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Can innovation be measured? A framework of how measurement of innovation engages attention in firms

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ABSTRACT

Many firms manage the innovation process by using metrics. Yet, whether measurement supports or hinders innovation continues to be a topic of debate. To shed new light on this debate, this paper presents a conceptual framework of how measurement engages attention in firms. We draw on attention based theory and conceptualize innovation measurement as an attention-focusing device. We identify two ideal types of measurement practices. i) *Directional Measurement*: which is based on few and unidirectional metrics and encourages exploitative innovation efforts. ii) *Conversational Measurement*: which is based on multiple and ambiguous metrics and encourages exploration. We extend theory building in the technology and accounting literatures by theorizing the role of metrics and measurement for attention and by discussing the implications of such attentional engagement for innovation performance. In so doing, we engage closely with the managerial task of managing innovation while simplifying its conditions, thereby providing actionable advice.

1. Introduction

Many firms manage the innovation process by using metrics (Chan et al., 2008). This makes the measurement of innovation an important topic in the technology- and innovation management literature (Richtnér et al., 2017). The extent to which measurement is beneficial for innovation, however, continues to be a topic of debate (Criscuolo et al., 2017; Chiesa, 1999). Even after decades of research, results are mixed. One line of research suggests that measurement can be beneficial to innovation (e.g. Markham and Lee, 2013). Scholars in this stream have argued that measurement help managers to audit structural antecedents, processes and outcomes, thus ensuring that innovation is sufficiently supported and efficiently performed. Another line of research suggests that measurement discourage managers from pursuing more ground-breaking innovation (Criscuolo et al., 2017). Here, studies have shown that innovation measurement obstructs or hinders innovation since it pushes organizational members to focus their attention too narrowly (Abernethy and Brownell, 1997; Amabile et al., 1996; Tushman, 1997).

The purpose of this paper is to shed new light on this debate by proposing a framework on how innovation can be measured. Drawing on attention based theory (Ocasio, 1997, 2011) we conceptualize innovation measurement as an attention-focusing device.

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We identify two ideal types of measurement practices: *Directional Measurement*, which is based on the use of few and unidirectional metrics, and *Conversational Measurement*, which is based on the use of multiple and ambiguous metrics. Our framework specifies mechanisms through which directional and conversational measurement affect attention and, in extension, innovation performance. We discuss how different levels of ambiguity, meaning that there is unclarity such as that it is difficult to interpret or distinguish issues and action alternatives, requires different types of measurement practices. Our core argument is that situations of low ambiguity call for directional measurement since this allows a sustained and persistent focus of attention. Situations of higher ambiguity, on the other hand, call for conversational measurement. This is because conversational measurement engages attention in a bottom-up process, allowing organizational members to consider multiple issues and action alternatives simultaneously.

On the basis of our framework, we develop actionable advice on how innovation can be better measured to produce desirable outcomes. The paper builds upon and contributes to two streams of literature: the technology- and innovation management (e.g. Boly et al., 2014; Richtnér et al., 2017) and the managerial accounting literature (e.g. Davila et al., 2009; Bisbe and Malagueño, 2015; Carlsson-Wall and Kraus, 2015). Both literatures provide important insights into the different contingencies surrounding innovation measurement. By theorizing the role of metrics and measurement for attention, our framework extends both literatures by proposing different ways in how the use of metrics can engage attention; and by discussing the implications of such attentional engagement for innovation performance. In so doing, we engage even more closely with the managerial task of measurement and innovation while simplifying its conditions, thereby providing actionable advice to managers.

2. Measuring innovation: a literature background

Following the Oslo manual, we define innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. We adopt a broad definition of innovation performance, acknowledging that innovation can have a range of performance implications within and across firms, from effects on turnover and market share, to improved productivity or efficiency. Two literatures have addressed how measurement of innovation improves or reduces innovation performance: the technology- and innovation management literature, and the literature on managerial accounting. In the following section, we provide a short overview of each.

2.1. Prior insights from research in technology- and innovation management

Table 1 provides an overview of research on innovation measurement in the technology- and innovation management literature.

Research in technology- and innovation management conclude that many firms use predefined innovation metrics to evaluate their innovative efforts, and firms that do so tend to perform better than the ones that do not (Chan et al., 2008; Markham and Lee, 2013). Multiple survey studies have aimed to identify a set of “best-practice” metrics (e.g. Chan et al., 2008; Rejeb et al., 2008; Shapiro, 2006; Visser et al., 2001). Rejeb et al. (2008), for instance, developed an innovation measurement index based on 13 best practices for innovative firms. Another example is the global Product Development Management Association’s best-practice study (see Markham and Lee, 2013). This survey identified 12 commonly applied innovation metrics, and suggested that “Profit from new product sales’ and “New product sales as a percentage of total sales” were the two most frequently applied. Other studies have discussed types of metrics. For example, Pawar and Driva (1999), along with Werner and Souder (1997), emphasized the need for balancing qualitative with quantitative metrics. Shapiro (2006) suggests that firms should combine fixed and variable metrics, while Brown and Svensson (1998) conclude that firms should use a limited number of metrics.

Research in the technology- and innovation management literature further acknowledges that innovation encompass multiple performance objectives, and that different objectives require different metrics. Chiesa et al. (2009a,b), for instance, emphasize the need for metrics that capture both innovation objectives and innovation activities. Chan et al. (2008) surveyed best practices in the use of innovation metrics, and concluded that firms should pay greater attention to the measurement of innovation inputs, as a complement to innovation output metrics. Adams et al. (2006) conducted a thorough review of the innovation-measurement literature. They identified a comprehensive set of metrics, which they organized according to seven dimensions of innovation: inputs; knowledge management; strategy; organization and culture; portfolio management; project management and commercialization.

