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Analysing Causal Complexities in IT Business Value Research

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Abstract

In the study of IT business value (ITBV), the notion of complementarities has been used to explain why firms with similar level of IT investments have received varying level of returns. Complementarities suggest that greater business value can be derived when IT investment is accompanied by other complementary organizational investments. This paper introduces a novel analytical approach called fuzzy set Qualitative Comparative Analysis (fsQCA). The method is based on principles of comparison used in the field of social and political science, and can be applied to explain the complex causality of IT business value. We have found that fsQCA was able to show that organizational factors in complex configurations may play different roles as core and periphery factors in affecting organizational performance. Such organizational practices have often been overlooked in many empirical studies but can play a non-trivial role in the organizational processes.

Keywords:

Causal Complexities, Complementarities, IT Business Value, fuzzyset QCA, Configurations

INTRODUCTION

In the mid-1980s, Robert Solow (Solow 1987) and others argued that there was insufficient evidence to link the massive investments in information technology (IT) to productivity growth. This phenomenon, which came to be known as the IT productivity paradox has startled an important research topic concerning IT business value (ITBV) for economists, information systems researchers, and management theorists. Since then, a range of models and methods has emerged and more recent evidence has indicated positive benefits from IT investments (e.g. Brynjolfsson et al. 1996; Jorgenson et al. 2002; Kudyba et al. 2002; Stiroh 2004).

The definition of IT as general purpose technology has triggered a chain of activities and potentially accelerated the pace of organizational practices in many firms (OECD 2001). A number of studies focus on managerial practices as decentralised decision making (e.g. (Malone et al. 1987); (Hitt et al. 1997)) and others on new work systems, organizational practices, and business process reengineering (e.g. (Malone et al. 1991), (Barua et al. 1996); (Bresnahan et al. 2002), (Aral et al. 2007), (Aral et al. 2009)).A related research area is how IT investments are complementary to various organizational practices (e.g. (Aral et al. 2009), (Bocquet et al. 2007), (Poon et al. 2010)), and thus the causality of IT business value. However, the study of the complementary relationship between IT and organizational practices seems to be extremely complex. Part of the research problem is related to the inconspicuous nature of IT complementary factors, and how these factors are used in conjunction with IT in organizations. The main issue is the availability and measurement of organizational practices because they are often unobservable and their surrogates are difficult to find.

Modelling complementarities among organizational practices presents empirical challenges. Firstly, organizational practices are often hard to quantify. Secondly, some sets of practices are usually adopted in combinatons, and this makes the modelling problem difficult. The combinations of practices are likely to be interdependent and complex. Milgrom and Roberts (1995) described the problem as a web of complementarities, and argued that the failure to recognise complementarities was due to the lack of understanding of the interdependencies amongst adopted practices, but that does not imply the absence of complementarities. Thirdly, the return on IT investment would depend on what role IT plays among other practices in the web of complementarities.

The evidence of significant returns on IT investment from OECD (2004) further highlights the need for clearer insights into the dynamics between IT investments and organizational productivity. This applies in particular to the need for discovering the influences of different IT components, as well as the complementary influences of organizational practices on business value.

We enrich the analysis on IT business value by introducing a qualitative comparative analysis method developed in the field of social and political science by Ragin (1987). The variant we adopt is called Fuzzy Set Qualitative Comparative Analysis (*fs*QCA) (Ragin, 2000; 2008). It encapsulates models of complex interdependencies, and thus is able to capture and explain the complex causality of IT business value. The method is applied in a case study using a dataset of 1050 firms collected by the Australian Department of Communication, IT and Arts (DICTA) in 2004 (Gregor et al. 2004). The contribution of our approach enables a comprehensive analysis of how IT business value is generated from the different types, strength as well as the degree of interdependencies within the IT and complementary resource bundle of firm.

The remainder of this paper is organized as follows. Section 2 describes the related literature. In section 3, the conceptual model of IT complementarities is derived from a macro or system level view of organizational practices. The model is operationalized using *fs*QCA. The results of the case study are then presented in section 4. A discussion of results and conclusion are provided in section 5.

LITERATURE

It is well acknowledged that realizing business value from IT investments has been an important research area for more than two decades. Initially, IT business value research explored the relationship between IT investment and productivity. Subsequently, consistent empirical evidences of business benefits gained through IT investments have emerged (Brynjolfsson and Hitt, 1996; Kohli and Devaraj, 2003). The recent focus is on how IT enables organizations to achieve better business value (e.g. Aral & Weill, 2006). Brynjolfsson et al. (2000) see organizational complements as a major driver of the contribution of information technology whereas Bresnahan et al. (2002) argued from an organizational perspective that the new work practices are more likely to detect complementarities between IT and skilled work. Melville et al. (2004) concluded that IT business value is generated by the deployment of IT and complementary organizational resources.

