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IS Faculty Research Productivity: Influential Factors and Implications

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Why are some faculty members more productive than others in academic research? We constructed a number of hypotheses about faculty research productivity based on the life-cycle model of academic research and previous studies. Tests were conducted using data collected via a national survey of information systems (IS) faculty. The results show that while there are only two significant factors contributing positively to the research productivity—the time allocated to research activity and the existence of IS doctoral programs—many other factors appear to have significant adverse effect on research productivity, such as the number of years on faculty, the teaching load when exceeding 11 hours weekly, and non-IS, non-academic employment experience. The results also suggest that some of the commonly proposed influential factors, such as tenure status, academic rank, school type, as well as IS-related employment experience, have no significant effect at all. The implications of these findings and the limitations of the study are also discussed.

INTRODUCTION

What makes a faculty member more productive in academic research? This is a question of great interest to many tenure-earning and tenured faculty members in academic institutions where faculty performance is evaluated heavily based on research productivity. Productive faculty not only further the knowledge in their professional fields by integrating their findings with those of others via scholarly publications disseminated around the world, they also bring visibility and prestige to themselves and their affiliated institutions, which in turn attracts research grants and more qualified faculty and graduate students (Grover, Segars, and Simons, 1992; Levitan and Ray, 1992). Because of this, academic institutions are increasingly emphasizing research productivity when evaluating tenure, merit, funding, and salary decisions (Lane, Ray, and Glennon, 1990; Levitan and Ray, 1992; Im and Hartman, 1997).

As a consequence, it is no surprise to see a growing interest in studying the factors affecting research productivity of individual faculty members as well as institutions (e.g., Niemi, 1988; Lane, Ray, and Glennon, 1990; Levitan and Ray, 1992; Grover, Segars, and Simon, 1992; Hancock et al., 1992). Two distinctive research approaches can be identified in the literature of research productivity. One approach examines the collective characteristics of all academic researchers by focusing on the motivation of research, as represented by the life-cycle model (Diamond, 1986; Levin and Stephan, 1991; Goodwin and Sauer, 1995). This model posits that research productivity of a researcher is determined by the interaction of investment motivation and consumption motivation modulated by the process of aging and career maturity. The other approach emphasizes the effects of institutional and personal characteristics on the research productivity, such as teaching load, time management, and tenure status (Lane, Ray, and Glennon, 1990; Levitan and Ray, 1992; Hancock et al., 1992).

Although these studies have significantly improved our understanding of academic research productivity, the findings are often inconsistent, sometimes even conflicting, depending upon the research approach undertaken and the

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academic disciplines being studied. In this study, we examine the institutional and personal factors affecting the research productivity of information systems (IS) faculty in the United States based on the results of a national survey. Our data and test model show that factors influencing research productivity of junior and senior IS faculty members differ, although many factors, such as teaching load and time allocation for teaching, research, and service, are common to both groups. We found that prior IS-related employment experience shows significant positive correlation with research productivity of junior faculty members, but has no relationship to that of the senior faculty. On the other hand, we found that the affiliation with an IS program that offers a doctoral degree is significantly positively correlated with the research productivity of senior faculty members, but has no apparent effect on that of the junior faculty members. These findings, augmenting previous ones, should help administrators and faculty members alike make informed decisions in evaluating performance, managing time, and balancing teaching, research, and service loads.

REVIEW OF RESEARCH PRODUCTIVITY

As higher education institutions compete with each other in getting funding for research and teaching programs and attracting quality faculty and students, it has become increasingly important for academics to be more productive in their research fields. Being classified as a "research university" is often perceived as an indication of quality programs, faculty, and students. Very often such classification is based on the research productivity of faculty members or specific programs of a university. In the area of information systems, there have been regular publications comparing the statistics of faculty research productivity of various IS programs in this country (Vogel and Wetherbe, 1984; Lending and Wetherbe, 1992; Swanson and Ramiller, 1993). Grover, Segars, and Simon (1992), for instance, studied the publications by IS faculty members of more than 190 institutions in "core" MIS journals. The top 50 institutions were ranked based on a weighted page count of articles published by their IS faculty. The study, however, did not provide any analysis of why these institutions achieve higher research productivity and if they share any common characteristics that contributed to the high productivity.

There are many reasons why academic institutions want to be ranked high in these types of studies. Prestige is one thing, but enhanced ability to attract funding for various research and teaching programs from public and private sources may be even more important. To achieve sustained high productivity, an institution can either keep hiring productive faculty members for their programs, which is often impractical due to high cost, or try to identify the factors that most significantly influence the productivity of faculty members. It is the second issue that is the primary interest of this study: What factors make a faculty member more productive? And closely related to the first question: What can an institution do to help its faculty members to be productive?

One of the well-established theories of research productivity is the life-cycle model which posits that the interaction between two major factors dictates the behavior of an academic researcher, modulated by the process of natural aging: investment-motivated research and consumption-motivated research (Diamond, 1986; Levin and Stephan, 1991). The investment hypothesis states that an individual engages in research because of the perceived significant future financial reward for the research activity. The consumption hypothesis stresses an individual's fascination with research and the satisfaction associated with solving research puzzles. The life-cycle model suggests that early in the career, the strong investment incentive for research complements a researcher's puzzle-solving urge, resulting in an initial surge in research productivity. But as the researcher ages, and the present value of the investment declines, they become less productive.

