting voluntary measures and assuming new soft regulation and reporting frameworks. In the late 1990s, a second wave emerged when large corporations moved toward a more proactive approach experimenting with how environmental and social issues could create new strategic competitiveness (McWilliams & Siegel, 2001; Porter & Kramer, 1996). The third wave arrived with the new century when large corporations were affected by globalization and the development of global supply chains facing new environmental and social challenges. This affected corporate practices directly and changed the way leading corporations assumed societal and stakeholders' expectations (e.g., as bribery and corruption, human rights, environmental protection, political influence, greenwashing, local communities; Kolk, 2016). The notion of extended corporate citizenship emerged, calling for corporations to go beyond philanthropy to assume responsibility for protecting the social rights that governments fail to fulfill appropriately (Loorbach & Wijsman, 2013).

2.2. Challenges faced by large caps in sustainability efforts

However, large corporations are slow to change when compared to emerging small-scale sustainable and social ventures (Aguilera et al., 2007) or when assessed against the goals of sustainable development (Hockerts & Wüstenhagen, 2010; Schaltegger et al., 2016). In the last decade, we have seen many disruptive innovation changes transform technologies and products and services as a key driver for change (Ahlstrom, 2010; Hart & Christensen, 2002; Iñigo & Albareda, 2016), and a broad movement of social and sustainable ventures in key topics, such as renewable energies, sustainable mobility, climate change, and natural resource scarcity (Hockerts & Wüstenhagen, 2010). These changes come together with new sustainable supply chain management practices (Seuring & Muller, 2008) and the emergence of sustainable business models (Schaltegger et al., 2016). Although economic profit is essentially linked to creating social and ecological value (Hart & Milstein, 2003; Loorbach & Wijsman, 2013), it is not easy for large multinational corporations to implement these strategies.

First, the transformation of large cap corporations is hampered by institutional inertia (Boons, 2009; Campbell, 2007; Loorbach & Wijsman, 2013) and the lack of a clear corporate commitment to organizational justice and sustainable development (Banerjee, 2008). Thus, age, size, and objective functions are determinants that signal the differences between how start-ups and even small business enterprises connect directly to these sustainability-oriented transformations (Hockerts & Wüstenhagen, 2010). Incumbent corporations normally react only when they are affected by new entrants that transform the markets with new sustainability-oriented technologies or sustainable products and services (Schaltegger et al., 2011).

Second, large corporations operating around the globe have to deal with the inconsistencies of national policies, cultural customs, and management practices, making it hard to develop strategies and business models that meet the (sometimes conflicting) needs of various stakeholders (Andersson et al., 2005; Kolk & Pinkse, 2008; Escobar & Vredenburg, 2011). Furthermore, the global nature of many social and environmental issues calls for globally integrated strategies because activities in one country can have implications for stakeholders in other countries (Duran & Bajo, 2014), and integrating the sustainability strategies in day-to-

day operations across supply chains and subsidiaries is seen as a major challenge (Lacy & Hayward, 2011).

3. Sustainable business models: An activity system perspective

In this study, our aim is to understand the business sustainability of firms in terms of their socially and environmentally sustainable business activities. We see sustainable activities as contributing to sustainable business model development and innovation, in line with social practice theory, describing practices as the fundamentals of a sustainability transition (Shove et al., 2012). Indeed, Shove et al. (2012) as well as Boons (2016) argue that emerging (social) practices provide the evidence of a transition in society and business. This is aligned with the viewpoint of sustainable business model innovation as an ongoing and iterative process (Boons, 2016; Nidumulo et al., 2009; Lüdeke-Freund et al., 2016; Zollo et al., 2013). Sustainability-related activities are the constituent parts of large cap firm's sustainability efforts, and can be seen as an important indicator of business model transition. 'Key activities' are also an element of the business model canvas by Osterwalder and Pigneur (2010), along with other dimensions. Importantly, we expect that the activities and practices are often those salient constituent parts of the business models which will be reported publically, in contrast to the other elements of the business model (such as internal revenue model etc).

To this end, we utilize the business model approach for zooming in on the activities and practices of the firm. In the mainstream literature, business models are viewed as templates between a firm's strategy and practice, allowing to examine the value proposition, value creation, delivery, and capture (Osterwalder and Pigneur, 2010; Richardson, 2008; Teece, 2010; Ritala et al., 2014). Recently, the business model approach has been increasingly adopted in business sustainability discussions. This is driven by key sustainability challenges such as climate change and its immediate consequences, growing populations, and increasing resource scarcity; changes in competition in global markets; and changes in the role of the government and economic and ethical crises (Boons et al., 2013). These developments have paved the way for sustainable businesses, pursuing the triple bottom line and gaining business opportunities while resolving societal challenges. Sustainable business models, along with new product design, technologies, and value chains, are at the center of transforming the way business is done to move to the development of sustainable businesses (Rashid et al., 2013).

Business models are viewed as strategic and a key source of competitive advantage in the seminal business model literature, as well as in the sustainable business model literature (Boons & Lüdeke-Freund, 2012). Stubbs & Cocklin (2008), based on innovative company cases, conceptualized the business model for sustainability or the "sustainable business model," and describe that such businesses adopt systems and firm-level perspectives, build on the triple bottom line to define the firm's purpose and measure performance, and include a wide range of stakeholders—in particular, the environment and society—in the way business is done (Bocken et al., 2013). Such business models can contribute positively to society and the environment, while delivering a competitive advantage (Boons & Lüdeke-Freund, 2013). For instance, Product Service Systems (PSSs), originating in the mainstream business model literature on servitization, that is, the move from products to services, have been described as a key potential sustainable business model (Tukker, 2004; 2015; Goedkoop et al., 1999). By delivering services and (often) moving away from product ownership, such business models can better align stakeholder interests, by delivering only what is needed (e.g., mobility in car-sharing models). Moving beyond PSSs as the main model, authors such as Clinton and Whisnant (2015) and Bocken et al. (2014) have developed a much wider range of sustainable business model archetypes and examples. The literature has moved from the conceptualization

of sustainable business models (Stubbs & Cocklin, 2008; Boons & Lüdeke-Freund, 2013; Boons et al., 2013; Bocken et al., 2014) to the development of tools and methods to start implementing new sustainable business models (Keskin et al., 2013; Baldassarre et al., 2017; Breuer and Lüdeke-Freund, 2017; Geissdorfer et al., 2016; Joyce et al., 2016; Upward and Jones, 2016). However, a lot of work is still required to increase the occurrence of sustainable business models in practice (Tukker, 2015).