Several firm-level studies have found that IT investments generally contribute positively to organizational productivity. However, there are still a number of unsolved issues in relation to why impacts of IT investments still vary widely among different companies. Brynjolfsson et al. (2000) argued that the complementary organizational practices could be thought of as a kind of input (as organizational capital) and are often omitted in the traditional production analysis. They further argued that to realize the potential benefits of computerization, investment of many additional ''assets'' such as new organizational processes and structures, workers knowledge, and redesigned monitoring, reporting and incentive systems may be needed. Aral and Weill (2006) found that complementarities between organizational capabilities and IT investments not only strengthened the impacts of IT on a firm's performance, but could also explain two to twelve percent of the variation in the returns among organizations. If complementary investments in organizational practice could explain part of the variation in IT payoffs, then the question is to understand what and how these practices help firms achieve higher IT business value. Interestingly, our understanding to date of the complex relationships between the use of IT and organizational practices remains somewhat sketchy.

Milgrom and Roberts (1995) proposed the concept of a web of complementarities which marked a paradigm in conceptualizing other complex dynamics among organizational practices. Previous studies such as Weill and Aral (2004) have contributed to our understanding of whether and how complementary relationships among organizational practices lead to significant increases in firm-level performance. However, Poon at al. (2009) argues that model construction is still a critical problem in studying complementarities. First, complementary factors need to be considered simultaneously. Second, the levels of impact can vary significantly between different configurations. Third, there can be many possible complex forms of relationship structures amongst the complementary factors. This is because the model construction requires the identification of potential input factors in addition to the relationship structure of those potential factors.

While previous works applying the complementarity framework may identify a range of complementary resources, they generally have one common limitation. That is, the inability to explain the complex causality of IT business value (Porter and Siggelkow, 2008). Also as suggested by Tallon (2007), the widely ranged complementary resources examined shows a lack of clarity on the specific firm characteristics that leads to IT business value in the current trajectory of research. Therefore, the inquiry of how and why IT business value is created from resource interdependencies remains understudied (Kohli and Grover, 2008). In particular, three main causal complexities of IT business value remain unaddressed. These include the notion of conjunctural causations where a cause can be the result from the interdependency of two or more variables, equifinality in which different causes can have similar or the same effect and causal asymmetry that argues for causes leading to the absence of an effect is not the inverse of causes leading to the presence of an effect (Fiss, 2007; 2009; Ragin, 2008). Indeed, the effect can be non-linearly dynamic (Ennen and Richter, 2010).

Configuration Theory

To understand the causality of business value from complex interdependent firm resources, the configuration theory (Meyer et al.1993; Miller, 1987; Miller, 1996) in organizational literature is discussed. This theory argues for a holistic view of resource alignment from the interplay among organizational variables (Meyer et al. 1993; Doty et al. 1993; Ketchen et al. 1993; Miller, 1996). Miller (1987) provides a commonly referenced description of configuration, in which it is defined as pattern or archetype that describes the systemic connections among the variables in the organizational subsystems such as strategy, structure, environment and technology. A configuration is thus a combination of organizational resources that may contribute positively or negatively to firm performance. However, using the definition of Siggelkow (2002), we specifically refer to configuration as a combination of variables that are highly consistent (mutually reinforcing) collectively (Siggelkow, 2002; Miller and Friesen, 1982; 1984), and that Configuration, in essence, means harmony.

Configuration theorists posit that firm performance depends on the overall fit among the organizational variables of the configuration. This theory builds on the notion of contingency by recognizing the multi-dimensional nature of organizational system. It suggests that variables from organizational domains such as strategies, structures and processes should be considered as a whole entity (Ketchen et al. 1993; Miller, 1987). In relation to IT business value study, the analyses of key practices relating to each dimension of IT business value in Gregor et al. (2004) illustrated that organizations with certain configurations achieved much higher returns on their IT resources.

Core and Periphery

The notion of core, as taken by its definition exerts attention and priority. This idea has also been adapted in organizational literature, where scholars often insist that some organizational mechanisms are more central (as core) to firm than others (as periphery) (Siggelkow, 2002). For example, Hannan and Freeman (1984) describe that the core aspects of organization include its stated goals, forms of authority, technology and marketing strategy. Prior studies also look to the notion of core versus peripheral to help draw attention to non-existent relationships, as well as when reflecting on management's cognitive thinking that tend to favour parsimonious solutions for achieving high firm performance (Fiss, 2009).

A very generic causal perspective may suggest that a resource is causal core if it is more likely to be causally connected to the outcome of business value generation than others, whereas a periphery resource is less causally connected to the outcome and thus may be expendable, substitutable or changed without affecting other firm resources (Hannan et al. 1996). However, very few works have attempted to distinguish between causal core and periphery systematically (Siggelkow, 2002). Currently, the conceptual development from Hannan et al. (1996, p.506) where "...Coreness means connectedness, elements in the core are linked in complicated webs of relations with each other and with peripheral elements" is widely accepted. This argues that core resources are most likely to be a part of the interdependencies leading to positive performance outcome. Fiss (2009) conceptualizes causal core according to the causal significance on each resource in the configurations. This relates more closely to the idea where core elements are critical to organizational survival (Romanelli and Tushman, 1994) and are understood in relation to outcome (Doty and Glick 1994). From these studies, we can conceptualize that a causal core resource should be most frequently likely to be a part of resource interdependencies that cause business value (Hannan et al. 1996).

