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Has Information Technology Competence Ever Increased? Evidences from the Annual User Satisfaction Survey of Information Technology Services

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Abstract

This study challenges a common myth on information technology competence and examins whether information technology competence has increased as the technology develops. An analytic framework considers if an inforation technology service is technologically sophisticated and if it is developed for general purpose for all users. The annual user satisfaction survey data from 1998 through 2014 are analyzed to present historical patterns of use of information technology services, satisfaction, and unawareness. A surprising finding is that informaiton technology competence has been stable and rarely increased or decreased rapidly. The usage rate of information technology service, satisfaction, and unawreness are also relatively stable and consistent as a whole. Finally, usage and satisfaction of information technology services are not always positively related. This research suggests that the prevailing thought on information technolgoy competence is questionable and even misleading and calls for further research on this conclusion.

Keywords: Information technology competency, computer ownership, user satisfaction, information technology usage, unawareness of information technology, end-user computing.

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INTRODUCTION

As information technology (IT) pervades modern human life, most people appear to take it for granted, consciously and unconsciously, that they are more knowledgeable about IT and more heavily use IT services. Rapid progresses in process speed, capacity, interface, and networking have drastically changed the computing landscape in the globe. Individual IT services become technically sophisticated and highly user-friendly, making it easy for users to utilize these services. Widespread use of IT in society implies that users' IT competence has ever increased; people become more knowledgeable and skilful and thus use more IT facilities and services.

In 2013, the 84 percent of U.S. households have desktop or laptop at home, 64 percent use smart phones or handheld wireless computer, and 74 percent use the Internet (File & Ryan, 2014). The 81 percent of American adults use computers in 2014, rising from 42 percent in 1990, 62 percent in 2000, and 77 percent in 2010; adults' Internet use rate jumped up to 87 percent in 2014 from 14 percent in 1995 and 66 percent in 2005; and cellular phone ownership increased from 53 percent in 2000 to 90 percent in 2014 (Fox & Rainie, 2014). Also American teens ages 13 to 17 use computer and the Internet heavily. The 87 percent of them have desktop or laptop access; 58 percent and 73 percent use tablet PC and smartphones, respectively; and 91 percent have Internet access and 92 percent of them use the Internet almost constantly or every day (Lenhart & Page, 2015).

However, most people appear to be dependent heavily on and overwhelmed by increasing information abundance and technical sophistication. Do most people really have high IT competence (literacy) and take full advantage of IT services in this information era? Is there consistent equality of IT competency and usage among groups of people? This study challenges these questions that have been widely accepted implicitly but have not yet been examined empirically. It is important to understand users' characteristics and behaviors when

planning, designing, managing information systems and applicaitons. This research analyses annual surveys of user satisfaction on various information technology services at a state university.

The next section reviews literature on information technology competence, use of information technology, user satisfaction, and technology adoption. An analytic framework are explained in section 3. The next section explain survey data and method to be employed. Section 5 summarizes findings from the analysis and section 6 discusses stable IT competence and usage.

INFORMATION TECHNOLOGY COMPETENCY AND USE

This section review studies on information technology (IT) competence, use of IT services, user satisfaction, and technology acceptance model.

Information Technology Competence

Computer literacy or IT competence is broadly defined as the "ability to do computing" (Luehrmann, 1981: 683) and "ability to utilize the capabilities of computers intelligently" (Tobin, 1983: 22). Computer literate people comprehend the capabilities and limitations of computer, understand that computers do exactly what they are told to do, and have confidence to operate a computer (Tobin, 1983: 23). Similarly, Tipping and Sohi (2003) define IT competence as "the extent to which a firm is knowledgeable about and effectively utilize IT to manage information within the firm" or "ability to understand and utilize IT tools and processes" (p. 748). This construct is comprised of three variables: IT knowledge ("the extent to which a firm possesses a body of technical knowledge about objects"), IT operations ("the extent to which a firm utilizes IT to manage market and customer information"), and IT object ("computer-based hardware, software, and support personnel") (pp.748-749). IT knowledge appears to be theoretical understandings of IT, while IT operations and objects are considered as IT skills and facilities, respectively. Merritt, Smith,

and Di Renzo (2005) report that students' self-reported computer literacy is not reliable because it is signifiicantly different from their actual literacy score.

This paper defines *hard IT competence* or IT knowledge as the ability to understand IT and *soft IT competence* or IT proficiency as practical skills and confidnece (self-efficacy) to utilize IT. IT proficiency needs training, practice, and experience rather than formal education. Two types of competence oftentimes overlap and their borders are blurring. As IT applications are equipped with highly user-friendly interfacce in the age of digital convergence, people are able to use them without understanding how computers and telecommunicaiton work. While users' IT proficiency has grown steeply, their IT knowledge has increased gradually, if not remained almost unchange from generaltion to genertion. Hard and soft IT competences were not seprable in the past, but IT proficiency becomes almost independent of IT knowledge these days. Most users do not distinguish one from the other and often appear to treat their soft competence as hard competence. Under this circumstance, self-reporting meature of IT competence may be misleading.

Information Technology Use and User Satisfaction

IT has been expected to improve organizational performance. Tipping and Sohi (2003) argue that IT competence leverages (is mediated by) organizational learning and eventually influences performance. Devaraj and Kohli (2003) show that the impact of IT on performance is explained by actual use of information technology rather than by investment. Venkatesh and Davis (2000) posit that perceived usefulness and easy of use influence intention to use technology on which voluntariness and experience mediate the impact of subjective norm. There must be good task-technology fit to produce positive impact on performance (Goodhue & Thompson, 1995). But this positive expectation has been challenged by IT productivity paradox (Brynjolfsson, 1993; Stratopoulos & Dehning, 2000).

DeLone and McLean (1992 & 2003) propose an information success model that consists of system quality, informaiton quality, service quality, information system use (intention to use), and user satisfaction. Informaiton system use is closely interelated to user satisfaction; informaiton use preceeds user satisfaction that in turn leads to intention to use and evenutually informaiont use (DeLone & McLean, 2003: 23). Testing DeLone-McLean Model, Iivari (2005) reports a strong relationship between user satisfaction and actual use of information systems and individual impact (performance). Burton-Jones and Gallivan (2007) suggest multilevel approach to system usage that incorporates user, system, and task to measure "user's employement of a system to perform a task" (p. 659).

User satisfaction is one of a common information systems evaluation mtehod. Ives, Olson, and Baroudi (1983) defines user satisfaction on information systems as the extent to which users believe the information systems meet their information requirements and then argue that this construct is used to refer users' need, acceptance, perceived usefulness, feeling about the systems, etc. (pp 785-786). Au, Ngai, and Cheng (2008) incorporate expectation theory, need theory, and equity theory into their equitable needs fulfilment model and posits that equitable relatedness, work performance, and self-development fulfilment constructs influence end-users' satisfaction on information systems. IT users are more likely to be satisfied when they perceive benefits (need fulfillment) are greater than the inputs required (Au et al., 2008: 48). These studies imply that well developed IT applications make need fulfilment to input ratio greater than 1 and thus increase usage and users satisfaction. Doll and Torkzadeh (1988) and Doll, Deng, Raghunathan, Torkzadeh, and Xia (2004) suggest content, accuracy, format, timeliness, and easy of use as constructs for end-user computing satisfactin. Hartwick and Barki (1994: 454-455) distinguish mandatory use from voluntary use of information systems and argue that voluntary users are more likely to engage in participation (involvement) and have positive attitudes toward information systems use.

However, Devaraj and Kohli (2003) point out that self-reported usage (satisfaction) involves biases because the "same respondents answer similar questions on their perceptions of the IT and its effectiveness" (p. 274).