Work in this research stream has also emphasized the need for more adaptive approaches to innovation measurement. Richtnér et al. (2017) develop a framework for innovation measurement, suggesting that innovation measurement should be seen as a process, where current measurement practices are continuously evaluated and re-evaluated. Boly et al. (2014) proposed a framework of innovation capacity evaluation. In contrast to traditional measurement frameworks, where the focus centres on outcomes (e.g. number of new products), the purpose was to provide an action-oriented evaluation framework where the objective was to compare outcomes to up-front objectives. In a similar vein, Loch and Tapper (2002) implemented a performance measurement system for a technology research group by means of the case-study method. These authors also take a systemic perspective on innovation and propose four dimensions: new technologies, technical support, knowledge repository, and research process. In their paper, Loch and Tapper (2002) also discuss the need for adjusting metrics according to the nature of innovation work – such as long-term or short-term, or routine versus breakthrough innovation efforts.

In sum, the technology- and innovation management literature suggests a contingency and systemic approach to innovation measurement. Metrics should be chosen to align with external and internal conditions, and metrics should be adapted to firm-specific objectives of measurement. While this literature provides important insights about what to measure, it tells us less about how metrics are actually put to use by organizational members. For this latter issue, we turn to insights from research into managerial accounting.

Table 1
An overview of research on innovation measurement in the technology- and innovation management literature.

Study	Perspective	Object of analysis	Core findings
Werner and Souder (1997)	Types of metrics	Metrics	Found that integrated metrics that combine several types of quantitative and qualitative measures to be the most effective, but also the most complex and costly to develop and use. Guidelines are provided for selecting an appropriate measurement method within these parameters.
Brown and Svensson (1998)	Types of metrics	Metrics	Explains some of the major reasons why R&D measurement and evaluation systems fail, and presents some suggestions for designing a successful system entailing a combination of measures (input, process, output).
Pawar and Driva (1999)	Types of metrics	Metrics	Identified metric-related principles, such as the need to combine hard (e.g. time to market) and soft (e.g. customer perceptions) measures, but also to have different measures at different stages in the innovation process.
Visser et al. (2001)	Best practice	Metrics; Innovation measurement activity	Reports the process of designing and implementing an innovation measurement system to increase the control of the research process.
Loch and Tapper (2002)	Types of metrics; Objects of measurement	Metrics	The authors developed a measurement system that systematically supported the business strategy. The measures were adjusted for different project profiles: short-versus long term, hardware versus software, routine support services versus breakthrough ideas and knowledge development.
Gatignon et al. (2002)	Types of metrics, Objects of measurement	Metrics	Develops a comprehensive set of measures to assess an innovation's locus, type, and characteristics and point to the importance of taking a structural approach to describing innovations.
Bremser and Barsky (2004)	Types of metrics	Metrics, Innovation measurement activity	The paper integrate the Stage-Gate approach to R&D management with the Balanced Scorecard and present a framework that show how firms can capture financial and nonfinancial performance.
Ojanen and Vuola (2005)	Best practice; Types of metrics	Metrics	The study introduce a process for choosing applicable metrics of R&D performance for a specific need, context and situation and show the linkages of various measurement dimensions to the selection of R&D measures.
Adams et al. (2006)	Objects of measurement	Metrics	Develops a framework of the innovation management process consisting of seven categories. In each category the authors identifies measures, which help to map the territory of innovation management measurement.
Shapiro (2006)	Best practice; Types of metrics	Metrics	Measuring innovation is difficult with a single measure. Companies should therefore pair a "fixed" with a "variable" innovation measure. Thereby companies can combine structure and flexibility.
Anthony et al. (2006)	Best practice; Objects of measurement	Metrics; Innovation measurement activity	Identifies companies should not use financial metrics such as NPV or ROI as rank-order tools in early phases of the innovation process, as it make companies risk-avert, the opposite of innovation as an uncertain process.
Chan et al. (2008)	Best practice; Objects of measurement	Metrics	Outcome metrics are most widely used in companies. The companies that get the highest returns from innovation do use metrics well. However, there is significant room for improvement in many individual applications.
Rejeb et al. (2008)	Best practice	Metrics	Develops a best practice index for innovation evaluation based on 13 innovation practices.
Chiesa et al. (2009a,b)	Objects of measurement	Metrics	Explains the interplay between measurement objectives, performance dimensions and contextual factors in the design of a measurement system for R&D activities and point out firms measure R&D with different purposes.
Chiesa et al. (2009a,b)	Types of metrics, Objects of measurement	Metrics, Innovation measurement activity	Identifies the need to differentiate metrics for research and development activities. The development of metrics needs to account for that the internal and external measurement context has certain characteristics.
Schwartz et al. (2011)	Best practice	Metrics	Identified that the three top innovation metrics are unchanged over the past 15 years, but there are significant differences in metrics used depending on the industry type.
Markham and Lee (2013)	Best practice	Metrics	The Product Development and Management Association (PDMA) best practice research study on new product development (NPD). The study identified 12 commonly applied innovation metrics.
Boly et al. (2014)	Best practice	Metrics	Identified that the three top innovation metrics are unchanged over the past 15 years, but there are significant differences in metrics used depending on the industry type.

2.2. Prior insights from research in managerial accounting

Historically, research in managerial accounting has focused on control and the execution of strategy (Cardinal et al., 2004), and it has been understood that personnel and clan controls are more appropriate than managerial controls for innovative environments

(Abernethy and Lillis, 1995; Amabile, 1998). As Davila and colleagues summarize:

> The traditional view of management control systems is at odds with the dynamic nature of entrepreneurship and innovation. … Traditional control tools encourage a command and control approach based on explicit contracts, hierarchical organizations and extrinsic motivation. In fact, they are designed to eliminate innovation (an inefficient process because of the likelihood of failure) and deliver pre-determined objectives as efficiently as possible (2009: 282)

Increased attention has been given to innovation in recent years, and the managerial accounting literature has proposed some theoretical touch-points as early as the 1970s that may prove useful for understanding the relationship between accounting and innovation. Below we illuminate these touch-points as a spring-board for expanding our analysis of innovation measurement beyond those provided by the technology- and innovation management literature.

