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Formative vs. Reflective Measurement: A Reply to Hardin, Chang, and Fuller

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1. Introduction

The 18th century French essayist and moralist, Joseph Joubert, posited, "It is better to debate a question without settling it than to settle a question without debating it." In many ways, Joubert's observation stands at the heart of knowledge creation in all academic endeavors.

In this spirit, Hardin, Chang, and Fuller have taken up the debate regarding formative vs. reflective construct measurement and validation by focusing their attention on the work of Marakas, Johnson, and Clay (2007). Hardin et al., have accepted the invitation set forth in 2007 by Marakas and his colleagues:

...we also must acknowledge that this perspective of the CSE construct is relatively new and thus requires additional empirical study to determine whether or not the formative approach is valid in all instances and applications of the construct.

In this response to Hardin et al., we see an opportunity to clarify several issues and concerns raised by the authors regarding the specification of CSE as a formative construct as well as provide the research community with a balanced and informed perspective on the questions at hand.

The remainder of this manuscript will be as follows: We intend to provide a detailed response to the specific concerns raised by Hardin et al. from both a theoretical and a statistical basis. Following this, we offer some thoughts intended to provoke additional debate and investigation into, what we believe to be, this fruitful and important area of IS research.

2. Summary Concerns of Hardin et al.

We identify three areas of concern raised by Hardin et al.: 1) substantive theory indicates the CSE construct is best measured using reflective indicators, 2) CSE is a psychological construct and, as such, is best modeled in a reflective manner, and 3) the specification of CSE as formative will result in misspecification of not only the construct, but of relationships entrenched in the nomological net. These three areas of concern combine to draw Hardin et al. toward their conclusion that the specification of CSE in a formative manner is not in the best interests of the IS research community. They take the rather dogmatic position that "there seems to be little disagreement that indicators that 'reflect' the underlying concept are most appropriate." We suggest there is yet a "little disagreement" and hope to offer evidence as such.

3. Issues of Substantive Theory

We must begin by making the somewhat troubling observation that the apparent contribution offered by Hardin et al. seems to be demonstrating the dangers of considering CSE in a formative sense rather than continuing to abide by classical test theory and specify the construct using reflective indicators. Hardin et al. go to great lengths, in an almost tutorial posture, to make the point that formative constructs must be justified by theory, yet they do little to strike any solid blows, on theoretical grounds at least, beyond what is already present in the literature on the subject. The entire basis for this area of concern seems to be driven by disagreement with the literature advancing our understanding of formative constructs (Diamantopoulos et al., 2001; Diamantopoulos, 2006; Jarvis et al., 2003; Podsakoff et al., 2003), and agreement with researchers who have questioned the validity of formative measurement in general (Bagozzi, 2007; Wilcox et al., 2008; Howell et al., 2007a; 2007b). This list of dissenting citations as a basis for their position comes primarily from a single issue of *Psychological Methods* in which the issue was debated in far greater depth and breadth than has been seen in the IS literature to date (inclusive of this writing). As such, we are unable to find any new insight in Hardin et al.'s discourse beyond this cited body of writings. While we firmly support their right to align themselves with a position on the subject, we are concerned that no additional contribution to our understanding of the issues and, more to the point, of the nomological net associated with the CSE construct appears to have been made. In the spirit of a balanced investigation of the issues, we must also make note of the mere casual mention of Bollen (2007), who served as the lone dissenting opinion (in the same issue) to those of Bagozzi, Howell, and Wilcox and

who raised many of the counterarguments we are positioned to raise again herein. Debate must begin somewhere, but it is our hope that it will eventually evolve to greater level of contribution than that of reiteration. More specifically, Hardin et al. offer several interpretations of extant theory associated with psychological constructs, including self-efficacy, in a syllogistic attempt to provide additional support for their concerns. Citing Bandura (2005), Hardin et al proffer:

'Efficacy items should accurately *reflect* the construct' (p. 2), and then further recommends that self-efficacy items should be correlated and that their homogeneity should be established through factor analysis. Finally, Bandura states that internal consistency reliabilities should be computed using Cronbach's alpha, and if reliability coefficients are low, the affected items should be discarded. We note that, reflect, intercorrelation, homogeneity, and internal consistency reliabilities are all consistent with reflective rather than formative measurement.

