Fact or Fiction? A Sensemaking Perspective on the Reality Behind Executives' Perceptions of IT Business Value

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ABSTRACT: Although research has made significant strides in recent years in evaluating the performance impacts from information technology (IT), a dearth of easily accessible objective measures, particularly at the process level, continues to limit IT research. Suggestions that researchers use perceptual measures instead are met with claims that the biased nature of perceptions renders them imperfect proxies for the true extent of IT impacts. In this paper, we use sensemaking theory to explore this claim. We outline a model relating what executives notice about process-level IT impacts with sensemaking-based perceptions of IT impacts at the firm level, and firm performance as the ultimate arbiter of perceptual accuracy. Estimating the model with survey data from executives in 196 firms, we find that executives' perceptions are more fact than fiction. While perceptions are not a perfect proxy for hard-to-find objective measures, perceptual accuracy should stimulate greater consideration of executives' perceptions in future IT business value research.

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DESPITE SIGNIFICANT PROGRESS IN RECENT YEARS in evaluating the performance impacts of information technology (IT) [48, 56], executives remain frustrated at the lack of metrics to assess the true value of IT to their firms [38]. Behind this frustration lies a sense that aggregating IT impacts into firm-level financial measures such as sales [4, 12, 15, 50], value added [30, 36], financial accounting ratios such as return on assets [65], or costs [1] does not adequately convey the broad diversity of effects, nor do such measures necessarily align with firms' goals for IT [41]. Instead, executives have risen to the challenge of assessing IT impacts by supplementing internal data analysis (if any exists) with insight, intuition, perception, or gut feel to instinctively decide if, and to what extent, IT is delivering on its promise [81, 82].

From a research perspective, the absence of easily accessible objective measures of IT impacts at both the process and firm levels represents a barrier that researchers have long struggled to overcome. Any inclination to use executives' perceptions in lieu of objective data has struggled against claims of bias or subjectivity [20, 53], notwithstanding the fact that perceptions have been found accurate in other contexts [85]. The perceptual accuracy of IT impacts is a different matter, however, something that cannot easily be inferred or extrapolated from other contexts, and yet research has not, to this point, tried to definitively confirm or deny the accuracy of perceptions of IT impacts. In this research, we examine the accuracy of executives' perceptions through the lens of sensemaking theory with the aim of reassuring or dissuading researchers from using perceptual measures of IT impacts in future research. Our analysis will reveal an enlightening sense of reality behind executives' perceptions of IT impacts, a reality that has long been overlooked by researchers, potentially to the detriment of IT research. However, more than simply discovering that perceptions are accurate, our analysis offers a basis for researchers to expand their portfolio of IT impact measures (beyond already established objective measures) by translating what executives *notice* into research constructs. Researchers have long struggled against claims that perceptual measures of IT impacts are flawed. Our results help to counter such claims and yet, given the relative ease with which perceptions can be collected from executives, we also sound a word of caution against opening the floodgates to wholesale adoption of perceptual measures in lieu of objective measures.

Sensemaking and Perceptions

Although perceptions have been criticized for reasons of bias and subjectivity, perceptions do not exist in a vacuum. Research in psychology and organizational studies has found that executives engage in a complex cognitive process of observing (noticing)

and analyzing (sensemaking) events to discover, interpret, and react to informational cues in the environment [34, 77, 87]. With respect to the complex task of evaluating the performance impacts of IT, executives have accordingly devised intricate noticing and sensemaking routines to perceptually infer the existence, absence, and sufficiency of IT effects within their firms. Sensemaking theory recognizes that individuals sometimes fit information into preconceived notions of the world. Individuals see only what they want to see, so that what may seem obvious to one person is readily dismissed by another. Depending on how executives filter information on IT impacts, this could mean that executives maintain a distorted sense of reality and that their perceptions are so manipulated and counterfactual as to be of questionable value in any research context. However, if executives' perceptions of IT impacts are accurate (meaning objectively verifiable), then the sensemaking processes that yield such perceptions become an important vehicle for discovering what executives notice about IT. Thus, if executives' perceptions of IT impacts coincide with measures based on income, sales, productivity, or other broadly accepted financial metrics, we can dissect the sensemaking process to learn what executives are noticing and leverage this to expand our repertoire of IT impact measures.[1]

Our research focuses on the following questions: First, to what extent are executives' perceptions of IT impacts consistent with reality as revealed in objective measures of IT impacts? Second, beyond perceptual accuracy, can we identify what executives are noticing in relation to IT business value? To address both questions, our paper is structured as follows: First, we review sensemaking theory, leading to a conceptual model linking perceptions of IT impacts at the process level (a level that marks the locus of noticing or fact gathering as described later) with perceptions of IT impacts at the firm level (the locus of sensemaking) and traditional financial measures of firm performance. We then outline an instrument and measures to evaluate perceptual accuracy. We use a two-step approach to formally test our model and hypotheses, first using survey data from executives in 196 firms, followed by an assessment of interrater reliability using survey data from 88 executives in seven firms. Finally, we review our results with a view to resolving the fact or fiction issue that has stymied the broader use of perceptual measures in studies of IT impacts, identify weaknesses in our methods and data, and offer some suggestions for future research.

Theoretical Background

WEBSTER'S DICTIONARY DEFINES PERCEPTION AS "the act of apprehending material objects or qualities through the senses."[2] The focus of this definition is on external stimuli and how they are interpreted by the individual through sensory filters. Sensemaking theory uses this idea of *discovery* to develop a framework that maps the cognitive processes involved in sensing, weighing, and synthesizing external stimuli into a single point or statement of belief [77, 87], and so sensemaking can be loosely defined as the "reciprocal interaction of information seeking, meaning ascription and action" [83, p. 240].

Sensemaking recognizes that individuals' interpretation of facts can be distorted deliberately (for example, if a rote answer is provided) or unintentionally (if individuals' innate characteristics lead them to omit, exaggerate, or misinterpret the facts). Weick presents seven properties of sensemaking that show how individuals "concerned with identity in the context of others engage ongoing events from which they extract cues and make plausible sense retrospectively" [87, p. 18]. As noted in the definition of sensemaking, these seven properties (Table 1) synthesize how individuals extract cues from their environment and then, through a cognitive process, form an impression of their surroundings that may encompass (if bias, error, or distortion negatively affects their thought processes) more than what the bare facts alone might reveal. These properties can be further divided into three areas: the first pertaining to individuals and their belief systems, the second to noticing or extraction of informational cues, and the third to plausibility. Of these properties, the one that is directly relevant to our analysis of perceptual accuracy is plausibility, which, as a terminal statement of belief or the culmination of sensemaking, is what ultimately must be evaluated for accuracy [87]. Using these properties to probe the thought processes underlying perceptions of IT impacts gives researchers an opportunity to peer inside the minds of executives and test whether certain factors, cited by many as a source of bias, are so severe as to erode all confidence in executives' perceptions. We now offer a brief synopsis of each property and its meaning in the context of perceptions of IT impacts.

As seen in Table 1, *identity construction* suggests that in interacting with researchers, executives try to project a sense of personal accomplishment and success. This form of selective bias echoes a widely held view that chief information officers (CIO) will report higher IT impacts than non-IT executives. Even if business executives are less likely to exaggerate, there is still some debate over whether business executives know enough to truly give an accurate and thoughtful opinion. While sensemaking theory does not resolve this debate, it means that researchers must be careful in selecting their respondents to minimize the potential for bias.

Executives' perceptions are retrospectively shaped by earlier experience [55], previous *social* contacts with executives from other firms, reports of IT success stories in the media, analysis from colleagues and subordinates, and business intelligence tools such as the balanced scorecard [28, 86]. Sensemaking is *ongoing* rather than discontinuous, so perceptions may be slow to change in the face of disconfirming evidence, a feature seen in other contexts, such as when firms continue, rather than halt, derailed software projects despite clear evidence of failure [75]. Ongoing also means noticing facts or informational cues over an extended period of time, although recency effects would suggest that later-stage events receive a disproportionate weighting in how perceptions are formed [23].

When executives engage in sensemaking, they *enact an environment* or model of the world where information is processed according to certain rules. The adage "When you've seen one, you've seen them all" captures the essence of a worldview in which executives feel that IT must behave in a certain way—a belief that can allow invalid causal effects to enter the sensemaking process. For example, executives may believe that if their firm is spending a substantial amount on IT, then IT payoffs

Table 1. Properties of Sensemaking (adapted from Weick [87])

General description	Relevance for executives' perceptions of IT impacts	Relevance to this research
Characteristics of the individual		
1. Grounded in identity construction Individuals care about how they are perceived by others; they do not want to be linked to failure.	Executives care about how they and their firms are perceived by researchers; if asked to give an opinion, they may report what they think researchers would expect them to report even if this is not what they actually see and believe.	The second part of our study surveys teams of senior executives in different firms. Consensus views minimize the probability that respondents will report data that merely project a favorable view.
2. Retrospective Sensemaking is driven by lived experiences.	Perceptions of IT impacts could be shaped by recency effects; individuals give greater weigh to recent rather than historical events. This could produce a knee-jerk reaction if, for example, there was a recent IT outage.	Our survey instrument asks executives to report realized impacts rather than to speculate on future impacts. This helps to focus executives on retrospective events.
3. Enactment of sensible environments Individuals construct mental models of how stimuli fit together; such models can create expectations of how the future will unfold.	Executives could construct a mental model based on how similar firms in their industry should behave. This could, for example, lead them to conclude that if their firm spends more on IT than others, then their IT impacts must necessarily be higher.	Our model controls for IT spending per employee, IT spending as a percentage of sales, sales, and profits of the five largest competitors in each firm's industry.
4. Social Individuals' interpretation of events can be influenced by other individuals' sensemaking.	Besides personal experiences with IT, executives can rely on opinions and reports of peers and subordinates, both inside and outside their firm.	Our model controls for the extent of IT–business interaction, the role of IT in the firm, and the presence of an IT strategy.
5. Ongoing Sensemaking is both iterative and continuous.	Executives perceive current and past IT impacts in a continuous setting, updating their perceptions over time as new information becomes available.	Executives are not asked to base their assessment of IT impacts on events in a defined time window.