One stream of literature has sought to define specific measures or kinds of measures that enable rather than constrain innovation. Occasionally, this literature has sought to address the topic of innovation directly. Most often, this literature has treated innovation as part of a package of measures that can be more or less effectively designed to produce value (Bourne et al., 2000; Chenhall, 2005; Neely et al., 1995). Kaplan and Norton (1996) and others, for instance, specify that a measure of innovation will be effective only to the extent that its contribution to strategy and financial performance is capable of being causally mapped and statistically validated. Other authors mobilize psychological theories such as “role-clarity” and “psychological empowerment” (Hall, 2008) to specify the conditions under which measures will result in desired actions and outcomes. Although not focused on innovation directly, all of these papers propose important conditions under which specific measures of innovation would prove more or less effective.

Another stream of accounting studies has focused less on the measures per se, and more on the way in which they are mobilized within and beyond the organization to achieve different effects. Most famous is perhaps Simons (1987, 1994, 1995) levers of control framework, which distinguishes between the use of measures in either “diagnostic” or “interactive” ways (Tessier and Otley, 2012). The diagnostic use, consistent with the traditional focus of accounting and control, functions to eliminate variation and impose boundaries on actions. The interactive use, by contrast, functions to “focus attention and force dialogue throughout the organization” and to “provide frameworks or agendas for debate, and motivate information gathering outside the organization” (Simons, 1994, p. 96). Such a use of measures, “creates (rather than eliminates) the variations required for innovation” (Davila et al., 2009, p. 288). A similar distinction has been made between “enabling” and “coercive” uses of bureaucracy (Ahrens and Chapman, 2004; Wouters and Wilderom, 2008; building upon Adler and Borys, 1996). Although – again – not addressing innovation directly, these papers highlight that it is not the measures themselves, but rather the way in which they are mobilized, that would determine their effects on the innovation process. They suggest that a measure like return on investment (ROI) is not in itself a hindrance or crutch for innovation, but that the way that it is actually used within the organization (to control or question, for instance), interpreted (diagnostically or interactively) and understood (as a leading or lagging indicator) moderates its effects.

In recent years, research has begun to focus on innovation itself, and the way that management control interacts with various aspects of innovation. Researchers, for instance, are beginning to differentiate among types of innovation (exploration, exploitation and ambidexterity (Bedford, 2015) and radical and incremental (Chiesa et al., 2009a,b; Davila, 2005)), sites and sources of innovation (individual, group, organization, or inter-organization (Adler and Chen, 2011), and top-down or bottom-up (Davila et al., 2009)), and stages in the innovation process (Bisbe and Malagueño, 2015; Chiesa and Frattini, 2007). Innovation in new product development in particular has been subdivided into various process phases (Hertenstein and Platt, 2000; Nixon, 1998), decision requirements (Anderson and Sedatole, 1998), and competing pressures (Davila, 2000; Jørgensen and Messner, 2010), and their individual and combined relation to managerial accounting explored.

This work paints a complex picture of the relationship between measurement and innovation. By decomposing innovation into its various and overlapping types, sources, or stages, it illuminates that each reacts differently to different types and uses of measures individually and in combination (Davila et al., 2009, p. 284). It also shows that the effectiveness of control packages seeking to moderate countervailing ambitions are impacted by various confounding factors such as entrepreneurial orientation (Bisbe and Malagueño, 2015). More generally, this work cautions against a view of either measurement or innovation as singular objects. Instead it highlights that the relationship between measurement and innovation must be studied in relation to situational conditions. These include the nature of the decisions that need to be made about or in relation to innovation, the competing pressures around innovation that decision-makers face, the organizational and intra-organizational conditions under which innovation is pursued and other such concrete managerial tasks. Adding a twist to this challenge, Revellino and Mouritsen (2015) even suggest that such tasks might emerge from the use of managerial accounting as much as the other way around.

In sum, the managerial accounting literature highlights that in the relationship between measurement and innovation, the measures themselves might not be as important as the ways in which they are mobilized within and beyond the organization. Measures can be used diagnostically or interactively (Simons, 1995), in a way that is enabling or coercive (Adler and Borys, 1996), and can be designed as a package to balance countervailing pressures and achieve strategic aims (Kaplan and Norton, 1996). Similar to insights put forward in the technology and innovation management literature, a contingency approach is advocated, where it is emphasized that measures and their various uses relate differently to various kinds, sites, stages, etc. in the innovation process. This highlights the need to explore the role of measurement in relation to the specific management tasks and settings in which innovation occur. This is the setting to which we now turn.

3. Innovation measurement as an attention focusing device

To address the need for developing theory and engage with the managerial task and condition of innovation, we develop in the

following sections a conceptual framework that delineates how measurement of innovation shapes attention. In Section 3, we introduce the attention based view and we discuss the role of attention under different levels of ambiguity. In Section 4, we present a framework of how measurement engages attention in firms and the implications of that attentional engagement for innovation performance.

3.1. The attention based view

The relevance of an attentional perspective is recognized both in the technology- and innovation management and managerial accounting literatures. In the technology- and innovation management literature, scholars have primarily focused on the link between attention and innovative outcomes (Dahlander et al., 2016; Dahlander and Piezunka, 2013; Yadav et al., 2007), but no prior study discuss the role of measurement in this process. In the managerial accounting literature, the power of measures to direct attention is well recognized (Burchell et al., 1980; Simons, 1995, p. 16–17; Merchant and Van der Stede (2007), but its relationship to the heterogeneous types, sources, and sites of innovation has only recently been opened up to exploration, illuminating a new degree of complexity. These bodies of literature lead us to propose and elaborate the attention based view as a relevant, but currently underutilized theoretical lens through which to better understand the role of measurement in innovation.

3.1.1. Attention, issues and action alternatives

As noted by Simon (1947), decision-making and actions in organizations are contingent on how organizational members distribute and channel their attention. Building on this insight, Ocasio (1997, 2011) formulated the attention-based theory, which describes how organizations structure the attention of individual decision-makers. *Attention* refers to the "noticing, encoding, interpreting and focusing of time and effort by organizational decision makers' on both 1) *issues,* defined as "the available repertoire for making sense of the environment; problems, opportunities and threats", and 2) *action alternatives,* meaning "the available repertoire of action alternatives: proposals; routines; projects; programs and procedures" (Ocasio, 1997, p. 188). Thus, the key idea is that behaviour is the result of the way firms channel and distribute decision-makers' attention (Stevens et al., 2015).