The life-cycle model is appealing in explaining aggregated productivity data across institutions. But it fails to address individual and institutional differences. It is not unusual for some individuals to remain productive throughout their career, while others quickly drop out of the race after a promising start. Goodwin and Sauer (1995) studied 140 tenured economic faculty members in seven research-oriented academic departments. They found that in general the research productivity of an individual researcher follows the basic pattern of the life-cycle model: the productivity rises sharply in the initial stages of a career, peaks at the time of tenure review, and then begins a decline. However, the rate of the decline is slower than that predicted by the life-cycle model. Several factors were examined in explaining the different declining patterns. It was found that the post-peak decline in productivity is quite modest for the high publication rate group compared to the low publication rate group, which is consistent with the hypothesis that early recognition provides the so-called reputation capital, which yields positive returns in subsequent periods. Career choices of individual researchers after tenure also were found to significantly affect the decline patterns: those who took academic administrative positions, such as department head, dean, or journal editor, showed a significant drop in productivity compared to their colleagues. The study also found a strong tendency for institutional productivity equalization: those who graduated from the top economics Ph.D. programs were significantly more productive than others, and faculty in one institution tended to be more productive then those of another across the board.

While these findings are informative, they offer few insights for individual faculty members and administrators seeking to improve research productivity in a given institutional environment. Levitan and Ray (1992) provided a more detailed description of the personal and institutional characteristics affecting research productivity of academic accountants. They found that the most important factor in research productivity is the ability to effectively manage time. They suggested that individuals who allocate longer hours to research can seemingly increase their research productivity, and that institutions, by providing graduate assistants and reducing teaching and administrative duties for their faculty, can raise their aggregate research productivity.

Although most findings in later studies are in general agreement with the life-cycle model, the effect of tenure on research productivity is an area where many inconsistencies have surfaced. According to the life-cycle model, after a faculty member receives tenure, the investment motivation should decline significantly, resulting in a drop in research productivity. However, in studying the research productivity of academic accountants, Levitan and Ray (1991) found that more members of the productive group are tenured than the ones in the control group, and their self-reported productivity has increased, or at least remained the same, since tenure. Even stronger evidence is provided by the study of Hancock et al. (1992) in which 128 authors who published in *Management Science* and *Operations Research* were surveyed to ascertain what individual and institutional factors correlate with their productivity. They found that the research productivity of the high publishing group (13 or more articles in a five-year period) has actually increased since tenure while that of the low publishing group (seven or less articles in the five-year period) has remained about the same. It was hypothesized that tenure no longer diminishes the tangible rewards to be gained through publication because the rapid rise in academic salaries maintains an on-going pressure on faculty members to stay marketable. Further, by the time of tenure, a faculty member has prepared courses, defined a research stream, and honed the skills to follow it. These conditions provide the newly tenured faculty member both motive and opportunity to maintain productivity at no less than pre-tenure levels (Hancock et al., 1992).

RESEARCH HYPOTHESES

Summarizing the findings of previous studies of academic research productivity, one can conclude that many factors may have contributed to the research productivity: age, education, tenure, time management ability, institutional support, financial incentive, mobility, etc. Furthermore, it has been shown that differences in scientific disciplines may affect the productivity patterns of academics (Levin and Stephan, 1991). With almost all of the previous studies of research productivity being discipline-specific, it is only natural to ask: Which, if any, of these factors are more pronounced in the information systems discipline?

As one of the fastest growing academic fields, the IS discipline poses many unique and demanding challenges to its faculty members. For example, not only do IS faculty members have to conduct scholarly research while keeping up with the requirement for teaching and service duties, they also need to constantly upgrade themselves with new knowledge and skills demanded by the rapidly changing information technology (IT) environment, and IS management practices. This need to upgrade skills competes directly with research activity for the precious time that remains after teaching and service duties have been fulfilled. Thus the unique challenge of the IS environment may lead to the consequences that do not exist, or are less pronounced, in other disciplines on which previous studies of research productivity were based.

For example, consider the effect of tenure and seniority on research productivity. Naturally, all the arguments of the life-cycle model that apply to other fields also apply to IS faculty members, suggesting that productivity should decline with tenure and seniority. Beyond the life-cycle model, however, the fast changing IT environment may favor the productivity of junior faculty members over senior faculty. We argue, for example, that the newly graduated doctoral candidates are likely to be better technically equipped for doing research on current IS issues than faculty members who graduated many years earlier for two main reasons. First, IS as a discipline has matured with established theoretical foundations and doctoral programs designed to provide rigorous training in research methodologies and theories. Second, doctoral candidates are more likely to be exposed to the advanced information technologies in their research and teaching. As a consequence, junior faculty members would need to spend less time upgrading their skills and knowledge than senior members, resulting in more time for research activities. These arguments lead to the following hypotheses:

Hypothesis 1a: There is a negative relationship between tenure and research productivity. In general, the tenure-earning faculty members are likely to be more productive than tenured faculty members.