(continues)

Table 1. Continued

General description	Relevance for executives' perceptions of IT impacts	Relevance to this research
Noticing—gathering of facts and opinions		
6. Focused on and by extracted cues Sensemaking is a reaction to what individuals notice in their environment.	Information on IT impacts can come from various sources: personal experience and peer reports as noted above, data from business cases, or project analyses.	Executives are presented with a common set of IT impact questions derived from previous survey research.
Perceptual outcomes: the culmination of sensemaking		
7. Driven by plausibility rather than accuracy Sensemaking leads to plausible outcomes; signal overload can overwhelm individuals' thought processes and so lead them to adopt satisficing approaches to information processing.	Accurate perceptual evaluations of IT impacts require a great deal of information processing in an uncertain and often ambiguous environment. Executives might instead report a "best guess" perception, partly due to incomplete information or the need for immediacy.	This is the ultimate test of perceptual accuracy. We formally assess accuracy in our model; we also examine correlations between objective (e.g., financial) and perceptual measures of IT impacts.

must correspondingly be high. This aspect of sensemaking recognizes the ability of attitudes and beliefs to shape perceptions. For example, research finds that executives' attitudes toward IT can determine a firm's progressive use of IT [18, 37], while Broadbent and Weill [13] posit a relationship between executives' perceptions of the role of IT infrastructure, the perceived value of that infrastructure, and their subsequent IT investment biases. Since attitudes toward IT can vary even among executives in the same firm, it is possible that executives perceive the same IT impacts in different ways. For example, a failing project might be interpreted by one executive as evidence that IT is failing overall while another considers it an outlier rather than prima facie evidence of systemic failure. Thus, attitudes and beliefs can shape how executives notice and make sense of IT. At the same time, attitudes can be falsified to conform to what others feel is appropriate [87]. As a result, any attempt to examine perceptual accuracy must pay particular attention to socially derived biases as described in the last paragraph and to biases associated with executives' attempts to enact a worldview with predefined ideas of how IT should relate to firm performance.

As individuals move toward a *plausible* outcome, they iterate between fact gathering, weighting, and interpretation [87]. The outcome of this process may not reflect all information because of timing or cognitive limitations (if there is insufficient time to weigh all information or if information overload leads to selective censoring). Perceptions may therefore not be entirely accurate, but, in the subconscious reasoning of executives who are trying to give a reasoned response to the question of IT value, it is accurate enough. Not unlike the polarization seen in hung juries, further sensemaking or deliberation may not bring about a change in opinion. Hence, plausibility is a form of sensemaking through rational satisficing [78, 83].

In looking across these properties, particularly those involving characteristics of the individual, it should be clear that not all executives are created equal. It may not simply be enough to pick executives at random and ask them what they feel about IT impacts. For plausibility to have any chance of mirroring reality, executives must have an ability to notice IT impacts, just as juries cannot be expected to render an accurate verdict unless they have first been presented with the evidence. This could mean that by virtue of visibility into the firm, senior executives have a greater likelihood of perceiving IT impacts, though it does not rule out midtier managers with broad functional experience. Irrespective of seniority, executives may want to hype their views of IT impacts in order to avoid embarrassment and to convey a personal sense of achievement. Equally, if noticing is limited for any reason, there is a real risk that managers will resort to inference to fill in the gaps in their thinking. Our challenge, therefore, is to assess whether any deviation between *plausibility* and *reality* is so small as to be immaterial, or so large and inescapable as to cast a cloud of suspicion over executives' perceptions and their broader use in IT impact research.

Findings from Previous Research

While perceptions have been widely accepted in certain areas of the information systems (IS) literature, most notably in end-user computing satisfaction [31] and IT

usage studies [24], the idea of using executives' perceptions to assess IT impacts is controversial [20]. Although not developed using sensemaking theory per se, prior research has documented conflicting evidence as to the accuracy of executives' perceptions. For example, Mezias and Starbuck [57] find significant error in managers' recall of earlier firm performance. However, in reappraising their findings, Maule and Hodgkinson note that "the cognitive strategies underlying managerial perceptions may be functional in the everyday organizational context where feedback induced revision is possible" [53, p. 35]. In a further critique of perceptual measures, Straub et al. find significant differences between computer-recorded and self-reported system usage measures, leading them to claim that "research that has relied on subjective measures of system usage . . . may be artifactual" [79, p. 1328].

Elsewhere, perceptual measures of firm performance have been found to correlate with objective measures, leading Venkatraman and Ramanujam to argue that "perceptual data from senior managers, which tend to strongly correlate with [objective data], can be employed as acceptable operationalizations of [firm performance]" [85, p. 118]. In assessing perceptual measures of firm performance involving multiple executives in manufacturing firms, Ketokivi and Schroeder similarly argue that "perceptual measures are not 'fiction' as some proponents of operational definitions may argue" [44, p. 262]. Reacting to claims of forgetfulness in managers' ability to accurately recall what business strategy their firms used in the past, a claim that could distort how information is aggregated into an overall perception of IT impacts, Miller et al. note that "retrospective reporting is a viable research methodology *if* the measure used to generate the reports is adequately reliable and valid" [58, p. 189]. Finally, in a study of end-user satisfaction with data, Karimi et al. identify positive and significant correlations between perceptual and objective measures of environmental uncertainty, dispelling "the notion that CEOs' perceptions are inclined to be imprecise, erroneous, or inferior to objective measures" [39, p. 185].

While these studies might, on balance, say that executives' perceptions are accurate, extrapolating from this performance context to the case of IT impacts would be a giant leap of faith. The noticing and sensemaking processes that executives use to evaluate IT impacts are very different from those used to evaluate firm performance. Perceptual recall of firm performance can be unambiguous when an executive can point to a line item in a published report, but with IT impacts there are no such reports and so IT impacts remain highly uncertain. Sensemaking of IT impacts involves a complex interplay between expectations, identification of objective facts regarding IT impacts, and how this information is subsequently used to create an overall perception. While it is useful that research has found evidence of perceptual accuracy elsewhere, IT impacts present a very different set of challenges, and yet, as Mezias and Starbuck argue, "many research studies rely on managers' perceptions . . . yet almost no research has examined the accuracy of these perceptions" [57, p. 7]. In the next section, we introduce a conceptual model and hypotheses to address this lack of prior research.

Research Model

While we recognize that reverse engineering the process by which executives perceive IT impacts is highly complex, the distinction between noticing (fact gathering) and sensemaking (fact interpretation) that lies at the heart of sensemaking theory requires us to first examine how executives notice IT impacts; only then can we validate the information that executives cite as being instrumental in their evaluation. As Starbuck and Milliken report, "if events are noticed, people make sense of them; and if events are not noticed, they are not available for sensemaking" [77, p. 60]. Noticing is largely involuntary in that individuals do not purposefully set out to scan their surroundings in search of facts and opinions, and so the sources of noticing can include much more than official management reports and individual IT project analyses [87].

Noticing as a Prelude to Sensemaking: A Process Perspective

Starbuck and Milliken argue that "noticing may be at least as important to effective problem solving as sensemaking" [77, p. 36] but that the challenge is in deciding at what level within the firm noticing is most likely to occur. From the perspective of IT impacts, if the locus of noticing is deep within the firm at, for example, the application level, the enormity of the sensemaking task would be overwhelming since executives would need to identify and weigh the effect of all applications in order to form an aggregate view of the contribution of IT to firm performance. Researchers would face an equally arduous task to compile a list of applications for verification purposes, a list that is sure to vary between firms. At a more macro level, such as a division or business unit, the opposite problem arises if executives fail to notice sufficient information from which to draw an accurate conclusion. Complicating this issue is the fact that some lower-tier executives may have limited knowledge of IT impacts, making it difficult, for example, for a vice president of sales to extrapolate from a relatively narrow domain to a broad sense of how IT has affected costs, profit, or productivity. In this way, the locus of noticing and the identity of the *noticer* are closely related and so any attempt to validate executives' perceptions using objective firm-level data must first try to find a locus of noticing and an executive who, by noticing IT impacts in several areas of the firm, can formulate a plausible but yet reasonably accurate firmwide perception of IT impacts.[3]

A possible solution to this challenge can be found in the literature where researchers have called for measuring effects at an intermediate or process level using the argument that "the primary economic impacts or contributions (to performance) of information technology (if any) can be measured at lower operational levels in an enterprise" [8, p. 6]. Kohli further argues that IT impacts are "more likely to be detected at the process level than at the firm level" [47, p. 25], while elsewhere researchers have lobbied for process-level measures on the basis that the data they provide to management are more actionable and reflective of the strategic goals behind IT investment [3, 40, 56, 81, 82]. As Barua and Mukhopadhyay [7] and Melville et al. [56] note in their review

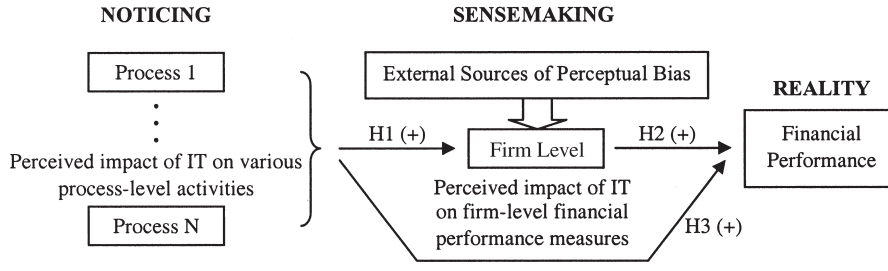

Figure 1. Conceptual Model—Linking Perception to Reality

of the literature, if IT impacts are likely to materialize within individual business processes, in time these effects will aggregate up to the firm level. If this means that the primary locus of IT impacts is at the process level, then a sensemaking exercise that asks executives to identify IT impacts could focus on perceptions of IT impacts at the process level, or more specifically, perceptions of how IT has affected critical activities within each process [81, 82].

If the process level is the preferred locus of noticing, it follows that senior executives, rather than functional managers, are more likely to have visibility into multiple processes. Senior executives may not be able to cite specific effects for individual applications but, at a process level, they may be able to give general insights into whether IT has allowed their firm to improve sales by customizing products and services or whether IT has allowed the firm to lower costs through greater quality control. In the same way that empirical studies find a link between IT impacts at the process and firm levels, whatever effects are perceived at the process level should affect firm performance. We employ sensemaking theory below to examine this relationship in more detail, leading to a series of three hypotheses to evaluate the accuracy of executives' perceptions. In Figure 1, we provide an overview of our conceptual model and hypotheses.

Relating Noticing to Sensemaking

If research suggests that executives are more likely to first notice IT impacts at the process level, how will this shape their perceptions of IT impacts at the firm level? Sensemaking theory helps to answer this question by focusing on the retrospective and ongoing nature of sensemaking. In explaining the roots of sensemaking, Weick invokes cognitive dissonance theory to explain how "post-decision outcomes are used to reconstruct pre-decisional histories" [87, p. 12]. What this means is that if individuals are asked to retrospectively explain their point of view, they will do so by selectively recalling variables that appear to prospectively endorse their espoused view. This phenomenon is often observed in juries—cited by Weick [87] as a motivating factor behind sensemaking theory—where jurors cite specific facts in support of their verdict. In the IS literature, Seligman [70] uses this idea of retrospective justification or

selective recall to show how users justify a decision to not adopt a new technology by emphasizing negative characteristics of the system. Similarly, Griffith [34] reveals how users make sense of system features by retrospectively attaching a concrete, abstract, core, or tangential label to each feature in a way that justifies later adoption.

