4-2013

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Decision Support Systems 55 (2013) 186–193

Contents lists available at SciVerse ScienceDirect

Decision Support Systems

journal homepage: www.elsevier.com/locate/dss

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ARTICLE INFO

Article history:
Received 23 March 2012
Received in revised form 22 November 2012
Accepted 21 January 2013
Available online 29 January 2013

Keywords:
Core and periphery
Complementary resources
Firm performance
Resource based view
Strategic human resources

ABSTRACT

Scholars have widely argued, but not previously examined, that core employees with firm specific skills are critical to the firm's strategic success. This argument has led to the belief that employees whose skills are not firm specific can be readily replaced in the external market and are peripheral to the firm's strategic goals. Employing a resource based view of the firm, we find that the core information technology (IT) employees with firm specific skills are value-adding resources that aid the firm's performance whereas peripheral employees with less firm specific skills provide no value to the firm's performance. Examining the issue deeper, we find that the economic impact of the presence of core IT employees is moderated by the organization's non-IT investment intensity. The findings of the research provide insights that help to expand the understanding of resource complements and the role of strategic human resources in a firm.

1. Introduction

Scholars commonly categorize employees with firm specific skills as core employees to the firm while they categorize those employees whose skills are more generic as peripheral employees. Building on labor economics [9], the strategic view of human resources argues that better performance will result if firms focus their efforts on training and retaining employees with core skills rather than those employees whose skills are peripheral or easily substitutable [12]. Yet, strategic management scholars have yet to do a systematic investigation of the impact of core versus peripheral employees on the performance of a firm. This paper fills this gap by examining the role played by core versus peripheral information technology (IT) employees in impacting firm performance.

We study IT employees because of the wide spread debate concerning the value of IT to firm performance [31,35,37]. We suggest that realizing advantages from IT requires intelligent utilization of skilled personnel [27,30,33]. We identify core IT employees as those employees with firm-specific IT knowledge and skills while peripheral employees possess generic IT knowledge that can easily be replaced in the wider market place [28]. The focus on the core–periphery employees allows us to also examine the potential role of resource complementarity [43]. Complementary resources work together to generate a greater impact than any of the resources by themselves. Thus, core and peripheral employees are resources, but the firm's investments in other related resources may moderate employees' potential impact on firm performance. A company's IT group consists of both core and peripheral employees, although the mixture of those employees will vary for each firm [17]. Therefore, in this paper, we investigate the impact of firms' relative emphasis on core or peripheral employees and the impact of investment intensity in non-IT specific complementary resources on firm performance.

The paper makes several important contributions to the literature. First, we provide insights from a strategic human resources perspective that core and peripheral employees have differential impact on firm performance. It has been theoretically appealing to argue that managers need to strategically focus on those core employees whose skills are firm specific since core employees' impact on firm performance is greater. However, there are competing pressures for firms to focus on peripheral employees as firms seek to control operating costs [28,39]. To date, to help answer this debate, scholars have made only a limited effort to develop any empirical investigation of the impact of core versus peripheral employees on firm performance. Additionally, we extend resource theory by expanding the existing understanding of the role of complementary resources. Specifically, we provide insights into

☆ An earlier version of the paper was presented at the 2008 American Accounting Association (AAA) IS Section Mid-Year Conference.

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http://dx.doi.org/10.1016/j.dss.2013.01.018

whether resources such as investment in technology in combination with the number of core employees demonstrate a non-linear relationship with firm performance.

2. Core and peripheral IT employees

A number of disciplines, including geography, economics, political science, and strategic management employ the conceptualization of core and peripheral resources [12]. However, few studies have applied the core–peripheral conceptualization to empirically examine the role of employees in a firm. From a resource perspective, core employees are those whose skills are specific to the firm [4]. In terms of IT, the core employees are those who have the ability to "conceive of, develop, and exploit IT applications to support and enhance other business functions" [31]. The development of such IT management skills relies on tacit contextually embedded knowledge that applies solely to specific firms for which the employees work [8,31]. For example, such employees may have skills to develop and deploy a proprietary system that supports essential business processes specific to the firm. Typically, such employees have tacit knowledge about the firm's needs.

In contrast, peripheral employees are those that the organizations can specify and seek from the external labor market as needed. For example, peripheral IT employees include those who have the generic technical skills to support certain types of computer operations, networking, help desks or off-the-shelf software such as office automation, payroll, and accounting. Thus, peripheral IT employees perform technically-oriented IT jobs with limited scope or tasks that require little organization specific knowledge [3]. Though the job functions of peripheral IT employees are important to a firm (e.g., supporting the daily operational activities), past research shows the turnover rate of the peripheral IT employees is usually quite high [17]. The turnover occurs because the number of peripheral IT employees is a function of the organization's operational needs, which vary over the time, and peripheral workers have generic skill-sets that allow them to search for the highest paid job in the market. It is important to stress here that while we define and separate core from peripheral employees, this differentiation of the two groups is not driven by the value created for the firm, but instead by the nature of the skills the employees possess and how easily the firm can replace those skills [15].