METHODOLOGY

The insights from IT complementarities literature and the notion of causal core and periphery can be useful for enhancing our understanding of IT business value causality. In Figure 1, a 4-factor resource bundle is shown as a simple example. Assuming a dataset with a number of sample cases, and with different configuration of use (or not) of organizational factors X_1, X_2, X_3 and X_4 and its corresponding organizational outcome, a configurational analysis can be applied to the data.

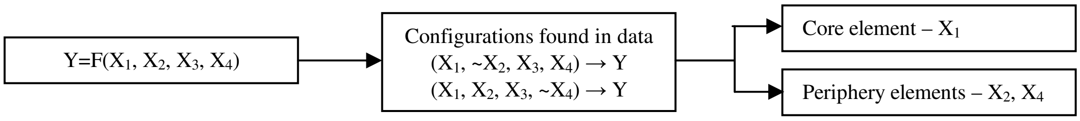

Figure 1: Example of a 4-factor resource bundle

To measure the causality of IT business value from complex interdependent resources, we apply the approach of Fuzzy Set Qualitative Comparative Analysis (*fs*QCA) originally developed by Ragin (2000; 2008). This method is part of a family of set-theoretic methods called Qualitative Comparative Analysis (QCA) (Ragin, 1987). They explain the relationship between the explanatory variables and the outcome variable in the model using sets and subset relations (Ragin, 2008). In general, QCA methods rely on two principle set-subset relationships which can be used to represent the theory for resource or combination of resources being necessary and/or sufficient in causing business value.

$$consistency\ (X_i \leq Y_i) = \frac{\Sigma_i m_{X_i \cap Y_i}}{\Sigma_i m_{X_i}} \qquad (3)$$

The causal consistency model is given by (3), where X represents the causal set and Y is the outcome set, m_{Xi} refers to case i's membership score in the set of the cause X, m_{Yi} indicates case i's membership score in the outcome set Y and $m_{Xi \cap Yi}$ defines case i's membership score in the intersection set of X and Y.

The steps in *fs*QCA can be divided into two stages (Greckhamer et al. 2008). The first stage involves calibrating the values of the variables for each observation into fuzzy membership scores. This can be done using the direct method of calibration (Ragin, forthcoming) which requires the researcher to supply three qualitative anchors for defining membership score of a given variable. The anchors are mapped to external criteria which indicate what value constitutes full membership, full non-membership and the cross-over point (Ragin, 2000). The second stage uses the Truth Table algorithm (Ragin, 2005) to sort the cases or instances into a truth table in which sufficiency analysis can be carried out. Once the truth table is constructed, it is possible to begin finding configurations in the resource bundle. Finally, to enable robustness in the configurations found, each configuration is further statistically tested at 5% significance level. Details of the *fs*QCA technique can be found in Ragin (2000; 2008). We operationalize the systems core as a resource that has the most frequently likely occurrence in statistically significant resource configurations. Conversely, resources that are non-systems core are considered periphery.

APPLICATION TO IT BUSINESS VALUE STUDIES

Data Description

The data set used for our analysis was originally collected by the Australian Department of Communication, IT and Arts in 2004 (Gregor et al. 2004). It is based on a questionnaire and contains responses from 1050 Australian firms of different industries and organization sizes. It provides information about organizational practices (as IT complementary resources) that firms used as well as the benefits they gained from their IT investments. The questionnaire has been developed based on a collection of previous research with a focus on organizational transformation and IT investments. It provides ideal dataset for our approach to analysing IT business value causality. The original dataset contains four dimensions of IT business value and eleven organizational practices. After removing records with incomplete data, a sample of 558 organizations was subject to analysis. In Table 1, the three ITBV dimensions (Y), in Table 2, the two measures of IT resource and in Table 3, the eleven complementary resources (X) are described.

Table 1. IT Business Value Dimensions

Outcomes	**Descriptions**	**Mean (sd)**
Strategic IT Business Value (Y1)	Strategic benefits include the ability to create competitive advantage, align business strategies to directly support organizational goals, provide new products or services, and improve relationships with customers	6.74 (1.83)
Informational IT Business Value (Y2)	Informational benefits include faster and easier access to internal and external information, more useful, accurate and reliable information, and increased flexibility for manipulation of content and format of information	7.67 (1.64)
Transactional IT Business Value (Y3)	Transactional benefits include operational and cost savings, supply chain management savings, staff cost savings, and improved business efficiency of employees, business processes and financial resources.	6.23 (1.86)

Note: The three dimensions of ITBV were collected on a scale of 1 (never achieving business value) to 10 (always achieving business value from a particular IT investment).