Technology Acceptance Model

Davis (1989) posits that perceived usefulness and easy of use determine individuals' acceptance of technology. Perceived usefulness refers to as "the degree to which a person believes that using a particular system would enhance his or her job performance," while perceived easy of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (p. 320). This technology acceptance model (TAM) predicts that IT is growingly used as it becomes user-friendly and technically sophisticated. Venkatesh and Davis (2000) propose an extension of TAM by incorporating intention to use, social influence processes (e.g., subjective norm), and cognitive instrumental processes (e.g., perceived easy of use). They show that subjective norms (institutional rules) have significant influence on perceived usefulness and intention of mandatory use of technology. As IT pervades modern society, the subjective norm or institutional pressure to use IT becomes stronger and more people are likely to use IT. The perceived usefulness and easy of use are more closely related to soft IT competence rather than hard one; people without IT knowlege may perceive high level of usefulness and easy of use if they have high IT proficiency.

ANALYTIC FRAMEWORK

This section describes the analytic framework and information technology services to be examined.

Classification of Information Technology Services

This study classifies IT services into four categories on the basis of two dimensions (Figure 1). Technological sophistication denotes the extent to which an information technology service requires users to have knowledge and skills. For example, supercomputer

and high performance computing require fundamental understanding of computers and hard IT competence, while knowledge base services do not but needs soft IT competence. The second dimension is whether an information technology service is developed for general users. Specialized IT services like student self-service are customized to a certain group of users, while general services like knowledge base service are not.

Figure 1. Classification of information technology services

General IT Services	E-mail service (Unix/Microsof Exchange) Knowledge base Library online catalog Software download service	Network storage service Web site hosting and publishing service
Specialized IT Services	OnCourse CL Student self-services Financial information (Kuali service) Purchasing and accounts payable service	Supercomputer service Statistical and mathematical compputing Visualization laboratory service
	Low Technological Sophistication	High Technological Sophistication

The first group of IT services are developed for general users and do not require IT competence to use. Students use official email accounts (UNIX or Web-based), while faculty and staff members can have Microsoft Exchange account as well.[1] Also UITS provide various proprietary and non-proprietary software packages (”IU ware”), knowledge base service, and library online catalog services. The general IT services with high technological sophistication include massive data storage or scholarly data archive service (network storage service) and Web site hosting/publishing services for individuals and departments.

OnCourse provides an online collaboration and learning environment for faculty members and students (OnCourse CL since 2006).

The specialized IT services with low technological sophistication include OnCourse, student self services (e.g., register for classes, unofficial transcript, bursar account, and payment), faculty services (e.g., rosters and grades), E-Doc services for staff only, Time Information Management Environment (TIME) (a timekeeping system), general functionality

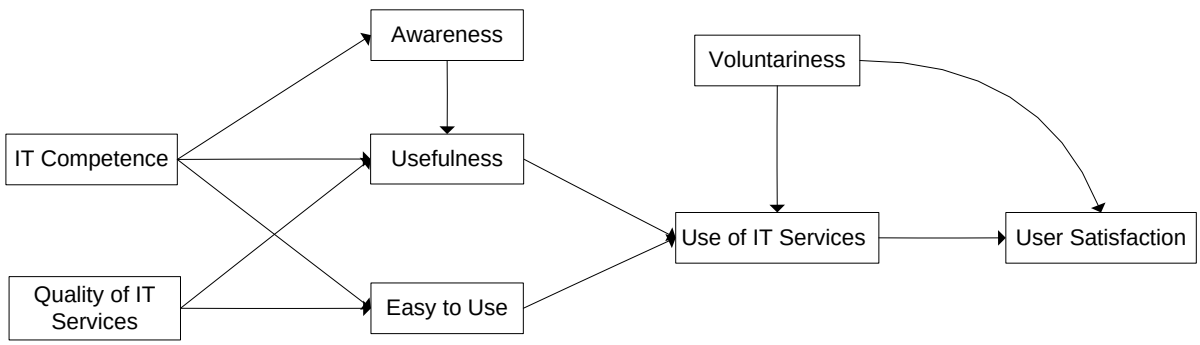
[1] Indiana University community members are allowed to have multiple email accounts depending on their status. Email servers have evolved over time. This study considers only main email account of the year (e.g., imail/Umail and Microsoft Exchange).

self service (e.g., payroll deposit, paycheck, and electronic W-2), Kuali financial information system, purchasing and accounts payable (the online purchasing systems--TOPS), and travel system for faculty and staff. OnCourse provides an online collaboration and learning environment for faculty members and students (OnCourse CL since 2006). The last group of specialized IT services with high technological sophistication includes supercomputers,[2] high performance computing services, advanced visualization laboratory service, and life science services including biomedical IT core and national center for genome analysis that the Research Technologies Division provides.

Analytic Framework of Information Technology Service Use

The analytic framework starts with hard/soft IT competence and quality of IT services (e.g., system, information, and service quality) that jointly determine usefulness and easy to use. Indiana University is one of the Sakai Project institutions to develop open source collaboration and learning environment software. It provides high level of information technology services and emphasizes user-friendly services that are easy to use. It is less likely that technologically sophisticated information technology services are mandatory. Accrodingly this research assumes well developed IT services with task-technology fit in the university for the sake of simplicity.

Figure 2. Analytic framework of information technology service use



[2] This question is available for graduate students, staff (starting from 1999), and faculty members.

A good IT service is perceived by IT competent users as useful and easy to use correctly. They are able to use even a poorly developed IT services. However, less competent users are less likely to aware availibility, usefulness, easy of use of IT services even when they are actually useful and easy to use. They may perceive an IT service with high technological sophistication as useful one but do not have confidence in their IT abilities. Therefore, highly sophisticated IT services are often used by power users rather than end-users.

Usefulness and easy of use influence intention to use or actual use of IT services. Use of IT services are also influenced by institutional rules or social norm (Venkatesh & Davis, 2000). User satisfaction is determined by the outcome of the use of IT services. If an IT service is mandatory or virtually compulsory, its usage rate will be higher than voluntary services but user satisfaction will be lower (Hartwick & Barki, 1994). Use of IT services improve IT competence, in particular, soft competence. User satisfaction later influences users' perception of usefulness and easy of use and then use of IT services. If users are satisfied with using IT services, they will become more confident of using IT services to get tasks done.

If all aspects of IT competency have increased, there will be no significant difference in usage and satisfaction between power users and end-users when well developed IT services are assumed. Otherwise, a relatively small number of power users will use highly sophisticated IT services. IT competent users are more likely than incompetent end-users to report usage, satisfaction, and unawareness corrctly. Due to their high expectation and pickiness, they will not be fully satisfied with well developed sophisticated IT services.

Specialized IT services are developed for target users and accordingly will have lower usage but higher satisfaction than general services. Technologically sophisticated IT services, if well developed, will be used largely by a group of power users and their satisfaction level

is high with small variance. By contrast, less sophisticated IT services are widely used by general users and their satisfaction will have large variance.

DATA AND METHOD

This section describes annual survey data and data analysis methods employed.

User Satisfaction Survey

This paper analyzes the annual user satisfaction survey conducted by the University Information Technology Services (UITS) at Indiana University in Bloomington (IUB) and Indiana University-Purdue University Indianapolis (IUPUI) campuses from 1998 through 2014. This survey is to assess and improve information technology services that UITS offers and its result has been released on the survey Web site http://www.indiana.edu/~uitssur/ since 1991. The surveys before 1998 contain incomparable questions due to change in computing environment and were accordingly excluded from this analysis.

This annual survey is conducted by a joint effort of Research Analytics (formerly Center for Statistical and Mathematical Computing) of the UITS Research Technologies Division and the Center for Survey Research, Indiana University. Research Analytics prepares the questionnaire by reflecting feedback from each UITS division and unit. The Center for Survye Research takes a random sample and administers the online survey in March and then provides a master data file to Research Analytics. This Research Technologies unit analyzes the survey data and releases the result on the Web.

The population is comprised of full-time faculty members (about 2,500 at IUB and 2,100 at IUPUI), staff members excluding UITS employees (service providers), graduate students (7,000 at IUB and 6,000 at IUPUI), and undergraduate students (33,000 at IUB and 18,000 at IUPUI) (Indiana University, 2014). The numbers of full-time faculty, staff, and graduate/undergraduate students are obtained from the annual fact book of the year and used to calculate sample weight. A total of 2,000 are randomly selected (800 undergraduate

students and 400 each for graduate/staff/faculty) in each campus and the average response rate is 40-45 percent during 1998 through 2014. Once a person (network ID) is randomly selected this year, he or she will not be selected again within two years.