Hypothesis 1b: There is a negative relationship between years on faculty and research productivity. In general, junior faculty members are likely to be more productive than senior faculty members.

Next we consider the effect of time management on research productivity. The time management of faculty members is limited by three factors: teaching and service load, availability of graduate assistant, and non-academic related activities, such as consulting and outside employment. It can be argued that the IS faculty member in the institutions where graduate programs (master's and doctorate) are offered have a better chance of getting graduate assistants, and are more likely to have a lower teaching load due to the research orientation of the programs. On the other hand, they also tend to have more responsibility for service-related workload, such as serving on dissertation committees and supervising graduate theses. Thus it is not automatic that a lower teaching load and a graduate program lead to more time for research activity and higher research productivity. In balance, however, we would expect that having graduate student assistants and working with doctoral students should have a positive effect on faculty research productivity. This is because, in most cases, a faculty member who supervises graduate and doctoral students can concentrate his or her time on the more critical activities leading toward publications and leave the non-productive but necessary activities to the student assistants. Co-authorship with doctoral students may also contribute significantly to the supervising faculty member's article count. This line of reasoning leads to the following hypotheses:

Hypothesis 2a: There is a positive correlation between research productivity and time allocated for research activity. The faculty members who allocate more time for research activity tend to be more productive than otherwise.

Hypothesis 2b: There is a positive correlation between research productivity and the affiliation with graduate programs. The faculty members in the institutions where graduate IS programs are offered are more productive than those in the undergraduate only institutions.

Another factor of time management is the teaching load. It has been suggested that research productivity may be inversely related to the teaching load (Hancock et al., 1992), which is intuitively appealing. We add the hypothesis about the relationship between teaching load and research productivity here as a check of validity of our data sets and models to be tested:

Hypothesis 2c: There is a negative correlation between research productivity and the teaching load. The faculty members who have the lighter teaching loads are more productive than those who have heavier teaching loads.

Finally, we consider the effect of non-academic employment experience on research productivity of faculty members. As an applied discipline, the majority of the IS research focuses on the practical issues of IT usage and management. It is reasonable to argue that real world IS related employment experience would enhance an individual's ability to conduct academic research. On the other hand, we can expect that non-IS related employment experience may have little effect for obvious reasons. This leads to the following hypotheses:

Hypothesis 3a: There is no correlation between research productivity and the non-IS, non-academic employment experience before becoming an IS faculty member. The faculty members who have more years of such employment are no more productive than those who have fewer or none.

Hypothesis 3b: There is a positive relationship between research productivity and the number of years of IS-related employment before becoming an IS faculty member. The faculty members who have more years of IS-related employment are more productive than those who have fewer or none.

DATA AND METHOD

The Survey

The data set for this study was collected via a survey[1] conducted as a joint project of the authors and a sponsoring company that specializes in undergraduate education products. The immediate objectives of this survey were to advance the state of knowledge of IS education in the United States. It was also intended to provide information about existing IS programs for a biannual reassessment of the undergraduate Computer Information Systems major being conducted at the authors' university. The questions in the survey were designed to help address a number of questions regarding the overall characteristics of the IS programs and faculty in the United States. Among the 90 questions, we asked each respondent to indicate how many referred academic journal articles she or he had published during the last five years. This number, combined with information collected in other questions, was used to assess the factors that influence the research productivity of IS faculty.

The survey instrument was mailed in late October 1996 to over 2,000 IS faculty members in 442 different U. S. higher education institutions listed in the Management Information Systems Research Center (MISRC) directory. Responses were accepted through January 15, 1997. By the cut-off date, there were 240 usable responses received, representing a 12% individual response rate. Viewed in terms of institutions, the rate was much higher: surveys were returned from faculty at 193 different institutions, a 44% institutional response rate.

Most of the respondents were affiliated with traditional four-year colleges and universities with advanced degree programs: about 84% of the responding institutions offered graduate level programs, with 46% of them offering doctoral level degrees, and 38% offering master's level degrees. More than 85% of the responding faculty members were affiliated with four-year graduate degree-granting institutions. Among them, over 90% were professors, associate professors, and assistant professors, the rest were adjunct faculty and instructors. Since we are interested only in the factors related to academic research productivity, and adjunct faculty and instructors are usually not required to do research, their responses were deleted from the sample. In addition, incomplete responses were deleted. The final sample consists of 172 responses from individual faculty members. The overall characteristics of these faculty members and their institutions are summarized in Table 1.

*Table 1. Characteristics of the Responding Institutions**

Institution	Respondents		Professor		Associate Professor		Assistant Professor	
	Count	%	Count	%	Count	%	Count	%
4YwD	92	53	28	43	41	63	23	55
4YwM	65	38	33	51	19	29	13	31
4YwU	15	9	4	6	5	8	6	14
Overall	172	100	65	100	65	100	42	100

* 4YwD, 4YwM, 4YwU represent four-year College/University with highest degree offered being Doctoral, Master's, and Bachelors, respectively.