Table 2. IT Resource

IT Latent Construct	IT Variables	Descriptions	Mean (sd)
Technical IT Resource (TIR)	PCNETWORK (T_1)	Internal IT infrastructure which includes the number of workstations, terminals and devices relative to firm size as well as networks such as LAN and servers.	-0.03 (0.74)
	EMAILWEB (T_2)	Relating to the firm's use of email and web applications	3.11 (0.88)
	EBUSEDI (T_3)	The firm's capabilities in E-business integration and Electronic Document Interchange	3.19 (1.23)
Human IT Resource (HIR)	ITSTAFF (H_1)	The level of IT staff or human resource in firm	3.63 (2.00)
	ITSKILL (H_2)	IT technical and managerial skills	7.61 (1.50)
	ITSUPP (H_3)	The level of IT support on a day to day basis for the firm	2.09 (0.94)

Note: The negative value of T1 is due to the level of IT outsourcing in the dataset. Firms with negative value in T1 have lower internal IT infrastructure than average.

Table 3. Organizational Practices (as IT complementary resources)

Practices	Descriptions	Mean (sd)
ICT opportunism (X1)	The frequency of recognizing and achieving significant additional benefits which were initially unanticipated	3.28 (1.11)
ICT Skill Level (X2)	The frequency of achieving valuable increases in ICT skill level within the organization	3.41 (1.10)
Business Strategy Planning (X3)	The frequency of engaging in formal business strategic planning	3.42 (1.29)
ICT Strategic Planning (X4)	The frequency of engaging in ICT strategic planning	3.06 (1.37)
Industry Leadership (X5)	The frequency of seeking to be an industry leader in adopting new ICT	2.72 (1.43)
Formal Contracting (X6)	The frequency of establishing formal contractual arrangements for ICT investments	2.88 (1.45)
ICT Integration (X7)	The frequency of integrating new ICT into existing business processes across key functional areas	3.63 (1.15)
Formal Project Management (X8)	The frequency of applying formal project management methodology	3.12(1.49)
Business Case (X9)	The frequency of developing business case	3.18(1.49)
Post Implementation Review (X10)	The frequency of having post implementation review performed	3.23(1.4)
Change Management (X11)	The frequency of employing external change management specialists	2.08(1.24)

Note: The IT complementary resources were originally rated by management executives based on how often their organization performs certain practices, ranging from 1 (never) to 5 (always).

Analytical Results

Developing the latent measure of IT Resource

We developed the IT resource construct using Exploratory Factor Analysis (EFA) of the six IT resources shown in Table 4, followed by Confirmatory Factor Analysis (CFA). The results from EFA using Principal Component Factor Analysis (PCA) with Varimax rotation Kaiser's criterion (Eigen Value > 1) confirmed the factors T_1, T_2 and T_3 were quite different to the factors H_1, H_2 and H_3.

Table 4. Exploratory Factor Analysis Results

IT Resource Items	Factor 1	Factor 2
T_1	**.569**	.107
T_2	**.812**	.049
T_3	**.764**	.075
H_1	.063	**.588**
H_2	.044	**.670**
H_3	.110	**.646**

We then verify the IT resource construct with a structure model using CFA. The CFA result shown in Figure 2 suggests a good model fit. The factor loading for the second order construct IT resource is high, and thus showing that HIR and TIR, as dimensions of IT resource are correlated. However, this measure is below the cut-off 0.9 (Zhu, 2004), which suggests that HIR and TIR are distinctive, but reinforces one another. As Zhu (2004) notes, a second order modelling approach as used in the case study allows for a higher level construct, integrative of the latent representation of IT resource.