In the context of perceptions of IT impacts, asking executives to explain why they hold a particular firm-level opinion (for example, if they perceive that IT is having a significant effect on firm profitability) will lead them to retrospectively recall examples of process-level effects that fully support their firm-level beliefs. Any data that might conflict with their firm-level views are unlikely to be reported even if such data are noticed. Since this aspect of sensemaking theory suggests that executives will rarely contradict themselves in citing data that substantiate their point of view, it means that researchers attempting to validate executives' perceptions of IT impacts would be well advised to not give executives a blank sheet to report what they notice—the result would be tautological. Instead, we can use the prospective reasoning aspect of sensemaking to present executives with a general, structured list of possible process-level impacts, asking them to report if they noticed each effect, and only then asking them if they think IT has had an effect on their firm's financial performance. This approach emphasizes plausibility as executives cognitively weigh and aggregate what they notice into an overall perception. Consistent with the argument given in Starbuck and Milliken [77] showing how noticing and sensemaking are closely related, an executive who perceives or notices that IT is having a positive effect on different business processes is likely to perceive that IT is also having a positive effect at the firm level. We summarize this argument in the following hypothesis:

> *Hypothesis 1: Perceptions of IT impacts at the process level (the locus of noticing) are positively related to perceptions of IT impacts at the firm level (the locus of sensemaking).*

Linking Perception to Reality

While theory posits a tight link between noticing and sensemaking, it imposes nothing more than plausibility requirements on executives who, in good faith, are trying to interpret what they see happening in their environment. However, while sensemaking theory does not insist on accuracy, it also does not preclude accuracy [77, 87]. For example, in a health-care setting, Thomas et al. [83] found a link between information scanning and interpretation (reflective of noticing and sensemaking) and subsequent hospital performance. Weick [87] posits that plausibility trumps accuracy for three primary reasons.[4] First, if there is a low signal-to-noise ratio where noticed data are either unavailable or untrustworthy, sensemaking can be based on incomplete data processing. Second, the argument that "accuracy is meaningless when used to describe a filtered sense of the present, linked with a reconstruction of the past, that has been edited in hindsight" [87, p. 57] echoes an earlier comment regarding selective recall which leads to an opinionated version of reality rather than a more general sense of reality [87]. Third, perceptual accuracy can suffer if executives are called to make

decisions without fully understanding the data that inform their decision. In this case, accuracy suffers if decisions must be made quickly, perhaps before all relevant data have been considered. Consistent with Thomas et al. [83], perceptual accuracy improves if these three conditions are removed or otherwise controlled through appropriate research design as attempted in this study.

In the case of IT impacts, information overload can be controlled, as indicated earlier, by focusing on perceptions at the process level rather than inundating executives with application-level data. There is, therefore, less need for noticing and so sensemaking theory would support higher accuracy. Instrument design, as we describe later, can steer noticing in a particular direction, away from the minutiae of particular applications (noise) and toward higher-order process-level effects (signal). This helps to limit selective recall, which will improve the odds that what is considered plausible is in fact accurate, or as Starbuck and Milliken argue, "filtered information is less accurate but, if the filtering is effective, more understandable" [77, p. 41]. Last, perceptions of IT impacts evolve over a period of time rather than being spur-of-the-moment decisions. As noted in our earlier literature review, executives recognize that IT is used for both operational and strategic purposes, and so effects tend to be judged with performance impacts expectations in mind [82]. Elsewhere the literature shows how IT use is tied to perceptions of expected value and managerial knowledge of IT [11]. Using sensemaking theory, these arguments suggest that, despite the complex nature of IT investment evaluation, executives have access to sufficient amounts of noticed data, have seen how past IT investments have performed, and are not under any obvious time pressures or restrictions to give a response to a question asking whether IT is affecting firm performance without first having sufficient noticed data on hand.

What sensemaking theory is effectively telling us is that factors that conspire to distort perceptual accuracy can be controlled in certain cases. Researchers who have found evidence of perceptual accuracy in non-IT contexts have been able to control these factors in the course of their analyses [39, 44, 58, 85]. Absent the possible intrusion of extraneous factors on the sensemaking process—factors that relate to executives' enactment of a sensible environment and social influences, as discussed in Table 1—there is every reason to argue that what executives notice, and their subsequent sensemaking, is accurate and fully consistent with reality. Again, focusing on the case of IT impacts, sensemaking theory suggests that what executives notice at the process level is derived from reality, and so if executives say that IT is having an effect on various business processes, these perceptions should reflect the underlying reality. In our case, reality is manifested in how a firm has actually performed, as seen through financial criteria such as sales, profit, or market share. Similarly, if sensemaking is a direct abstraction of what has been noticed, and what is noticed is real, then sensemaking must also be real. These arguments suggest the following hypotheses:

> *Hypothesis 2: There is a positive relationship between perceptions of IT impacts at the firm level (the locus of sensemaking) and objective measures of firm performance.*

Hypothesis 3: There is a positive relationship between perceptions of IT impacts at the process level (the locus of noticing) and objective measures of firm performance.

Operationalizing the Model

Noticing (Process-Level Perceptual Measures)

Mooney et al. [60] argue that IT affects the firm through operational and management processes. Operational processes such as production, design, and marketing are consistent with the primary activities in the value chain, while management processes such as control and communication are more reflective of support activities [63]. Using the generic value chain as a model of the firm, and with primary activities as the most likely target of IT spending, we identified five processes around which to collect IT impact data: supplier relations (inbound logistics), production and operations, product and service enhancement, sales and marketing support, and customer relations (outbound logistics). Then, using survey instruments previously created by Mahmood and Soon [51], Sethi and King [71], and Tallon et al. [82]—instruments that in each case identify ways in which IT creates value through process-level activities—we identified a short list of 20 items (four items per process) to capture perceptual data on IT impacts at each point in the value chain. Building these items into an executive survey, respondents were asked: "To what extent does IT contribute to the overall performance of your company along each of the following dimensions? Please limit your appraisal to realized, not expected impacts." This question helps to emphasize the retrospective property of sensemaking by drawing attention to *past events.* On the basis of pilot testing and informal feedback from several CIOs and business executives, item responses used a 10-point Likert scale where 1 denotes "weak realized impacts" and 10 denotes "strong realized impacts."

Sensemaking (Firm-Level Perceptual Measures)

We also designed four items to assess the output of executives' sensemaking. These items reflect executives' perceptions of the effect of IT on firm performance and are meant to reflect a synthesis and integration of what executives notice about IT impacts at the process level, but in a way that anchors each item to a specific aspect of firm performance. As a result, we selected measures that are easily understood by executives, that had been used in prior research on IT impacts [25, 48], and more importantly, could be corroborated using data from published financial statements. In this way, we designed four items to assess executives' perceptions of the effect of IT on profit margin, market share, labor costs, and selling, general, and administration (SG&A) costs. While this short list is not exhaustive, these four measures are widely seen as central to performance assessment [25].

Firm Performance (Measures of Reality)

In order to ensure consistency between sensemaking measures and measures of firm performance, we selected four widely known accounting measures: margin (or income as a percentage of sales), market share, labor costs as a percentage of sales, and SG&A as a percentage of sales.[5] These measures focus on profitability, market expansion, and cost avoidance, areas that are broadly targeted for IT investment [82] and have been used previously in research by Bharadwaj [9], Mitra and Chaya [59], and Sircar et al. [74].[6]

Potential Biases and Sensemaking Distortion Measures

As previously noted in our review of sensemaking theory, there are several possible forms of bias that could cause executives' perceptions to diverge from reality. In practice, it is impossible to isolate and control for all biases, particularly those associated with emotion or that occur at random. For example, the fact that an executive is having a *bad day* could introduce an uncontrollable degree of distortion into the sensemaking process. Instead, we try to focus on systematic biases relating to the *social* and *enactment of sensible environment* properties of sensemaking, as noted in Table 1. Organizational behaviorists refer to such biases as *contrast effects* [68].

From the viewpoint of social influences, contrast effects explain how, in an effort to save face and project a sense of personal or professional success, executives look past their firm's boundaries for copy-cat influences that indicate expected or desired outcomes rather than actual outcomes [76]. Executives are social beings whose interaction with individuals both inside and outside the firm can help to frame their thinking on a given subject and their overall attitude toward IT [86]. Such interactions can be a key source of information on IT impacts to the extent that executives are exposed to the views (good or bad) of others. However, it can also happen that executives simply regurgitate what they hear from others regarding IT impacts. If so, other individuals' biases can be inherited if executives fail to discern the truth in what they are being told; worse still, they might embellish what they hear. For those executives whose views on IT impacts are shaped by what they hear from their CIO (who not surprisingly may want to give an inflated assessment of how IT has performed), the extent of bias can be especially severe. Controlling for such biases is complex but, as sensemaking theory notes, these must be evaluated before perceptual accuracy can be proven [57, 78]. Accordingly, three items were created to assess IT–business interaction as a source of noticed (and potentially biased) information, namely, IS executive participation in strategic planning (ten-point Likert scale), IS executive involvement in business issues (three-point ordinal scale), and IS executive involvement in executive committee meetings (four-point ordinal scale). The text of each item (see Table 2) reflects previous research by Reich and Benbasat [66] and Jarvenpaa and Ives [37].