Survey Questions

The survey asks how much users are satisfied with specific information technology services that UITS offers. The information technology services are grouped into electronic mail, user support, communication, instructional and student computing, research technologies, enterprise software, Web and network, and voice sections in survey questionnaires although this categorization varies slightly across survey year.

Each section of services has questions about satisfaction of individual information technology services (e.g., satisfaction of facilities and services in support of research: “supercomputers and high performance computers”) as well as overall satisfaction (e.g., “Overall, how satisfied are you with the UITS research technology services available…”).

The IT competence is a self-reported computer expertise (“How would you rate your computer expertise?”) where hard and soft IT competences are blended togeter. The survey also includes questions about importance of information technology services to users (“How important are UITS systems and services to your work or study?”), computer ownership (“Do you have a computer at your residence?”), and operating system type (“What operating system/s do you have on your residence computer?”). Majority questions remain almost unchanged with minor modification, whereas some questions are changed, added, or dropped over time depending on feedback from individual divisions and units.

Some information technology services are used only by certain subpopulations. For instance, knowledge base and library online catalog services are used by everyone, whereas financial information and purchasing and accounts payable by faculty and staff members only. This survey has quesitons about respondents’ status (faculty, staff, graduate, or undergraduate

student), computer expertise, housing type (on or off campus) for students, computer ownership,[3] type of operating systems, and type of network connection but does not include private information, such as gender, age, department, ethnic group, and citizenship.

Each question has the 5-point Likert scale, ranging from 1 "Not at all satisfied" to 5 "Very satisfied" without neutral response. Respondents may choose "Cannot evaluate" (7) if they are not familiar enough with a particular service to make an evaluation, "Never heard of service" (8) if you have no knowledge of the service in question, or "Not applicable" (9 starting from 2014). This survey is basically online survey administered by the Center for Survey Research, but respondents are also allowed to print out the questionnaire and submit a hardcopy of their answers if they want.

Methods

This research relies largely on descriptive statistics, such as satisfaction score, satisfaction ratio, and usage rate, and unawareness of individual services. An average satisfaction score is a weighted average of responses from 1 through 5 only, treating this ordinal scale as if it is an interval scale. A satisfaction rate is defined as the percentage of respondents who are satisfied with the service (check 3, 4, or 5), whereas the usage rate is the percentage of respondents who rate the service in the 1-5 scale. Also the percentage of "Never heard of service" (8) is calsulated to measure unawareness of the IT service. "Unable to rate service" (7), "Not applicable" (9), and missing values are excluded from analysis. In order for interpretative convenience, the values 1 through 5 are recoded to 0, .25, .5, .75, and 1, respectively, so that they have a range of 0 through 1.

This study examines if there is any significant change in information technology competence, user satisfaction, and usage of information technology services for the past 17

[3] The typical question of computer ownership is "Do you have a computer at your residence (desktop computer or a laptop)?" But, 2004 question was "Do you have a desktop computer, laptop or PDA…" although all PDA holders owned a computer in that survey.

years. Major statistics are presented in a series of graphs. Each of Figures 13 through 27 present (1) users' satisfaction score, satisfaction rate, usage rate, and the portion of unawareness ("Never heard of service") of the information technology services selected, (2) average satisfaction score by IT comptence, (3) usage rate by IT competence, and (4) unawareness by IT competence. The paired sample t-test is employed to check if there is mean differences across groups.

FINDINGS

This section summarizes findings of IT competence, IT ownership, and satisfaction, usage, unawareness of indivdiual IT services.

Information Technology Competence, Importance, and Ownership

Figure 3 summarizes IT competence (self-reported computer expertise), importance of information systems and IT services, the impact (helpfulness) of IT einviroment on resaeach activities and learning experience. The IT competence and importance were about .60 and .84 out of 1.00 in both campuses. The helpfulness for research and learning was equally .78 at IUB and .74 and .77 at IUPUI. These figures show a stable and consistent pattern over time. Figure 4 suggests that computer ownership appears to reach its saturation point (greater than 90 percent) and Mac OS users have continuously increased to substitute Windows after 2000.[4] Table 1 summarizes descriptive statistics (i.e., mean, standard deviation, and range) of major variables.

* Figures 3 and 4 about here

[4] The question for the type of respondents' operating systems became a multipe response one starting from 2002, it should be interpreted with caution. OS use curves in this graph do not exactly indicate market share due to a group of users who use multiple operating systems. For instance, Mac OS uers might also use Unix/Linux and/or Windows as well. Survey data report that 79.1 percent of respondents use Windows only and 10.7 percent for Mac OS, while 5.8 percent use both Mac OS and Windows and 1.9 percent use both Unix/Linux and Windows. Only .8 percent use all Unix/Linux, Mac OS, and Windows for the past 17 years. The 76.3 and 13.1 percent of IUB clients use Windows and Mac OS and these figures are contrasted with 82.3 and 8.2 percent at IUPUI.

Table 1. Satisfaction, usage, and unawareness of selected IT services (1998-2014)

	IUB			IUPUI		
	Satisfaction	Usage	Unawareness	Satisfaction	Usage	Unawareness
IT competence	.591 (.022)	-	-	.602 (.045)	-	-
	[.547 .621]			[.518 .644]		
IT importance	.841 (.023)	-	-	.840 (.035)	-	-
	[.791 .879]			[.768 .899]		
IT ownership	.943 (.065)	-	-	.949 (.048)	-	-
	[.790 .996]			[.834 .993]		
Overall satisfaction	.780 (.019)	.974 (.017)	.002 (.003)	.785 (.026)	.955 (.018)	.006 (.004)
	[.730 .805]	[.946 .995]	[.000 .014]	[.726 .840]	[.911 .984]	[.000 .015]
Unix e-mail	.717 (.100)	.901 (.044)	.012 (.010)	.716 (.099)	.779 (.090)	.042 (.025)
	[.459 .840]	[.783 .976]	[.000 .033]	[.448 .835]	[.584 .900]	[.000 .086]
Exchange e-mail	.804 (.037)	.805 (.171)	.019 (.044)	.806 (.040)	.799 (.247)	.040 (.079)
	[.687 .838]	[.210 .919]	[.000 .184]	[.678 .855]	[.148 .953]	[.000 .263]
Library catalog	.729 (.026)	.817 (.032)	.020 (.011)	.754 (.023)	.722 (.034)	.027 (.020)
	[.683 .783]	[.737 .857]	[.000 .054]	[.707 .796]	[.637 .794]	[.000 .071]
Knowledge base	.730 (.033)	.517 (.108)	.043 (.028)	.732 (.044)	.418 (.135)	.068 (.048)
	[.680 .787]	[.337 .678]	[.000 .107]	[.641 .794]	[.209 .676]	[.000 .178]
Software download	.815 (.072)	.638 (.222)	.058 (.046)	.812 (.084)	.539 (.233)	.082 (.075)
	[.617 .887]	[.265 .867]	[.000 .157]	[.614 .891]	[.197 .815]	[.000 .234]
Web site hosting	.718 (.029)	.396 (.065)	.093 (.048)	.737 (.020)	.270 (.041)	.122 (.038)
	[.667 .779]	[.306 .498]	[.000 .173]	[.691 .764]	[.194 .329]	[.000 .185]
Network storage	.747 (.045)	.102 (.036)	.190 (.069)	.760 (.047)	.070 (.028)	.225 (.091)
	[.682 .842]	[.057 .162]	[.000 .280]	[.651 .830]	[.026 .111]	[.000 .375]
OnCourse CL	.739 (.052)	.869 (.151)	.025 (.038)	.751 (.084)	.830 (.174)	.024 (.030)
	[.598 .789]	[.383 .975]	[.000 .148]	[.526 .837]	[.273 .963]	[.000 .112]
Student self-service	.746 (.057)	.934 (.079)	.007 (.006)	.817 (.036)	.930 (.093)	.007 (.014)
	[.668 .880]	[.694 .988]	[.000 .019]	[.756 .893]	[.684 .997]	[.000 .049]
Financial information	.698 (.025)	.438 (.054)	.043 (.029)	.691 (.021)	.376 (.044)	.076 (.039)
	[.662 .767]	[.297 .527]	[.000 .127]	[.654 .725]	[.298 .455]	[.000 .137]
Purchasing & accounts	.658 (.034)	.324 (.044)	.048 (.038)	.661 (.053)	.288 (.065)	.080 (.050)
	[.602 .707]	[.243 .433]	[.000 .139]	[.575 .767]	[.176 .417]	[.000 .162]
Supercomputing	.755 (.041)	.114 (.029)	.172 (.062)	.746 (.047)	.082 (.024)	.214 (.081)
	[.682 .819]	[.064 .172]	[.000 .255]	[.660 .824]	[.022 .122]	[.000 .324]
Stat/Math computing	.732 (.032)	.144 (.043)	.204 (.064)	.745 (.032)	.080 (.038)	.212 (.084)
	[.676 .780]	[.083 .203]	[.000 .293]	[.681 .797]	[.017 .198]	[.000 .323]
Visualization lab.	.765 (.070)	.044 (.020)	.236 (.094)	.773 (.071)	.049 (.017)	.271 (.111)
	[.606 .871]	[.014 .078]	[.000 .361]	[.657 .934]	[.029 .072]	[.000 .407]