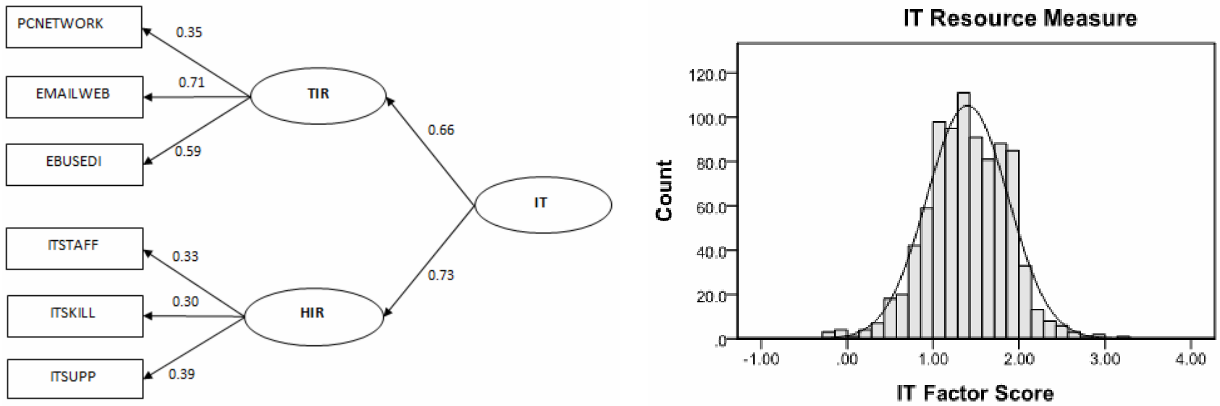

Figure 2: IT Resource Construct

Note that the modest factor loadings (< 0.4 cut-off) from (*Figure 2*) for the first order constructs (Gefen et al. 2000) is expected as the metrics were designed to measure multiple components or dimensions rather than multiple measures of the same underlying construct (Aral and Weill, 2007). The multidimensional nature of the first order constructs (TIR and HIR) may affect the level of adoption of the corresponding indicators by firms. For instance, from the HIR construct, we observed from the sample data that firms which outsource their IT support activities may still retain either high or low number of IT staff. Also, firms with high IT support or staff can have either low or high level of IT skill. Similar arguments can be applied to the relationship between the dimensions of the TIR construct. Aral et al (2009) suggest that such multidimensionality characteristic of constructs can cause weaker albeit positive correlation among the components. The authors also point out that for IT related resources, there is little reason to believe that firms frequently adopting a particular dimension will also frequently adopt all other IT resource dimensions. For example, firms with different strategies can rely on IT resources differently depending on the dynamics of their competitive environment (Teece et al. 1997).

Having mentioned that, the factor loading for the second order construct IT resource is high, and thus showing that HIR and TIR as dimensions of IT resource are correlated. However, this measure is below the cut-off 0.9 (Zhu, 2004), which suggests that HIR and TIR are distinctive, but reinforces one another. The CFA result shows a very good model fit. The Chi-square value is approximately 7.6 and the p-value is insignificant. The final IT resource construct is also found to be close to normal in *Figure 2*.

Results

To transform the raw scores into set membership scores, the Direct Method of calibration is applied (Ragin, forthcoming). The thresholds for causal conditions (IT and organizational practices) and outcome measures (ITBVs) are given in Table 5. It is known that selection of thresholds require substantive knowledge in the field such as previous empirical findings, researchers experience or relevant literature. Due to the nature of the dataset (being a secondary data source), calibration is done based on distributions of the data.

Table 5. Calibration Description

Variables	***Fully Out***	***Cross-over Point***	***Fully In***
ITBV	≤ 3.0	6.5	≥ 9.0
IT	≤ 50th percentile	62.5th percentile	≥ 75th percentile
Organizational practices	Five-value fuzzy set (1 - 0.2, 2 - 0.4, 3 - 0.6, 4 - 0.8, 5 - 1.0)		

Note: Firms with ITBV ≤ 3.0 raw values are non-membership of high performing firms, and have a membership score of ≤ 0.05, while those with 6.5 raw score in the outcome variable are neither more "in" or "out" of the set of high performing firms. Their membership scores will be 0.5. Finally, firms with ≥ 9.0 are considered full members of the set of high performing firms with membership score ≥ 0.95.

A truth table is created by assessing the relative success of each case and the degree to which each factor was adequately addressed. The truth table for each ITBV dimension shows 4096(2^{12}) feasible causal combinations since there are 12 explanatory variables (IT and eleven complementary organizational work practices). A total of 223 (5%) causal combinations have at least 1 case observed. Applying the frequency threshold of 5, 21 causal combinations remain in the truth table (Table 6.). The causal combinations are ordered by their sufficiency consistency. The value of the outcome is coded according to the consistency (0.75) threshold. We then only select the top 8 configurations for further analysis. This is to ensure only highly consistent configurations are considered. The Quine McCluskey Algorithm (Ragin, 2008) was run to obtain the configurations under each ITBV *fs*QCA analysis.