The separation of core IT employees from peripheral IT employees is consistent with the theory of residual rights in economics literature [20,21]. This theory has proven useful in examining other aspects of the IT industry and its employees [28]. For example, the theory of residual rights proposes that there are two types of contractual rights related to an asset: specific rights (which are ex ante contractible) and residual rights (which are only ex post contractible). Because residual rights are complex and very hard to place in contracting relationships, organizations need to outsource activities related to specific rights while internally sourcing activities related to residual rights. Core IT employees are associated with residual rights since they possess tacit knowledge about the firm and need to develop their skills internally. On the contrary, peripheral IT employees possess generic skills available from the external market.

Therefore, not only does the core and peripheral conceptualization appear relevant to the analysis of IT employees, but it also appears consistent with other theoretical analysis of human capital such as the theory of residual rights [20,21]. As noted earlier, contemporary IT organizations typically consist of both core and peripheral IT employees. The configurations of these core and peripheral IT employees vary among organizations with different IT staffing archetypes [17].

3. Human capital as firm resource

The literature related to strategic human resource management offers a theoretical basis for the argument that core employees have the potential to create value for the firm [35]. This view of human resource draws from the resource based view (RBV), which argues that the firm performance is a function of the differences of the 'unique' bundles of resources these firms possess. According to the RBV, if the resources are valuable, rare, difficult to imitate, and non-substitutable, they provide strategic benefits to the firm [7,8]. Recent development in human capital research has provided empirical evidence for the value of human capital to the firm.

From the perspective of specific human capital, one can argue that core employees form a key part of the stock of specialized knowledge and the idiosyncrasy of the institutional heritage inside that firm [18]. The unique knowledge the core employees possess ranges from best practices [42], to employee intellect [36], and tacit knowledge relevant to the firm [41]. The knowledge of the core employees resides in their brains, which makes it difficult to replace [36]. On the other hand, peripheral employees are not firm-specific resources (i.e., the technical skills are not heterogeneously distributed across firms). The fact that such employees are replicable has led to the recognition that peripheral employees have a higher turnover rate than core employees [4,17].

From a strategic perspective, scholars have argued that core employees can be a central resource of the firm and can have a significant impact on firm performance [12]. Frequently, firms treat employees as a group and as an intangible asset. However, the ability to segment employees into core and peripheral categories allows scholars greater specificity in analyzing employees and their nature as an asset for the firm. Those core employees who have greater firm specific knowledge represent intangible resources [35]. The skills are unique to the firm and make it difficult for other firms to match the employees' knowledge and specific support to the firm. In contrast, employees whose skills are readily replaceable by others in the marketplace are tangible assets — any firm can buy those assets if it is willing to pay a higher premium. The firm faces conflicting pressures in recruiting and retaining employees. There is a strong pressure for a firm to have a predominance of peripheral employees due to lower dependence on any specific employee and greater ease in replacing an employee if there is a need to do so. In addition, the costs for peripheral employees can be lower, in part because the training and support costs for such employees are lower. However, since the peripheral employees do not possess firm specific skills, so from an RBV perspective the peripheral employees do not create outstanding value to the firm. In contrast, developing core employees with specialized knowledge and skills that are unique to the firm creates intangible human resources that provide greater strategic benefits to the firm [8]. While core employees are initially more costly, resource theory argues that the firm ultimately benefits from the development of such intangible resources. Therefore, we hypothesize:

H1. A firm's financial performance is positively associated with the number of core IT employees but not with the number of peripheral IT employees.

4. How do core IT employees impact firm performance?

Furthermore, the relationship between firm performance and number of core IT employees may be more complex than simply a linear relationship as predicted in H1. Scholars have argued that the presence of other resources can moderate organizational performance [32]. Thus, it may not be the number of IT employees as resource per se, but their interaction with other organizational resources that provides strategic benefits to a firm [24,31]. The impact of the number of core IT employees may depend in part on the mobilization of additional complementary resources across the organization [13,35]. These assets include not only technological equipments but also other assets of the firm. The greater presence of such assets creates more opportunities for employees to build tacit knowledge that ultimately leads to competitive advantages for the firm. One can expect that the presence of greater investment in assets and a large number of core IT employees will interact to create a greater value for the firm.

Table 1
Descriptive statistics.

Variable	Minimum	25%	Mean	Median	75%	Max	Stdev.
No. of IT employees	11	200	1090	427	1000	28,376	2343
No. of non-IT employees	1242	10,244	52,204	23,877	53,332	1,380,982	100,415
Fixed assets (million)	22	495	3893	1243	3442	77,843	8.431
Accounts receivable (million)	0	300	3195	633	1726	224,092	14,782
Accounts payable (million)	8	149	1253	365	943	132,313	5916
Inventory (million)	0	220	1190	485	1210	22,614	2190
Capital expenditure (million)	5	99	883	235	666	33,143	2745
Depreciation and amortization (million)	5	89	616	199	490	14,943	1490

However, the addition of complementary assets may not have an unlimited positive impact. Instead, according to the law of diminishing marginal return, there may be diminishing returns from such complementary assets. Ultimately, the firm can have more core IT employees and IT assets than it can effectively employ. At that stage, the investment in additional core IT employees or IT assets may begin to provide diminishing benefits. Thus, at some point there starts a decline from greater investment in IT assets and number of core IT employees.