Source: Uniersity Information Technology Services, Indiana University (1998-2014)
* Standard deviation in parenthesis and range in braket.
* The average score without usage and unawreness is reported for IT expertise, importance, and ownership.

The average information technology competence was about .60 out of 1.00 and ranges from .52 in 1998 to .64 around 2010 in both campuses (Figure 3 and Table 1). This mean has increased gradually and showed a stable and consistent pattern. The average of individual difference in IT competence between IUB and IUPUI is almost zero and suggests no signficant regional difference (t=-1.661, df=16, and p<.116). About 43-45 percent of respondens have rated their competence as intermediate (.5), while 36 percent as high (.75),

7-9 perceint as very high, and 12 percent as low in both campuses (Figure 5). Figure 6 indicates that faculty, staff, and students have almost same and stable level of IT competence over time without significant regional difference. It is counterintuitive and surprising to find relatively consistent and stable IT competence across year and group. The average IT competence of Unix and Linux users was .83, about .20 higher than .58 for Windows users and .60 for Mac OS clients at IUB ($p<.000$) (Figure 7).[5] Similarly, IUPUI Unix/Linux users have higher IT competence (.78) than Windows and Mac OS users (60 and 62%) at the .01 significance level, but there is no significant difference between Window and Mac OS users ($p<.130$).

* Figures 5, 6, and 7 about here

Figure 3 and Table 1 also suggests that the importance of information systems and IT services has been on average .84 with a narrow range from .77 to .90 in both campuses without discernable regional difference ($p<.950$). Like IT competence, this figure has remained stable but rarely changed dramatically for the past 17 years. IT competent users tend to report higher and consistent importance than less IT competent users (Figure 8); faculty and staff members appear to rate the importance higher than students (Figure 9); Unix/Linux users show larger fluctuation in importance, probably due to its small portion, than Windows and Mac OS users report (Figure 10).

* Figures 8, 9, and 10 about here

The ownership of desktop or laptop computer at residence has increased from 47 percent in 1991 and 79 percent in 1998 to 86 in 2000, 97 in 2005, 98 in 2010, and 99 in 2014 at IUB (Figure 4 and Table 1). These figures are significantly higher than national computer use rates of 42 percent in 1990, 62 in 2000, 77 in 2010, and 81 in 2014 (Fox & Rainie, 2014). The computer ownership was 99 percent and the portion of smartphone and/or tablet PC (e.g.,

[5] In this research, Windows users are defined as those who use Windows only; Mac OS users are those who use Mac OS or Mac OS and Windows; Unix/Linux users are those who use Unix/Linux regardless of whether they use Windows and/or Mac OS.

Palm Pilot, iPAQ, iPad, Gallaxy Tabs, etc.) users was 72 percent in 2013, while corresponding figures were 84 and 64 percent, respectively, in File and Ryan (2014). Both campuses do not show significant difference in computer ownership for the past 17 years (t.=-1.047, p<.311). As expected, IT competent users are more likely than their less competent counterpart to own desktop or laptop computers but this difference diappeared after the saturation point in the early 2000s (Figure 11). Faculty and students are more likely than staff merbers to own desktop and/or laptop but this gap also disappeared gradually (Figure 12).

* Figures 11 and 12 about here

Figure 4 also illustrates that Windows users have increased from 84 percent in 1998 to 93 in 2005 and then declined down to 81 in 2010 and 71 in 2014 at IUB (89, 95, 92, and 80 percent, respectively, at IUPUI). At IUB, the portion of Mac OS users was 15, 9, 27, and 39 percent during the same period, while the figure for Unix or Linux has gradually increased from 1.8 percent in 1998 to 2.1 in 2005, and 4.4 in 2010 and 2014. IUB users used more Mac OS (19 versus 13 percent) and less Windows (85 versus 91 percent) than the IUPUI counterpart (p<.000).

Figures 13-27 consist of four graphs that are interpreted in a same manner. The first graph of Figure 13 depicts average satisfaction score, satisfaction rate, usage rate, and unawarenens of the overall service ("Overall, how satisfied are you with the computing and computer networking services…"). Both campuses have shown the almost same satisfaction score of .78. Low IT competent users appear to show larger functuations in satisfaction score (see the second graph). The third and fourth graphs suggest that almost all users have used at least one IT services (almost zero unawareness) and low IT competent users are less likely to use the services than the high competent counterpart.

Use of General and Less Sophisticated Information Technology Services

Most IT services are developed to provide general users with basic services and accordingly need to avoid high technological sophistication and do not ask high IT competence. Examples are electronic mail (e-mail), library online catalog, knowledge base, and software download services that are essential for campus life. Unix-based and/or Web-based e-mail service is targeted largely at students. The first and second graphs of Figure 14 illustrates a relatively stable average satisfaction scores of .72 in both campuses with a slump during the e-mail server's transition period in 2001. The third graph shows that the Unix-based e-mail service was used by 90 percent of respondents at IUB and 78 percent at IUPUI ($t=5.382$, $p<.000$), while unawareness was on average below 5 percent in both campuses (Figure 14 and Table 1). Similarly, Microsoft Exchange e-mail service largely for faculty and staff members showed high satisfaction score of .80-.81 and usage rate of 80-81 percent in both campuses despite its start-up period in the late 1990s (Figure 15 and Table 1).[6] Low IT competent users are less likely than those with high competence to use e-mail service and appear to show less stable responses.

* Figures 14 and 15 about here.

Library online catalog and knowledge base services show the similar pattern of high satisfaction score and usage rate with low unawareness (Figures 16 and 17). Since library catalog is widely used, its usage rate has remained around 82 percent at IUB and 72 percent at IUPUI ($t=13.323$, $p<.001$) and its satisfaction score was on average .73 and .75, respectively, with significant regional difference ($t=-4.950$, $p<.001$) (Figure 16). As expected, the unawareness of library catalog was less than 3 percent in both campuses. The usage rate of knowledge base has gradually increased from 34 percent in 1998 to 68 percent in 2012 to have mean 52 percent at IUB, which was significantly higher than IUPUI's average of .42 ($t=6.518$, $p<.000$) (Figure 17). Unawareness was on average 4 percent at IUB and 7 percent

[6] Some (graduate) students are also allowed to use an Exchange account when they become a graduate assistant or research assistant.

at IUPUI (t=-3.136, p<.006). IUB users appear to have higher IT competence than their IUPUI counterpart. Satisfaction score of knowlege base was .73 in both campusese. Power users with higher IT competence are more likely than less competent end users to use the knowledge base service. Figures 16 and 17 show that users with low IT competence responded in a less stable manner. Like knowledge base, software download service has shown an growing usage rate of 64 percent ranging from 26 percent in 1998 to 87 in 2011 at IUB and 54 percent with minimum 20 and maximum 82 percent at IUPUI (t=6.753, p<.000) (Figure 18). Its satisfaction score was around .81 across year in both campuses and unawreness was 6 and 8 percent, respectively. Again high competent users are more likely to use the software downlod service than end-users with low competence who responded with a larger variation.