The business model approach is particularly useful for our analysis as these models can be viewed as activity systems that cover internal and external activities in which the firm is engaged (Zott & Amit, 2010). These activities, when they represent sustainable issues, are best represented by the practical descriptions, communication, and expression of firms' activities (i.e., those that the firms would report to their stakeholders in press releases). To this end, we utilize and slightly extend the recent taxonomy of sustainable business model archetypes by Bocken et al. (2014), further developed in Bocken et al. (2016) and Lüdeke-Freund et al., (2016), including nine archetypes divided across environmental, social, and economic categories as the major innovation types derived from the triple bottom line (Elkington, 1997; see Figure 2).

The original sustainable business model archetypes framework (Bocken et al., 2014) was developed to introduce a range of sustainable business model opportunities, to develop a unifying research agenda, and to provide examples for practitioners. The archetypes aim to give examples of mechanisms and solutions that could contribute to building up the business model for sustainability (ibid.). In the updated framework in Figure 1, they are organized according to the major direction of innovation, that is, the major innovation types: environmental, social, and economic. In addition, the archetype inclusive value creation is added, reflecting the growing number of peer-to-peer and sharing models (Bocken et al., 2016), the growing need for collaboration (Elkington, 1998; Elkington & Hartigan, 2007; Kraaijenhagen et al., 2016), and the need to include previously underserved segments such as the Bottom of the Pyramid (Prahalad, 2012) and taking an inclusive approach to innovation. We expect this taxonomy to cover the most common instances of sustainable business activities, and therefore, it is an applicable tool to understand how sustainable business models are actually adopted.

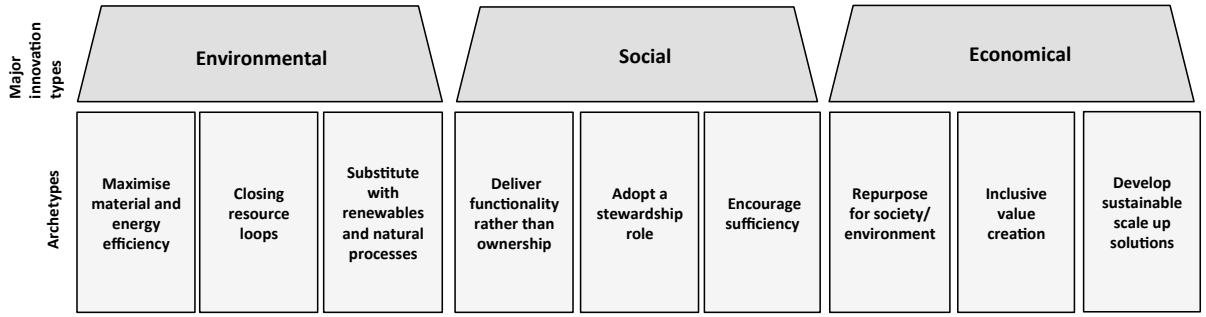

Figure 1. Sustainable business model archetypes and examples (Adapted from Bocken et al., 2014; 2016 and Lüdeke-Freund et al., 2016)

The environmentally oriented archetypes. *Maximize material and energy efficiency* is concerned with optimizing the resources used. Consider, for instance, the Toyota Production System as a near synonym for Lean manufacturing and continuous improvement. *Closing resource loops* then is concerned with reusing products and materials. In Interface's Networks programme, fishing nets are sourced from the sea and with various partners (e.g., Aquafil,

Zoological Society of London) turned into new carpets (Kraaijenhagen et al., 2016). *Substitute with renewables* is concerned with business model innovations in renewables. Several solar energy and electrification businesses have emerged in developed markets and rural areas (Jia et al., 2016).

The social archetypes. *Deliver functionality rather than ownership* focuses on moving away from the necessity for ownership to access to the use and functionality of products through the service type of models often referred to as PSSs (Tukker, 2004). For examples, in car-sharing models consumers do not own a car but pay per actual usage or access to cars through monthly fees. *Adopt a stewardship role* is about the stewardship role and additional responsibility that a business might take on in order to address a specific social or environmental issue (Bocken et al., 2014). For example, companies might sell only the most energy-efficient labeled appliances and specifically ban others (Sustainable Consumption Roundtable, 2006). Or companies might seek to improve the physical areas in which they operate: Patagonia, through their entry in the fish business, aims to support and promote conservation projects that positively affect wild salmon populations (Patagonia Provisions, 2016). *Encourage sufficiency* is about considering slow consumption as part of the business model. Companies such as Vitsœ and Patagonia have worked with more sustainable sales techniques, such as promoting sales of only what is needed (Bocken & Short, 2016).

The economic archetypes. *Repurpose for society/the environment* is about changing the corporate structure for sustainability. Benefit corporations, for instance, aim to "meet the highest standards of verified social and environmental performance, public transparency, and legal accountability, and aspire to use the power of markets to solve social and environmental problems" (B Lab, 2016). *Inclusive value creation* is about sharing resources, knowledge, ownership, and wealth creation. Examples include peer-to-peer product-sharing platforms (Belk, 2014), as well as innovations at the Bottom of the Pyramid creating value for previously under-addressed user and customer segments (Prahalad, 2012). Finally, *developing sustainable scale-up solutions* is about delivering sustainable alternatives at scale to maximize sustainability benefits. Examples include sustainability incubators and crowd-sourcing platforms focused on sustainable initiatives.