The Research Model

Previous studies have shown that faculty research productivity is a result of the interaction among many endogenous and exogenous variables, ranging from individual personal characteristics, academic discipline, and educational experiences to institutional characteristics, teaching, research and service assignments, and employment experiences. By focusing on one specific academic discipline (i.e., IS), many of the variables could be eliminated. As a further

$$Y = \beta_0 + \sum_{i=1}^{n} \beta_i X_i$$

simplification, we set our research objective to be identifying the variables that may have significant effect on research productivity, rather than quantifying such effects on the productivity or testing any specific theories of research productivity. For those reasons, we chose a general linear regression model as the most appropriate tool for the analysis, i.e.:

Where Y is the dependent variable, X_i (i = 1, 2, …n) are the independent variables, and b_i (i = 0, 1, 2, … n) are the regression coefficients.

In establishing the model, we chose the self-reported average number of articles published in refereed academic journals each year (averaged over the last five years) as the indicator of faculty research productivity. Thirteen independent variables were identified based on the findings of previous studies as well as our research hypotheses. However, preliminary tests on collinearity among the variables resulted in the elimination of three variables. As a result, ten independent variables were used in the final model. The detailed definitions and descriptions of these variables are presented in Table 2.

RESULTS

IS Faculty Research Productivity

To better describe the overall characteristics of the research productivity of IS faculty, the total number of articles published and the annual rate of publication are summarized based on faculty academic rank, teaching load, tenure status, and non-academic IS employment experience. These results are presented in Tables 3a through 3d. It should be noted, however, that since many respondents had been at faculty positions for less than five years, the total number of articles over the last five years may not be a reliable measure for productivity. It is included in the tables for reference. The annual rate of publication, which was the article count divided by the lesser of 5 and years of academic employment, was therefore viewed to be a more suitable indicator of research productivity.

In terms of average annual rate of publication, the professor group seems to have the highest research productivity with 1.22 articles per year, followed by the associate professors with 1.045, and then the assistant professors with 0.942. Overall, IS faculty members publish one article per year in referred academic journals, with a standard deviation of one article. The faculty members with the lowest teaching load (5-7 hours per week) enjoy the highest research productivity at 1.68 articles per year, which is almost double the rate of those with 8-11 teaching hours, and quadruple the rate of those who teach 12-14 hours per week. Tenure status and non-academic IS employment experience seem to have minimal impact on the research productivity, as shown in Tables 3c and 3d.

The average rate of publication, however, may have not depicted a fair comparison of the research productivity between different groups due to the presence of large variances. It can be seen that in all cases the standard deviations are almost as large as the averages, indicating a highly heterogeneous sample population in terms of research productivity. Under such circumstance, the median rate of publication may be a better alternative. From that point of view, assistant professors have the highest median publication rate at 0.9 articles per year, followed by the associate professors at 0.8, which is equal to the median of all faculty members, and the professor group has the lowest median rate at 0.6 articles per year. This is completely the opposite of the order based on the averages, largely due to the fact that the professor group has the highest variance and the assistant professor group has the smallest variance. Thus the true effect of academic rank could not be determined by the simple statistics.

On the other hand, the strong effect of teaching load was not blurred by the large variances: the order of productivity based on the median rate of publication is the same as the one based on the average rate of publication. In the cases of tenure status and employment experience, the median rates of publication suggest that tenure-earning faculty members are slightly more productive than tenured faculty members, which is consistent with the result based on academic ranks. The effect of non-academic IS employment is also more pronounced in terms of median rate than it is of the average: the faculty with prior non-academic IS employment experience are about 50% more productive than those without such

Table 2: Definition and Coding Scheme for Independent Variables

VARIABLE	TYPE	DESCRIPTION	CODING SCHEME
X_1	Metric	Number of years on IS faculty	1, 2, 3, ...
X_2	Metric	Number of years of non-IS, non-academic full time employment	1, 2, 3, ...
X_3	Metric	Number of years of IS related non-academic full time employment	1, 2, 3, ...
X_4, X_5, X_6	Metric	Percentages of time allocated for Teaching, Research, and Academic Services[2]	0.1, 0.8, 0.2, ...
X_7, X_8	Dummy	Variables for school type	(0, 0) for 4YwU, (1, 0) for 4YwM, and (0, 1) for 4YwD.
X_9, X_{10}, X_{11}	Dummy	Variables for weekly teaching load	(0, 0, 0) for < 5 hours, (1, 0, 0) for 5~7 hours, (0, 1, 0) for 8~11 hours, (0, 0, 1) for 12~14 hours[3].
X_{12}, X_{13}	Dummy	Variables for academic rank	(0, 0) for Assistant Professor, (1, 0) for Associate Professor, and (0, 1) for Professor[4].
X_{14}	Dummy	Variable for tenure status	0 for tenure-earning, and 1 for tenured.
X_{15}	Dummy	Variable for terminal degree	0 for Masters and 1 for Doctorate.
X_{16}~X_{23}	Dummy	Variables for IS programs offered in a university or college	Each variable represents the existence of undergraduate IS major (X_{16}), IS minor (X_{17}), undergraduate IS survey (X_{18}), IS masters (X_{19}), IS track in MBA (X_{20}), graduate IS survey (X_{21}), IS doctorate (X_{22}), and Executive IS Programs (X_{23}).