To date, scholars have paid scant attention to the argument that resources rarely act alone in creating or sustaining competitive advantage [43]. As a result, Wade and Hulland [43] have called for the examination of the interdependent role of resources. As we look specifically at IT employees, we expect that while core IT employees may create more value for the firm than peripheral employees, at some level a firm creates such a misbalance in the mix of its employees that there is ultimately a negative impact on the firm performance. Particularly, as assets increase there can be initially a greater need for employees who understand and support those assets. But ultimately, there is also a need for more generalized employee skills that ensure that those assets operate as they should. Therefore, we hypothesize that a firm's return on hiring core IT employees will have a concave relationship with complementary investments.

H2. The comprehensive investment intensity moderates the impact of core IT employees on financial performance of the firm in such a way that there exists a concave pattern of performance.

5. Analysis

5.1. Data collection

This research combines data from several sources. Data on IT employees are obtained from *InformationWeek* (*IW*) surveys for the years 1992–2002. Since the early 1990s, *InformationWeek* magazine has selected the 500 largest and most innovative IT organizations in the United States (*IW500*) on an annual basis. This data source provides an opportunity to understand and examine leading IT users' business practices across core areas of operations [11,38]. The focus on IT intensive firms in this data source ensures that there are critical numbers of IT employees in each firm. However, as the firms face strong price based competition, using this data source ensures that firms are actively making strategic choices on the balance of core versus peripheral employees in the firm. The *IW* survey identifies and ranks companies through extensive mail, phone, and fax-based questionnaires. Senior IT executives answer questions related to their organizational priorities and spending plans. The executives also report data about the firm's IT spending. However, such data is only available till 1997. Financial data are retrieved from *Compustat*. We collect data regarding organizational assets, including fixed assets, accounts receivables, accounts payables, and inventory. Firms included in the *IW500* are typically large firms with mean sales upwards of US$5 billion throughout the sample period. Table 1 provides some of the relevant descriptive statistics for the data.

5.2. Empirical models and estimation techniques

The number of IT employees reported by *IW* consists of both peripheral and core employees, so our first step in model development is to segregate the number of IT employees that a firm hired into two groups. Following the early attempts to estimate 'total factor productivity' in macroeconomic growth models [23,40], recent economics literature [29] has suggested that a primary approach to measure organizational capital is as a residual. Specifically, Lev and Radhakrishnan [29] have provided guidelines on how to estimate organizational capital from the residual of a production valuation function (i.e., by extracting the systematic component of the error term).

Following the method proposed by Lev and Radhakrishnan [29] we develop Model 1, which builds on the accounting literature [25][5] to estimate the number of core and peripheral IT employees. This model suggests that when the demand for a firm's products or services increases, it needs extra peripheral IT employees to support the additional investment in fixed assets.[6] Specifically, we extract the residual ε_{it} in Model 1 to represent the number of core IT employees as a measure of organizational capital [29]. We estimate the number of IT employees that a firm needs to support its routine daily operations by regressing it against the dependable variables derived from the annual financial data of the firm (i.e., fixed assets, accounts receivable, accounts payable, and inventory). The estimated number of IT employees is the number of peripheral employees recruited by the firm whereas the residual from the same regression is the number of core IT employees employed by that firm in the same time period.

Model 1:

$$\begin{aligned} Total\_IT\_employees_{i,t} = {} & \alpha + \gamma_1 * Fixed\_assets_{i,t} + \gamma_2 * Acc\_receivable_{i,t} \\ & + \gamma_3 * Acc\_payable_{i,t} + \gamma_4 * Inventory_{i,t} \\ & + \gamma_5 * Non\_IT\_employees_{i,t} + \varepsilon_{i,t}. \end{aligned}$$

Firms in different industries will have to deal with different challenges. Therefore, the predictive relationship between other organizational assets and IT employees is likely to vary systematically across industries. To accommodate for the variation of this parameter, we use random coefficient regression (RCR), with the estimated coefficients randomized by industry. Employing the RCR in our estimation also allows us to avoid the assumption that there is no parameter variation across firms. The data panels do not permit us to model stochastic variation at the firm level because the majority of firms appear fewer than five times in the data sample. As a result of this, we employ RCR to improve the quality of the estimation by modeling the parameter heterogeneity as stochastic variation across industries [19]. In our analysis, we randomize across industries on the basis of the industry classification provided by *IW* (on an average, *IW* data has more than 20

[5] Jones [25] modeled expected accounting accruals using a regression of total accruals on a panel of determinants based on change in revenue and the level of fixed assets.

[6] In order to control for the effect of firm size, we deflated all variables by the market value of the firm in the previous year.

industries every year). Table 2 shows the mean coefficient results for the RCR model.