4. Methodology

To examine the prominence of sustainable business models, we analyze the frequency with which firms refer to these in the firms' communications. This automated content analysis approach aims to quantify content in terms of predetermined categories in a systematic and replicable way (Bryman & Bell, 2007). Specifically, we calculate the number of mentions of specific sustainability-related keywords that describe the business models in the press releases of S&P 500 firms in 2005–2014. The data consist of more than 90000 press releases with approximately 40 million words by the 101 S&P 500 firms that fulfilled two criteria: 1) The firms have remained in the stock index during the given timeframe (i.e., we excluded firms that were not in the index for the whole timeframe), and 2) the firms had press releases available on their public websites. At the very least, the simplistic keyword frequency measure tells us how commonly the firms talk about sustainability, while also possibly and expectedly reflecting their actual sustainable behavior. In addition to analyzing changes in keyword prominence over time, we also contrast the keyword mentions with the total number of words in the press releases to understand how much emphasis the firms have put on sustainability over time. Similar kinds of keyword-based approaches have been used to detect technology trends from patent data (e.g., Lee et al., 2008; 2009).

We have several reasons for focusing on S&P 500 firms. First, we want to study whether and how sustainable business models have gone mainstream and evolved in global companies. Second, S&P 500 firms are typically globally diversified actors, which affect several different stakeholders with their actions. Third, S&P 500 firms are under major scrutiny in terms of their business activities, and due to the firms' visible stock listing, they need to report their activities in various forms (press releases, annual reports, other reports). This information is easily available due to the firms' high visibility.

The press releases were collected by hand, involving several research assistants scanning corporate web pages. Only the actual content of a press release was instructed to be collected, that is, repeating content such as "about firm X" or "contact information" should have been removed from a release—thus, the keyword frequencies should be unbiased in this regard. However, given the huge number of press releases, the manual data collection process resulted in errors in the data (e.g., duplicate press releases, repeating and missing content). However, such errors should not be systematic. Further, and in addition to automating the data analysis with the Python programming language, we performed programmatic crosschecks of the hand-collected data to mitigate the errors in data collection. Specifically, we detected and removed exact duplicate press releases. Further, we also filtered out each press release whose content was found in another release in its entirety (2835 press releases in total)—which is not only an error in data collection. Some firms actually reused content, biasing the results had we not filtered out the previous press releases. After filtering, the final sample consisted of 93770 press releases.

We utilize an extended conceptual taxonomy of nine business model archetypes in Figure 1, in creating the list of mutually exclusive keywords to be analyzed. Under each archetype, we used business model examples identified in these articles to generate keywords. In addition, more keywords were generated using expert panel brainstorming sessions, as well as individual industry experts. After the explorative phase of generating the keywords, all five authors went individually through the whole list and examined the keywords critically based on whether they unambiguously were related to sustainable business model activities or not. After these iterations, there were a total of 428 keywords in the nine categories. Some keywords were intentionally left in their basic form (i.e., without prefixes or suffixes) to capture the various ways in which the word can be used (e.g., "recycl" aims to capture "recycle" and "recycling"). To capture combinatory expressions, we included forms such as "low carbon" and "low-carbon" when applicable.

It is noteworthy that we focus on *activities* and *practices* as the evidence to a transition to sustainable business models. This follows Loorbach and Weichman (2013) describe (sustainability) transitions as major, non-linear changes in societal cultures, structures and practices that arise from the co-evolution between economy, society and ecology. Practices gradually evolve and over time fundamentally alter dominant practices, paradigms and structures (see Shove et al., 2012; Loorbach and Weichman, 2013; Boons, 2016). Therefore the keywords are used as a proxy for emergent business model activities and practices. The rationale behind this is that if companies are confident to publically express their support of and activity in a certain area, it can serve as evidence for (the start of) an internal transformation. This approach however has its limitations, the main one being that it will not reveal to what extent activities and practices have been embedded. Although we integrate knowledge from different fields, being sustainable business model innovation (Boons and Lüdeke-Freund, 2013; Boons et al., 2013; Schaltegger et al., 2016) and social practice theory

(Shove et al., 2012; Boons, 2016), in pursuit of the call for more systemic research approaches (Broman et al., 2017), we are not answering to the call for research on *measuring* progress towards sustainable development (Broman et al., 2017). Rather, we report on progress against a sustainable business model evolution in corporations based on emerging practices and activities.

Moreover, and important limitation is that words may have different meanings in different contexts, and not all firms are likely to discuss sustainable business activities when they use a particular phrase. To examine whether there is a bias in this regard, we conducted a manual robustness check to 100 randomly selected press releases from the data. Three of the authors independently went through these press releases, and reflected whether the press release in question clearly related to sustainable business activities. "Yes / no / maybe" categories were used to document the researchers' individual judgment. In particular, the three authors focused on what was discussed in relation to the particular keyword (e.g. "alternative energy", "reduce carbon", "refurbish") in those press releases to assess the reliability of the automatic categorization of those words in the sustainable business model archetypes. As a result, we found that the press releases mainly address sustainable business activities in connection to the words singled out by our algorithm. Using majority vote principle (i.e. two authors agree on yes/no/maybe), we found that 68 of the 100 releases unambiguously address sustainable business issues, 22 do not, and there were 10 borderline cases. Using full consensus (all three agree), the same numbers are 53 (yes) and 11 (no). We did not find any press release that would have been using the phrases in negative sense (i.e. seeing sustainability as a threat), as the "missed hits" constituted common language, ambiguous expressions, and other neutral instances. Overall, based on this robustness check, we can state that as expected, our method includes some noise and missed hits, but in general can produce findings that allow to examine broad trends of sustainable business activities across the nine business model archetypes.

Finally, the keyword frequency counting algorithm was very simplistic: Each press release was tokenized first, meaning each English word in the document was separated, by using a standard word tokenizer in the Python module Natural Language Processing Toolkit (Bird et al., 2006). Then, after the punctuation characters (i.e., "!"#$%&'()*+,-./:;<=>?@[\]^_`{|}~") were removed from the returned tokens, the total number of words in the document was counted, equal to the number of returned tokens. To clarify, the tokenization algorithm should correctly identify English words with punctuation characters (e.g., "sustainability-oriented"), enabling us to remove only the punctuation characters that were not part of English words. Finally, keyword frequencies were calculated with the built-in Python "count" function, which returns the number of (non-overlapping) occurrences of a substring (i.e., a keyword) in a string (i.e., the remaining tokens joined together with a space in-between each token). The keyword frequencies were then aggregated from the document level to the firm, quarter, and year level.