* Figures 16, 17, and 18 about here.

Use of General and Sophisticated Information Technology Services

The Research Technologies Division provides network storage and Web site hosting services that require relatively high IT competence. Web site hosting and publishing service has shown its average usage rates of 40 percent at IUB and 27 percent at IUPUI with significant regional difference (t=9.908, p<.000) (Figure 19). High IT competent users are more likely than low competent group to use the Web site hosting and publishing service. Unawreness of this service was on average 9 and 12 percent, respectively (t=-3.275, p<.005). Average satisfaction scores were .72 and .74 without discernable regional differenc. Similarly, network storage service have shown satisfaction scores of .75 at IUB and.76 at IUPUI with a large variance for less IT competent users (Figure 20). Due to the high technological sophistication of the network storage service, however, only small portion of users are aware of and use this type of service. The useage rates were 10 percent at IUB and 7 percent in IUPUI with minor fluctuation across year (t=6.018, p<.000), while its unawreness was 19

and 22 percent, respectively (t=-4.076, p<.001). This result is puzzling because more and more people are expected to use these network storange and/or equivalent cloud computing services (e.g., box.com) as they have become pervasive.

* Figures 19 and 20 about here.

Use of Specialized and Less Sophisticated Information Technology Services

Oline collaboration learning environment (OnCourse) is used by students and faculty memberrs and student self-service by graduate and undergraduate students. The usage rate of Web-based distributed learning environment has remained almost 87 percent at IUB and 83 at IUPUI and its unawreness has gradually decreased to have an average of 3 and 2 percent, respectively, after its start-up period before 2000 without regional difference (Figure 21). Satisfaction scores were .74 at IUB and .75 at IUPUI with marginally significant difference (t=-2.866, df=14, p<.013). Users appeared to feel unconfident using a renewed service during the transition period to OnCourse CL in 2008. End users with low IT competence are less like to use this service and show a large variation in their responses.

Student self-service allows graduate and undergraduate students to register classes, check their transcript and bursar account, and/or make a payment online. As expected, this servie has shown very high usage rate and low unawareness after its start-up period before 2002 (Figure 19). Almost all students (93%) have used this service and only .7 percent have not been aware of this service in both campuses. Ths average satisfaction was .75 at IUB and .82 at IUPUI with minor fluctuation (t=-6.675, df=14, p<.000). Since the service is easy to use, IT competence does not matter much in average satisfaction, usage rate,and unwareness between graduange and undersgraduat studednts.

* Figures 21 and 22 about here.

Faculty and staff members are eligible for Kuali financial informaiton serive and purchasing and accounts payable service. The usage rate of Kuali was 44 percent at IUB and

38 percent at IUPUI (t=5.794, p<.000) and its unawareness was 4 and 8 percent, respectively (t=-5.875, p<.000) (Figure 23). IT competent users are more likely than low competent group to use financial information service. The satisfaciton scores were .70 at IUB and .69 at IUPUI without significant regional difference. The usage rate and satisfaction score of the purchasing and accounts payable service were lower than those of financial informaiton service. The usage rate was 32 percent at IUB and 29 percent at IUPUI (t=2.446, p<.026), while satisfaciton score was .66 in both campuses. The unawareness rates were 5 and 8 percent, respectively (t=-4.773, p<.000). Again IT comptent users show higher usage rate and more consistent responses than end users with low IT competence. Staff members are more likely than faculty member to use financial information services (48 versus 27 percent, t=18.862, p<.000) and purchasing and accounts payable (42 versus 30 percent, t=6.002, p<.000) in both campuses, but there is no significant gap in unawareness.

* Figures 23 and 24 about here.

Use of Specialied and Sophisticated Information Technology Services

Research Technologies Division also provides supercomping or high performance computing (HPC) serives and related applicaiton services of statistical and mathematical computing, advanced visualizaiton laboratory, and life science (bioinformatics) research for science and medical schools. Usage rates are very low and unawareness is higher than other services, as expected. The usage rate of supercomputer was on average 11 percent at IUB and 8 at IUPUI (t=4.641, p<.000) and its unawreness was 17 and 21 percent, respectively (t=-4.762, p<.000) (Figure 24). These fugires has remained almost unchanged for the past 17 years.[7] Unix/Linux users appear to be more likely to use and be aware of supercomputer than Windows and Mac OS users. Faculty and graduate students are more likely than staff to use supercomputer, while students' unawareness of supercomputer is slightly higer than those of

[7] Since 2014 Survey introduces "Not Applicable" instead of "Never heard of service" and "Cannot evaluate," unawareness was not calculated separately in 2014. The unawareness in 2014 in figures should be read with special caution.

faculty and staff members. This result reflects the fact that supercomputer and high performance computing services require hard and soft IT competence to take full advantage of them. Despite its cutting-edge technology and high cost, the supercomputer service reports a bit lower satisfaction score of .75 than other supercomputer-related services in both campuses ($t=.759$, $p<.459$).

* Figure 25 about here.

The statistical and mathematical computing service by Research Analytics has showed low usage rates of 14 percent at IUB and 8 percent at IUPI ($t=7.034$, $p<.000$) without any significant fluctuation (Figure 26). The unawareness was 20-21 percent and has decreased over time in both campuses. However, the average satisfaction scores were as high as .73 at IUB and .74 at IUPUI. IT competent users are more likely to use and be satisfied with this service. The advanced visualization laboratory serivce is targeted at faculty and staff members in science and engineering and accordingly showed very low usage rate of 4-5 percent and relatively high unwareness of 24 percent at IUB and 27 percent at IUPUI ($t=-4.086$, $p<.002$) (Figure 27). Its average satisfaction score was .76 at IUB and .77 at IUPUI. Although this service was not asked during the later part of the 2010s, there has been no significant flucation in satisfaction, usage, and unawarenes after 2002.

* Figures 26 and 27 about here.

DISCUSSION

The most striking finding is that self-reported information technology competence with soft and hard IT competences combined has remained almost unchanged rather than has increased over time. This IT competence may not be absoute IT competence but relative one. As shown in Figure 3, the relative IT competence (computer expertise) of a state university community was about .60 out of 1.0 without significant difference between rural and urban campuses and neither increased nor decreased significantly for the past 17 years. Since a

university community is one of the highly IT competent groups, ordinary citizens are likely to rate their IT competence and the importance of information systems and IT services lower than university communities. They also tend to have lower computer ownership than univeristy community members although this ownership will not matter much once it reaches its saturation point. In the 2013 UITS servey, almost all students, faculty, and staff (99%) own desktop or laptop and 72 percent use smartphone or tablet PCs, while 84 and 64 percent of Amerian hourseholds own computers and smartphone/table PCs, respectively (File & Ryan, 2014).

It will be true that *absolute IT competence* has increased as informaiton technology has become indespensible to daily life in the informaiton era. However, why has self-reported *relative IT competence* remained almost stable and consistent? The answers involve examining development of information technology and users' attitudes toward learning and use of IT devices and services.

Information technolgy has been developing unprecedently fast and widely so that individual citiznes are oftentimes overwhemed. It is not likely that even a computer scientist knows all aspects of information technology. One consequence of rapid technology development is the polarization in IT competence. The IT competent grow more competent and the IT incompetent get more incompetent. Since it is not easy to understand core IT knowledge and up-to-date technologies, most users tend to give up learning computer knowldege but concentrate on soft IT competence. By contrast, high IT competent users are more likely than less competent group to use knowledge base and solve problems by themselves (Figure 17) and to use software download and statistical and mathematical computing services (Figure 18 and 26). Therefore, the gap between high and low IT competent users has widened but the average score of IT competence has remained almost unchanged. In addition to the speed of technology advancement, the development in

user interface and digital convergence (integration with other technologies) provides standardized and easy ways of using IT devices and services so that even children and old citizens feel comfortable using them without hard IT competence.