While we find this example to be an interesting play on words, we are concerned with regard to the inference being made. In all deference to the body of work by Bandura, we submit that neither his focus, nor his expertise, has ever been on the specification of the SE construct in either a reflective or a formative sense. Further, that his use of the word "reflect" is more likely in the correlational sense of the word rather than in the causal as suggested in the quote above. Short of a position statement from Bandura himself, we are forced to consider this conjecture on the part of Hardin et al. as weak.

Extending our, arguably, conjecture-laden position to the above, we must raise the more fundamental question that has yet to be answered in the extant debate: Given that we are working with correlational data in the first place, why does the direction of causality with regard to CSE (or any psychological construct) seem so dogmatically clear?

A review of the literature commonly cited when discussing formative vs. reflective specification (i.e., Diamantopoulos et al., 2008; Jarvis et al., 2003; Podsakoff et al., 2003; Bagozzi, 2007; Wilcox et al., 2008; Howell et al., 2007a; 2007b; Borsboom et al., 2003) highlights the extensive focus placed on the direction of causality between manifest indicators and latent variables or composites, and, congruent with Hardin et al.'s position, assumes that it is the conceptual definition (and theoretical basis) of the construct of interest that determines the most appropriate specification. This begs the question as to whether it is possible (or appropriate) for a researcher to define a construct in alternative forms such that either a reflective or a formative specification can be deemed appropriate. While there are clearly proponents on both sides of this question, two examples may serve to illustrate the lack of clarity with regard to its answer.

Socio-economic status (SES) serves as the iconic example for the need to specify at least some constructs as formative composites; and for the purposes herein, we define SES as a combination of *education, income, occupation, and residence* (Diamantopoulos and Winklhofer, 2001). Focusing on but one component for the purpose of example, researchers argue that a change in income will necessarily cause SES to vary, but the reverse is not true; a change in SES does not cause a change in income (or residence, or any other of its components). While we are not suggesting a reconceptualization of SES, we argue this to illustrate the existence of a rather restrictive and limited unidirectional conceptualization of causality. It becomes equally straightforward to fabricate a counterexample where an individual, because of his or her SES, is afforded greater exposure to prestigious organizations that result in increased opportunities to socialize with more powerful members of the local establishment, and thus land a better position providing greater income. In this example, a certain socio-economic status causally preceded a change in income.

Conversely, attitude is often invoked as a classic example of the appropriateness of reflective formulations for some constructs. However, as noted by Jarvis et al. (2003), a close reading of Fishbein and Ajzen (1975) suggests the expectancy-value formulation of attitude (an arguably psychological construct) is a clear example of a formative specification. We offer these two examples in an effort to demonstrate that arguments about the direction of causality between manifest variables and constructs are less straightforward than the literature (and Hardin et al. suggest) has assumed so far.

We proffer a position of ontology in this regard. While we freely admit that certain constructs may be deemed better represented in one manner than another, we believe it possible that a construct can be specified as either formative or reflective simply by the nature of the items chosen by the researcher to measure it. While the researcher may find it beneficial to measure a construct in a particular way, we find no reason to accept the notion that theory, practice, statistics, or any other externality should dictate the method by which a construct is measured. As such, we suggest a construct could be measured as both reflective and formative and, if done so appropriately, unique observations and understandings of that construct could result.

A researcher must make some decisions (rooted in both theory and research objective) regarding the specification of a given construct, and then form a contract with him- or herself to stick to the tenets and consequences of those decisions. If the researcher chooses to specify a construct as reflective, then the prescriptions regarding instrument creation and validation for reflective measures must be followed. Equally, if the choice is to specify a construct as formative, then conventional instrument validation techniques such as factor analysis and common reliability testing become both unavailable and inappropriate. In other words, we disagree with Hardin et al. that extant theory is the sole basis for determining a reflective or formative specification. Further to this point, we do not believe extant theory serves to pressure one perspective over the other – we believe the pressure may derive more from extant practice. Classical test theory has made the specification of constructs in a reflective sense clear-cut and almost formulaic; in short, convenient and familiar. To suggest that theory cannot be advanced through an investigation of alternative specifications of a construct simply due to the challenges presented in comparison to prior work closes the door on any opportunity to advance our understanding of a concept beyond conventional wisdom.