5. Results

5.1. Most common SBM expressions

Before discussing the SBM archetypes, it is worthwhile to examine the raw data in terms of the most common keywords. As can be seen in Table 1, several expressions dominate the frequency of all the press releases analyzed. The top three keywords are far ahead of the others: "recycle", "energy efficien", and "renewable energy." This is not a surprise, as they characterize the broad trends in business and society in turning toward recycling of materials, as well as improving energy efficiency. The same types of trends can be spotted among other top 30 keywords, which include many mentions of renewable energy forms (e.g., wind and

solar energy), as well as carbon reduction. Other interesting notions include the social value creation aspects, as the keyword “local communit” is the fourth most frequent one. Other society-related keywords include non-profits, public-private partnership, charitable organization, and community investment.

Table 1. Top 30 most common keywords

Keyword	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total
recycl	241	169	490	432	486	618	504	676	457	253	4326
energy efficien	85	126	350	405	587	597	448	475	363	300	3736
renewable energy	72	152	317	349	514	436	415	323	237	270	3085
local communit	74	102	154	150	146	156	148	169	134	124	1357
non-profit	129	90	138	146	166	150	143	135	137	109	1343
wind energy	36	37	92	64	110	127	92	117	65	49	789
solar power	7	35	65	62	103	128	105	73	67	76	721
solar energy	16	16	27	26	106	98	62	52	61	111	575
wind power	44	22	83	52	68	69	48	51	36	34	507
carbon footprint	0	3	13	58	83	120	83	55	49	42	506
reduce energy	13	10	23	42	67	96	60	80	36	39	466
green building	1	17	29	79	71	90	75	32	20	14	428
refurbish	22	47	55	35	58	40	44	40	26	25	392
alternative energy	0	16	25	28	59	65	57	64	21	9	344
sustainability report	4	9	10	12	25	40	61	52	45	52	310
environmental stewardship	15	26	31	24	41	47	33	34	25	32	308
public-private partnership	9	25	37	29	23	45	53	32	24	28	305
solar panels	4	4	9	21	47	42	53	27	38	48	293
reduce emission	9	18	44	31	25	31	31	33	18	14	254
charitable organization	13	25	22	22	24	20	15	23	43	24	231
green energy	1	2	15	12	13	20	19	23	27	56	188
waste management	8	7	20	16	12	22	18	39	11	16	169
community investment	16	22	22	17	13	8	8	17	21	18	162
reduce carbon	2	5	24	20	26	30	15	12	14	7	155
sustainable energy	4	7	9	13	19	30	33	16	16	5	152
compost	1	5	15	8	18	17	23	23	10	14	134
reduce waste	3	4	9	9	28	30	14	15	5	9	126
lean manufacturing	16	25	14	9	14	13	3	14	7	4	119
low-carbon	1	0	13	15	19	21	14	17	6	5	111
zero waste	1	5	5	9	13	9	6	13	12	23	96

5.2. SBM archetypes 2005–2014

Table 2, and Figures 2 and 3 report the raw baseline results of the SBM analysis, aggregated to include all 101 companies on a year-by-year basis and categorized among the nine business model archetypes. This data shows that the frequency of sustainable activities increases strongly after 2006. This finding is intuitive, as this period crosses the popularity of the energy-efficiency movement and the alternative and renewable energy sources globally, and therefore showcases the validity of our approach. The overall number of corporate communications spiked in 2009, followed by a decline until 2014. This is seen in Table 2, as well as in Figure 3, which shows that the amount of content related to sustainable business model activities has largely moved along the overall corporate communication (dotted line) over time.

However, other important findings emerge when a closer look is taken. Figure 4 analyzes the relative weights of different business model archetypes during the ten years of the analysis

period. The dominant archetypes remained much the same during the period. However, the relative rise of archetypes 1 (maximize material and energy efficiency) and 3 (substitute with renewables and natural processes) can be observed. Overall, latter of the two is the most prominent archetype across the years as indicated in Table 2 and Figure 2.

Evidence for archetype 4 (delivery functionality; not ownership) is very low. This echoes work by Tukker (2004; 2015) and Tukker and Tischner (2006). *"The reasons why PSS have nonetheless still not been widely implemented, particularly in the B2C context, seem to have already been explained fairly well in the literature available in 2006. For consumers, having control over things, artifacts, and life itself is one of the most valued attributes. PSS are often less accessible, or have less intangible value, than the competing product, in part because PSS usually do not allow consumers as much behavioral freedom or even leave them with the impression that the PSS provider could prescribe how they should behave."*(Tukker, 2015, p. 76). The actual design and implementation of PSS to become a viable sustainable, business and consumer option still requires significant attention (Mont and Tukker, 2006; Tukker, 2004; 2015).

Archetypes Encourage sufficiency (6), Inclusive value creation (8) and Develop scale-up solutions (9) also score relatively low, with a rise in the number of press releases related to develop scale up solutions. Encourage sufficiency (6) focused on slow consumption as part of a business model scores unsurprisingly low as this business model goes against typical business norms and is associated with relative niche players such as Patagonia and Vitsœ deliberately not trading on stock exchanges to preserve their business values (Bocken and Short, 2016). Inclusive value creation (8) reflects the growing number of peer-to-peer and sharing models and creating value for a broader customer-base, which is an apparent trend in start-ups, but, as can be seen from the data, is not yet widely carried by large corporations. With former 'sharing start-ups' now being bought by large corporations (e.g. Avis bought Zipcar in 2013) there may be a rise in 'sharing practices' in corporations, but it will take some time before these practices will become widely accepted in larger corporations. Similar intuition relates to archetype (9); large corporations are likely to adapt slowly to scaling up of sustainable solutions, which is at the moment left for other types of actors.

Finally, in Figure 5 the relative number of SBM-related keywords among all textual data is shown. An important observation is that the dotted line that represents all SBM-related keywords shows a pattern of increase across the whole period, with notable spikes and declines along the way. A major component of this increase are archetypes 1 and 3. However, the polynomial trend line suggests a decreasing trend after 2011 or so. Therefore, judging from the inverted-U shape of the trend, we could also conclude that although the SBMs gained in prominence in the early part of the observation period, the sustainable business models have been losing traction in corporate communication as observed in the latter part of the data (i.e., after 2011 or so). Yet this reduction, which is less than 0,02 percentage points (judging from the trend line), is relatively weak compared to the overall increase in communication about SBMs from 2005 to 2014: relative archetype mentions have more than tripled in terms of percentage points (i.e., from 0,022 to 0,073 %). We thus conclude that the overall trend remains positive, despite the decreasing trend in the later years.