Table 3a: IS Faculty Research Productivity by Academic Rank

ACADEMIC RANK	REFERREED ARTICLES PUBLISHED (Over Last Five Years)			RESEARCH PRODUCTIVITY (Annual Rate of Publication)		
	Median	μ	σ	Median	μ	σ
Professor	3.0	6.108	6.940	0.600	1.222	1.388
Associate	4.0	5.123	4.419	0.800	1.045	0.921
Assistant	3.0	4.071	3.195	0.900	0.942	0.620
Overall	4.0	5.238	5.372	0.800	1.087	1.078

Table 3b: IS Faculty Research Productivity by Teaching Load Levels

WEEKLY TEACHING HOURS	REFERREED ARTICLES PUBLISHED (Over Last Five Years)			RESEARCH PRODUCTIVITY (Annual Rate of Publication)		
	Median	μ	σ	Median	μ	σ
5-7	6.000	8.065	6.591	1.200	1.685	1.306
8-11	3.000	4.604	4.511	0.775	0.949	0.901
12-14	2.000	2.071	2.107	0.400	0.438	0.437

experiences.

Although the average and median rates of publication have presented an overall picture of IS faculty research productivity, the inferences based on these statistics are also conflicting and confusing as the result of large variances in the data sample. This is clearly demonstrated by the results of ANOVA performed on these groups, as shown in Table 4.

It is therefore obvious that more sophisticated statistical techniques need to be used in order to assess more accurately the effects of many individual factors. In the next section, we use the linear regression model defined in the previous section to evaluate such effects.

The Influential Factors

To determine the individual effect of the 13 independent variables, as defined in Table 2, on the research productivity, the linear regression model was first estimated using the 172 observations in our data set. The F statistic of the model is 4.580, significant at $p<0.001$ level, indicating a good fit between the observed data and the model. The R^2 is 0.416 and R^2-adj. is 0.325, indicating that

Table 3c: IS Faculty Research Productivity by Tenure Status

TENURE STATUS	REFERREED ARTICLES PUBLISHED (Over Last Five Years)			RESEARCH PRODUCTIVITY (Annual Rate of Publication)		
	Median	μ	σ	Median	μ	σ
Tenure-earning	3.000	4.476	3.387	1.000	1.055	0.720
Tenured	4.000	5.485	5.862	0.800	1.097	1.172

Table 3d: IS Faculty Research Productivity by Employment Experience

IS-RELATED EMPLOYMENT	REFERREED ARTICLES PUBLISHED (Over Last Five Years)			RESEARCH PRODUCTIVITY (Annual Rate of Publication)		
	Median	μ	σ	Median	μ	σ
Faculty w/ IS	3.000	5.661	5.516	0.900	1.180	1.110
Faculty w/o IS	4.000	4.450	5.044	0.600	0.913	1.002

Table 4: Summary of Single Factor ANOVA Tests

ANOVA FACTOR	REFERRED ARTICLES PUBLISHED (Over Last Five Years)			RESEARCH PRODUCTIVITY (Annual Rate of Publication)		
	F	p (α=0.05)	H_0:μ1=m2=..	F	p (α=0.05)	H_0:μ1=μ2=...
Academic Rank	1.876	0.156	Accept	0.933	0.395	Accept
Teaching Load	14.268	0.000	Reject	15.731	0.000	Reject
Tenure Status	1.119	0.292	Accept	0.047	0.827	Accept
IS Employment	1.996	0.159	Accept	2.403	0.123	Accept

about one third of the variance of the dependent variable, Y, the average annual rate of publication, can be explained by the variations of the independent variables. Giving the large sample size and the great heterogeneity of the respondents, this R^2-adj. should be considered as satisfactory.

The estimated values of the regression coefficients are presented in Table 5. Note that we used the indicator coding scheme for the dummy variables (for details, see Hair et al. 1995, p109). As a result, the effects of the dummy variables are relative to the comparison group (i.e., the group with all zero values) for each set of dummies. For instance, the effect of teaching load on the research productivity is relative to the comparison group that has a teaching load less than five hours per week, coded as $X_9 = X_{10} = X_{11} = 0$. For coding schemes of the other dummy variables, refer to Table 2.

Since the dependent variable, the rate of publication, is calculated using the self-reported number of referred articles in the last five years divided by X_1 if $X_1 < 5$ or by 5 if $X_1 \geq 5$, it may be inflated if a respondent had published some articles as a doctoral candidate and served less than five years on the faculty. To avoid this potential problem and to assess the impact of this factor, we constructed another data set with only the responses from the faculty members who have been on the faculty for six or more years. Of the 172 responses, 143 responses meet this criterion. As a result, this data set consists of virtually only the responses from senior and tenured faculty members. With this new data set, the regression F statistic is 4.687 (significant at $p<0.001$), the R^2 is 0.475 and R^2-adj. is 0.374. Comparing to the full data set, the goodness of fit of the model has been improved about 15%. This small improvement may be attributed to the more homogeneous data set. The estimated regression coefficients using this new data set are presented in Table 6.

DISCUSSIONS

Does tenure affect faculty research productivity?