A central premise underpinning attention-based theory is that human cognitive capacity is limited (Kahneman, 1973). Limited cognition means that an individual decision-maker can only focus on a limited number of issues and action alternatives in any given situation. Therefore, organizational members need to decide which issues and answers are most relevant and urgent, i.e. which ones require their immediate attention, and which are less relevant and can be ignored (March and Simon, 1958). This "selective focus of attention" (Ocasio, 1997, p. 190) enables decision-makers to concentrate their time and resources, thereby facilitating the speed (and sometimes the accuracy) of their decisions and actions (Ocasio, 1997).

3.2. Innovation and attention

Innovation requires both focus and flexibility in attention. Focus is important since attention easily becomes directed towards issues that are urgent rather than important. For example, managers are known to devote too much attention to the later, costly stages of the innovation process – at the expense of early stages, where they actually have the greatest scope to influence costs (Gluck and Foster, 1975; Wheelwright and Clark, 1992). Focus is also required because maintaining persistency and motivation can be challenging in innovation work. For example, when innovation occurs through a process of many and repeated failures, persistence and motivation is easily deteriorated (Shepherd et al., 2013), leading to a loss of attentional focus.

Focus of attention, however, is a double-edged sword. Too much focus, or focus on the wrong issues, may lead managers to miss out on valuable opportunities (Tripsas & Gavetti, 2000). Either because these fall outside their attention focus (McNamara and Bromiley, 1997; Palmié et al., 2016) or because decision-makers' attention focus is biased to capture certain issues and action alternatives at the expense of others (Hoffman and Ocasio, 2001). In addition to focus, therefore, managers also need flexibility in attention, meaning that they can consider multiple issues and action alternatives simultaneously.

3.2.1. Focus, flexibility and the degree of ambiguity

We propose that the higher the degree of ambiguity surrounding issues and answers, the greater the need for flexibility instead of focus of attention. Ambiguity represents an inability to interpret or make sense of something (Weick, 1969). When ambiguity is high, there is inadequate knowledge about, no explanation for, or inadequate understanding about, a goal, situation or task. For reasons of simplicity, we conceptualize ambiguity as an ordinal construct, ranging from low to high. Issues are more ambiguous when multiple and non-compatible goals are present. For example, innovation can be subject to both short-term and long-term goals; to tangible (e.g. profit) and intangible (e.g. learning) goals; or to organizational as well as individual (e.g. status, power) goals. Action alternatives are more ambiguous when a manager faces multiple action alternatives but do not know their relative effects or outcomes. For example, innovation can be done in-house or in collaboration with external parties; by applying a stage-gate process or through a design-thinking framework, or as a cross-functional or largely intra-departmental activity. Each action alternative has advantages and disadvantages, opportunities and challenges, which may be difficult to foresee when inadequate knowledge is at a shortage.

When ambiguity is high, managers ought to prioritize flexibility over focus (March, 1991; McKelvie et al., 2018). Because it's virtually impossible to know which answers and action alternatives that are the most optimal, multiple issues and action alternatives must be considered simultaneously. For example, managers must consider outcomes in the short- vs. the long-term; at the private- vs. the organizational level or tangible vs. intangible benefits. When ambiguity is low, on the other hand, focus is probably more important than flexibility. When managers have a good understanding of their goals, their task and the available action alternatives, a

focused attention allows efficient problem solving. For example, focus allows for a structured and well-designed experimentation, a well-organized design process, or the dedication of time and money to spend on a particular project (Brattström et al., 2012). Against this background, we propose:

Proposition 1a. The higher the ambiguity surrounding issues and action alternatives in innovation work, the higher the need for flexibility in attention, meaning that multiple issues and action alternatives are considered simultaneously.

Proposition 1b. The lower the ambiguity surrounding issues and action alternatives in innovation work, the higher the need for focused attention, meaning that a limited range of issues and action alternatives are considered simultaneously.

4. A framework for improved measurement of innovation

After having proposed the role of attention for innovative work in the prior section, we now turn to the question of how measurement engages attention and the implications of such attentional engagement for innovation performance. According to the attention based theory, attention is situated (Ocasio, 1997, p. 188). This means that the situational context in which individuals are embedded determine which issues and answers an individual focus upon. The organizational context, its routines, decision-making structures and incentive systems thus play a critical role in situating and regulating attention. In particular, scholars (e.g. Ocasio and Joseph, 2005) have emphasized that attention is situated and regulated through procedural communication channels such as reports, meetings, budgets, cost accounts and personal evaluations (Ocasio, 1997). These channels regulate attention of organizational members by dividing tasks, guiding the prioritization of attention among different sets of issues and answers and by providing incentives for engaging in some actions over others.

We conceptualize innovation measurement as an attention-focusing device that influences how organizational members notice, encode, interpret and focus their time and effort on certain issues and action alternatives. We outline two ideal-types of innovation measurement practices. The first one we term *Directional Measurement*, which refers to the ideas of measurement as a mechanism for control and direction. Directional measurement is based on the use of a few, specific and unidirectional metrics provided in a diagnostic manner (Simons, 1994). Directional measurement, we propose, engages attention mainly through a top-down process where attention is shaped by pre-existing interpretative schemas and cognitive frames (Eggers and Kaplan, 2013; Kaplan, 2008; Tripsas and Gavetti, 2000). An example would be the application of a narrow set of Key Performance Indicators, which would direct the attention of organizational members towards a specific set of goals. Directional Measurement focuses attention and allows an efficient pursuit of well-defined innovation problems.