A further source of social bias involves executives' attitudes toward IT. Executives in firms with strategic goals for IT might bias their perceptions of IT impacts to conform to what is expected of strategic IT. Prior research identifies a series of critical

Table 2. Linking Purported Bias in Sensemaking to Measures of Perceptual Bias

Potential sources of bias	Item identification/measurement scale	Supporting literature
Sensemaking property: Social (misshaping perception through social interaction)		
IT–business executive interaction Business executives may look to IT executives to get a sense of how IT is impacting the business. Visibility of IS executives in solving business issues, participating in high-level executive committee meetings, and participating in setting firm strategy may create a perception that IT is on top of things, potentially creating an impression that IT must also be having a significant impact on firm performance. Interaction with IT executives can also bias perceptions if business executives simply repeat verbatim what they hear about IT impacts from their IT peers.	Ten-point Likert scale (one item) 1. IS executive participation in the firm's strategic planning process.	[18, 37, 42, 66, 86]
	Three-point ordinal scale (one item) 1. IS executive deals with IS issues only. 2. IS executive has some role in broader business issues. 3. IS executive has strong role in broader business issues.	[18, 32, 42, 66, 86]
	Four-point ordinal scale (one item) 1. IS executive does not participate in any executive committee meetings. 2. IS executive participates in some executive committee meetings; for example, to present plans or budgets. 3. IS executive participates in many executive committee meetings; for example, as an advisor or reviewer of technology issues. 4. IS executive is an active member of the executive committee.	[11, 18, 37, 42, 66, 86]
Role of IT (utility versus strategic) Corporate goals or strategic intent for IT can vary widely. In firms with more ambitious goals, there may be a tendency to exaggerate IT impacts to reflect what is anticipated of IT.	Ten-point Likert scale (four items) 1. IT is a low-cost information utility. 2. IT is an agent of change, facilitating critical changes to business processes. 3. IT enables business improvement by being integrated into products and services.	[54, 64, 82, 84]

(continues)

Table 2. Continued

Potential sources of bias	Item identification/measurement scale	Supporting literature
	4. IT facilitates strategic leadership through innovative applications.	
Nature of IT strategy The use of an IT strategy and the extent to which non-IT executives were involved in its creation can shape expectations of how much IT should impact firm performance. As non-IT involvement rises, there may be a desire to exaggerate IT impacts to convey a sense of self-worth.	Five-point ordinal scale (one item) 1. There is no IT strategy. 2. IT strategy developed by IS for IS with no business executive oversight. 3. IT strategy developed by IS for IS with business executive oversight. 4. IT strategy developed by IS for business units with business executive review. 5. IT strategy jointly developed by IS and business units with joint executive review	[67, 82]
Sensemaking property: Enactment of sensible environment		
Contrast effects Executives may enact a sensible environment by referring to retrospective IT spending patterns or by trying to imitate the success of their peers and competitors.	Four objective measures 1. IT spending / IT capital per employee. 2. IT spending as a percent of sales (expressed as a deviation from an industry average). 3. Sales of the five largest competitors in the same industry (based on four-digit SIC codes). 4. Profits of the five largest competitors in the same industry (based on four-digit SIC codes).	[15, 30, 68, 76]

Note: All Likert-scale items are anchored on "disagree completely" and "agree completely."

goals for IT ranging from automation of utility applications and manual processes to the use of IT as an agent or catalyst in organizational transformation [35, 61, 84, 89]. Accordingly, four measures were designed to reflect different goals for IT (see Table 2). Respondents were asked to declare their agreement with each item on a ten-point Likert scale. Subsequent analysis found that these four items divided into two factors: three items identified a factor relating to the strategic role of IT while a fourth revealed a utility role for IT [82]. Accordingly, we decided to treat these measures as two separate factors labeled *strategic IT* and *utility IT* in our later analysis. Finally, we used a single item (five-point ordinal scale) to highlight the existence and sophistication of IT strategy on the basis that executives may base their perception on the expectations inherent in such a strategy. The text of this item was based on previous research by Reich and Benbasat [66] and Parsons [61].

In using contrast effects to identify how attempts to enact a sensible environment can lead to bias and distortion, we can see how inadequate noticed data can lead executives to supplement whatever data do exist with data drawn from competitors, firms of equal size, or those with an established record of IT success. Mezias and Starbuck [57] also report that managers resort to managerial folklore or anecdotes to augment a lack of direct personal experience. Regarding IT impacts, this could mean that executives subconsciously adapt what they hear or read about IT in other firms to their own specific circumstances. For perceptual accuracy to hold, these factors must also have minimal influence on the sensemaking process.

As indicated in the bottom panel of Table 2, we operationalize the enactment of sensible environment property in four ways. First, to identify if executives' perceptions are colored by competitors' success or by size comparisons, we consider the sales of the five largest firms in each industry, a proxy for each firm's largest competitors and representative of those most likely to be used by executives as a contrast as they struggle to make sense of their own IT impacts. Second, we also consider the profits of these five largest firms. Third, we use the absolute amount of IT spending per employee in each firm, and, fourth, the rate of IT spending (IT spending as a percentage of sales), both standardized to reflect a degree of deviation from an industry mean. Both IT spending measures provide important insight into the confounding effects of IT budgets to the extent that executives feel that IT spending (either in absolute or relative terms) should be strongly correlated with IT impacts. These measures can help executives to build a sense of identity that they then project to the outside world in reporting how IT has affected their firm. These measures are also reflective of a worldview where executives define rules for how their firm ought to perform—rules that link IT impacts with spending levels or that exonerate the executives from having to methodically process the information that they notice on IT impacts at the process level.

Robust Assessment of Perceptual Accuracy

While H2 is a necessary test of perceptual accuracy—determining if perceptions of IT impacts are consistent with financial reality—support for H2 is not sufficient to confirm that executives' perceptions are an accurate and reliable way to identify and rate IT

impacts. The reason for this heightened skepticism is not simply based on fears that sensemaking could be overwhelmed by bias, but that sensemaking could be covertly responding to other events besides IT impacts. Asking executives their opinion on what they consider to be the effect of IT on firm performance does not guarantee that their response will have any bearing on IT. Therefore, there needs to be an additional layer of perceptual testing that not only involves estimating the conceptual model shown in Figure 1, but that embeds within that model objective measures of IT impacts that serve as proxies for sensemaking-based perceptual measures.

As our sensemaking items reflect perceptions of IT impact on profit margins, market share, and labor and SG&A costs, we needed to identify comparable objective measures, and so we devised four ratio-like measures: income per IT dollar, sales per IT dollar, sales per employee (or productivity), and market share per rate of IT investment. Data for all four measures are available from firms' financial statements and IT budgets. As explained below, these four measures would then allow us to determine whether executives' perceptions are indeed accurate and objectively verifiable. If what executives perceive about IT impacts is firmly grounded in reality, then their perceptions should correlate with objective measures of IT impacts.

If executives perceive that IT is enhancing profit margins so that each dollar spent on IT leads to progressively higher profitability, then we could uncover confirmatory evidence of this if their perception correlates with a measure of income per IT dollar. Equally, if IT is enhancing market share, this could be confirmed by correlating executives' perceptions with a measure of market share to IT spending. Dividing market share (a percentage) by IT spending (a dollar amount) would be awkward and so we instead use IT spending relative to sales as a denominator to create a measure of market share per rate of IT investment.

We considered using labor costs per IT dollar as a way to evaluate executives' perceptions of the effect of IT on labor costs. However, since financial reporting procedures afford considerable discretion in how firms account for labor costs, we could not be universally certain that what one firm treats as labor costs would not be treated as SG&A by another. For example, service firms tend to treat all labor costs as SG&A, while manufacturing firms tend to divide labor costs into blue-collar costs which are part of cost of goods sold and white-collar costs which are part of SG&A. Regardless of how firms account for labor costs, any reduction in labor costs attributable to IT should expand profits, which we can corroborate using income per IT dollar. Equally, automation or substitution between labor and IT that leads to a fall in labor costs should be observable in firm productivity statistics as measured by sales per employee.

Similarly, identifying a suitable objective proxy measure of executives' perceptions of the effect of IT on SG&A is challenging since financial accounting rules allow firms to report SG&A costs separately from advertising, R&D, depreciation, and other costs, or to optionally aggregate and report all such costs under SG&A. Regardless of how firms account for SG&A, an IT-led reduction in SG&A will lead to an increase in profit that can be corroborated using income per IT dollar. Furthermore, if IT reduces SG&A by automating aspects of sales, marketing, or customer service that allow firms to make more effective use of their remaining resources, we can expect

to see an improvement in productivity and an increase in sales [72]. Therefore, if executives perceive that IT is helping firms to reduce SG&A costs, we can confirm this by correlating their perceptions with income per IT dollar and to a lesser extent with sales per IT dollar.

While these ratios are an attempt to capture some notion of output (performance) relative to input (IT), ratios can be misleading [52]. For example, sales per IT dollar will likely increase in absolute terms if IT is used to improve customer loyalty, allowing firms to expand wallet share or sales per customer (the numerator expands faster than the denominator). However, sales per IT dollar could also increase if a firm was to scale back its IT spending without suffering a decline in overall sales (the denominator falls faster than the numerator). Thus, ratios can send mixed signals. To address this limitation in our measures, for each firm, we express each of the four objective measures as a deviation from their industry average.

Data Collection and Analysis

THE DATA FOR THIS STUDY WERE COLLECTED AS PART of the Intercorporate Measurement Program (IMP), a research program conducted during the late 1990s by the Center for Research on Information Technology and Organizations (CRITO) at the University of California, Irvine and CSC Index, the consulting division of Computer Sciences Corp. The sample frame for the research consisted of CSC's North American client base. Packets containing an IT impacts survey and an IT spending survey (a survey of IT spending for the most recent year) were sent to the CIO of each firm with the request that the CIO personally complete the IT spending survey and forward the IT impacts survey to a business executive (at senior vice president (SVP) level or above) for completion. To protect the confidentiality of business executives' responses, a covering letter invited them to mail their survey directly to us rather than returning it through the office of the CIO.

From an initial mailing and subsequent phone follow-up, matched responses were received from 196 firms. Summary statistics are shown in Table 3. All IT spending surveys were completed by the CIO; 89.3 percent of our business executive surveys were completed by executives ranging in seniority from SVP to chief executive officer (CEO). A comparison of our sample to the Fortune 500 on criteria such as revenues, income, and total assets failed to uncover significant differences, allowing us to broadly generalize our findings to this group. We also ran a series of Kolmogorov–Smirnov and ANOVA tests to confirm that our data are normal and not significantly distorted by differences in respondent types.

Financial data for 1998, the year immediately following the survey, were extracted from Standard & Poor's Compustat database and matched with the 196 firms in the survey. Productivity studies have used various time periods to model the interval between when IT investments are made and when the effects of those investments first materialize in the financial statements. For example, Brynjolfsson et al. [16] report that the effect from an initial IT investment is similar at the end of the first and second year, but then climbs in the third year. Elsewhere, Devaraj and Kohli [29] report lags

Table 3. Characteristics of the Sample (N = 196)

Variable	Frequency	Percent
Revenues (1998)		
Less than $500 million	9	4.6
$500 million to $1 billion	30	15.3
$1 billion to $5 billion	87	44.4
$5 billion to $10 billion	36	18.4
More than $10 billion	34	17.3
Industry Segment		
Paper and packaging	22	11.2
Computers and electronics	23	11.7
Chemicals and metals	11	5.6
Utilities (electric or gas)	31	15.8
Wholesale and retail trade	15	7.7
Telecommunications	18	9.2
Finance, insurance, and real estate	31	15.8
Business and professional services	16	8.2
Other	29	14.8

on the order of six months or less, basing their assessment in part on interviews with hospital administrators, while Brynjolfsson et al. [17] find that the effects of IT on reduced firm size become apparent after a two-year lag. Strictly speaking, our focus in this study is not on how long it takes for IT impacts to materialize but on the length of time that it takes for noticed IT impacts to materialize in the financial statements. Our decision to consider a one-year lag is a compromise between the two-year window that empirical research has suggested as an appropriate time lag [16] and the shorter six-month interval reported by Devaraj and Kohli [27].