This study measures firm financial performance in terms of annual return on assets (ROA), a widely used measure in IT value research (e.g., [11]). It is possible that the impact of IT employees has a time lag because, like other organizational resources, human capital accumulation is complex and can take time to generate [8]. Therefore, we relate ROA data of the firm in the year of interest (time t) with the number of core and peripheral IT employees recruited by the firm in the same year to predict ROA for the next three years (times $t+1$, $t+2$, and $t+3$), while controlling for other value relevant variables. In particular, to evaluate H1 that the number of core IT employees (but not the number of peripheral IT employees) of a firm has a positive impact on the firm financial performance, we take an incremental approach and test the following three models, 2A, 2B, and 2C.

Model 2A:

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Core\_IT\_employees_{i,t} + \varepsilon_{i,t}(k = 1,2,3)$$

Model 2B:

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Peripheral\_IT\_employees_{i,t} + \varepsilon_{i,t}(k = 1,2,3)$$

Model 2C:

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Core\_IT\_employees_{i,t} + \beta_4 * Peripheral\_IT\_employees_{i,t} + \varepsilon_{i,t}(k = 1,2,3).$$

In the above three models, *Core_IT_employees* is the residual core IT employees from time *t*, and *Peripheral_IT_employees* is the predicted number of peripheral IT employees from time *t*. Both items are estimated on the basis of Model 1. We assume the relationship between earnings and the number of core IT employees is defined as:

$$Earnings_{i,t+k} = f\left(TA_{i,t}, Core\_IT\_employees_{i,t}, Earnings_{i,t};\ \ k = 1,2,3\right)$$

where $Earnings_{i,t+k}$ is the earnings of firm i in period $t+k$, $Earnings_{i,t}$ is the current earnings of firm i in period t, $TA_{i,t}$ is the total tangible assets, and $Core\_IT\_employees_{i,t}$ is the number of core IT employees. We deflated the variables by total assets (*TA*) to mitigate heteroscedasticity. In addition, we used operating income (*OI*) as a measure of earnings of the firm.

$$\left(\frac{OI}{TA}\right)_{i,t+k} = \alpha + \beta_1 \frac{1}{TA_{i,t}} + \beta_2 * Core\_IT\_employees_{i,t} + \beta_3 \left(\frac{OI}{TA}\right)_{i,t} + \varepsilon_{i,t}(k = 1,2,3)$$

To evaluate H2, whether the impact of the number of core IT employees on firm performance is concave because IT human capital is complementary with other organizational resources, we use Model 3. In this model, a firm's investment intensity (*Invtinen*) is a proxy of other value relevant non-IT organizational resources, as it excludes the firm's investment in IT. Specifically, we use a firm's current ROA, its size of core IT employees, and investment intensity to predict its ROA for the next three years. For the reasons described above, we use a deflated asset term (i.e., 1/*Asset*) in Model 3. To portray the complementary relationship between the number of core IT employees with other organizational resources, we include two interaction terms in the model: *Core_IT_employees* × *Invtinen* and *Core_IT_employees* × *Invtinen*^{2}.

Model 3:

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Core\_IT\_employees_{i,t} + \beta_4 * Core\_IT\_employees_{i,t} * Invtinen_{i,t} + \beta_5 * Core\_IT\_employees_{i,t} * Invtinen^2_{i,t} + \varepsilon_{i,t}(k = 1,2,3)$$

Following prior research [6], we measured investment intensity (*Invtinen*) as $\frac{\sum_{i=t-2}^{i=t} Capital\_Expenditure_i}{\sum_{i=t-2}^{i=t} Depreciation_i}$. (For the purpose of a robustness check, investment intensity was also approximated by other variables, such as R&D, acquisition, capital expenditures, and $\frac{\sum_{i=t-2}^{i=t} (Capital\_Expenditure + R\&D + Acquisitions)_i}{\sum_{i=t-2}^{i=t} Depreciation_i}$, and the results are found to be similar).

We stack the data to include each firm-year observation as an observation for period t to relate future earnings, or $Earnings_{t+I}$ ($i = 1$, 2, and 3 years), to current earnings and number of core IT employees (i.e., $Earnings_t$ and $Core\_IT\_employees_t$). Because the data are stacked, the estimation may include more than one observation for a specific firm. We use the Yule–Walker approach [26] to check the existence of autocorrelation in the error terms and the results show that this is not as issue. We check for multicollinearity by computing the condition number of the moment matrix, as suggested by Belsley et al. [10]. None of the condition numbers is sufficiently high to indicate the presence of multicollinearity. White's test indicates that the null hypothesis of homoscedasticity cannot be rejected at the 5% level of significance [44].

5.3. Additional robustness test

Ideally the investment intensity that we measure should include non-IT related investments only. However, *IW* data do not include the salary expense for IT employees for the sampling period. Furthermore, after 1997, *IW* did not release IT spending data for each individual firm. The absence of such data can lead to a potential measurement error with our model because our measurement of investment intensity (based on the data from *Compustat*) may include investment in IT employees.