4. If It's Psychological, It Must Be Reflective

The second category of Hardin et al.'s concerns with the specification of CSE as a formative construct can be expressed by the following:

CSE, like self-efficacy, is therefore a psychological process that exists independently of any attempt to measure it. We believe that because of its psychological origins, its reference to a belief in one's ability, and the recommendations of Bandura (2005) that are consistent with reflective measurement, the suggestion by Marakas et al. (2007) to measure CSE with formative indicators appears inconsistent with its substantive theory. Finally, it is important to note that the substantive theory surrounding self-efficacy—developed and refined over a period of several decades—has positioned it as an underlying psychological concept that is best measured using reflective indicators (Borsboom et al., 2003).

It appears that Hardin et al. have taken the position that a psychological construct must be specified in a reflective sense because that's the way we have always done it. Notwithstanding our discussion above regarding their suggestion that Bandura (and, therefore, theory) supports their position, it seems they base this contention on their belief that CSE “exists independently of any attempt to measure it” and, therefore, must be reflective in nature.

We must, respectfully, submit this logic to be troubling at best. The iconic formative concept of socio-economic status exists, albeit made up of several components. It is also an idea that exists apart from any attempt to measure it. The consumer price index (CPI), an equally quintessential formative construct also can be described as existing apart from measuring it. Its existence is easily seen by reviewing any commercial lease document, as CPI is often used to index certain costs and rent increases. Bollen (2007) provides a further example:

Robins and West (1977) provided an empirical example in which η_1 is home value; the causal (formative) indicators are square footage of house, age, lot size, number of rooms, and so on; and the effect (reflective) indicators are appraised value, owner estimate, and assessed value of the home. Suppose that a researcher had only the effect (reflective) indicators of home value (η_1). According to the logic of Howell et al. (2007), the latent variable home value (η_1) would exist apart from the model because

of the use of effect (reflective) indicators. Now assume that a researcher did not have the effect (reflective) indicators but had causal (formative) indicators of home value (η_1). Following Howell et al.'s logic, the latent home value variable would no longer exist apart from the model. It seems odd to say that the existence of the same latent variable depends on which type of indicator is available. (p.221)

We must wonder if Hardin et al. are implying that formative constructs are dependent upon measurement. We admit to being unclear on this issue but cannot fully state our concerns, as provided for by this forum, without its mention.

Their concerns taken in the collective, Hardin et al. appear, via the gathering of the admonitions of others, to be attempting to assemble a formulaic set of rules that will determine whether a researcher should or should not view a construct as formative or reflective. While we fully support the development of frameworks and prescriptive guidelines (i.e., Jarvis, 2003; Marakas, et al., 1998) to aid researchers in their work (as we clearly are guilty of providing them ourselves), we must question both the lack of anything new to this discourse as well as the accuracy of some the premises used in its construction. To wit, the quote above, taken from Hardin et al., implies that Borsboom et al. (2003) is being used to support their position regarding self-efficacy as a reflective construct. We find further evidence of this later in their manuscript:

Thus, self-efficacy represents a complex psychological process that is formed and then used to guide human action. Such a description supports the notion that self-efficacy is an underlying factor that exists apart from any attempts to measure it, and further, that changes in the self-efficacy latent construct will precede changes in the indicators used to measure it. Therefore, the underlying theory supporting self-efficacy is consistent with reflective latent variable analysis (Borsboom et al., 2003).