On the other hand, most users want to aquire the minimum level of IT competence, mostly soft IT competence, that is necessary to use IT devices and services. They are not willing to go beyond the minimum requirement and become more competent than required. It is not surprising, however, that rational users calculate their optimal level of IT competence to minimize cost, time, and effort for learning. Accordingly, most citizens are not willing to use IT devices and services that are complicated and difficult to use. E-mail and library catalog services have showed 80-90 percent usage rate, while network storage and supercomputing services have been used by 10-11 percent of respondents with 17-19 percent of unawareness at IUB for the past 17 years (Table 1, Figures 14-16, 25). This market demand leads IT vendors and developers to provide IT devices and services with high accessiblity and usability and again reduces the minimum level of IT competence that users have to have. Accordingly, most users tend to concentrate on IT skills rather than knowledge that are necessary to use IT devices and services. As a consequence, service provision (quality) and demand (need or expectation) are mutually adjusted to stay at a certain market equilibrium where extremely high quality of service and satisfaction are rarely observed.

Less IT competent users appear to have misunderstandings of soft and hard IT competence. As information technology evolves, people are more interested in IT operations and object rather than IT knowledge. They oftentimes fail to distinguish hard IT competence from soft competence and then unconsciously displace hard competence with soft one. They appear to perceive owning (and using) computer or tablet PC/smartphone itself as (hard) IT competent. Hence, their hard IT competence remained almost unchanged, while their perceived soft competence have increased in proportion to ownership and experiences with

IT devices and services (Figure 11). Figure 14 through 27 illustrate that less IT competent users responded in a unstabe and inconsistent manner over time with larger variation and fluctuation than more IT competent group. Self-reported IT competence appears to be less reliable somehow (Merritt, Smith, and Di Renzo, 2005), but Figure 5 suggests that subjective IT competence are stable as a whole with a small portion of too high or too low competence.

The young generation tends to be more exposed to IT devices and services than their old counterpart when they started to learn informtion technology. Hence, there might be gap in IT competence between old and young generation and between faculty/staff members and students. Figure 6, however, evidences no significant gap among faculty, stafff, and students. It is another surprising and counterintuitive finding. IT ownership appeared to be associated with IT competence before the saturation point in the midst of the 2000s (Figure 11). Unix/Linux users are more likely to have high IT competence than Windows and/or Mac OS clients because Unix/Linux requires basic understandings of information technology.

The usage rate of a sophisticated IT service is substantially lower than that of less sophisticated service. For instance, 10 percent of respondents have used the network storage service, 11 percent for supercomuting, and only 4 percent for the advanced visualization laboratory service at IUB, whereas 93 percent of students have used self-service, 87 and 82 percent for OnCourse CL and libary online catalog services, respectively, for the past 17 years. Unawreness was 17-24 percent for these sophisticated IT services and only 1-3 percent for less sophisticated services (Table 1). IT competent users are more likely than the less competent group to use sophisticated services but IT competence does not matter much for less sophisticated services. This result is not surprising because most users do not appear to have sufficient IT knowledge and skills to use advanced IT services and not all people need such services. Also powerful microprocessors available at affordable prices provide alternatives to supercomputing or centralized high performance computing.

The results of survey data analysis are consistent with the technology acceptance model. People are likely to use IT services that are easy to use and helpful to them (Davis 1989); they prefer less sophisticated IT services that bring practical benefits to them. E-mail, library catalog, OnCourse CL, and students self-services, which provice direct benefits to clients, showed relatively high usage rate (Table 1). These services are virtually mandatory in a university and constrased by voluntary services such as software download, Web site hosting, and netowrk storage services. Staff members are more likely than faculty members to use financial information and purchasing and accounts payable services and less likely to use library online catalog and Web site hosting services than faculty and students (Figures 28-31). Whether an IT service serves specific purpose and/or target client does not matter much.

Another finding is that satisfaction and use of information technology services do not always move to the same direction although Iivari (2005) argues that user satisfaction is strongly related to actual use of information systems. For instance, knowledge base and software download have usage rates of 52 and 64 percent at IUB and 42 and 54 percent at IUPUI, but its satisfaction score were about .73 and .82, respectively, in both campuses (Table 1). Network storage, supercomputing and statistical and mathematical computing services showed low usage rates of 10-14 percent at IUB and 7-8 percent at IUPUI, but its satisfaction scores were .74-.76 without regional difference (Table 1). There is no subtantial difference in satisfaction between sophisticated and less sophisticated IT services. IT use appears to depend more upon ability (knowledgeable and easy to use), willingness (helpful to users), and pressures to use the IT services, while satisfaction appears to be involved with users' subjective expectation. Highly sophisticated IT services are often used by a small group of people who have necessary knowledge and skills, but their user satisfaction may not necessarily be higher than less sophisticated counterpart.

CONCLUSION

This study examines if users' informaiton technology competence has increased over time by analyzing the user satisfaction survey data of information technology serices at a state university for the past 17 years. The analysis suggests that the prevailing thought is questionable and even misleading. Most people have a relatively stable IT competence, usage rate, and satisfaction. Information technology has developed fast and provided highly user-friendly interfaces of IT services, whereas most users want to use IT devices and services with minimum effort and avoid sophisticated technologies and services. Users tend to be unable to distinguish hard IT competence from soft competence correctly and focus on practical skills and experiences. The usage rates of sophisticated IT services are significantly lower than those of less sophisticated services. User satisfaction is loosely related to the use of IT services and appears to be more associated with users' expectation. These findings provides understandings of users' IT competence and perception on IT services and thus gives important implications for designing and managing informaiton systems.

The annual survey data employeed here have strength in random sampling, response rate, and longitudinal (not panel) nature. As Devaraj and Kohli (2003) argue, however, self-reported usage and satisfaction are likely to be biases somehow. And the data do not include basic demographics such as gender, age, and income. The population is faculty, staff, and students of an American state univeristy that provide advanced IT services that other institutions in the public and private sectors. Hence, IT competence, usage rates, and unawareness obtained from a secondary educational organization may not be generalized to ordinary citizens, government, and for-profit sectors. Users' IT competence and usage rates of IT services in this study appear to be overestimated compared to national average, whereas the unawareness of IT services will be underestimated somehow.

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Fig. 3. IT competence, importance & impact