Table 6. *fs*QCA Results

		IT (X_0)	Formal Project Management (X_8)	Business Case (X_9)	Post Implementation Review (X_{10})	Change Management (X_{11})	ICT opportunism (X_1)	ICT Skill Level (X_2)	Business Strategy Planning (X_3)	ICT Strategic Planning (X_4)	Industry Leadership (X_5)	Formal Contracting (X_6)	ICT Integration (X_7)	Consistency	Raw Coverage	Unique Coverage	p-value	Number of Cases (N)
Transactional ITBV	1	C	-	1	1	0	1	C	C	C	-	1	C	0.78	0.56	0.02	0.041	119
	2	C	1	1	1	0	-	C	C	C	-	1	C	0.78	0.55	0.01	0.033	113
	3	C	1	1	1	-	1	C	C	C	-	1	C	0.77	0.65	0.01	0.016	188
	4	C	1	1	-	0	1	C	C	C	1	1	C	0.81	0.52	0.00	0.023	82
	5	C	1	-	1	1	1	C	C	C	1	1	C	0.80	0.53	0.01	0.022	87
	6	C	1	1	1	0	1	C	C	C	1	-	C	0.81	0.53	0.01	0.018	87
	Overall consistency													0.7743				
	Overall coverage													0.6625				
Strategic ITBV	1	C	-	1	1	0	1	C	C	C	-	1	C	0.88	0.52	0.02	0.018	120
	2	C	1	1	1	0	-	C	C	C	-	1	C	0.89	0.50	0.01	0.011	113
	3	C	1	1	1	-	1	C	C	C	-	1	C	0.88	0.60	0.10	0.005	189
	4	C	1	1	-	0	1	C	C	C	1	1	C	0.91	0.48	0.00	0.009	83
	5	C	1	-	1	0	1	C	C	C	1	1	C	0.91	0.49	0.01	0.007	88
	6	C	1	1	1	0	1	C	C	C	1	-	C	0.91	0.49	0.01	0.007	88
	7	C	0	0	0	0	1	C	C	C	1	0	C	0.90	0.19	0.01	0.015	6
	Overall consistency													0.6622				
	Overall coverage													0.8562				
Informational ITBV	1	C	-	1	1	0	1	1	1	1	-	1	1	0.95	0.43	0.02	0.001	119
	2	C	1	1	1	0	-	1	1	1	-	1	1	0.95	0.42	0.01	0.001	113
	3	C	1	1	1	-	1	1	1	1	-	1	1	0.94	0.5	0.09	0.000	188
	4	C	1	1	-	0	1	1	1	1	1	1	1	0.96	0.39	0.00	0.005	82
	5	C	1	-	1	0	1	1	1	1	1	1	1	0.96	0.4	0.01	0.004	87
	6	C	1	1	1	0	1	1	1	1	1	-	1	0.96	0.4	0.01	0.004	87
	7	C	0	0	0	0	0	-	0	0	0	0	0	0.94	0.12	0.03	0.237	18
	8	C	0	0	0	0	1	1	1	1	1	0	1	0.97	0.16	0.01	0.400	6
	Overall consistency													0.9357				
	Overall coverage													0.5902				

The results of *fs*QCA sufficiency analysis are shown using the notation similar to Fiss (2009). Coverage and consistency are two measures used to evaluate the effectiveness of each configuration. The significance is benchmarked at 0.7 consistency for transactional ITBV, 0.8 for strategic ITBV, and 0.85 for informational

ITBV to account for randomness in social science data as well as measurement errors. The benchmark measure is linked to linguistic qualifiers. For example, "more often than not" = 0.5 consistency, "usually" = 0.65 and "almost always" = 0.8 (Ragin, 2000). We have chosen different benchmarks for each ITBV to demonstrate their variation in level of sufficiency consistency. In identifying systems core and periphery, we assess the frequencies of occurrence of each resource in the configurations obtained from *fs*QCA sufficiency analysis.

As shown in Table 6, the *fs*QCA sufficiency analysis on transactional ITBV shows 6 quasi-sufficient configurations. The 6 configurations cover or explain about 66% of the total cases, with sufficiency about 77%. Applying our operationalization of core and periphery, IT, ICT Skill Level, Business Strategy Planning, ICT Strategic Planning and ICT Integration are core practices, while Business Case, Formal Project Management, Post Implementation Review, Change Management, ICT Opportunism, Industry Leadership and Formal Contracting are found to be periphery.

There are 7 configurations are found to be consistently sufficient in yielding high strategic ITBV. The overall solution consistency is 66.23%. The overall coverage is also very high at 85.62%. Only the 7th configuration is statistically significant at 5% level under the benchmark 0.85. From this, IT, ICT Skill Level, Business Strategy Planning, ICT Strategic Planning, ICT Integration are identified as core. Whereas, Formal project management, business case, post-implementation review, change management, ICT opportunism, industry leadership and formal contracting are found as periphery.

The last solution shows 8 configurations for achieving informational ITBV. The overall consistency is 93.57%. However, the coverage of the configurations is only 60%. It also indicates that IT is the only core practice, while leaving all other practices as periphery. This is worth noting that configurations found in informational ITBV dimension have much higher consistencies than in strategic and transactional dimensions.

DISCUSSION AND CONCLUSION

In this study, we pursue the overarching research question of understanding ITBV causality. We had proposed a novel method called *fs*QCA to help understand ITBV causality. As illustrated from the case study, this analytical method can be employed as a tool to support the decision making process of high level management in organizations with regards to IT investments. It also serves a dual role in enabling purposeful management of organizational resource complementarities. We have applied a configurational analysis of the complementarities among IT and 11 organizational practices over 3 ITBV dimensions. As a result of our analysis, we identified significant configurations, along with core and periphery components in relation to the causality of ITBV.

Our results clearly showed that there is much greater business value achieved when certain complements are implemented together than when implemented independently. Based on the findings, most factors are found to be peripheral components for all three ITBV dimensions. We suspect that these organizational practices play only non-critical roles in achieving all three dimensions of IT business values. Our findings are consistent with the two important concepts (known as *equifinality* and *multifinality*) described in the systems thinking. On one hand, there are many alternative configurations of attaining the same ITBV dimension. On the other hand, more than one ITBV dimensions could be attained from the same set of core components. Such results can be partially explained by the 2-factor organizational theory developed by Herzberg (1968). In Herzberg original 2-factor theory (also known as motivation-hygiene theory), it describes a situation where factors that are affecting one dimension of motivation could be quite different to the other dimension.