To address this possible measurement problem, we design an additional robustness test. The purpose of the test is to link a firm's IT spending to its current and future performance by considering the non-IT investment intensity only. Similar to our approach of grouping

Table 2
Model for estimation of number of core IT employees by using random coefficient regression for years 1992–2002.

$$Total\_IT\_employees_{i,t} = \alpha + \gamma_1 * Fixed\_assets_{i,t} + \gamma_2 * Acc\_receivable_{i,t} + \gamma_3 * Acc\_payable_{i,t} + \gamma_4 * Inventory_{i,t} + \gamma_5 * Non\_IT\_employees_{i,t} + \varepsilon_{i,t}.$$

	Predicted sign	No. of IT employees
		Coefficient (p-value)
Intercept		0.0234 (0.0009)
Fixed assets	+	0.0308 (0.4471)
Accounts receivable	+	0.1896 (0.0020)
Accounts payable	+	0.3227 (0.0011)
Inventory	+	0.1057 (0.2292)
No. of non-IT employees	+	0.0336 (0.3126)
N = 1285	−2 Res Log Likelihood −1513.6	
	AIC (smaller is better) −1481.6	
	AICC (smaller is better) −1481.2	
	BIC (smaller is better) −1464.9	

IT employees into two categories, previous accounting literature on cost behavior suggests that Sales, General, and Administrative (SG&A) costs may be partitioned into discretionary and non-discretionary components. Discretionary costs are the SG&A costs incurred above the level necessary to support current operations. Anderson et al. [2] document that discretionary SG&A is significantly and positively related to future earnings. Following the same argument, we partition IT spending into two components, operational and strategic. Operational IT spending supports a firm's daily activities whereas strategic IT spending may involve extra expenses to support strategic endeavors such as new product development or market penetration.

In this design, we apply Model 1 to estimate a firm's strategic IT spending and operational IT spending by replacing the dependent variable 'number of IT employees' with 'total IT spending of the firm' from *IW*. We also replace the independent variables 'number of core IT employees' and 'number of peripheral IT employees' with 'strategic IT spending' and 'operational IT spending' respectively in Model 3. Due to the limited availability of the IT spending data from *IW*, this robust test only uses data from 1992 to 1996.

To estimate the non-IT capital asset expenditures, previous researchers simply subtract IT capital assets from total capital expenditure and consider the net capital expenditure to be non-IT capital [16]. To provide a finer grain measure we adjust non-IT spending by subtracting a portion of IT budget from the total capital asset expenditure. Since firms in the sample do not disclose the percentage of IT spending they capitalize versus expense, we test different allocation methods to ensure our results still hold.[7]

6. Results

Tables 3A, 3B, and 3C present the results of the estimations of the earnings models based on the number of core IT employees. Table 3A shows the results for the scenario in which we only include estimated number of core IT employees to predict future ROA (Model 2A). It documents that the estimated coefficient ($\beta_3 = 0.0169$) of the 'number of core IT employees' variable is not significant for predicting earnings in time period $t+1$ (p-value = 0.3802), significantly positive ($\beta_3 = 0.0416$, p-value = 0.0279) for period $t+2$, and moderately significant ($\beta_3 = 0.0307$, p-value = 0.0813) for period $t+3$.

Table 3B shows the results obtained when predicting future earnings using estimated number of peripheral IT employees only (Model 2B). For all three future periods, $t+1$, $t+2$, and $t+3$, the number of peripheral IT employees is negatively associated with future firm performance (p-value = 0.0007, 0.01, 0.0251).

To check the robustness of the above findings, we then estimate Model 2C, which examines the impact of the number of core and peripheral IT employees on future firm performance. From the results shown in Table 3C, we can see that the number of core IT employees at time t is still significant and positively associated with earnings in years $t+2$ and $t+3$ (p-value = 0.0269, 0.0809), whereas the number of peripheral IT employees has a significantly negative relationship with future firm performance at time periods $t+1$, $t+2$, and $t+3$ (p-value = 0.0007, 0.0097, 0.025). Combining these findings with the prior results, we obtain support for H1 which states that the number of core IT employees (but not the number of peripheral IT employees) in time period t is positively associated with future firm financial performance, although the evidence suggests that the positive impact of the number of core employees occurs with a time lag and appears only in time periods $t+2$ and $t+3$.

To examine H2 and complementary organizational resources, we consider marginal productivity of core IT employees on firm financial performance using model 3D. This model includes the recognition that when there are other investments along with the investment on core IT employees, the coefficient of the variable 'the number of core IT employees' is negative ($\beta_3 = -0.1885$, p-value = 0.0272 for $t+1$; and $\beta_3 = -0.1123$, p-value = 0.1766 for $t+2$). The coefficient of the interaction between number of core IT employees and linear investment intensity is significantly positive ($\beta_4 = .3324$, p-value = 0.0016 for $t+1$; and $\beta_4 = 0.1976$, p-value = 0.0522 for $t+2$), whereas the coefficient of the interaction between number of core IT employees and squared investment intensity is significantly negative ($\beta_5 = -0.1070$, p-value = 0.0001 for $t+1$; and $\beta_4 = -0.0484$, p-value = 0.0637 for $t+2$). These results appear in Table 3D.