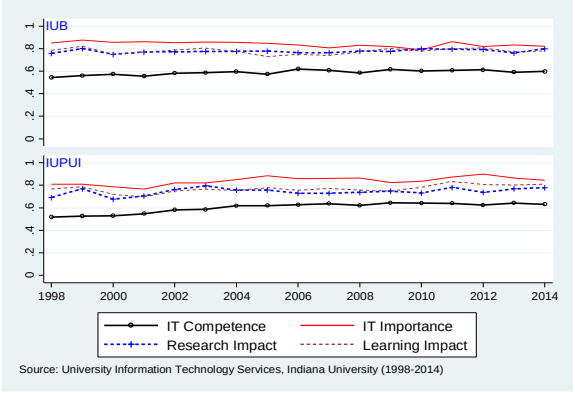


Figure 4. IT ownership and OS use

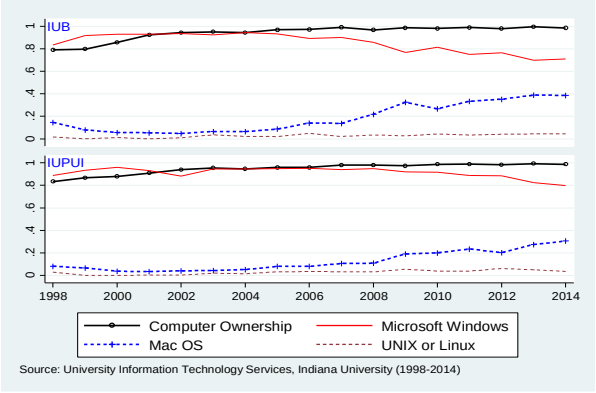


Figure 5. Portion of IT competence level

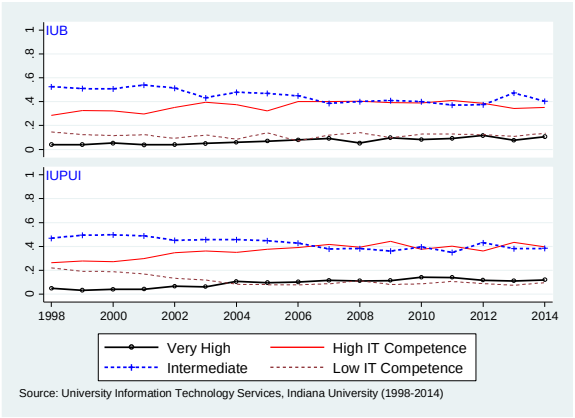


Figure 6. IT competence by group

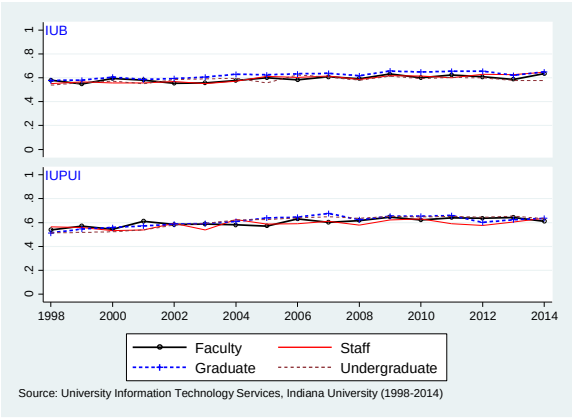


Figure 7. IT competence by OS type

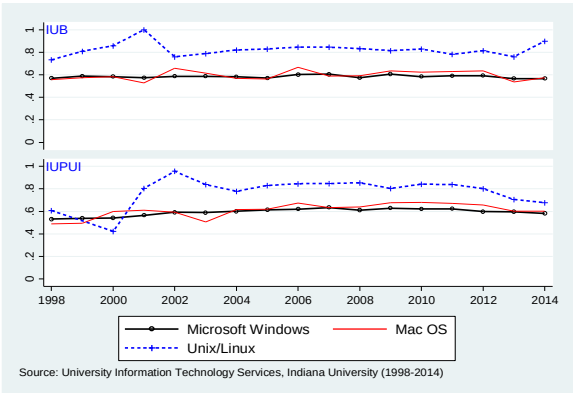


Figure 8. IT Importance by IT competence

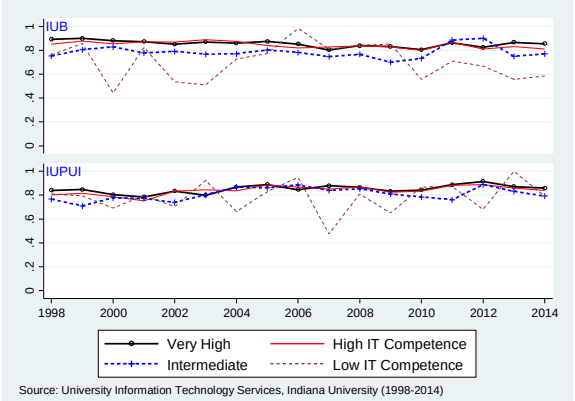


Figure 9. IT importance by group

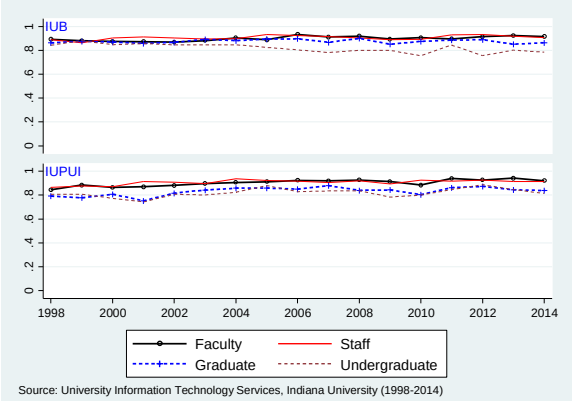


Figure 10. IT importance by OS type

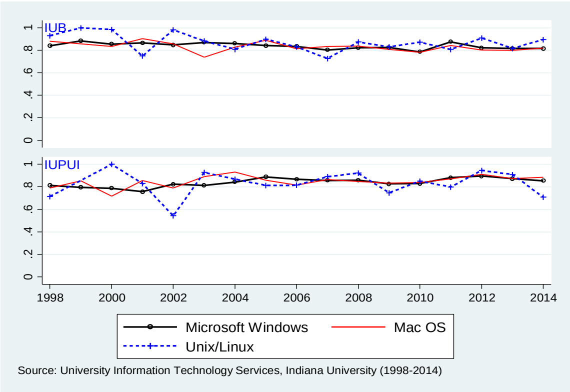


Figure 11. IT ownership by IT competence

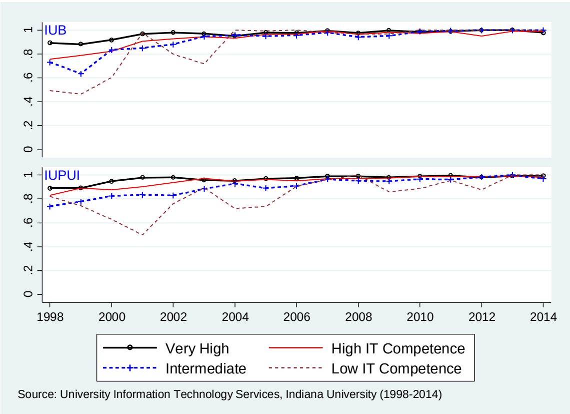


Figure 12. IT ownership by group

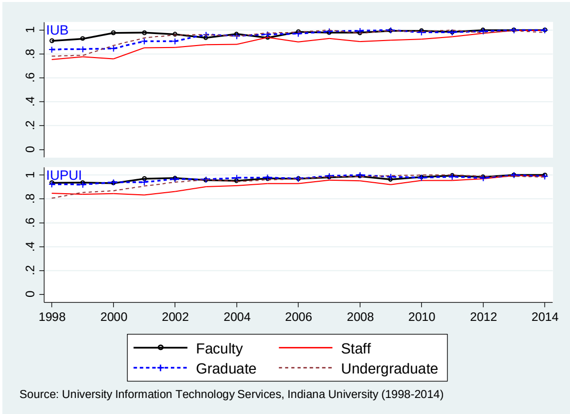


Figure 13. Overall IT services (summary, satisfaction score, usage rate, unawareness)