To address sources of bias, we extracted data from Compustat for over 2,500 firms whose four-digit SIC codes matched that of our sample. Grouping firms by four-digit SIC code allows us to determine overall industry sales and thus each firm's approximate market share. We also compiled total sales and profits for the five largest firms (by sales) in each four-digit SIC code. We used Information Week 500 data for 1998 to identify industry average rates of IT spending, and then matched these data with each firm in our sample.

One could argue that the scale of IT's impact on firm performance is not only reflective of current IT spending but the cumulative effect of IT spending over time as represented by IT capital. Accordingly, we acquired from Harte-Hanks data on IT capital at the end of 1997 from which we were able to extract data for 129 of the 196 firms in our sample. IT capital is computed by Harte-Hanks (previously Computer Intelligence Infocorp) from aggregate site-level surveys of firms' mainframes, PCs, servers, and other IT hardware. This measure of IT capital has been used extensively in productivity studies by Bresnahan et al. [12], Brynjolfsson and Hitt [15], Kudyba and Diwan [49], and Lehr and Lichtenberg [50], and hence has legitimacy among researchers. We, therefore, supplemented the three measures of IT impacts that used

IT spending (sales per IT dollar, income per IT dollar, and market share per rate of IT investment) with three measures based on IT capital. These three additional measures are: sales per IT capital dollar, income per IT capital dollar, and market share per IT capital dollar. Similar to our IT spending ratios, these IT capital ratios are open to interpretation and so each was normalized to reflect deviations from industry averages.

Measurement Model

To assess the psychometric properties of our items, we used partial least squares with PLSGraph[7] to perform a factor analysis. This involved estimating a measurement model with 20 process-level items, divided into five factors with four process-level items each, four items denoting sensemaking perceptions of IT impacts at the firm-level loading on one factor, four objective measures of firm performance loading on one factor, three items denoting the strategic role of IT loading on one factor, and three items denoting IT–business interaction also loading on one factor—single-item constructs were not included in the analysis; reflective indicators were used throughout. While PLSGraph reports standardized factor loadings for each factor's indicators, cross-loadings were found by computing factor scores for each factor (as the product of PLSGraph-generated indicator weights and the raw indicators), and then correlating each factor score with all indicators for all other factors. Descriptive data, factor loadings, and the text of each survey item appear in Table 4. All factor loadings exceed a suggested minimum of 0.6 [2], indicating that the structure of our first-order factors is appropriate.[8]

We also used the measurement model to review convergent and discriminant validity of the items and constructs arising from our factor analysis. Convergent validity identifies if the indicators of a factor correlate higher with other indicators of the same factor than with indicators of a different factor, whereas discriminant validity determines if the indicators of a particular factor load higher on that factor than any other factor. In order for the factor structure to be valid, the shared variance (squared correlation) between each factor-pair must be less than the variance extracted for each factor [33]. The results of these validity checks appear in Table 5; convergent and discriminant validity are present throughout. Finally, composite reliability was also identified and found to exceed a suggested minimum of 0.7 for each construct [88].

Hypothesis Testing Using PLSGraph

To estimate our model, we first created a second-order factor reflecting the five first-order factors denoting process-level IT impacts. This allowed us to test H1 as one path rather than five separate paths.[9] We then estimated three models. As indicated in Figure 2, the first model uses firm-level sensemaking or perceptual measures and includes a broad list of control variables to account for potential sources of bias and perceptual distortion. The second and third models, seen in Figure 3, use objective measures based on IT spending and IT capital as proxies for the perceptual sensemak-

Table 4. Measurement Model Statistics (N = 196)

		Mean	Standard deviation	Standard factor loading
Noticing (perceptual process-level measures of IT impacts)				
Supplier relations (SR)				
SR1	Reduce transaction costs by making it easier for suppliers to handle orders	4.71	1.97	0.924
SR2	Help to reduce variance in supplier lead times	4.54	1.95	0.957
SR3	Enhance the ability to monitor the quality of products/services from suppliers	4.43	1.85	0.917
SR4	Facilitate the development of close relationships with suppliers	4.56	1.95	0.947
Production and operations (PO)				
PO1	Improve the levels of production or throughput	5.60	2.16	0.932
PO2	Reduce the level of production/service required for economies of scale	5.30	1.94	0.937
PO3	Improve the utilization of machinery	5.33	2.09	0.870
PO4	Improve the productivity of labor through automation	5.95	2.16	0.856
Product and service enhancement (PSE)				
PSE1	Reduce the development time for new products/services	4.87	2.15	0.970
PSE2	Reduce the time-to-market for new products/services	4.85	2.21	0.971
PSE3	Reduce the cycle time for development of new products/services	4.82	2.22	0.982
PSE4	Reduce the cost of designing new products/services	4.95	2.18	0.893
Sales and marketing support (SM)				
SM1	Help to track market response to pricing strategies	4.37	2.25	0.927
SM2	Track market response to discounts	4.15	2.13	0.969
SM3	Track market response to promotional or introductory pricing	4.22	2.18	0.964
SM4	Facilitate targeted response to competitors' pricing strategies	3.86	2.01	0.936

Customer relations (CR)				
CR1	Enable your corporation to provide administrative support to customers	6.21	2.20	0.868
CR2	Facilitate a higher level of flexibility and responsiveness to customer needs	6.03	2.04	0.895
CR3	Facilitate the development of detailed customer databases	5.89	2.06	0.828
CR4	Provide online access of your corporation's products/services to customers	4.24	2.22	0.747
Sensemaking (perceptual firm-level measures of IT impacts)				
FL1	Increase your corporation's profit margins	6.12	1.94	0.889
FL2	Increase your corporation's market share	5.33	2.00	0.822
FL3	Reduce your corporation's labor and related expenses	6.27	2.05	0.882
FL4	Reduce your corporation's selling, general, and administrative expenses	5.67	2.04	0.846
Reality (objective financial measures of firm performance)				
OF1	Profit margin (net income/sales percentage)	15.00	11.58	0.901
OF2	Market share (firm sales/industry sales percentage)	19.10	22.66	0.713
OF3	Labor costs as a percentage of sales	20.09	12.90	0.307
OF4	Selling, general, and administration costs (SG&A) as a percentage of sales	36.65	38.77	0.803
Control variables (see description of scales and items in Table 2)				
IT-business interaction				
IBI1	IS executive participation in the strategic planning process (10-point Likert scale)	7.20	2.15	0.813
IBI2	IS executive involvement in resolving business issues (three-point ordinal scale)	1.24	0.61	0.943
IBI3	IS executive involvement in business committee meetings (four-point ordinal scale)	1.90	0.95	0.934
Strategic role of IT				
SIT1	IT is an agent of change, facilitating critical changes to business processes	6.02	1.53	0.813
SIT2	IT enables business improvement by being integrated into products and services	6.70	1.78	0.919
SIT3	IT facilitates strategic leadership through innovative applications	6.71	1.64	0.833

Notes: All factor loadings (except OF3; $p < 0.05$) are significant at $p < 0.001$. Single-item constructs (used as control variables) have not been included in the above factor analysis since their factor loadings will always be 1.0.

Table 5. Construct Validity and Reliability (Correlation Matrix)

Measurement model constructs	1	2	3	4	5	6	7	8	9
1. Supplier relations (SR1–SR4)	**0.77**								
2. Production and operations (PO1–PO4)	0.21	**0.65**							
3. Product and service enhancement (PSE1–PSE4)	0.30	0.45	**0.83**						
4. Sales and marketing (SM1–SM4)	0.36	0.27	0.38	**0.81**					
5. Customer relations (CR1–CR4)	0.36	0.31	0.33	0.23	**0.50**				
6. Firm-level perceptions (FL1–FL4)	0.31	0.39	0.36	0.34	0.43	**0.55**			
7. Objective measures of performance (OF1–OF4)	0.15	0.08	0.15	0.13	0.19	0.11	**0.51**		
8. IT–business interaction (IBI1–IBI3)	0.12	0.13	0.12	0.18	0.08	0.10	0.26	**0.81**	
9. Strategic role of IT (SIT1–SIT3)	0.13	0.16	0.12	0.17	0.08	0.21	0.16	0.44	**0.73**
Composite reliability	0.97	0.94	0.98	0.97	0.90	0.92	0.75	0.93	0.89

Notes: Variance extracted appears in boldface along the main diagonal; off-diagonal elements denote shared variance or the correlation between factors. Single-item constructs are not relevant for validity or reliability purposes.

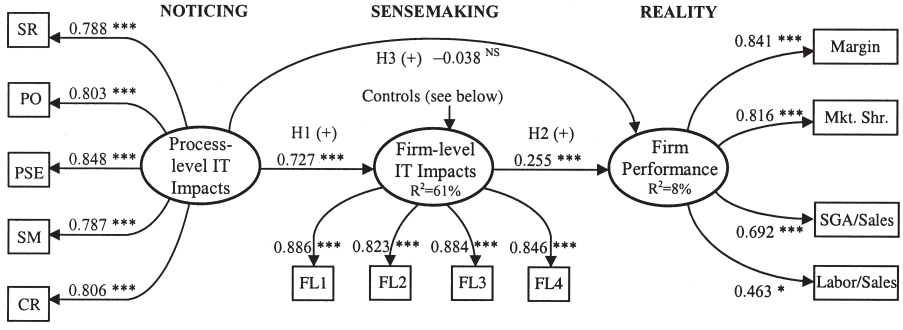

Figure 2. Standardized Path Estimates with Perceptual Measures of IT Impacts ($N = 196$)
Notes: Control variables denoting sensemaking biases: Enactment of sensible environment property: IT spending per employee (0.106, ns), rate of IT spending (0.039, ns), sales of the largest five competitors (–0.084, ns), profit of the largest five competitors (0.056, ns). Social property: utility role of IT (–0.132, $p < 0.01$), strategic role of IT (0.163, $p < 0.01$), IT–business interaction (0.126, $p < 0.01$), nature of IT strategy (0.039, ns). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

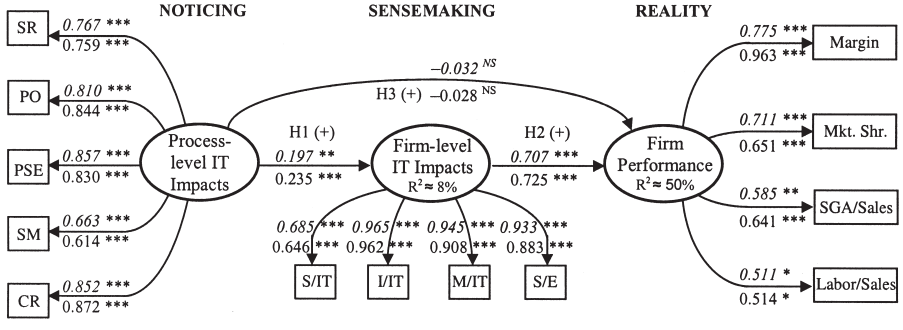

Figure 3. Standardized Path Estimates with Objective Measures of IT Impacts
Notes: The upper coefficient (in italics) represents the path estimates for Model 2 ($N = 196$), which uses objective firm-level IT impact measures computed from IT spending as proxy measures for perceptual sensemaking, while the lower coefficients reflect Model 3 ($N = 129$) where objective firm-level IT impact measures are instead based on IT capital. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

ing items used in Figure 2. Significance levels were determined throughout on the basis of 1,000 bootstrap samples.