The second measurement practice we term *Conversational Measurement*, which refers to the idea of measurement as a mechanism for conversation and collective sense-making. Conversational measurement is based on the use of multiple, ambiguous (e.g., qualitative) and even conflicting metrics in a more interactive way (Simons, 1994). Conversational measurement, we propose, engages attention through a bottom-up process, where organizational members rely largely on observations to find meaning and make sense of their situation. An example would be the use of qualitative evaluations, “strategic buckets” or color-codes (e.g. green/yellow/red-light coding of projects), which can be subject to multiple interpretations. Conversational measurement allows for flexibility in attention, important when pursuing more explorative innovation. In the following section, we describe these different innovation measurement practices; how they engage attention; and how their effectiveness varies according to the degree of ambiguity surrounding issues and action alternatives. Fig. 1 provides an illustration of our framework.

4.1. Directional innovation measurement

Directional measurement starts by managers formulating a deliberate strategy for innovation work. In a directional measurement process, the manager approaches innovation with clear ideas of desirable outcomes and action alternatives, as ambiguity levels are low. Through applying a few, specific and unidirectional metrics, a manager can assess innovation performance, validate assumptions about market opportunities; and foster a coherent and focused innovation process within the organization.

Directional measurement, we propose, engages attention largely in a top-down process, focusing the attention of organizational members to a narrow set of goals and action alternatives. We suggest two mechanisms underlying this process. (1) Issue sorting, where the use of a few, specific and unidirectional metrics enable organizational members to *sort* among a large set of issues that otherwise would have been perceived as equally relevant. (2) Action prioritization, where the use of a few, specific and unidirectional metrics enable organizational members to *define and prioritize* among a broad set of action alternatives to those issues.

4.1.1. Issue sorting in directional innovation measurement

We define *issue sorting* as the process of assigning weights to innovation-related inputs, activities and outputs. Directional measurement can trigger this process by providing decision-makers with a set of guiding principles and boundaries, with which they interpret and make sense of innovation-related work (Cooper, 2011). The use of a few, specific and unidirectional metrics narrow down decision-makers’ attention to a specific set of quality issues, which are socially constructed and contextually embedded. Consider, for example, an R&D project manager who is set to follow up on quality and cost in an innovation project. By providing this project manager with a set of metrics, s/he can monitor progress, identify important issues and do an analysis of where performance is lagging, all of which takes place in a rather straight-forward and low-ambiguity context. The metrics then define what is important (e.g. number of ideas or quality of R&D output) and provide guidance on what constitutes optimal quantity (e.g., many or few ideas)

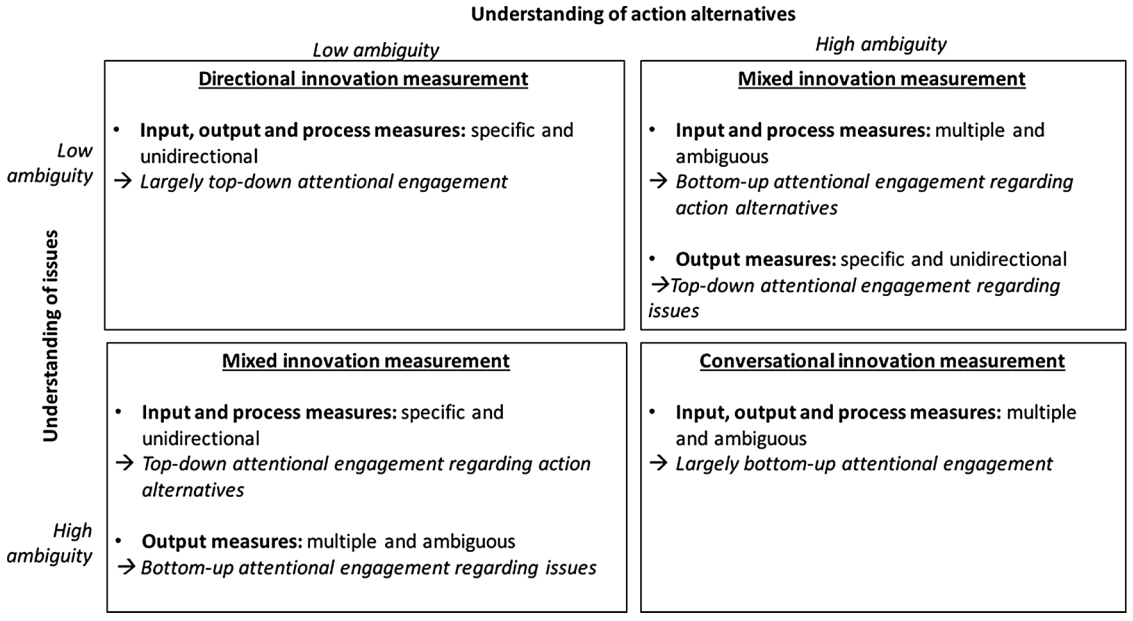

Fig. 1. A process framework of the relationship between attention and measurement of innovation.

and/or quality of those ideas. By facilitating issue sorting, metrics enable organizational members to identify both problematic and promising issues, i.e. opportunities.

4.1.2. Action prioritization in directional innovation measurement

We define *action prioritization* as the process of defining the range of action alternatives related to innovation inputs, activities and outputs, and putting them in order. Directional measurement assigns weights to innovation inputs, activities and outputs. The use of a few, specific and unidirectional metrics direct organizational members to produce the behaviours that the metrics imply are appropriate and desired. In other words, the metrics define the appropriate range of action alternatives. Consider, for example, a metric such as "Resources invested into R&D" in comparison to a metric such as "number of ideas generated". Whereas the former directs organizational members' attention to investment decisions, the latter draws attention to routines, evaluation procedures or time spent on ideation activities. Due to the inherent complexity and uncertainty of innovative activity (Sjödin et al., 2016), organizational members must choose among multiple approaches to its planning and execution. At the same time, it is difficult, if not impossible, for them to objectively assess the "true" value of the various options before them (Kahneman, 1973). They cannot know, with certainty, whether spending a day in a brainstorming session is a better use of their time than spending that same time on quality control. Innovation metrics, however, assign weights to innovation issues. In so doing, metrics constrain, define and focus the appropriate range of innovation-related answers, as well as the order in which they should be pursued.