We also found strong evidence that IT resource has direct influence on all three ITBV dimensions. Low adoption of all other resources is still sufficient in achieving informational value. However, usually the presence of high IT resource enables more benefits to be extracted. This study reinforces the complementary effects of work practices and IT investments for maximizing IT business value. We have also demonstrated the existence of complex interdependencies within the IT and complementary resource bundle of firm. These interdependencies are characterized by non-linearity in effect on firm performance, multiple order of the interplay of resources, equifinal outcome, as well as core and periphery resources at the systems or configuration level.

Naturally, the present study is not without its boundaries. The major limitation of this research is the calibration of the fuzzy scores for the study factors and outcome factor. It is due to the small number of people involved in deciding the calibration thresholds. Although, the thresholds were given independently by the authors, bias could not be avoided. Authors are also aware of the limitation in the dataset to provide evidence of causality for IT business value. These include the issue of limited diversity in the operational model and the formulation of the IT and complementary resource bundle for the case study. Future studies will plan to include more cases and consensus of more experts involved in deciding the calibration thresholds.

REFERENCES

Aral, S., and Weill, P. 2006. "IT assets, organizational capabilities and firm performance: Do resource allocations and organizational differences explain performance variation?", *CISR working paper, MIT (No. 360).*

Aral, S. and Weill, P. 2007. "IT Assets, Organizational Capabilities, and Firm Performance: How Resource Allocations and Organizational Differences Explain Performance Variation", *Organization Science*, (18:5), pp.763-780.

Aral, S., Brynjolfsson, E. and Wu, L. 2009. "Testing Three-Way Complementarities: Performance Pay, Monitoring and Information Technology ", *ICIS 2009 Proceedings*, Paper 163.

Computerized Reservation Systems," *Journal of Organizational Computing* (5:3), pp. 255-275.

Barua, A., Lee, S., S.H., and Whinston, A.B. 1996. "The Calculus of Reengineering," *Information Systems Research*, 7(4), pp.409-428.

Bresnahan T., Brynjolfsson E and Lorin M.H. 2002. "IT, workplace organization, and the demand for skilled labor: firm-level evidence", *Quarterly Journal of Economics*, 117(1), pp.339–76.

Bocquet, R., Brossard, O., and Sabatier, M. 2007. "Complementarities in organizational design and the diffusion of information technologies: An empirical Analysis," *Research Policy*, (36:3), pp.367-386.

Brynjolfsson, E. and Hitt, L.M. 1996, "Paradox lost? Firm level evidence on the returns to information systems spending", *Management Science, (*42:4), pp.541–558.

Brynjolfsson, E., Hitt, L. and Yang, S. 2000. "Intangible assets: how the interaction of information systems and organizational structure affects stock market valuations", *Mimeo, MIT and Wharton*.

Brynjolfsson, E., Hitt, L. and Yang, S. 2002. "Intangible Assets: Computers and Organizational Capital", *Brookings papers on economic activity (1)*, pp.137-199.

Doty, D. H., Glick, W. H. and Huber, G. P. 1993, "Fit, equifinality, and organizational effectiveness: A test of two configurational theories", *Academy of Management Journal*, 36, pp.1196-1250.

Doty, D. H. and Glick, W. H. 1994. "Typologies as a Unique Form of Theory Building: Toward Improved Understanding and Modeling", *The Academy of Management Review*, (19:2), pp.230-251.

Ennen, E. and Richter. A. 2010. "The whole is more than the sum of its parts. Or is it? A review of the empirical literature on complementarities in organizations", *Journal of Management*, 36, pp.207-233.

Fiss, P. C. 2007. "A Set-Theoretic Approach to Organizational Configurations", *Academy of Management Review*, (32:4), pp.1180-1198.

Fiss, P. C. 2009. "Building Better Causal Theories: A Fuzzy Set Approach to Typologies in Organization Research", *Academy of Management Journal*, in press.

Greckhamer, T., Misangyi, V.F., Elms, H. and Lacey, R. 2008. "Using Qualitative Comparative Analysis in strategic management research: An examination of combinations of industry, corporate, and business-unit effects". *Organizational Research Methods*, 11, pp.695–726.

Gregor, S., Fernandez, W., Holtham, D., Martin, M., Stern, S., Vitale, M. Pratt, G. 2004, "Achieving value from ICT: key management strategies", *Department of Communications, IT and the Arts, ICT Research Study, Canberra*.

Hannan, M. T., and J. Freeman. 1984. "Structural inertia and organizational change", *American Sociological Review*, 49, pp.149–164.

Hannan, M. T., M. D. Burton, and J. N. Baron. 1996. "Inertia and change in the early years: Employment relations in young, high-technology firms", *Industrial and Corporate Change*, 5, pp.503–536.

Hitt, L.M., and Brynjolfsson, E. 1997. "Information Technology and Internal Firm Organization: An Exploratory Analysis", *Journal of Management Information Systems*, (14:2), pp.81-101.