As seen in Figure 2, there is significant ($p < 0.001$) support for H1 and H2, confirming the tight link between noticing and sensemaking as argued by Starbuck and Milliken [77] and Weick [87]. This degree of significance offers the first sign of support for perceptual accuracy. Interestingly, the path representing H3 is insignificant. We found, however, that if this path was estimated separately (removing the paths for H1 and H2 from the model), H3 became positive and significant (0.241, $p < 0.01$). To understand why this path is insignificant in the overall model, it is first necessary to recognize that

sensemaking mediates the link between perceptions of IT impacts at the process level and firm performance. As noted in Baron and Kenny [6] and Kenny [43], complete mediation occurs when the inclusion of a mediator causes the direct path to transition from significant to insignificant. In this case, the inclusion of sensemaking causes the direct path (H3) to become insignificant. This is an important finding as regards our interpretation of sensemaking, for it shows that what executives notice about IT at the process level is fully encapsulated in their sensemaking views of IT impacts at the firm level—no further variance is explained by the inclusion of a direct path from noticing to reality. If H3 was still significant in the overall model, it would indicate that executives have embellished, censored, or omitted certain noticed IT impacts from their sensemaking. The fact that H3 is insignificant, therefore, further strengthens our confidence in the ability of executives to take what they see at the process level and to make sense of it—yet again confirming that perceptions are more accurate than one might otherwise suspect.

We also find that the control variables denoting the social and enactment of sensible environment properties of sensemaking—the most likely forms of bias and distortion—are insignificant. This implies that executives do not look to IT spending patterns, the size of their IT budget, or the performance of their largest competitors to infer what IT impacts they should be receiving from IT. Interestingly, sensemaking perceptions of IT impacts are positively associated with a strategic role for IT but negatively associated with perceptions of IT impacts when firms pursue a more utility-based role for IT. This result is consistent with Tallon et al. [82], who found that firms with more focused or strategic goals for IT realize higher IT business value. Finally, sensemaking is also shaped by the interaction between IT and business executives consistent with previous research showing how closer cooperation leads to tighter alignment between IT and business strategy [66]. Interactions can mold executives' attitudes toward IT but it could also suggest a causal relationship where IT executive involvement in business planning, executive committee meetings, and general outreach to users could help to improve IT impacts. Consequently, across all our results, there is a consistent indication that executives' perceptions of the effect of IT on firm performance are not as susceptible to bias and perceptual distortion as researchers may have been led to believe.

Evaluating Perceptual Accuracy: Further Analysis

While the results in Figure 2 reveal that executives' perceptions are more fact than fiction, we use Figure 3 to provide a further assessment of perceptual accuracy and to examine any possible confounding effects of common method bias in Figure 2. An application of sensemaking theory necessitates collection of data on noticing and sensemaking from the same individual, a situation that raises the risk of common method bias [62]. As seen in Figure 2, the coefficient of H1 is high (0.727)—necessarily so since theory calls for a tight link between noticing and sensemaking but also high enough to raise some concerns that common method bias could be adversely

shaping our results. In effect, common method bias could create a false appearance of perceptual accuracy, thus necessitating further review.

One approach to controlling for common method bias is to reestimate the model using objective measures as proxies for perceptual sensemaking measures. The results of this reestimation are shown in Figure 3, where objective measures are based on IT spending (sales per IT dollar, income per IT dollar, market share per rate of IT investment, and sales per employee) and IT capital (sales per IT capital dollar, income per IT capital dollar, market share per IT capital dollar, and sales per employee). As seen in Figure 3, support for H1 and H2 remains strong regardless of which type of objective measure is used.

Equally, sensemaking could incorporate certain nuances of IT impacts that might not be reflected in our objective measures [14]. For example, the retrospective nature of sensemaking allows executives to identify current IT impacts before these effects have had an opportunity to flow through to the financial statements—sensemaking is not confined by accounting rules (such as the accruals or prudence concepts) that contribute to the time lag often associated with the detection of IT impacts on firm performance [14]. Sensemaking can also reflect strategic initiatives and management practices that are meant to improve IT conversion effectiveness, practices that might not be adequately reflected in a ratio such as income per IT dollar. Yet, even if these ratio-based measures are less than perfect and incapable of fully communicating the depth or richness of sensemaking, we should still expect to find a significant correlation between them and the various perceptual sensemaking measures they are said to represent.

As seen in Table 6, when we perform a correlation analysis–controlling for various sensemaking biases noted previously in Table 2 (and used as control variables in Figure 2)—we find several significant correlations that point to the existence of perceptual accuracy. For example, if executives perceive that IT has had a positive effect on profit margin, this is corroborated in virtually all objective measures, though particularly in income per IT dollar and productivity measures. If executives perceive that IT is helping to contain labor and SG&A costs, this is corroborated by a significant correlation with income per IT dollar, while executives' perceptions that IT is boosting market share is corroborated by a significant correlation with market share per rate of IT investment.

The net result of this analysis points to significant positive correlations between perceptual and objective measures of IT impacts. We do not require very high correlations to support this result since, as noted earlier, neither set of measures is an exact mirror image of the other, but what is critical, however, is a significance level that shows that both sets of measures move in unison. Consequently, if the underlying reality involves IT having a positive influence on firm performance, executives' perceptions will confirm as much but, if IT is not delivering on its promise, executives' perceptions will show a sense of frustration and dissatisfaction. Overall, the key conclusion of this work is that perceptions are consistent with reality—a result that casts doubt on suspicions long held by IT researchers that perceptions of the effects of IT on firm performance are biased and distorted by any number of factors and so should

Table 6. Partial Correlation Analysis: Objective and Perceptual Measures

	Business executives' perception of IT's contribution to			
	Increasing profit margin	Increasing market share	Reducing labor costs	Reducing SG&A costs
Objective measures of IT business value based on IT spending ($N = 196$)				
Sales per IT dollar	0.159*	0.196*	0.330***	0.350***
Income per IT dollar	0.186*	0.197*	0.365***	0.356***
Market share per rate of IT investment	0.178*	0.143*	0.366***	0.363***
Sales per employee (productivity)	0.194*	0.181*	0.370***	0.404***
Objective measures of IT business value based on IT capital ($N = 129$)				
Sales per IT capital dollar	0.112^{ns}	0.139*	0.063^{ns}	0.089^{ns}
Income per IT capital dollar	0.289**	0.336***	0.277**	0.261**
Market share per IT capital dollar	0.178*	0.188*	0.134*	0.147*
Sales per employee (productivity)	0.394***	0.357***	0.397***	0.353***

Notes: Partial correlations control for the effects of objective measures of firm performance (ROA, ROE, ROI, and asset turnover) and the following control variables as identified in Table 2: IT spending or IT capital per employee, IT spending rates in each industry, revenues and income of the five largest firms in each industry, role of IT, nature of IT strategy, and IT–business interaction. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

not be used in this domain of research. Such views have long denigrated perceptual measures [20], unnecessarily so in our view if in fact executives' perceptions prove to be a close approximation of the reality underlying IT impacts.

Beyond Perceptual Accuracy: A Field Investigation

If our analysis could speak to IS researchers, it would simply ask that we not be so dismissive of perceptions, but this begs the question, "What do you do with perceptual measures of IT impacts now that we know that perceptions reflect reality?" While it is one thing to show perceptual accuracy across a broad sample of firms, the truthfulness and reality behind the views of any single executive are an entirely different matter. As seen in the properties of sensemaking in Table 1, sensemaking is a way for executives to project an image to the outside world [87], and so for researchers, there is an obvious question of trust, reliability, and consistency when it comes to relying on the views of a single executive. As argued earlier, seniority matters when it comes to noticing and sensemaking of IT impacts but one could also argue that, even with seniority, respondent selection is critical. Could some executives be more accurate than others?

Theoretically, this is an essential test of sensemaking, for if executives in the same firm notice the same things—as they should since each faces the same reality—then their sensemaking should come to a similar conclusion. Quite simply, we would be challenged to claim perceptual accuracy (notwithstanding our earlier results) if it occurred that executives in the same firm had dissimilar and potentially conflicting views on IT impacts in their firm. We must, therefore, ask whether executives in the same firm will notice the same IT impacts, both in terms of the level and locus of value, and form similar views as to the effect of IT on their overall firm performance. If executives maintain contradictory views on how much value IT is creating and where within the value chain that value is being realized, then we cannot make any useful inferences as to whether IT is delivering significant value or not, but if there is consensus, then perceptions have intuitive meaning, enabling them to play a greater role in IT decision making. Consensus also means that no one executive's opinions are superior to another's, implying that researchers could look to different respondents as they strive to collect perceptual measures across organizations.

To investigate this issue further, we worked with CSC Index in identifying seven firms where we could distribute multiple copies of the survey to teams of senior executives; five of these firms were part of our original sample of 196. Six of the seven firms were ranked in the Fortune 500. The intention of this exercise was not to undertake an extensive survey but, rather, to explore through a small sample of firms whether consensus (interrater reliability) could be determined among a firm's most senior cohort of business executives. After obtaining access to executives in each firm at SVP level or above, we mailed surveys to each executive with the request that they reply directly to us. From a population of 140 senior executives (all executive committee members) in these seven firms, we received 88 completed responses or

a 60 percent response rate. Survey items were identical to those used in the earlier business executive survey.