Table 2. Word count in the press releases across the SBM archetypes

Year	1. Maximize material and energy efficiency	2. Create value from waste	3. Substitute with renewables and natural processes	4. Deliver functionality rather than ownership	5. Adopt a stewardship role	6. Encourage sufficiency	7. Repurpose for society/ environment	8. Inclusive value creation	9. Develop scale up solutions	Total number of words in the press releases
2005	150	289	196	1	112	12	170	0	16	3 321 185
2006	258	253	304	4	188	12	166	4	24	3 840 897
2007	588	619	661	5	251	11	228	3	26	4 189 725
2008	752	537	646	1	253	21	242	7	23	4 102 616
2009	1027	606	1068	4	264	24	243	6	21	4 230 182
2010	1152	742	1048	2	287	8	286	3	34	4 068 043
2011	850	615	928	5	288	9	272	7	37	3 980 202
2012	831	843	797	1	307	10	251	2	37	3 960 596
2013	573	531	605	3	235	9	279	9	48	3 639 697
2014	503	354	702	7	262	12	226	4	64	3 191 934
Total	6 684	5 389	6 955	33	2 447	128	2 363	45	330	38 525 077
%	27,42 %	22,11 %	28,53 %	0,14 %	10,04 %	0,53 %	9,69 %	0,18 %	1,35 %	

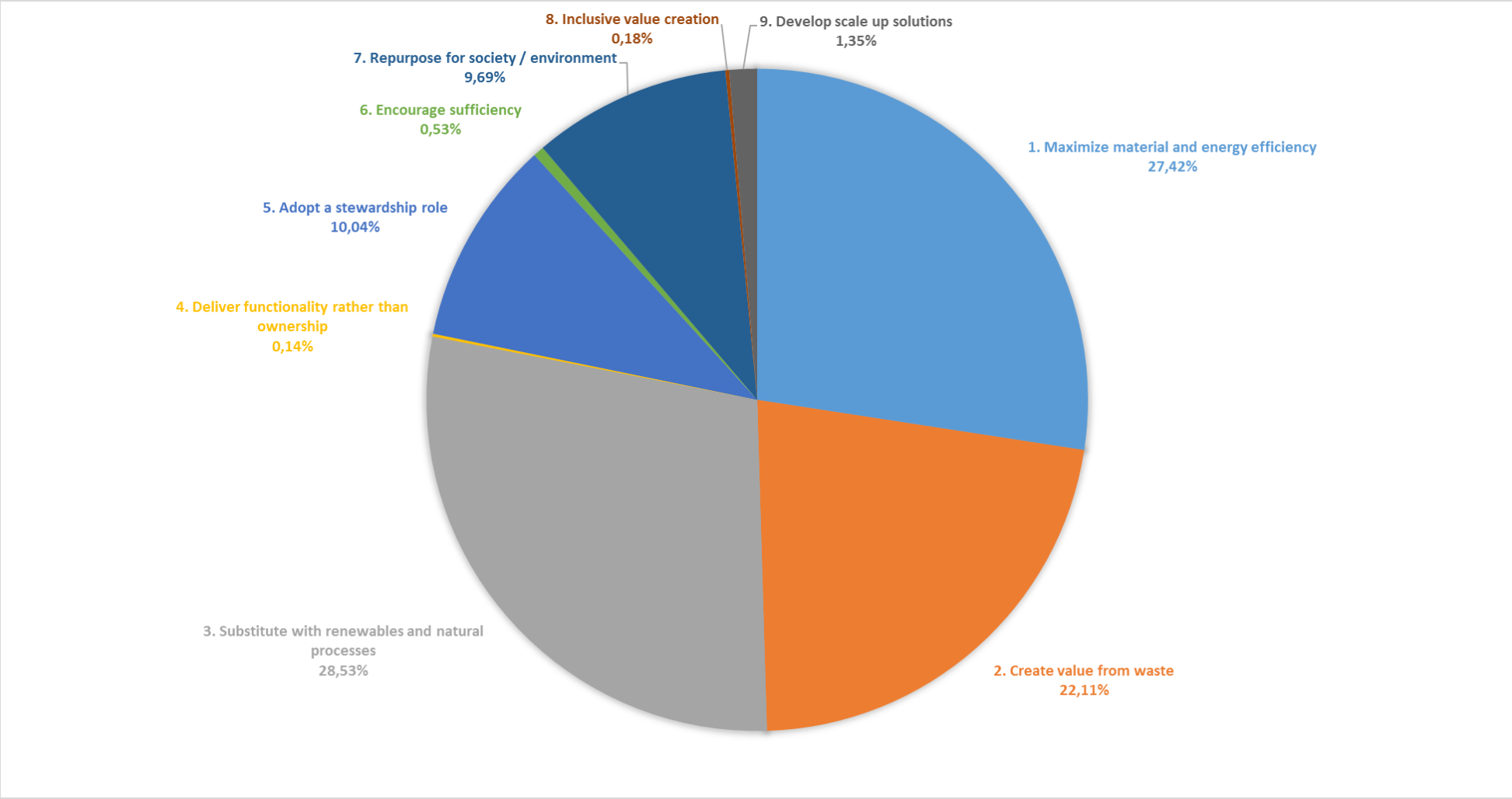

Figure 2. Relative share of SBM archetype mentions in the whole sample (2005-2014).