The findings in Table 3D indicate that the marginal productivity of core IT employees on firm financial performance is non-linear. Specifically, our data exhibit a concave relationship. Thus, H2 is supported. We portray this concave function in Fig. 1, based on the earnings and investment intensity in time $t+1$. Fig. 1 shows that in order for marginal productivity of core IT employees on financial performance to be greater than zero, firms must have investment intensity greater than 0.7448 and less than 2.3654. In particular, the optimal non-IT investment intensity is 1.55, at which point the firm will enjoy the highest marginal return. When we compare the firms' investment intensity to these boundaries we observe that 82.5% of the firms in our sample have investment in this region. Among those firms, 58.8% are under-investing whereas 23.7% are overinvesting.

We conducted an additional robustness check for the non-linear impact of strategic IT spending on future firm performance by

Table 3A
Relationship between future earnings and the estimated number of core IT employees.

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Core\_IT\_employees_{i,t} + \varepsilon_{i,t} (k = 1, 2, 3).$$

	Predicted sign	Earnings $t+1$	Earnings $t+2$	Earnings $t+3$
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Intercept		0.0193 (0.0001)	0.0251 (0.0001)	0.0287 (0.0001)
Earnings$_t$	+	0.4438 (0.0001)	0.3631 (0.0001)	0.3510 (0.0001)
1/*Asset*	+	11.2493 (0.0205)	9.0901 (0.0618)	4.9107 (0.2881)
Core_IT_employees$_t$		0.0169 (0.3802)	0.0416 (0.0279)	0.0307 (0.0813)
		N = 1285	N = 1229	N = 1067
		adj. R^2 = 0.3149	adj. R^2 = 0.3029	adj. R^2 = 0.2600

The p-value is two-sided.

Table 3B
Relationship between future earnings and estimated number of peripheral IT employees.

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Peripheral\_IT\_employees_{i,t} + \varepsilon_{i,t} (k = 1, 2, 3).$$

	Predicted sign	Earnings $t+1$	Earnings $t+2$	Earnings $t+3$
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Intercept		0.0250 (0.0001)	0.0289 (0.0001)	0.0319 (0.0001)
Earnings$_t$	+	0.4367 (0.0001)	0.3572 (0.0001)	0.3469 (0.0001)
1/*Asset*	+	15.9392 (0.0013)	13.1815 (0.0079)	8.2248 (0.0816)
Peripheral_IT_employees$_t$		−0.0407 (0.0007)	−0.0306 (0.0100)	−0.0257 (0.0251)
		N = 1285	N = 1229	N = 1067
		adj. R^2 = 0.3207	adj. R^2 = 0.3042	adj. R^2 = 0.2611

The p-value is two-sided.

[7] To check whether our results are affected by the level of allocation of IT budget into capital expenditure (non-IT spending), we approximate the non-IT expenditure with many extreme cases. We find that the adjustment of non-IT spending and the proxy for investment intensity do not affect our results.

Table 3C
Relationship between future earnings and estimated number of core and peripheral IT employees.

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Core\_IT\_employees_{i,t} + \beta_4 * Peripheral\_IT\_employees_{i,t} + \varepsilon_{i,t}(\ k = 1, 2, 3).$$

	Predicted sign	Earnings $t+1$	Earnings $t+2$	Earnings $t+3$
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Intercept		0.0252 (0.0001)	0.0293 (0.0001)	0.0322 (0.0001)
Earnings$_t$	+	0.4372 (0.0001)	0.3587 (0.0001)	0.3481 (0.0001)
1/*Asset*	+	15.4317 (0.0020)	11.9667 (0.0001)	7.3611 (0.1207)
Core_IT_employees$_t$		0.0168 (0.3824)	0.0418 (0.0269)	0.0307 (0.0809)
Peripheral_IT_employees$_t$		−0.0407 (0.0007)	−0.0307 (0.0097)	−0.0257 (0.025)
		N = 1285	N = 1229	N = 1067
		adj. R^2 = 0.3206	adj. R^2 = 0.3055	adj. R^2 = 0.2634

The p-value is two-sided.

considering the non-IT investment intensity only. The results are shown in Table 3E. With the existence of other investments, the impact of spending in strategic IT is negative ($\beta_3 = -1.4601$, p-value = 0.0038 for $t+1$, $\beta_3 = -1.8095$, p-value = 0.0016 for $t+2$). The coefficient of the interaction between spending in strategic IT and linear investment intensity is significantly positive ($\beta_4 = 1.1007$, p-value = 0.0023 for $t+1$, and $\beta_4 = 1.7318$, p-value = 0.0001 for $t+2$), whereas the coefficient of the interaction between spending in strategic IT and squared investment intensity ($\beta_5 = -0.1360$, p-value = 0.0079 for $t+1$, and $\beta_5 = -0.2716$, p-value = 0.0001 for $t+2$) is significantly negative. This finding again shows that the marginal productivity of strategic IT investments on future performance is a non-linear and concave function, providing further support for acceptance of H2.