Our review of Borsboom et al. (2003) leads us to believe Hardin et al. have somewhat overgeneralized, or misconstrued, the authors' position in this regard. Our review of the manuscript finds but one reference to self-efficacy in the entire manuscript, wherein the authors are describing a hypothetical situation relating Einstein's ability to advance his Theory of Relativity (an observable behavior) to his extraordinary intelligence (an unobservable attribute). More precisely:

In psychology, there are many constructs that play this type of role in theories of human behavior; examples are constructs like extraversion, spatial ability, self-efficacy, and attitudes (Borsboom et al., 2003; p. 203).

Unless we have overlooked something, we cannot accept Hardin et al.'s use of this citation as providing anything as dogmatic as their statements imply. We must, therefore, conclude that the conjecture of Hardin et al., rather than the theory set forth by Borsboom et al. (2003), is the source for this position.

5. Issues of Misspecification and Statistics

In this category of Hardin et al.'s concerns, they contend their research shows that a formative specification of the CSE construct resulted in different weights obtained depending upon the endogenous variables investigated. They conclude (as have others in this debate) that misspecification of existing CSE measures as formative can result in unstable estimates across varying endogenous variables and research contexts. As such, the comparison of results across studies over time becomes conceptually problematic and compromises our ability to replicate and extend research in a particular domain. They continue to suggest:

Because the meaning of formative latent constructs relies on the indicators used (Diamantopoulos and Winklhofer, 2001), changing indicators changes the meaning of the CSE constructs. Such changes in meaning represent a significant threat to both construct and external validity in future studies (Shadish et al., 2002), as researchers cannot be certain as to the true meaning of the constructs being measured.

Notwithstanding the following, we generally agree with all of the above statements (including those

related to their results). We believe, however, several issues of overgeneralization and questionable premises must be, again, identified to place our agreement in better perspective.

One area of concern in this regard lies with the characterization of the techniques employed by Marakas et al. (2007) in reaching some of their conclusions. To begin:

As a first step in the measurement validation process, Marakas et al. (2007) generated formative items to measure Windows, word processing, database, and Internet CSE. Indicators for existing reflective measures of spreadsheet CSE (Johnson and Marakas, 2000) and general CSE were respecified as formative.

To be precise, formative items are not (and were not) created. In the same manner as the development of reflective measures, items were selected from a pool of candidates to assemble a measure that represents a formative construct. While this may appear by some to be a simple semantic argument, it suggests to us a weakness in the overall understanding of the concepts and foundations upon which our work is built.

Continuing in this regard, Hardin et al. cite Howell et al. (2007) to suggest that it is inappropriate to take items from a reflective measure during a post hoc visual review for the purposes of respecifying the indicators as formative. At its foundation, we must wholeheartedly agree. While reflective measures are supposed to be generated according to the domain sampling model (Churchill, 1979; Nunnally, 1978), items comprising formative scales should represent a census of causes affecting the latent composite (Bollen and Lennox, 1991). As such, it would be highly unlikely that these two procedures would result in the same original pool of items. Marakas, Yi, and Johnson (1998) made clear the position that reusing measures of CSE in one context that were originally created for another may result in a number of errors or misspecifications. The work of Marakas et al. (2007) certainly subscribes to that position as well. Given the lengths we took to follow an exact validation process (as prescribed by some of the very authors being used to support their position) and then test the measures with new data, we humbly suggest this to be a position with no grounds. If the CSE or GCSE construct is ultimately deemed to be useful in a formative specification, then the final set of items may be remotely different from those currently being used in reflective instruments. That said, the demonstration of the process by which formative measures are created and validated contained in Marakas et al. (2007) would have been weakened by the generation of entirely new items. By demonstrating that a smaller number of items could, in fact, increase explained variance, the parsimony realized by formative specification was made clear. We also contend that the items retained were selected not only by their weights in the MTMM analysis but also by theoretical value (in keeping with the importance of content validity placed on the development of item pools for formative construct measures). Finally, we are concerned that Hardin et al. may be inferring that we worked backward in the process to get some good variance and then arbitrarily decided what items to keep or drop to make the construct formative. Again, a review of the extensive validation process employed by Marakas et al. (2007) should serve to erase any doubts, if such doubts exist.