Hauser (1998) provides an illustrative example of how the mechanism of answer prioritization is put to work. They show how measuring internal ideas incentivize managers to become more dismissive of external input, whereas measuring both externally and internally generated ideas incentivized managers to scout outside the focal organization in search for knowledge. Similarly, in an in-depth study of the front end of a new product development project in the aerospace industry, Carlsson-Wall and Kraus (2015) found that the use of managerial accounting and control legitimized allocation of resources to an innovation project, as well as towards external partners.

4.1.3. When to rely on directional measurement

We propose that directional measurement is beneficial when there is a low degree of ambiguity surrounding issues and action alternatives. Through issue sorting and action prioritization, the use of a few, specific and unidirectional metrics help overcome problems of scattered attention, paralyzed action or lack of motivation. Such metrics serve as a heuristic that simplifies decision-making in an otherwise complex environment. And they have a motivational effect by allowing organizational members to visualize short-term progress. Directional measurement reduces cognitive costs of scanning and using scattered information, and thereby enables a more persistent, action-oriented and focused innovation work. Against this background, we state the following proposition:

Proposition 2. Using a few and unidirectional metrics for measuring innovation leads to persistence and focus of attention. Therefore, when ambiguity surrounding issues and action alternatives is low, directional measurement allows for higher innovation performance.

4.2. Conversational innovation measurement

Conversational measurement is driven by observations and conversations from the bottom up. Similar to induction, conversational measurement allows a manager to identify patterns in observations, even though s/he might lack a clear a-priory hypothesis about what patterns s/he is looking for. This makes conversational measurement fundamentally different from directional measurement. In a conversational measurement process, metrics helps create innovation-related data, based upon which organizational members can collectively make sense of issues and answers. For example, measurement can help to create a visual overview of what innovation projects that are currently pursued. They can also provide useful information about how different external or internal stakeholder prioritize among conflicting goals or how they evaluate the usefulness of different action alternatives. But in comparison to a directional measurement approach, a manager does not have a clear idea about what data is needed to move forward. In a conversational measurement approach, the manager therefore relies on i) multiple and ii) ambiguous metrics. Multiple metrics is important, because they can collectively capture a broad range of issues and action alternatives. Ambiguous metrics are important, because they force organizational members to engage their attention when making sense of data.

Qualitative metrics are good examples. A metric such as “idea potential”, for example, is important not because it provide a unidirectional interpretation of what is a high potential idea, but because it requires organizational members to have a conversation about what they mean by a high potential and why. A manager might even consider using conflicting metrics, because they force organizational members to consider different issues and action alternatives. For example, to both measure direct and indirect effects of innovation may lead to performance indicators that point in different directions, but which thereby also force organizational members to identify and prioritize among important dilemmas.

Conversational measurement, we propose, engages attention in a bottom-up process, where members consider a broad range of goals and action alternatives. We suggest two mechanisms underlying this process: (1) Issue and action coordination, where innovation measurement enables a collective of organizational members to *coordinate* between multiple issues and action alternatives. (2) Issue and action translation, where innovation measurement enables a collective of organizational members to *translate* tacit perceptions of issues and action alternatives into codified information.

4.2.1. Issue and action coordination in conversational measurement

Issue and action coordination refers to the process of aligning different organizational members’ focus on, and interpretation of, innovation-related issues and answers. Conversational measurement, which relies on the use of multiple and ambiguous (e.g. qualitative) metrics, triggers this process by enabling organizational members to engage in conversations about similar (or identical) sets of issues and answers. As such, conversational measurement enables organizational members to establish a shared attention focus and, subsequently, to develop shared intentions (Ocasio et al., 2015). In this process, they coordinate and align understandings of alternative issues and action alternatives.

We can think of examples of this process in practice. For example, when measuring the number of projects in a pipeline, the attention of organizational members will be drawn towards the various projects currently in that pipeline. This will trigger them to engage in a discussion about this specific dimension of innovation management and measurement. They will need to engage in in-depth discussions about what the pipeline is, how many projects it currently contains, how many it should contain and how many are about to enter it. By doing so, the activity of measurement will enable organizational members to enact a shared idea of what they intend to do with their pipeline of projects (Criscuolo et al., 2017). Examples include reducing or increasing the number of projects, which projects to fund or drop, whether to add a service dimension to physical products, or increasing the extent of external collaboration. In this view, the activity of measuring innovation becomes, in itself, an arena for discussion.

4.2.2. Issue and action translation in conversational measurement

Issue and action translation refers to the process of translating tacit perceptions of issues and answers into codified information that can be transferred across time and space. The use of multiple and ambiguous metrics triggers this process by enabling communication and debate across intra-organizational contexts. When measuring innovation, organizational members codify a tacit, mental interpretation of issues and answers formed in one particular context and subsequently apply this interpretation into other contexts. While attention is context-specific (Barreto and Patient, 2013), conversational measurement triggers attention translation by providing a common set of rules, language and knowledge upon which individuals can coordinate. As Ocasio et al. (2015, p. 36) emphasize, “Translating involves applying practices and narratives in new contexts and, in the process, reshaping the understandings that are transmitted.”

Such translation is important in innovative work. Members of different organizational functions are often said to represent different thought worlds (Dougherty, 1992). Difficulties in communicating, aligning and coordinating across thought worlds is seen as an important barrier to innovation (Dougherty, 1992). Conversational measurement, however, provides organizational members with a stable, yet adaptable, language and frame of reference. In this way, conversational measurement enables organizational members to translate otherwise tacit understandings of issues and answers across time and space. In short, the use of multiple and ambiguous metrics enables organizational members to express otherwise tacit understandings by means of issue and answer translation.