Jorgenson, D.W., Ho, M.S., and Stirok, K.J. 2002. "Projecting productivity growth: Lessons from the US growth resurgence", *Conference on Technology, Growth and the Labor Market, Federal Reserve Bank of Atlantia*,

Ketchen, D.J. Jr., Thomas, J. B. and Snow C. C. 1993, "Organizational Configurations and Performance: A Comparison of Theoretical Approaches", *The Academy of Management Journal*, (36:6), pp.1278-1313.

Kohli, R. and Grover, V. 2008. "Business Value of IT: An Essay on Expanding Research Directions to Keep up with the Times", *Journal of the Association for Information Systems*, (9:1).

Kudyba, S., and Romesh, D. 2002. "Research Report: Increasing Returns to Information Technology," *Information Systems Research* (13:1), pp.104-111.

Malone, T., and Rockart, J.F. 1991. "Computers, Networks and the Corporation", *Scientific American* (265:3), pp.128-136.

Malone, T., Yates, J., and Benjamin, R.I. 1987. "Electronics Markets and Electronic Hierarchies", *Communications of the ACM*, (30:6), pp.484-497.

Melville, N., Kraemer, K. and Vijay Gurbaxani. 2004. "Information Technology and Organizational Performance: An Integrative Model of IT Business Value", *MIS Quarterly*, (28:2), pp.283-322.

Meyer, A. D., Tsui, A. S. and Hinings C. R. 1993. "Configurational Approaches to Organizational Analysis", *Academy of Management*, (36:6), pp.1175-1195.

Milgrom, P. and Roberts, J. 1990. "The Economics of Modern Manufacturing: Technology, Strategy and Organization", *American Economic Review*, (80:3), pp.511–528.

Milgrom, P., and Roberts , J. 1995. "Complementarities of Fit: Strategy, Structure, and Organizational Change," *Journal of Accounting and Economics*, 19, pp.179-208.

Miller, D. 1987. "Strategy Making and Structure: Analysis and Implications for Performance", *Academy of Management Journal*, 30, pp.7-32.

Miller, D. 1996. "Configurations Revisited", *Strategic Management Journal*, 17, pp.505-512.

Miller, D. and Friesen, P. H. 1982. "Structural Change and Performance: Quantum Versus Piecemeal Incremental Approaches", *Academy of Management Journal*, 25, pp.867-892.

Miller, D. and Friesen, P. H. 1984. "Organizations: A quantum view", *Englewood Cliffs, NJ: Prentice-Hall.*

OECD. 2001. "OECD Science, Technology and Industry Scorecard: Towards a Knowledge-based Economy", *OECD Paris.*

OECD. 2004. "The Economic Impact of ICT: Measurement,Evidence and Implications", *OECD, Paris*, p. 303.

Poon, S.K., Poon, J., Gupta, N., Peters, G. and Land, L. 2010. "Complementary Organizational Mechanisms - A Case Study on Information Technology Business Value", *Proceedings of the 18th ECIS 2010, Pretoria, SA.*

Porter, M. E. and Siggelkow, N. 2008. "Contextuality Within Activity Systems and Sustainability of Competitive Advantage", *Academy of Management Perspectives*, (22:2), pp.34-56.

Ragin, C.C. 1987. "The comparative method: Moving beyond qualitative and quantitative strategies", *Berkeley, CA: University of California Press.*

Ragin, C.C. 2005. "From fuzzy sets to crisp truth tables", *Working paper, University of Arizona, Tucson.*

Ragin, C. C. 2008. "Redesigning Social Inquiry: Fuzzy Sets and Beyond", *University of Chicago Press.*

Ragin, C. C. forthcoming. "Calibration Versus Measurement", in David Collier, Henry Brady, and Janet Box-Steffensmeier (eds.), Methodology volume of Oxford Handbooks of Political Science.

Romanelli, E., and M. L. Tushman. 1994. "Organizational transformation as punctuated equilibrium: An empirical test." *Academy of Management Journal*, 37, pp.1141-1166.

Siggelkow, N. 2002. "Evolution toward fit", *Administrative Science Quarterly*, 47, pp.125–159.

Solow, R.M. 1987. "We'd Better Watch Out," in: *New York Times Book Review*, p. 36.

Stiroh, K. 2004. "Reassessing the Impact of IT in the Production Function: A Meta-Analysis and Sensitivity Tests", *Federal Reserve Bank, US, New York.*

Tallon, P.P. 2007, "A Process-Oriented Perspective on the Alignment of Information Technology and Business Strategy", *Journal of Management Information Systems*, (24:3), pp.227-268.

Weill, P. and Aral, S. (2004) “Managing the UT Portfolio: Returns from the different IT Assets Classes,” *Research Briefing*, MIT Sloan Center for Information Research.

Zhu, K. 2004. "The complementarity of information technology infrastructure and e-commerce capability: A resource-based assessment of their business value", *Journal of MIS*, (21:1), pp.167–202.

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