Table 3D
Marginal productivity of core IT employees on financial performance.

$$ROA_{i,t+k} = \alpha + \beta_1 * ROA_{i,t} + \beta_2 * 1/Asset + \beta_3 * Core\_IT\_employees_{i,t} + \beta_4 * Core\_IT\_employees_{i,t} * Invtinen_{i,t} + \beta_5 * Core\_IT\_employees_{i,t} * Invtinen^2_{i,t} + \varepsilon_{i,t}(\ k = 1, 2, 3).$$

	Predicted sign	Earnings $t+1$	Earnings $t+2$	Earnings $t+3$
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Intercept		0.0206 (0.0001)	0.0263 (0.0001)	0.289 (0.0001)
Earnings$_t$	+	0.4384 (0.0001)	0.3631 (0.0001)	0.3459 (0.0001)
1/*Asset*	+	10.6699 (0.0270)	9.0681 (0.0585)	4.3914 (0.3522)
Core_IT_employees$_t$		−0.1885 (0.0272)	−0.1123 (0.1766)	0.0890 (0.2686)
Core_IT_employees × Invtinen		0.3324 (0.0016)	0.1976 (0.0522)	−0.0549 (0.5749)
Core_IT_employees × Invtinen^2		−0.1070 (0.0001)	−0.0484 (0.0637)	0.0052 (0.8330)
		N = 1252	N = 1196	N = 1040
		adj. R^2 = 0.3242	adj. R^2 = 0.2950	adj. R^2 = 0.2715

- The p-value is two-sided.
- $Invtinen = \dfrac{\sum_{i=t-2}^{i=t} Capital\_Expenditure_i}{\sum_{i=t-2}^{i=t} Depreciation_i}$.
- ROA = return on asset.

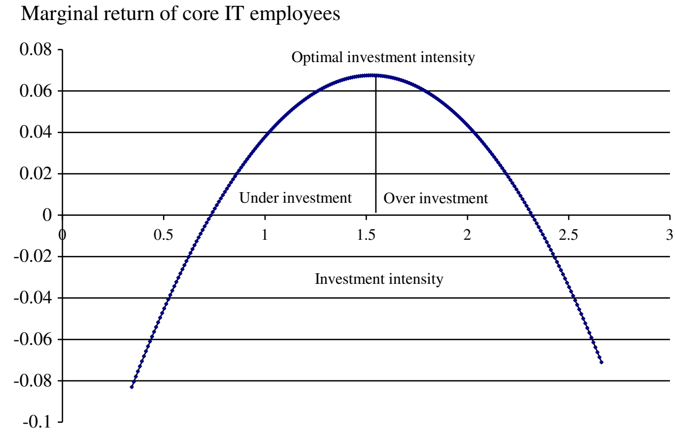

Fig. 1. Marginal return of core IT employees on future firm performance with respect to investment intensity (for time period $t+1$).

7. Discussion

In this study, we contribute to the literature by showing that core IT human capital is a valuable resource that can bring superior performance to a firm. On the other hand, we demonstrate that peripheral IT employees who possess generic technical skills are a lesser critical organizational resource (H1). Furthermore, we discover that the number of core IT employees recruited by a firm does not have an immediate effect on the firm's future earnings (i.e., $t+1$). Instead, such an effect is staged and manifested over multiple time periods (i.e., $t+2$ and $t+3$). This finding is consistent with the RBV which suggests that the development of core IT human resources is a socially complex and lengthy process, and, therefore, the contribution of the IT human capital to the firm is difficult to appreciate in advance and realize immediately [43].

This study also contributes to the theory of complimentary resources. This research is among the few to demonstrate that the impact of core IT human resources on firm performance is not linear, but a concave function (Fig. 1) and that its impact is related to the firm's investment intensity (H2). Specifically, we find that the marginal productivity impact of organizational investment on core IT human capital is moderated by the investment intensity of other organizational resources. And such a relationship demonstrates a non-linear pattern. For robustness check,

Table 3E
Robustness check using IT spending and non-IT investment intensity.

	Predicted sign	Earnings $t+1$	Earnings $t+2$	Earnings $t+3$
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
Intercept		0.0195 (0.0001)	0.03349 (0.0001)	0.0371 (0.0001)
Earnings$_t$	+	0.6877 (0.0001)	0.4572 (0.0001)	0.3743 (0.0001)
1/*Asset*	+	1.8459 (0.8105)	6.2588 (0.4693)	16.5006 (0.0624)
Strategic_IT$_t$		−1.4601 (0.0038)	−1.8095 (0.0016)	−0.8339 (0.1435)
Strategic_IT × Invtinen		1.1007 (0.0023)	1.7318 (0.0001)	0.8866 (0.0301)
Strategic_IT × Invtinen^2		−0.1360 (0.0079)	−0.2716 (0.0001)	−0.1244 (0.0288)
		N = 358	N = 344	N = 336
		adj. R^2 = 0.4446	adj. R^2 = 0.2450	adj. R^2 = 0.1734

- The p-value is two-sided.
- $Invtinen = \dfrac{\sum_{i=t-2}^{i=t} (Capital\_Expenditure + R\&D + Acquisitions)_i}{\sum_{i=t-2}^{i=t} Depreciation_i}$.

we also document that the impact of core IT spending on firm performance is not linear as well. Fig. 1 highlights the fact that the marginal return of core IT human capital investment (y-axis) is diminishing after some point (i.e., increasing first and then decreasing) with the increase in non-IT related investment (x-axis). Thus, as we theorized, in order to reap higher return from IT human resource investment in core employees, firms need to make other investments. However, the firm must be aware that there will be a point where the benefits from such complementary resources will decline, and, as a result, investment in additional assets and core employees may lead to a negative impact on the firm.