Another troubling aspect of the Hardin et al. analysis is with regard to their use of the Compeau and Higgins (1995) CSE measure in both a formative and reflective specification:

"The relationship between CSE and CA was then reevaluated using the software CSE (CH) measure developed by Compeau and Higgins (1995) (both reflectively and formatively) across the three assessment periods." (p. 526)

We see no evidence of any attempt on Hardin et al.'s part to validate their formative measure of CSE using any prescribed techniques (including the use of the MTMM approach used by Marakas et al. (2007)). We are told that certain items loaded well and others didn't, yet we have no way of assessing why. This discovery becomes less potent sans any attempt to explain the nature of their findings other than to suggest the formative specification is flawed. Using the example of faculty performance provided by Hardin et al., we can postulate that if a given application of the measure does not load well on all three items (say, teaching, for example), the measure is flawed. We do not believe this is a tenable suggestion. Given this, we have no basis of assessing the measures they are using to arrive at their conclusions and, therefore, must question the conclusions as well.

6. Construct Misspecification Issues

Finally, we come to the concerns raised by Hardin et al. that our formative specification of the CSE construct resulted in misspecification of the construct. Petter et al. (2007) found:

Both the original Jarvis et al. simulation (2003) and our extended simulation revealed that misspecified endogenous formative constructs result in a downward bias in the structural paths leading into them.

Given this, Type II errors can occur in such situations. We submit that this cannot be the misspecification suggested by Hardin et al., since a review of the results obtained by Marakas et al. (2007) shows all hypotheses to have been supported – a condition that cannot exist if Type II errors are present.

Conversely, according to Petter et al.'s (2007) Table 2, Type I errors "can occur regardless if the model is specified correctly (i.e., formative) or incorrectly (i.e., reflective)." Given this, the argument of misspecification cannot be true in this case, since Type I errors are not dependent on misspecification errors alone. While all of this could be sorted out via a concerted, and collective, effort to analyze the suggestions for further exploration of formative applications for this construct set forth in Marakas et al. (2007), we instead find ourselves conducting public reviews of each others' works in this forum. We are not sure if the field is well served through this approach. We also cannot help but observe that after suggesting Marakas et al.'s (2007) specification of CSE in a formative sense is overly data-driven rather than theory driven, Hardin et al. may have fallen into a metaphorically similar trap causing them to overstate their case based on stereotypes of how the field might make use of (or not use) formative constructs.

We believe the real question isn't whether Marakas et al. (2007) explained more or less variance but, rather, were they accurately representing the variance? Petter et al. (2007) contend that when formative variables are misspecified as reflective, we run the risk of under representing the construct. This doesn't mean one should simply change the direction of the arrows in order to obtain higher explained variance. It does mean that allowing convention, past practice, and the heuristics that tend to evolve from such to drive exploration into alternative construct specifications will likely preclude us from improving our understanding of human behavior beyond that which the assumption of latent constructs will allow. We find this to be untenable.

If one abandons formative constructs, one has to immediately abandon the heuristic maxim of Occam's razor and concepts of parsimony, since almost all of our models will necessarily be more complex. This potential outcome stands in opposition to every scientific principle. Consider how limited our models would be if firm performance were simple measures like profit (or delta changes in profits over time), rather than the formative constructs that researchers almost always use. We contend that we will lose richness in measurement by abandoning formative constructs. Further, we need to explore the notion that "if it's psychological, it must be reflective," if we are to find ways in which the virtues of formative constructions can be exploited as our reflective world has done to date. Yes, it is possible that known relationships might be weakened. Maybe because they should be – we will never know otherwise.

7. Summary Comments and Discussion

Before we continue with some observations of our own, it is important to state clearly that our intention here is not to criticize the work of another. We suspect Hardin et al. will agree with this posture. We believe their intention was to use the work of Marakas et al. (2007) to make a point to the research community. The concerns raised above, therefore, are focused solely on the strength of their point and not their intentions.