Take the example of a mid-level R&D manager who measures innovation. In so doing, s/he defines, calculates and communicates his or her understanding of innovation inputs, activities and outputs to other members of the department, as well as to members of other departments, such as marketing or production. S/he then translates something that is complex, highly ambiguous and subtle into a number of brief qualitative estimates that is relatively straightforward and understandable, and which form the basis of a

discussion with his or her team members; other functional managers; as well as top-level directors. For example, s/he can explain to his or her team members why s/he is prioritizing some activities over others, and can facilitate the emergence of a collectively held understanding of innovation-oriented activities going on within his or her firm. S/he can also explain the activities of his or her unit to operations, sales and marketing, allowing them to get a better understanding of the R&D unit s/he leads. Finally, s/he can explain the rationale to top-level directors, facilitating the negotiation for time and money. Therefore, innovation measurement activity provides the means for translating a context-specific understanding of issues and answers so that it can be understood in new contexts.

4.2.3. When to rely on conversational measurement

We propose that conversational measurement is beneficial when there is a high degree of ambiguity surrounding issues and action alternatives. In this context, conversational measurement helps organizational members to engage in conversations about innovation across functional domains. These conversations or communicative events provides opportunity for organizational members to revise, bend, break and adapt their understanding of issues and action alternatives (Ocasio, 2011). Innovation measurement provides a "lingua franca" through which organizational members are allowed to exchange knowledge, which is otherwise tacit (Ocasio and Joseph, 2005). It also forces different groups to come together and compare, contrast and debate their various views on innovation work (Mouritsen et al., 2009). In this process of productive friction, new ideas emerge and new issues and answers can emerge as well, and new innovation measurement categories can be identified. This might increase the exploration of new opportunities within the firm or lead to the adaptation or development of novel innovation metrics.

Consider, for example, a R&D group who conducts an annual innovation audit. The purpose of innovation auditing is to identify strength and weaknesses in innovation (Chiesa et al., 1996). Hence, the auditing is likely to stimulate a discussion within this R&D group around what innovation activities are being pursued, which investments should be made in innovation and how well structures, such as organizational routines or organizational culture, support innovative work. Through this communicative event, the R&D group is likely to identify issues and formulate answers that fall *outside* those predefined by existing innovation metrics. For instance, group members may merge, couple or modify existing metrics in order to capture more accurately the innovation activity they are seeking to accomplish. If such bending and breaking of innovation metrics occurs repeatedly, it may eventually lead to a broader, organization-wide change in metrics. In this way, the activity of measuring innovation can be seen as a communicative event, which stimulates box-breaking of attention.

Proposition 3. Using multiple and ambiguous metrics allows organizational members to consider multiple issues and action alternatives simultaneously. Therefore, when ambiguity surrounding issues and action alternatives is high, conversational measurement allows for higher innovation performance.

4.3. Combining directional and conversational measurement

We can think of issues and action alternatives as two distinct facets of innovation. Issues refer to how managers make sense of problems and opportunities. This sense-making process is crucial for defining the focus of innovation work. Action alternatives, on the other hand, refer to the repertoire of routines or procedures for addressing problems. This facet of innovation is related to, but not exactly the same as, opportunity recognition and problem formulation. It follows from this definition that the level of ambiguity in issues does not necessarily co-vary with the level of ambiguity in action alternatives (Ocasio, 1997).

A company may, for example, face low ambiguity in action alternatives but high ambiguity issues. This can happen if a company has already made substantial investments in a particular type of technology, routine or production system. Such investments create resource lock-in that limits the range of possible action alternatives, reducing ambiguity in this particular dimension. Consider for example incumbent companies in the forest industry. Wood production generates a huge amount of wood residuals, such as bark and wood chips. Such wood residuals are automatically produced. In other words, the degree of ambiguity in action alternatives is low: generation of wood residuals is both a foreseeable and inevitable action alternative for forest companies. Low ambiguity in the action-alternative dimension, however, does not mean that ambiguity in the issue dimension is low. Quite the contrary: what to do with wood residuals is a pressing and ambiguous challenge for many forest companies (Hellsmark et al., 2016). Forest companies used to transform wood residuals into low-quality paper, predominantly newspaper. With the declining market for newspapers, forest companies are searching for new outlets. They could produce alternative paper products, or transportation fuels, bulk- or fine chemical by means of thermochemical or biochemical conversion technology platforms (Hellsmark et al., 2016). But the understanding of these different opportunities remains ambiguous.

Similarly, we can think of a situation where there is a high degree of ambiguity surrounding action alternatives, but less ambiguity surrounding issues. A company may, for example, have a clear understanding of the environment, its opportunities and threats, but face ambiguity around how to approach these issues. One example is the media and news industry. The incumbents of this industry face clear threat in terms of a declining rate of subscribers and increasing availability of alternative media. In other words: the issue they face is a rather unambiguous one. How to innovate in response to this threat, however, is less clear. At the moment, we witness different action alternatives aiming for innovation being tried out by different actors in the industry.

We propose that in such situations, where the level of ambiguity in one facet of innovation does not correspond to the level of ambiguity in the other facet, a bundling of different measurement practices is feasible. If issues are ambiguous, but action alternatives are relatively clear, managers may consider to use a conversational measurement approach regarding innovation output, but directional measurement of innovation input and process. In line with our Proposition 2, directional measurement of innovation input

and process would allow a sustained and persistent attention focus on an unambiguous set of action alternatives. At the same time, and in line with our Proposition 3, the use of conversational measurement for innovation output would allow organizational members to engage in conversation about an ambiguous range of alternative issues. Conversely, if issues are clear but action alternatives are ambiguous, managers may consider using a directional measurement approach regarding output, but a conversational measurement approach regarding input and process metrics.

5. Discussion

One of the most fundamental dilemmas that firms face is finding a balance between structure and flexibility in innovation work (Brattström et al., 2012, 2015). In this paper, we address innovation measurement, a managerial practice where this dilemma is at the forefront. As our core contribution to the technology and innovation management literature, we build on current insights about the contingencies that makes different metrics optimal (e.g. Boly et al. 2014; Richtnér et al., 2017). We extend these insights by addressing the more fundamental question of how measurement engages attention and the role of attention in shaping innovative outcomes. We outline two different innovation measurement practices. Directional measurement, which is based on using a few and unidirectional set of metrics, and conversational measurement, which is based on using multiple, ambiguous and even conflicting metrics. Drawing on attention based theory (Ocasio, 1997, 2011) we outline propositions that predicts how directional and conversational measurement influence innovation performance under different degrees of ambiguity.