Agreement, or interrater reliability, among executives in each firm was assessed as an intraclass correlation coefficient with two-way mixed effects [73]. While the number of survey items remains fixed, respondents represent a sample of the executives in each firm. This calculation is computed separately for each firm rather than across the entire set of seven firms. Interrater reliability measures were first applied to the survey items measuring IT impacts in different processes in the value chain, then to all survey items for all processes simultaneously, and finally to the sensemaking items capturing the effect of IT on firm performance. The results of this analysis appear in Table 7. Firms have been alphabetically labeled: firms A, F, and G are in financial services, B is an energy utility, C manufactures paper and wood products, D produces consumer electronics, E is a telecom provider. Sample size data are also reported in Table 7.

Overall our results show a consistently high rate of interrater reliability within each firm for each of the primary processes in the value chain and the firm-level sensemaking items. This reveals that when senior executives are given a common framework for evaluating IT impacts (in the form of a survey) and are then asked to render an opinion on how their firm has performed in each dimension or area of IT value, executives within the same firm tend to respond in a similar manner. The fact that there is a pattern of interrater reliability across all seven firms, while far from being representative of all firms, offers some reassurance that executives in the same firm notice and make sense of IT impacts in the same way. Again, this reveals that executives' perceptions are more accurate and unbiased than perhaps previously thought.

Discussion and Implications

The use of perceptual measures of IT impacts has invoked widespread mistrust and suspicion of systematic or deliberate bias and error, even as researchers decry a dearth of easily accessible objective measures that can act as definitive measures of IT impacts. The aim of this research has not only been to ascertain the accuracy and reliability of executives' perceptions but also to dissect and understand the cognitive processes that give rise to such perceptions. Sensemaking theory affords a unique opportunity to achieve both goals simultaneously, thus resolving a debate that has long plagued research in this area.

Researchers do not need an alternative approach to evaluating IT impacts inasmuch as they need a more accurate and reliable set of measures. While researchers have embraced process-level measures on the basis that the first-order effects of IT arise at the process level, the challenge is that objective process measures are extremely difficult to obtain [8] and so any additional reliability and validity can only come at enormous cost and inconvenience to the researcher, not to mention the loss of generality that can ensue if process measures are industry or firm specific [47]. The fact that executives' sensemaking yields valid, accurate, and reliable insights and that these insights are broadly shared by other executives from the same firm suggests that the

Table 7. Interrater Reliability Correlations (Two-Way Mixed Effects)

Firm identifier	A	B	C	D	E	F	G
Number of respondents	$N = 14$	$N = 11$	$N = 16$	$N = 14$	$N = 13$	$N = 10$	$N = 10$
Noticing							
Supplier relations	0.662*	0.783**	0.779**	0.789**	0.551*	0.538^{ns}	0.738*
Production and operations	0.747**	0.877***	0.693*	0.759**	0.733*	0.857***	0.740*
Product and service enhancement	0.658*	0.684*	0.784**	0.818**	0.601*	0.798**	0.712*
Sales and marketing support	0.693*	0.613*	0.737*	0.698*	0.659*	0.773**	0.677*
Customer relations	0.846***	0.936***	0.836***	0.979***	0.836***	0.899***	0.844**
All process-level items	0.907***	0.901***	0.813***	0.866***	0.682***	0.906***	0.830***
Sensemaking							
All firm-level items	0.836**	0.919***	0.792**	0.730*	0.804**	0.880***	0.833**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ns = not significant.

data behind sensemaking (i.e., what executives notice at the process level) can yield richer insights into IT impacts than what might be available at the firm level.

Notwithstanding the relative ease with which researchers can collect perceptual measures, we are not advocating that researchers stop collecting objective process measures, nor do we think that perceptual measures should replace objective measures—this is not an *either* objective *or* perceptual measures issue. There is, instead, a complementarity between each set of measures that forces us to question whether our tacit and continued rejection of *soft* perceptual measures in favor of *hard* objective measures is justifiable [20]. It may have been prudent to reject perceptual measures when accuracy was an unresolved issue, but to the extent that our research shows that the perception and reality of IT impacts are related, perhaps the time has come to reconsider our stance toward perceptual measures. Does this mean that perceptions can contribute to a new process-level measurement paradigm for IT impacts? We address this issue below.

Perception as Reality: A New Paradigm for IT Impact Analysis?

As the process level emerges as a focal point for research on IT impacts [7, 47], we are reminded that researchers face tremendous difficulty in finding objective process-level data that firms are willing to share or that are not limited in some manner.[10] As noted in literature reviews by Dehning and Richardson [25], Kohli and Devaraj [48] and Melville et al. [56], firm-level outcome measures such as sales or value added are key to determining the marginal effect of IT investment, but such measures fail to pinpoint the locus of value within the firm. Recognizing these limitations, perceptual measures provide an opportunity to lift the lid on the black box of how and where IT creates value within the firm. As our analysis reveals, process-level perceptual measures not only distinguish between low and high effects, but can also reveal the locus of value at a more granular level in the firm. Consequently, perceptual measures have remedial value should the level and locus of IT value be insufficient or inconsistent with the goals of the firm [82].

Chan [20] notes that a reluctance to consider more qualitative approaches to IT impact assessment has created a schism between qualitative and quantitative measures and the research camps that favor one type of measure over another. Our research does not especially favor one side of the divide over another. Qualitative and quantitative measures are equally informative and imperfect, given the often subjective and highly complex nature of IT impacts. Overall, our intent in this research has been to bridge this divide and, in so doing, establish credibility for executives' perceptions as an emergent—though still underutilized—approach to IT impact analysis. Being able to show that perceptions are accurate is an important first step toward building credibility around a diverse set of process-level measures.

Sensemaking theory represents a marked departure from traditional thinking about IT impacts as a cause-and-effect relationship linking variables such as IT spending or IT capital to productivity or other firm-level performance outcomes. As Weick notes, "to talk about sensemaking is to talk about reality as an ongoing accomplishment that

takes form when people make retrospective sense of the situations in which they find themselves and their creations" [87, p. 15]. Sensemaking does not (and likely cannot) answer the question of how firms realize value from IT or what management practices firms should implement to boost their level of realized impacts. However, in terms of selecting dependent variables that can serve as close approximations of reality, sensemaking or perceptual measures, particularly at the process level, can (with the inclusion of controls for perceptual bias or distortion as used in this study) begin to unravel the link between predictors of value (management practices, strategic alignment, IT resources, or capabilities) and value-based outcomes in ways that traditional firm-level objective measures have been unable to do.

Contribution of the Research

This research contributes to the extant literature on IT business value in three ways. First, we use sensemaking theory to show that executives' perceptions of IT impacts at both the process and firm levels are sufficiently accurate, credible, and unbiased as to constitute a viable approach to IT impact assessment. Executives' perceptions have been found credible in areas such as evaluating environmental uncertainty [39] or relative firm performance [26, 85]. However, perceptions of IT impacts pose a very different set of challenges that prevent extrapolation of perceptual accuracy from these other studies. As the first study to directly confront the issue of perceptual accuracy in an IT business value context, we dispel the myth held by many IS researchers that perceptions are inherently biased and untrustworthy. It is natural to think that perceptions may be self-serving, but at a time when it is increasingly difficult to collect primary data on IT impacts, particularly at the process level, perceptual accuracy prompts greater use of perceptual measures.

Our second contribution reflects the ability of perceptions to report on the level and locus of IT impacts in a single firm. While our analysis revealed the presence of perceptual accuracy across a sample of firms, it was equally important to ascertain if the perceptions of a single respondent in each firm would reflect the collective views of all executives. Through additional analyses of surveys from teams of senior executives across seven firms, we found through interrater reliability tests that executives tend to agree with each other as to the level and locus of IT impacts. Consequently, perceptual measures have the ability to provide new and useful insights into a wide variety of IT impacts across the firm. Together with our first contribution, this result offers some encouragement to IS researchers who want to use perceptions of IT impacts in their research but are uncertain if multiple respondents are necessary or not. This issue is moot as regards objective measures but cannot be overlooked when perceptual measures are used. Our findings would not discourage use of multiple respondents, but consensus across executives in the same firm offers some evidence that multiple respondents may not be needed to justify using perceptual measures.

Our final contribution reflects our use of sensemaking theory. While sensemaking has been used previously in the IS literature [34, 46, 70], this is the first time that sensemaking has been used to examine IT impacts and the cognitive processes behind

the noticing and sensemaking of IT impacts. What emerges from our use of the theory is validation of prior arguments by Starbuck and Milliken [77] and Weick [87] that noticing (the act of identifying facts, peer evaluations, expectations, and other key informational cues) and sensemaking (combining and filtering these various elements into a plausible interpretation of reality) are tightly intertwined. For executives who rely on their gut to make key investment decisions or to assess the adequacy of post-investment effects, our results suggest that executives' instincts are not wrong [5].[11]

Implications for Practice and Research

Our findings are directly relevant to business and IT practitioners who need to evaluate IT impacts but who receive relatively little guidance from the large-sample studies that have dominated the IS literature to this point [38]. To the extent that executives within the same firm share a common set of views on what IT has achieved or perhaps failed to achieve, there is the potential to begin using these perceptions to benchmark IT impacts over time, perhaps in response to a new wave of IT investment [69]. As Bannister and Remenyi [5] report, IT value is still very much an act of faith for many firms that, even with some rudimentary cost-benefit analysis, typically fail to do any form of postimplementation audit to detect if IT is delivering what is expected of it. Where firms decline to do postimplementation audits on the basis that there are insufficient data to inform their analysis [69, 82], perceptions could begin to play a more open and direct role in their post hoc benchmarking and evaluation efforts.

Our work also has implications for researchers. Despite the attractiveness and relative availability of perceptions, we emphasize that perceptions are not a panacea. Perceptions are accurate and credible but this fact alone does not make them universally applicable in all research—perceptions can only tell us so much; perceptions in isolation could never have debunked the productivity paradox! Econometric studies and time series analyses are still key to understanding input substitution and how inputs (IT capital, non-IT capital, and labor) are transformed into outputs (sales, value added). However, beyond asking if there is a payoff from IT, Chan argues that the "*why, where, when, how,* and *to whom* [questions involving IT impacts] . . . may require an examination of a variety of qualitative and quantitative measures [that] ultimately require us to unite the 'hard' and 'soft' camps, and the 'high' and 'low' camps" [20, p. 245, emphasis in original]. What this means is that while perceptions may be helpful in providing insight into research questions for which econometric analysis may be awkward, researchers should give consideration to using *both* objective and perceptual data when necessary. For example, in process-level studies, whatever objective measures exist could be supplemented with perceptual data to render a more comprehensive account of IT impacts.