The regression results based on both data sets show that there is no significant correlation between tenure status and research productivity. The regression coefficients for tenure status variable X_{14} in both regression models are not significantly different from zero. Thus Hypothesis 1a is not supported by our data. This is inconsistent with the findings of many previous studies of other academic fields (Levin and Stephan, 1991; Goodwin and Sauer, 1995), especially the prediction of the life-cycle model. It is also inconsistent with the findings of Lane, Ray and Glennon (1990) on statisticians, Levitan and Ray (1991) on academic accountant and Hancock et al. (1992) on management science researchers, which suggest that tenured faculty members are more productive than those without.

Are junior faculty members more productive than senior ones?

The life-cycle model predicts that faculty research productivity will decline as an individual's academic experience increases, mostly due to the reduction of investment motivation. Examining the estimated regression coefficient of variable X_1, the number of years on IS faculty, in Table 5, we can see that X_1 is significantly ($p < 0.05$) negatively ($\beta_1 = -0.025$) correlated with an IS faculty member's research productivity. The decline of investment motivation of senior faculty members is one plausible reason for the inverse correlation. Meanwhile, senior faculty members tend to have more service and administrative responsibilities than junior ones, which may seriously hinder their research productivity. When most of the junior faculty response are excluded from the data set, as is the case of Table 6, this effect is no longer significant at the $p < 0.05$ level. These results indicate that

Table 5: Result of Regression with All Faculty

Variable	Description	DF	β_I	SE	t : (β_I=0)	p >|T|	
X0	Intercept	1	2.723	0.940	2.895	0.004	***
X1	Years on IS faculty	1	-0.025	0.013	-2.009	0.046	**
X2	Years of non-IS, non-academic	1	-0.047	0.023	-2.026	0.045	**
X3	Yes of IS-related non-academic	1	0.003	0.013	0.262	0.794	
X4	Time for teaching	1	-0.989	0.435	-2.274	0.024	**
X5	Time for research	1	1.129	0.593	1.904	0.059	*
X6	Time for services	1	-1.813	0.708	-2.559	0.012	**
X7	Masters program	1	-0.315	0.280	-1.123	0.263	
X8	Doctoral program	1	-0.170	0.290	-0.585	0.559	
X9	Teaching 5-7 hours	1	-0.752	0.665	-1.131	0.260	
X10	Teaching 8-11 hours	1	-1.102	0.673	-1.639	0.103	
X11	Teaching 12-14 hours	1	-1.445	0.702	-2.060	0.041	**
X12	Associate Professor	1	0.326	0.290	1.128	0.261	
X13	Full Professor	1	0.548	0.315	1.739	0.084	*
X14	With tenure	1	0.115	0.301	0.384	0.702	
X15	Doctorate degree	1	0.178	0.349	0.511	0.610	
X16	IS major	1	0.218	0.232	0.938	0.350	
X17	IS minor	1	-0.403	0.158	-2.555	0.012	**
X18	IS survey	1	0.092	0.172	0.534	0.594	
X19	IS Masters	1	-0.071	0.169	-0.422	0.673	
X20	IS MBA	1	-0.005	0.154	-0.034	0.973	
X21	IS graduate survey	1	-0.091	0.153	-0.601	0.549	
X22	IS Doctorate	1	0.164	0.209	0.783	0.435	
X23	IS Executive Program	1	0.339	0.222	1.562	0.129	

Note: 1) N = 172, F = 4.580, $p < 0.001$, R^2 =0.416, R^2-adj.= 0.325
2) * Significant at $p < 0.1$, **Significant at $p < 0.05$, *** Significant at $p < 0.01$
3) For detailed variable description and coding schemes, see Table 2.

Table 6: Result of Regression with Faculty (Years on IS Faculty $X_1 \geq 6$)

Variable	Description	DF	b	SE	t (b_I=0)	p >|T]	
X0	Intercept	1	2.609	0.996	2.619	0.010	**
X1	Years on IS faculty	1	-0.025	0.015	-1.717	0.089	*
X2	Years of non-IS, non-academic	1	-0.034	0.028	-1.196	0.234	
X3	Years of IS-related non-academic	1	0.011	0.015	0.764	0.446	
X4	Time for teaching	1	-0.977	0.478	-2.045	0.043	**
X5	Time for research	1	1.721	0.655	2.628	0.010	**
X6	Time for services	1	-1.490	0.772	-1.931	0.056	*
X7	Masters program	1	-0.464	0.335	-1.388	0.168	
X8	Doctoral program	1	-0.268	0.342	-0.784	0.434	
X9	Teaching 5-7 hours	1	-0.646	0.690	-0.937	0.351	
X10	Teaching 8-11 hours	1	-1.024	0.696	-1.470	0.144	
X11	Teaching 12-14 hours	1	-1.276	0.730	-1.749	0.083	*
X12	Associate Professor	1	0.072	0.333	0.215	0.830	
X13	Full Professor	1	0.323	0.352	0.919	0.360	
X14	With tenure	1	0.174	0.340	0.512	0.610	
X15	Doctorate degree	1	0.348	0.393	0.885	0.378	
X16	IS major	1	0.011	0.290	0.038	0.969	
X17	IS minor	1	-0.425	0.177	-2.403	0.018	**
X18	IS survey	1	0.173	0.192	0.901	0.370	
X19	IS Masters	1	-0.114	0.190	-0.603	0.548	
X20	IS MBA	1	-0.051	0.177	-0.288	0.774	
X21	IS graduate survey	1	-0.003	0.178	-0.017	0.987	
X22	IS Doctorate	1	0.416	0.245	1.67	0.092	*
X23	IS Executive Program	1	0.367	0.269	1.363	0.176	