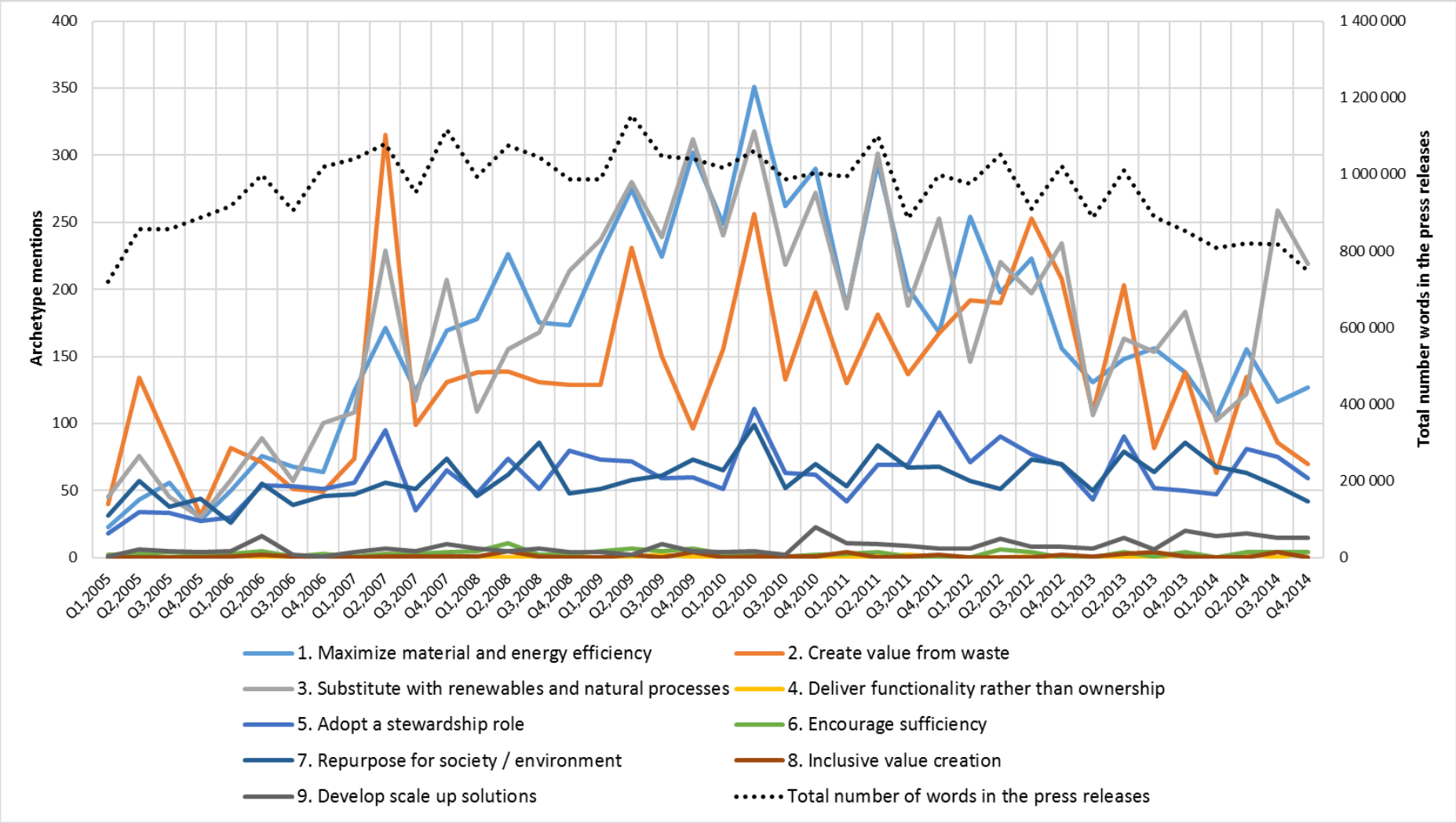

Figure 3. The total number of words in press releases (dotted line) and the number of SBM archetype mentions over time.