It is interesting to note from Fig. 1 that except at the optimal investment intensity point, two different values of investment intensity can render the same value of marginal return on core IT employees. The difficulty for the firm is to find the ideal mix of capital investment and core employees. Overinvestment in either assets or core employees can lead to a less ideal return. Thus, firms need to find a balance in the number of core and peripheral employees and the assets that it needs to invest for gaining superior performance. The human capital theory [9] suggests that organizations develop resources internally only when investments in employee skills are justifiable in terms of future productivity. Therefore, from an economic perspective, when a firm decides how many IT employees to keep, the firm needs to set the marginal benefit of hiring one IT employee to the marginal cost of hiring that is determined by the market rate. Under such a circumstance, because the marginal cost (salary) is relatively same across different firms in the same industry, firms that generate higher marginal benefit from IT employees end up hiring more IT employees.

7.1. Limitations and future research

Some of our study's limitations lead to the suggestions for future research. First, we used IT employee and IT spending data reported by *IW* to test our hypotheses. Though *IW500* has become a popular data source in IT research, a potential concern is the validity of using secondary data [5] and the inability to generalize the results. For example, our results may be biased because *IW500* only covers big firms with average annual sales of five billion US dollars. However, to the best of our knowledge, *IW500* is by far the most comprehensive source for IT employee and IT spending data. Future research can build on our findings through the use of other data sources (for example, combining secondary data with questionnaires sent to IT managers in the organization) to expand our understanding of the critical issues.

Additionally, to examine the theorized complementary relationship between core IT human capital and other non-IT organizational resources, we used investment intensity as a proxy of non-IT resources. We acknowledge that there may be other proxies of firm resources and using an objective financial economic indicator may not capture the complete picture of organizational capabilities. However, the current study is among the first to investigate the interaction effect of complimentary resources on firm performance. Our data analysis supports with empirical evidence the concept of complementary resources. Future research can employ other subjective measures (e.g., survey items) and triangulate with financial measures to test the hypotheses.

While we address the impact of different types of employees on firm performance, a pertinent research question this research raises is whether a firm needs to keep the same number of in-house core IT employees during the economic downturn as in an upturn. The theory of 'sticky cost behavior' from the accounting literature [1] may provide a good lens through which to view this problem.[8] For example, Anderson et al. [1] demonstrate that costs can increase more with an increase in given activity than they decrease with an equivalent decrease in that activity. In the future researchers can examine whether such a sticky behavior applies to IT investment and, thereby, affects the variation of IT employee size. Further, how does the variation of corporate IT employee size correlate with the variation of non-IT investment intensity? Future research can seek to better understand the role of IT employees on firm performance by exploring such sticky costs.

[8] According to the sticky cost theory, the magnitude of a change in cost depends only on the extent of change in the level of activity, and not on the direction of the change [34].

Theoretically, this research expands our understanding of RBV of the firm by expanding the understanding of complementary resources. Scholars have recognized the potential impact of complementary resources [32]. However, to date, there has been no well-developed understanding of such complementary resources. This research helps to theoretically establish that there are limits to the impact such complementary resources can have on firm performance, and, in fact, such resources can ultimately cause negative performance for the firm. This understanding helps scholars employ a more theoretically concise application of the RBV theory.

In practice, over the past 20 years there has been a significant growth of IT outsourcing in all industrial sectors [14,39]. This ongoing trend, accompanied by the recent US recession, has forced many companies to reduce the number of employees. Prior empirical research has shown that outsourcing is not always a money-saving mechanism [22]. Our study supports this finding but offers an alternative perspective on sourcing. Rather than emphasizing the cost side, we suggest that it is equally important to investigate the economic value generated by human capital. In particular, findings of this research indicate that the starting point of studies on any sourcing decision is to understand the business value of different types of employees. Our results support the theory that core employees are the value-adding assets that organizations need to keep in house.

8. Conclusion

This study integrated the RBV and the core–periphery hypothesis to investigate the impact of IT human resources on firm performance. While theoretically it has been appealing to argue that core employees who have firm specific knowledge have the potential to be key resources for the firm, this study is one of the first to empirically support this argument. However, the study also highlights that there are limits to the emphasis that can be placed on such core employees. Particularly, as we consider complementary resources, we determine that with overemphasis on core employees and asset investment ultimately there will be a negative impact on the firm. Future research can build on these findings to expand our understanding of the relationship between strategic human resources and firm performance.

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