Note: 1) N = 143, F = 4.687, $p < 0.001$, R^2 = 0.475, R^2-adj. = 0.374
2) * Significant at $p < 0.1$, **Significant at $p < 0.05$, *** Significant at $p < 0.01$
3) For detailed variable description and coding schemes, see Table 2.

among the senior faculty members, number of years on faculty has a less significant influence on research productivity. This is consistent with our hypothesis that one major difference between junior and senior faculty members is the investment motivation. Overall, then, we can conclude that Hypothesis 1b is supported by our data.

Does spending more time on research improve productivity?

One consistent finding of previous studies of research productivity has been that research productivity heavily depends on how much time one spends on research-related activities: productive researchers allocated more time on research activity (Lane, Ray, and Glennon, 1990; Hancock et al., 1992). The IS faculty data here show more complicated patterns. While the percentage of time allocated for teaching (X_4) shows strong ($p < 0.05$) negative correlation with the research productivity of all faculty members ($\beta_4 = -0.989$) and senior faculty members ($\beta_4 = -0.977$), the positive effect of time allocated to research (X_5) is more pronounced on senior faculty members ($\beta_5 = 1.721$, significant at $p < 0.05$ level) than on all faculty members ($\beta_5 = 1.129$, significant at $p < 0.1$ level), and the negative effect of time allocated for services (X_6) is more pronounced on all faculty members ($\beta_6 = -1.813$, significant at $p < 0.05$ level) than on senior faculty members ($\beta_6 = -1.490$, significant at $p < 0.1$ level). Thus we conclude that, in general, Hypothesis 2a is supported by our data. We should note, however, the differences between the junior and senior faculty members. These may help explain, to certain degree, why senior faculty members are less productive than the junior faculty. Giving the same teaching load, junior faculty members are likely to have a lighter service load, which alleviates the negative effect of time for services; while senior faculty members are likely to spend less time for research due to heavier service load, which reduces the positive effect of time for research. It is also important to note, when interpreting this result, that the faculty member who allocates a higher percentage of time for research does not necessary have a lighter teaching and service load. He or she may simply work more hours than the others in order to achieve higher research productivity while fulfilling the same teaching and service responsibility as others.

Do IS programs affect faculty research productivity?

In our model, there are two groups of dummy variables designed to measure the effect of IS programs on faculty research productivity. Variables X_7 and X_8 represent the effect of school types (4YwU, 4YwM, and 4YwD). The regression coefficients of these two variables in both Tables 5 and 6 show that there is no significant correlation between school types and the faculty research productivity. However, significant coding error may occur with this type of classification: when a faculty member is affiliated with, for instance, a 4YwD type of university, it is not necessarily true that the IS program also has a doctoral program. For this reason, the second group of variables, X_{16} to X_{23}, may be better indicators of the effects of IS programs. It can be seen that the existence of an IS minor program is strongly ($p<0.05$) negatively ($\beta_{17} =$ -0.403 and -0.425) correlated to the research productivity of IS faculty members in both data sets; while the IS doctoral program is marginally ($p < 0.1$) positively ($\beta_{22} = 0.416$) correlated to the research productivity only in the second data set where the responses from junior faculty members have been excluded. Other IS programs, such as undergraduate major, graduate major, or MBA with IS track, have insignificant effect. IS faculty in the schools where only IS minor programs are offered usually get the minimum support and least emphasis on research, which inevitably leads to lower productivity. On the other hand, those faculty members, especially the senior faculty members, in the schools where IS doctoral programs are offered usually get the best support such as graduate assistants, collaboration and co-authorship with doctoral students, which leads to higher productivity. Thus we conclude that Hypothesis 2b is partially supported: only the affiliation with doctoral programs is positively correlated with the research productivity of senior faculty members.

Does teaching load affect faculty research productivity?

The regression coefficients of X_4 confirm the common sense that teaching load has an adverse effect on research productivity. However, to what degree does teaching load significantly hinder an IS faculty member's research productivity? Using the three dummy variables, X_9, X_{10}, and X_{11}, representing four levels of teaching loads, the regression model suggests that the negative effect of teaching load on research productivity becomes significant ($p < 0.05$) only when the weekly teaching load exceeds 11 hours. If a faculty member's weekly teaching load is below 11 hours, there is no significant correlation between teaching load and research productivity. Noting that the regression coefficients of the three variables are all large negative values, this result is perhaps more an indication that when the teaching load is too high, the research productivity of even the highly motivated faculty members willing to work extra hours would be severely affected, than that teaching load would not affect faculty research productivity if it is within the 11-hour limit. Thus, in general, Hypothesis 2c is supported by our data.

Does IS related employment experience help IS academic research?

As an applied scientific discipline, the majority of IS research issues have their roots in the real-world IS environment. We therefore hypothesized that non-IS, non-academic employment experience should have no significant effect on faculty research productivity, and that the faculty members who have extensive real-world IS-related employment experience should be more productive than those who do not.