As with all new concepts and treatises, dogma becomes overly, and often unnecessarily, prevalent. While we have suggested this to be the case in Hardin et al.'s treatise, we must admit that Marakas et al. (2007) stands as no exception:

...we argue that validation of CSE and GCSE instruments must use techniques appropriate for formative constructs rather than the commonly adopted techniques associated with reflective constructs.

The word “must” represents the same zeal, on the part of Marakas et al. (2007), to bring new knowledge to the research community as is displayed in Hardin et al.’s discourse. We hope to provide a clearer statement of a more balanced position in the remainder of this venue.

In keeping with our position to date, we believe the exploration of CSE and GCSE in a formative sense will result in the achievement of greater understanding of these constructs and their relationships than we currently possess. The basis for this expectation may be more driven by a logical reconsideration of our current knowledge than anything else. We offer some thoughts for consideration in this regard.

Marakas, et al. (1998) theorized that GCSE may be conceptualized as a weighted sum of all prior task-specific experiences and perceptions of ability within the computing domain. While (somewhat surprisingly) no substantive empirical investigation of this proposition has been conducted to date, we regularly refer to (and use) reflective measures of GCSE in our research without regard to the possibility that we are not faced with a latent variable but rather a latent composite. Is it possible for CSE to be reflective within applications, but as one moves forward, because of each individual’s different application experiences and skills, it becomes more formative at higher levels?

For example, perhaps spreadsheet and word processing is important for one person and would correlate highly, but programming and networking skills are not. Conversely, perhaps an IT professional would display different sets of skills as more or less important in determining overall CSE. Thus, we go back to a key question of how we measure and assess CSE at different levels. Perhaps GCSE would be better thought of as formative, as it is theorized to be the weighted sum of prior perception formations. A general measure of self-efficacy may not explain as high a proportion of variance in a dependent variable as compared to task-specific measures, but having numerous task-specific constructs is not as parsimonious. There is a tradeoff here, and we believe the consideration of CSE and/or GCSE in the formative sense may be warranted.

Hardin et al. state, “Self-efficacy represents a complex psychological process that is formed and then used to guide human action.” While we do not wish to risk falling into the same trap we have suggested our colleagues fell into earlier in this manuscript, considering the method by which a CSE perception is “formed” may allow us to consider alternate specifications of it.

We have assumed to date that CSE is a perception that we carry with us and act on (and, it would seem, continuously update). An empirical question, to be sure, but can we conceive of the possibility that CSE is “formed” by the very nature of the questions being asked when measuring it? A closer review of this question may reveal a construct that is affected as much by our repeated questions causing one to actually and consciously ponder their abilities, as it is by enactive masteries and vicarious experiences. Does that not suggest the need for a more stable conceptualization of the construct? We do not know the answers to these questions, but we believe exploration of formative specifications may lead to them.

We applaud and share Hardin et al.’s concern for the field with regard to heading down dark alleys and wrong paths exploring formative specifications. We feel strongly, however, that working toward creative solutions would be better for the field (since formative constructs are here to stay) and, as such, it may be better for the field to begin exploring the creation of indices for formative measures or multidimensional constructs where some groups of indicators are reflective but the whole construct is formative. This would allow us to run standard tests on the individual sub-constructs and create indices for the formative elements and thus recapture some parsimony. Technology is constantly evolving and as it does, items (and their associated measures) may need to evolve with it. We acknowledge the challenges this will bring with regard to comparison from study to study, but we believe the challenges can be overcome and the effort to be worth the price. We may find our existing

measures will work well for basic tasks, but for advanced, complex tasks, a whole new set of items will likely be necessary. While we have developed reasonable measures for computer tasks, we have only begun to explore the fact that no one simply uses a spreadsheet or a word processor. They use these tools to accomplish complex tasks. As such, we may find CSE serving more as a moderator to the relationship between the task self-efficacy and the performance of it. This may require us to radically rethink our approach to measurement and measure creation for the construct.

In closing, we wish to express our sincere appreciation for the opportunity to engage in this debate and to further express the hope that this debate will continue in the future. We believe our creation of a cumulative tradition depends upon it.

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