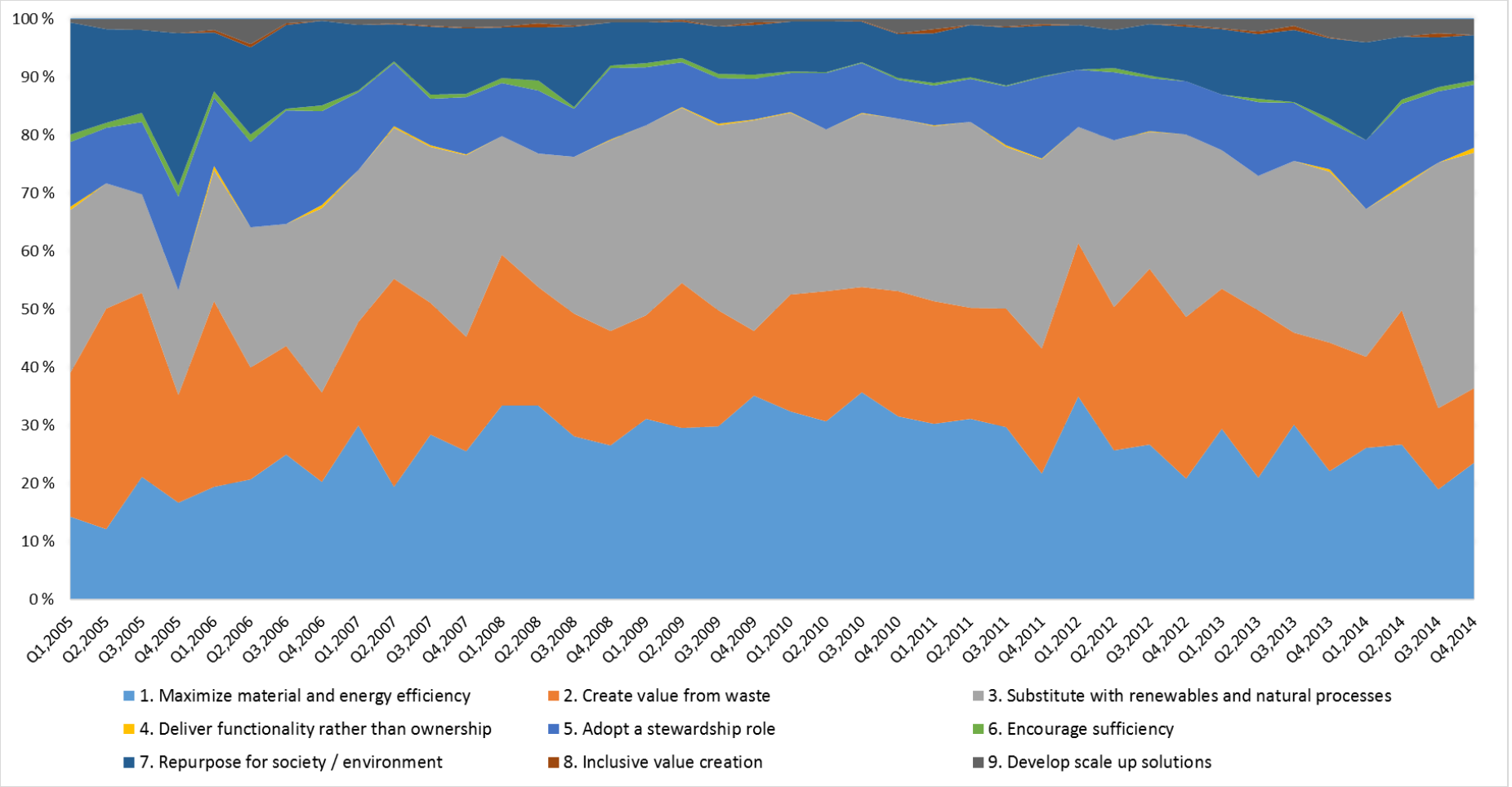

Figure 4. Relative share of SBM archetype mentions over time.

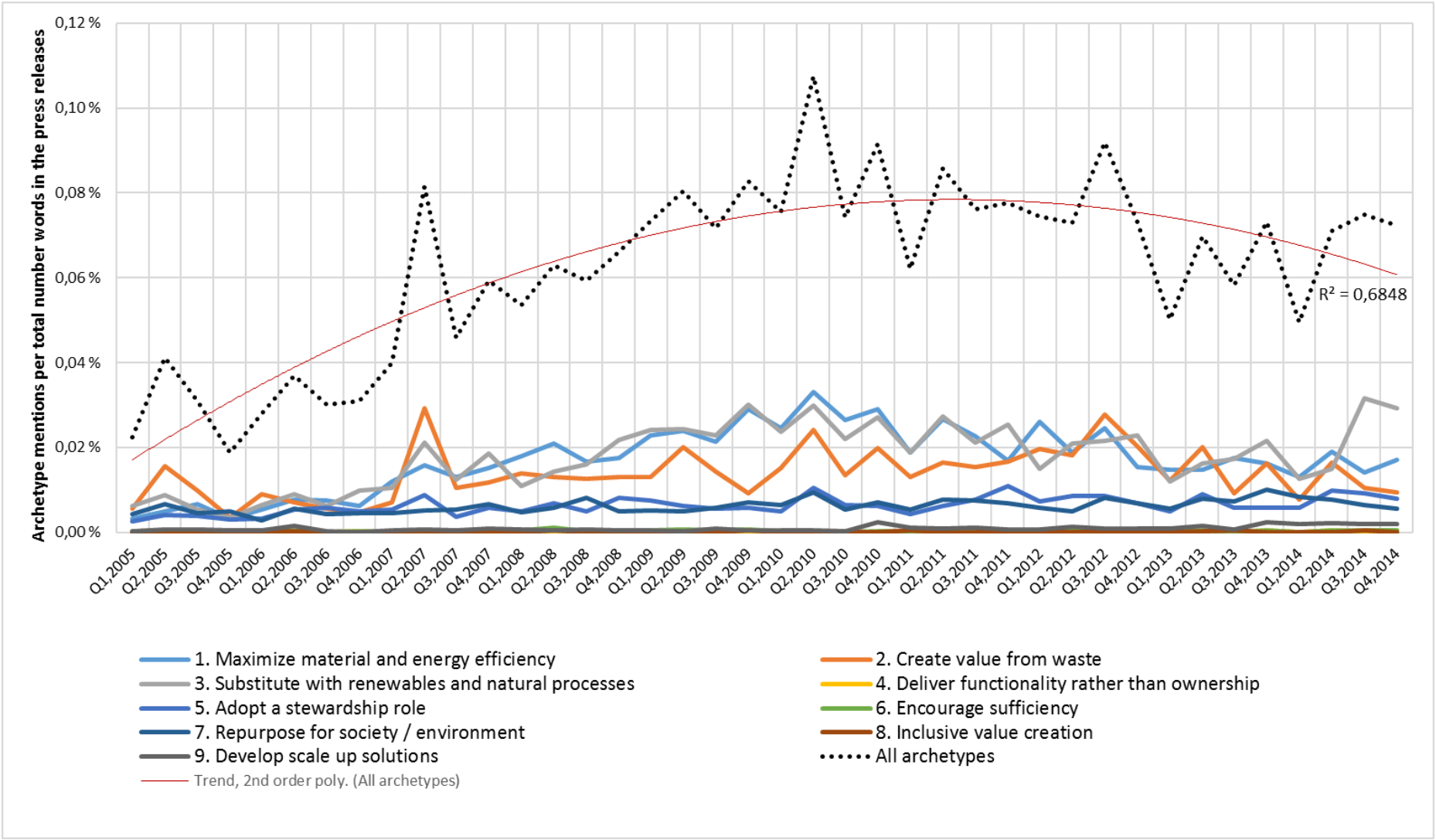

Figure 5. SBM archetype mentions divided by the total number words in the press releases over time.

6. Discussion and implications

Based on the analysis, we can conclude that large global corporations listed on the S&P 500 stock exchange have started to engage in a broader variety of sustainable value creation and business activities over time. This increase is steady and evident throughout 2005-2014. The largest amount of such activities can be attributed to energy and material efficiency, circular economy (creating value from waste), as well as renewable energy sources (such as solar and wind). Overall, this study contributes to the growing debate about the economic, social, and environmental engagement of global corporations (e.g., Porter & Kramer, 2011) and sustainable business models (Boons et al., 2013; Bocken et al., 2014) with a unique longitudinal, big data–driven research design. These results provide a broad (if not the broadest) analysis to date in the academic literature in this regard. We discuss the theoretical and practical implications in the following sections, followed by limitations and suggestions for further research.