Variables X_2 and X_3 are used to represent such experiences. The results are interesting. First it shows that the IS related, non-academic full time employment experience (X_3) has no relationship with research productivity: the estimated regression coefficients are not different from zero in both full faculty and senior faculty data sets. On the other hand, the results show that non-IS, non-academic full time employment experience (X_2) is significantly ($p < 0.05$) negatively ($\beta_2 = -0.047$) correlated to the research productivity for all faculty members, but not for senior faculty members ($\beta_2 = -0.034$, $p = 0.234$). Thus, the two hypotheses on the effect of employment experiences are not supported by the data.

There are plausible explanations for these seemingly counter-intuitive results. The initial negative impact of non-IS, non-academic employment experience on research productivity can be explained by the fact that faculty members who had extensive non-academic experience often join academic institutions for the purpose of teaching rather than conducting academic research. However, pure teaching faculty members can rarely survive long in today's higher education institutions. More and more colleges and universities use publication as one of the major criteria for faculty performance evaluation, promotion, and salary decisions. Eventually most faculty members conduct some sort of research, which explains why the negative effect of the non-IS, non-academic employment experience becomes insignificant when tested using the data of faculty members who have been on the faculty for six or more years.

The insignificant effect of IS-related employment experience is possibly accounted for by the fact that people with corporate IS experience are often at low level positions when they decided to pursue a doctoral degree in the IS field. Our own experience in faculty recruiting over the years suggests that the candidates with IS employment experience often worked at the level of programmers and systems analysts. At these positions, the likely benefits of IS-related employment experience with respect to scholarly research is minimal, if any. In addition, the fast-changing nature of IT and related management issues further diminish the impact of IS-related employment experience on research productivity, given the fact that it normally takes four to five years of full-time study to get a doctoral degree, which is comparable to the time it takes to introduce an entirely new generation of IT and the related IS research issues.

CONCLUSIONS

In this study we have attempted to identify the set of variables that have the most significant effect on the research productivity of IS faculty members. From the results of both the overall statistics and the results of the linear regression model, we can see that productive IS faculty members come in many shapes and forms. A junior faculty member may be productive due to his or her current technological skills, or a strong investment motivation that leads to longer working hours and more time being allocated for research activities. A light service load will be very helpful, too. A senior faculty member may be productive due to favorable teaching loads, opportunities to work with multiple junior faculty members and doctoral students on research projects, or more time for research activities due to fewer new preparations for classes. On the other hand, our findings suggest that the research productivity of an IS faculty member will be adversely affected if he or she is assigned with a weekly teaching load of more than 11 hours, works in a department where no IS major programs are offered, takes on too many academic service responsibilities, or has been on the faculty position for a long time.

There are a few factors that seem to affect only selected groups of faculty members. For instance, non-IS, non-academic full-time employment experience seems to have a greater negative impact on the research productivity of junior faculty members than senior ones. In contrast, affiliation with an IS program that offers a doctoral program seems to have a greater positive impact on the research productivity of senior faculty members than junior ones.

We also found that some commonly proposed influential factors, such as tenure status, academic rank, and school type, seem to have no significant correlation to faculty research productivity. It implies that an assistant professor working in a business department of a undergraduate university can be as productive as the one working at a major university with doctoral IS programs, as long as she or he is highly motivated, not overly booked for teaching and service, and is supported by the department for research.

Like any other study relying on survey data, there are potential limitations to this study that might affect the reliability of the data as well as the validity of the statistical results. First, it should be noted that the publication data is self-reported. It is possible that some of the numbers may be inflated for various reasons. Second, the quality of the academic journals was not considered in this study. We can reasonably assume that articles published in the top-tier IS journals usually take much more effort and longer time cycles than the ones published in the bottom-tier journals. This may explain partially why school type has no apparent effect on faculty research productivity. Previous studies have clearly established the fact that the top IS journals were dominated by the faculty from the top IS programs (Vogel and Wetherbe, 1984; Lending and Wetherbe, 1992).

Finally, there was no control over co-authorship. It is reasonable to assume that it takes more effort and time to publish a sole authored article than to publish multiple co-authored ones. This may explain why full professors have been shown to have the higher research productivity, even though the life-cycle model, as well as the factors examined in this study, clearly imply that they should have much lower research productivity. Full professors may be more likely to work with multiple junior faculty members and with multiple doctoral students on different research projects that lead to multiple co-authored publications.

With these limitations in mind, we believe that the findings of this study can be helpful to faculty members who want to improve individual research productivity, and to the administrators who want to understand the impact of faculty working environment on research productivity. This study may also serve as a basis for future research into the research productivity issue of IS faculty members, having highlighted relevant theoretical models and practical issues related to data gathering.

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Endnotes

1 The complete survey instrument is available upon request from the authors.

2 In the questionnaire, respondents were asked to provide information about percentage of time allocated for eight activities, which were then combined into four categories: teaching, research, academic service, and outside activity. Since all four categories add to 100%, only the first three are used in the model.

3 No respondents in the sample reported higher than 14 hour weekly teaching load.

4 We are mostly interested in understanding the effect of academic ranks on research productivity. The responses of adjuncts and instructors are not included in the sample.

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