There is also some potential to extend our research in several directions. For example, our process items (see Table 4) are not exhaustive of all possible process-level effects. Future research could extend and refine this list through industry- or process-specific analysis. There is also some question as to whether executive seniority is essential to

perceptual accuracy. For example, is it better to collect perceptual data from multiple function-level managers who may be more knowledgeable of IT impacts in specific parts of the firm than to rely on the opinions of one or more senior executives? Future research could also tap into the retrospective nature of sensemaking in order to determine how quickly executives can detect a change in performance due to a new investment or an increase in spending—research by Devaraj and Kohli [27] highlights the importance of such analysis in showing how time lags affect the search for value. At a time when firms are calling for progressively shorter payback periods on their IT spending—in part because of the "IT Doesn't Matter" debate [19]—there is some doubt as to whether year-end financial data can confirm if IT is delivering value or not. Perceptual measures may provide an answer to this dilemma.

Limitations

Our research suffers from several weaknesses and limitations. First, in asking CIOs to forward a survey of IT impacts to a business executive, there was a risk that CIOs could select their best customer—someone who could be trusted to give a positive view of IT regardless of the underlying reality. While our overall finding of perceptual accuracy would discount a systematic "best customer effect" in our data—an effect that would increase the gap between perception and reality by driving down the correlation between objective and perceptual measures—individual exceptions are always possible. From our later analysis of responses from multiple executives in the same firms, high interrater reliabilities confirm that executives tend not to hold deflated or inflated views of IT impacts, and so there is no evidence to say that in asking CIOs to help identify a business executive respondent, this somehow distorted or predetermined our results. It may also be argued, however, that perceptual value is "in the eye of the beholder." The beholder must be in a position to observe sufficient information with which to form an opinion. The point is not to have an opinion, per se, but to have a valid basis for having that opinion. All too often, whether through a sense of indifference toward IT or failure on the part of IT executives to reach out to their business peers, business executives struggle to perceptually identify how much value IT is generating for their firms. Value can exist in an objective sense but with echoes of the saying that "if a tree falls in the forest, does it make a sound?" if value cannot be perceptually identified, there may be an assumption that IT has failed in its mission. Mindful of the ensuing political fallout, there may be a need for IS executives to use a tool to detect any gap between perception and reality. In the domain of service quality, the marketing literature offers some insights into how such a tool (SERVQUAL) might be designed and implemented [45].

A further limitation involves our choice of objective measures of IT impacts to act as proxies for our perceptual sensemaking measures. Selecting suitable objective measures was a challenge, but without some consideration of objective measures, it would be difficult to assess perceptual accuracy. Even then, one needs to be careful with ratio-based measures that relate outputs to inputs such as sales per IT dollar. While

we adjusted objective measures to reflect deviation from industry averages, a broader limitation of our research is whether the four measures we used were sufficient. These measures may be suitable in a multi-industry study, but other measures may be more appropriate in industry-specific studies. One could also question whether sales per employee is an appropriate measure of productivity when sales is but one measure of output. When output prices are subject to decline, as for example in the electronics industry, it may appear that productivity is falling, whereas in reality IT is helping to accelerate production unit output.

The focus of this study was large firms (median 1998 sales: $3 billion), and so we caution against extrapolating our results to small and medium-sized firms. This limitation is especially important in terms of how business executives establish an expectation for what is an average IT impact. In pilot testing our survey, we asked executives to interpret the midpoint (5–6) on the 10-point scale used in the IT impact survey. It was clear from their comments that this midpoint reflected a separation between success (high effect) and failure (low effect) but that success or failure hinged upon what many considered "normal" in their industry. If executives anchor their expectations and perceptions of what IT has achieved against a benchmark that is set by industry peers and potentially by their desire to imitate IT success stories at firms such as Dell, FedEx, and Wal-Mart, then what might be judged as high IT impact in small firms could be judged as inadequate in large firms. By limiting our study to large firms, we hoped to control for this possibility. Our sample was also drawn from CSC's consulting clients—a group whose executives are arguably more IT-savvy and, therefore, in a better position to realistically assess their IT impacts.

A final limitation involves timing issues of IT impact recognition. Other than asking respondents to focus on realized rather than expected effects from IT—consistent with the retrospective property of sensemaking—respondents were not asked to confine their perceptions to a predefined period of time. A potential downside of this is that some executives might limit their noticing to the recent past while others consider a longer time frame. Our use of IT capital measures is an attempt to resolve this issue, and while our results in Figure 2 do not appear to have been biased by the possibility of different time frames, timing would be an issue for firms trying to benchmark or infer substantive meaning from their perceptions.

Conclusion

THIS RESEARCH REPRESENTS AN OPPORTUNITY to bridge the divide between qualitative and quantitative research traditions by combining perceptual and objective metrics in a way that is mindful of the strengths and limitations of each. Where mismeasurement of IT impacts has been blamed in part for the appearance of a productivity paradox [14], the use of perceptual measures provides an opportunity for researchers to devise new measures that highlight a variety of IT impacts at the process level, thereby reducing the risk that mismeasurement will allow key IT impacts to "fall through the cracks." To the extent that executives' perceptions are characterized as qualitative, they have

suffered from the schism that has formed between quantitative (hard) and qualitative (soft) measures [7, 20]. Over time, there has been a tendency to rebuff perceptual measures out of a sincere belief that these measures are more fiction than fact. We do not deny that perceptual bias is a significant challenge facing researchers who wish to use perceptual measures [57, 80], but our results show that with careful attention to respondent selection and a valid survey instrument, as noted by Miller et al. [58], it is possible to use perceptions to glean important insights into IT impacts. As such, our results echo a sentiment that is gaining ground in other areas of the academic literature—that executives are more accurate and consistent in their views than previously thought [44, 53, 58].

Few researchers would disagree that IT impact analysis is a complex task, particularly when there is an expectation that, in order to be valuable, IT must contribute to firm performance in a way that can be detected in the financial statements [10]. Alas, the simplicity and stricture of financial reporting belie the complexity of how IT can fundamentally alter the dynamics of business operations and firm performance. As active participants in the everyday activities of firms, executives implicitly form perceptions of how IT is helping them to achieve their strategic and tactical goals. By tapping these perceptions and confirming that they are credible and accurate, we can supplement what we have learned from econometric and other quantitative analysis by using perceptions to develop richer insights into the level and locus of IT impacts. With the expectation that firms are likely to be more willing to share perceptual insights than confidential objective data (if they exist), our hope is that researchers will give some thought to using perceptions more openly to generate new insights into process-level IT impacts. Such a move would help to bridge the great divide that defines much of the extant literature on IT impacts and that has sadly constrained the practical merits of this research in the eyes of many practitioners.

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Notes

1. As detailed by Weick [87], among the factors motivating sensemaking theory was an attempt to understand how jurors reach a verdict. Even though jurors are presented with the same facts and legal opinion, hung juries are not uncommon; guilty or not-guilty verdicts are earnestly defended by persons on the same jury who can cite a litany of facts to support their views. Sensemaking theory offers a way to reconcile perceptions with the evidence that jurors accept or dismiss in reaching their verdict. Similarly, sensemaking theory says that whatever executives perceive about aggregate IT impacts must emerge from the facts that they have

noticed or cognitively gathered in rendering their judgment. Another way of viewing this is to say that, like jurors, executives will always be able to substantiate their perceptions by pointing to specific informational cues. If their perceptions are found to be valid and reliable, we can use what they noticed to improve our understanding of how IT creates value within the firm.

2. Merriam-Webster online edition (www.m-w.com).

3. Although we do not identify in this paper if there are differences in perceptions of IT impacts between executives with different levels of seniority, it is an issue that is certainly worthy of consideration. If the level of noticing is at the application level, it may be preferable to collect perceptions from multiple managers with responsibility for the performance of each application (e.g., project managers or application owners). If the level of noticing is at a higher level within the firm, such as at the process level, the need for multiple respondents may not be as critical if senior executives with visibility into diverse business processes are able to report on IT impacts in several parts of the value chain.

4. Although Weick [87] lists eight reasons for why plausibility is unlikely to coincide with accuracy, only the first three reasons are relevant to this study since we are looking at retrospective IT impacts rather than future effects.

5. A positive effect of IT on firm performance is reflected in a *positive* effect on margin and market share but a *negative* effect on labor and SG&A costs as a percentage of sales. To ensure consistency in the design of our dependent variables (for later use in structural modeling), we applied a negative sign to the data collected from the S&P Compustat database for labor and SG&A costs.

6. We also separately tested a model whose dependent variables were based on measures of return on investment (ROI), return on assets (ROA), return on equity (ROE), and asset turnover (total assets divided by sales). The results from that alternative model are structurally identical to the results produced in this paper.

7. PLSGraph was used instead of covariance-based structural modeling because of small sample size issues. Using a rule of thumb of 10 observations per variable or measured item, we would need a sample size of approximately 400. A smaller sample size of 196 does not rule out covariance-based modeling using applications such as EQS, AMOS, or LISREL, but since PLS is less restricted by small sample size [21], we opted to perform all analysis in PLS instead, specifically PLSGraph V.3. Using the technique outlined by Chin and Newsted [21], we found that statistical power for the models in Figures 2 and 3 is 1.00—greater than the recommended minimum of 0.8 [22].

8. This form of factor analysis is more confirmatory in nature since the structure of the factors and items are known in advance. To confirm that this structure was appropriate, we also performed an exploratory factor analysis in SPSS with principal components extraction and varimax rotation. Using the eigenvalue rule, the resulting nine-factor structure (79.0 percent cumulative variance explained) was identical to the confirmatory factor structure tested in PLSGraph. Using Harman's one-factor test as a potential indicator of common method bias, we reviewed the variance explained by each factor. The first factor explained 38.4 percent of the overall variance, which would suggest that common method bias is not present in our data.

9. We also tested our model to identify if our results would be different if five separate paths were used instead. While this made for a more cluttered model, the overall structure of our results remains unchanged.

10. For example, the Management Productivity and Information Technology (MPIT) data set used by Barua et al. [8] in one of the earliest process-level studies is limited in terms of sample size (60 strategic business units in 20 large firms), industry scope (manufacturing primarily), and duration (data were collected from 1979 to 1983). Information Week 100 data used by Bharadwaj [9] and others to study the effects of superior IT resources and capabilities are also now dated since, beginning in the late 1990s, Information Week has stopped collecting IT budget data.

11. In a series of case study interviews accompanying this research, an airline IT executive with an unusual grasp of IT business value research remarked, "I know what marginal product means [referring to productivity studies], but I can't take that to my CFO and say, 'see, I told you our IT is paying off.' There's no way for me to use these [productivity] studies to infer anything about the state of IT business value in my firm. I still have to rely on my gut and whatever numbers we can come up with internally."

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