6.1. Theoretical implications

An important note is the strong link of sustainable activities to economic value creation. As the sustainable activities are mostly directed at categories that can reduce monetary costs or affect subsidies (resources efficiency and energy), for example, it seems that firms are pursuing "shared value" by linking economic- and sustainability-related goals (Porter & Kramer, 2011). When the business activities are in categories without clear economic value creation links (e.g., encourage sufficiency), they appear in press releases much more rarely. This confirms our expectation of the "incumbent inertia" that large cap firms face, making them less likely to invest in radically sustainable business models (Campbell, 2007; Boons, 2009; Bos-Brouwers, 2010; Schaltegger et al., 2011).

Another interesting implication is that we can witness how environmental and technological activities started before the social and organizational activities. This might be due to the firms in the sample. Some of the newest are very new business activities (e.g., hybrid business, slow fashion, collaborative approaches), proposed mostly by new ventures, start-ups, and social businesses (e.g., Hockerts & Wüstenhagen, 2010). Thus, we can already see the importance of for-profit stakeholders in the overall breadth of the firm's business activities. Thus, our results paint a reactive picture, in which S&P 500 firms mainly follow broad and profitable societal and environmental trends, instead of adopting a proactive profile toward business model innovation.

The results have implications for business model innovation as well. In particular, they indicate that large cap innovation is focused mostly on areas with low-hanging fruit and win-win situations where environmental gain, reputation, and cost savings clearly meet, such as the areas of efficiency (archetype 1) and renewable energy (archetype 2; Bocken et al., 2014). Thus, to pursue radical sustainable innovation, large businesses will need to start experimenting and make a start with the transition (Chesbrough, 2010; Kraaijenhagen et al., 2016; Nidumolo et al., 2009; Weissbrod and Bocken, 2017), and due to the rise of competition from fast-growing sustainable start-ups (e.g., Zipcar; Schaltegger et al., 2016).

Finally, progress towards sustainable development has not yet achieved the desirable scale and companies need to be guided in the process towards sustainable business (model) development (Baumgarter and Rauter, 2017). This research has highlighted the activities (Zott and Amit, 2010) and practices (Boons, 2016; Shove et al., 2012) as a proxy for sustainable business model development and innovation. While our evidence can only describe the overall trends, research

by Loorbach and Wijsman (2013) also suggests such practices contribute to changing the dominant logic in the transition to sustainable development. Further research should focus on how such practices can really be embedded in the firm and gradually transform the business model through experimentation and piloting, deliberate learning and upscaling (Lüdeke-Freund et al., 2016; Nidumolu al., 2009). Moreover, we did not discuss the extent to which these sustainable practices have been embedded – are these core to the business model or on the periphery? To what extent can progress towards sustainable development in these businesses be measured (Broman et al., 2017), and correlated with the different activities reported upon publically? Such questions will form an important basis for future work.

6.2. Practical and policy implications

This article has shed light on the types of sustainable business model activities companies are getting involved in but still shows major gaps in the activities that firms could pursue (e.g., the more social and economic/organizational types). This indicates ample opportunities for companies to identify win-win situations in areas where at first sight the business case for sustainability is less evident (e.g., cost savings and profitability; Schaltegger et al., 2011), such as sufficiency (archetype 6) or repurpose for society and environment (archetype 7). Inspiration from innovative start-ups and niche players (e.g., of sufficiency cases in Bocken and Short, 2016 or sharing business models in Schaltegger et al., 2016) can be a promising starting point to open up the discussion to pursue more radical innovation in large established businesses.

Results also provide policy implications. The steady rise in sustainable business model activities within the sample of more than 90,000 press releases is a testament to increasing communication about sustainability issues, as well as the infusion of these themes in the global corporate world. Large initiatives, such as the Ellen MacArthur Foundation's Circular Economy, have shown that the priority set among large cap senior management can be shifted and affected. Policy makers could use different types of big data approaches (such as ours) to follow how corporate communication and activities are slowly shifting toward sustainable themes.

6.3. Limitations and future research directions

There are some obvious limitations in our methodology. First, it is very hard if not impossible to come up with a taxonomy that consist of all sustainability-related keywords. Even the capturing of all possible ways in which the keywords may appear in language is probably beyond our ability. Second, some of the keywords may not always be used to describe sustainable business. Nevertheless, our exhaustive approach to generating keywords using expert panels and brainstorming sessions with practitioners and academics should mitigate some of these problems, and additionally, our robustness check (as reported in the methods section) found that the most of the keywords refer to sustainable business activities when used within press releases. Third, some keywords may naturally appear more or less often in language, so we must use caution in interpreting the term frequencies as indicators of sustainable business model prominence. Related to this, the term frequency distribution is highly skewed—few of the keywords count the most of all keyword hits, and most of the keywords received no hits—that may result in significant upward or downward biases in the individual business model keyword counts. However, these biases are not easy to assess, and they may simply be attributable to the true prominence of business models among the sample firms. Fourth, some firms might count disproportionally in the keyword term frequencies, which may again bias our measure of sustainable business model prominence (i.e., global firms may be significantly more or less sustainable than presented). However, our approach does not take a position on which firms are conducting these activities, but whether these activities are

conducted in the first place in the broader sample of firms over time. Finally, the time period of our study involves 10 years among the range of 2005-2014. Sustainable business developments – such as circular economy – have been recently picking up speed. Therefore, it remains a limitation that we are not able to examine the few latest years of the development, which might show increasing prominence of such trends.

Although the limitations of the adopted approach are evident, the results nevertheless reveal interesting patterns of relative weighting of sustainable business activities over time. This opens up many further research opportunities. For instance, the sustainable business activities could be examined in the future with links of these emphases to financial performance, social legitimacy, and sustainability impacts. It would also be interesting to compare this sample with contexts, including SMEs and start-up ventures. Additionally, automated content analysis could be combined with qualitative content analysis of selected keywords to provide more contextual implications for the analysis.

Furthermore, an interesting research avenue is the transformation of business structures in large corporations, such as the case in which Ben & Jerry's (a Unilever brand) restructured as a B Corporation (B Lab, 2016) in order to pursue the firm's societal mission. It would be interesting to investigate how such changes trickle down to the rest of the multinational and could act as a change agent. Finally, the area of "what constitutes business model innovation" is still a major topic (Teece, 2010) and similarly the definition of a sustainable business model innovation (Stubbs & Cocklin, 2008). Action research could focus on guiding companies in sustainable business model innovation, supporting a transition to more radical forms of innovation.

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