Our analysis offers several implications for the technology and innovation management literature. For example, in previous literature, innovation measurement has been criticized for excessively biasing firms towards exploitation, while limiting exploration (e.g. Abernethy and Brownell, 1997; Amabile, 1998; Ouchi, 1979). We propose that measurement of innovation can both increase efficiency and exploration, depending on how different metrics are bundled. This suggests that directional measurement is more appropriate in the pursuit of incremental innovation, while conversational measurement is more appropriate for a firm that seeks to stimulate radical innovation. This is important, as it suggests that also radical innovation can be systematically managed (Brattström et al., 2015).

As a second implication, our analysis takes an important first step in introducing attention-based theory to research on innovation measurement. With our framework, we highlight how this theory can be useful as it helps to specific the social mechanisms (Hedström and Swedberg, 1998) through which metrics influence performance. We hope to stimulate further research that focuses on the role of attentional processing in innovative work. For qualitative studies, in particular, it would be interesting to better outline the process of conversational measurement in more depth and detail. Coordination and translation across different cognitive domains is a central aspect of innovation work. In this paper, we have explored the role of metrics in this process. We hope that future research will build on our insights to further specify bottom-up processes of attentional engagement. The technology and innovation management literature has been criticized for a lack of theory development (Anderson et al., 2014). Based on our framework, we see attention based theory as an important theoretical lens through which we can better understand how innovation is managed.

We also encourage future empirical research to investigate measurement and attention at different organizational levels. Here, the literature on project-based organizations (e.g. Bredin and Söderlund, 2013; Hobday, 2000) could be a starting point. Project-based organizations are ideal for flexibility and integration of different skills, but are weaker in dimensions where a functional organization is strong, such as achieving economies of scale; efficiency and routine tasks (Hobday, 2000). The mechanisms proposed in our framework present one explanation for how organizations coordinate across projects and functions (Meyer, 1991). For example, a measure can make explicit how a delay in a project influences the performance of the larger organization (thus allowing for translation). We encourage future research to conduct more fine-grained empirical research into if and how measurement allow for issue and answer translation and coordination across organizational levels, such as projects vis-à-vis functional units in a matrix organization.

The managerial accounting literature specifies and illustrates the diversity of ways in which measures can operate within organizations. We illuminate how management accounting literature significantly extends the common assumption within technology- and innovation studies that measurement is a matter of finding the right measure or set of measures, rather than the appropriate mobilization or use of measures. The concepts we develop of directional and conversational measurement are deeply informed by how management accounting scholars describe and differentiate such uses. For instance, whether objectives are determined in a top-down or bottom-up manner (Simons, 1994), whether they are linked to strategy (Kaplan and Norton, 1996) or whether they are used diagnostically or interactively (Simons, 1995). Research in management accounting has also advanced our understanding of the relationship between measurement and innovation by showing that each component type, source and process relates differently to management control types, and that control packages seeking to balance competing pressures are moderated by external factors such as entrepreneurial orientation.

While this literature has helped managerial decision-making by further specifying the measurement type and use appropriate for different tasks, it has added complexity and reduced generalizability. A “key thrust” of the work, Bisbe and Malagueño (2015, p. 380) explain, is that “…caution must be taken in generalizing the significance and direction of the energy by […] specific forms of control to all firms”. This increase in knowledge, in other words, has highlighted just how little is currently known about the relation between various measurement types and uses, and a range of variations in aims, locations, and activities in the process of innovation (Davila et al., 2009, p. 284).

The contribution of our research to this literature is to reduce some of this complexity by moving the focus of analysis yet closer to the managerial work involved in innovation—a perpetual challenge within managerial accounting research (Hall, 2010). The attention-based view uniquely allows us to simultaneously specify and simplify the conditions under which innovation is pursued, and

to relate those conditions to multiple uses of measures. While embracing the emergent view that innovation needs to be treated as a heterogeneous task, we deconstruct this task into just two important variables, understanding of issues and action alternatives, which a manager responsible for innovation is able to encounter and identify. We also translate analytical terms such as diagnostic and exploratory into more situated constructs (conversation and attention-direction), which have a more directly actionable quality.

5.1. Limitations and future research

As for all conceptual frameworks, we have a set of boundary conditions to simplify our model. First, our argument is primarily centred on innovation activities that are pursued within firms, but not collaborative innovation such as partnerships, open collaboration or co-creation processes. As demonstrated by a few recent studies, how organizational members direct their attention is an important mechanism behind whether or not they are able to benefit from such open innovation practices (e.g. Piezunka and Dahlander, 2015; McKelvie et al., 2018). Based on the framework we have developed in this paper, further developing how directional and conversational measurement can be used to stimulate open innovation initiatives should be a fruitful area for future investigation.

As a second boundary condition, we have assumed that under situations of lower ambiguity, managers are able to set the appropriate range of directional metrics. This, however, might not necessarily be the case. We could also think of a situation, where managers set the *wrong* bundle of directional metrics, thus focusing the attention of organizational members on the *wrong* set of issues and action alternatives. For the sake of simplicity, however, we have assumed in this paper that managers are both informed and able to design an innovation measurement practice that is appropriate for their situation.

6. Conclusion

Most firms measure innovation (Markham and Lee, 2013). Yet, several studies have suggested that measurement leads organizational members too far down the path of exploitation, while undermining creativity and the exploration of new opportunities. In this paper, we develop a theoretical framework of how different bundles (directional vs. conversational) of metrics influence attention. This allows us to propose that measurement can have both explorative and exploitative effects. Our research emphasizes that there is more to the measurement of innovation than identifying best-practice metrics, and suggests that future research should carefully consider the effect of measurement on attention.

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