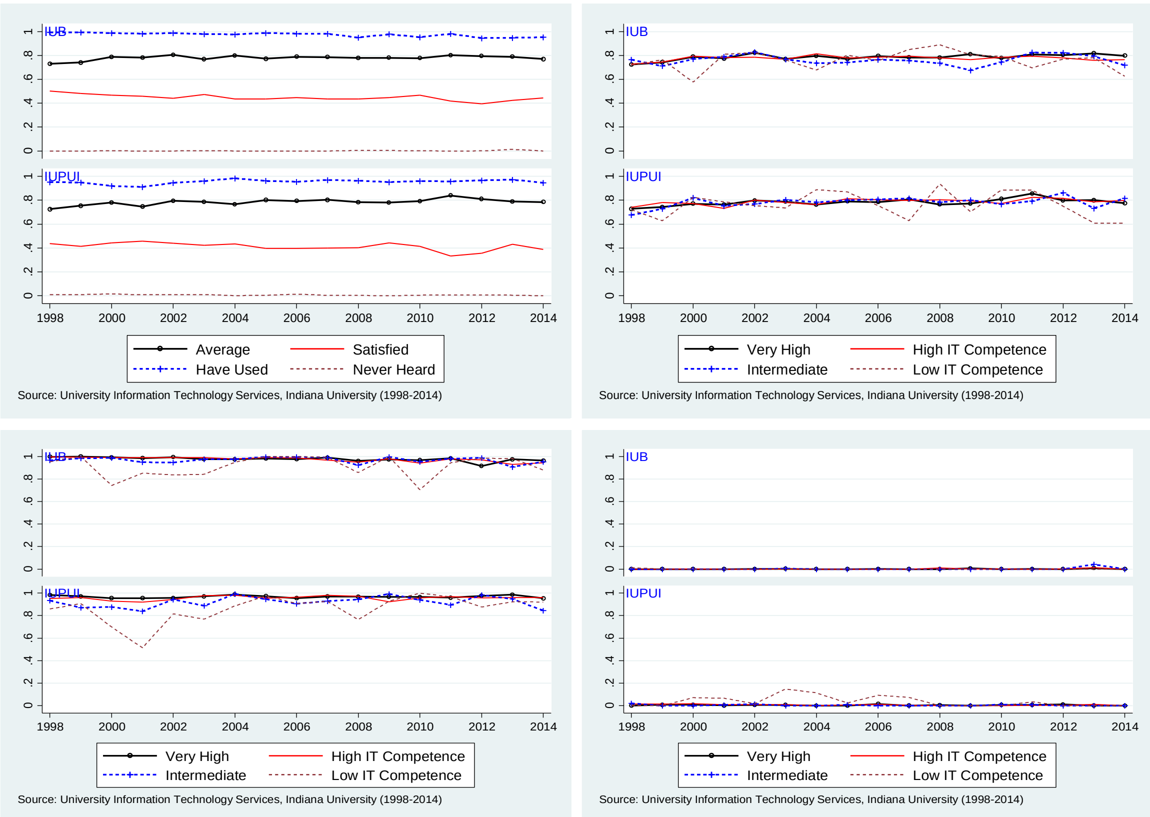
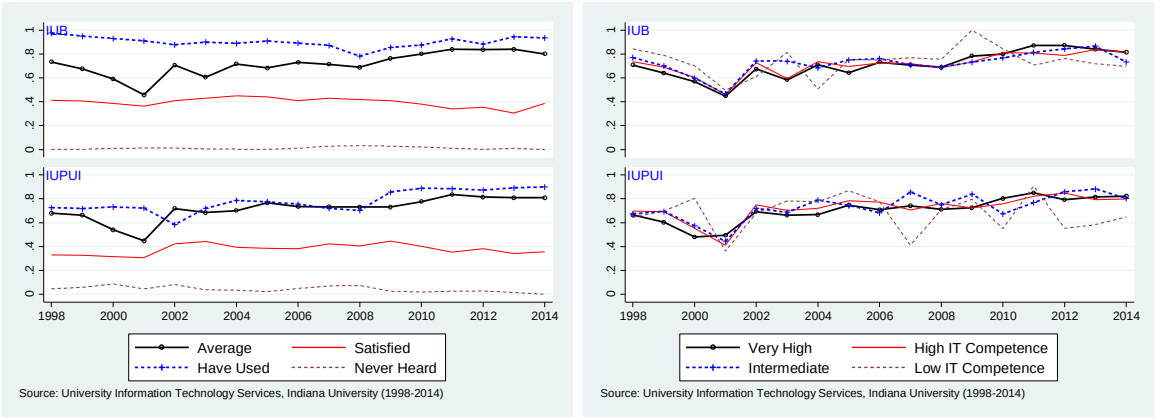


Figure 14. Unix-based e-mail (summary, satisfaction score, usage rate, unawareness)



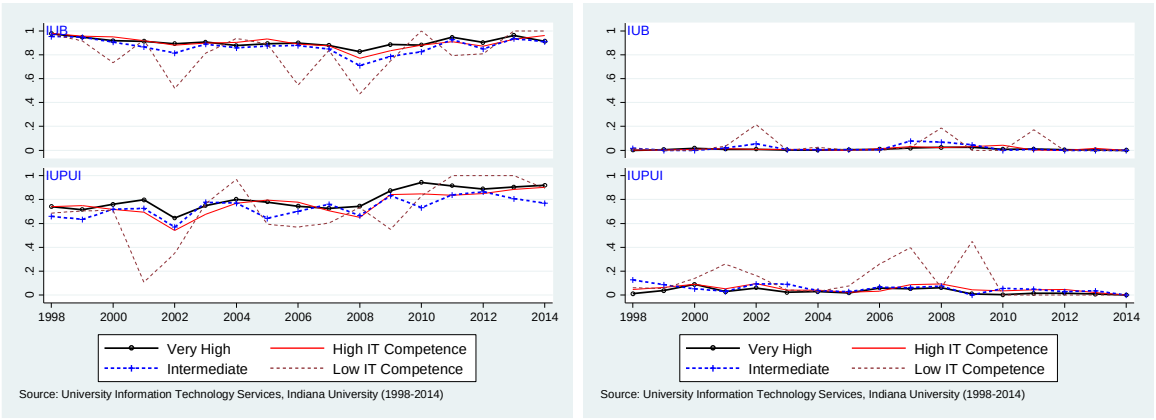
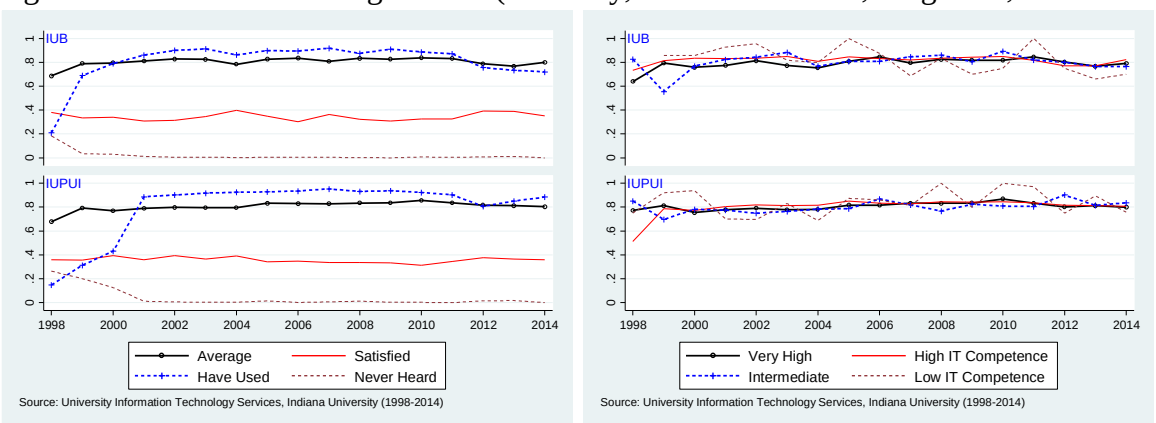


Figure 15. Microsoft Exchange e-mail (summary, satisfaction score, usage rate, unawareness)



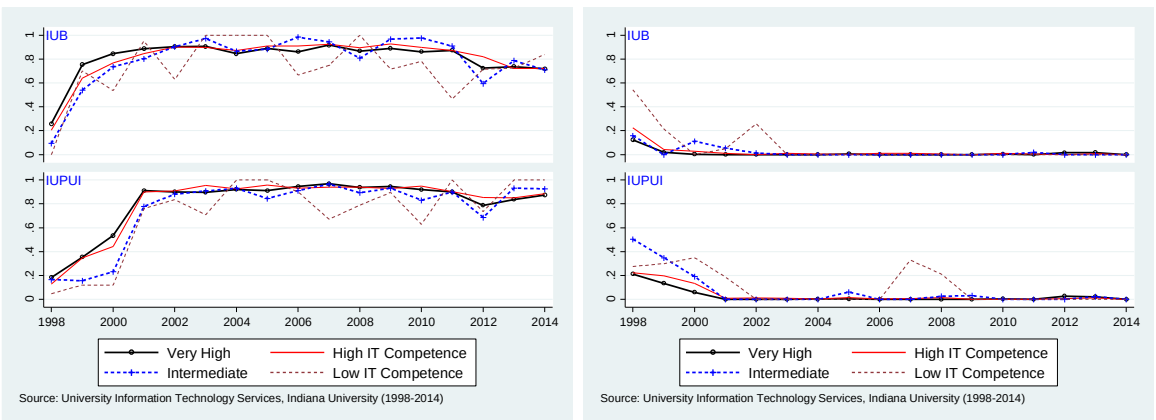
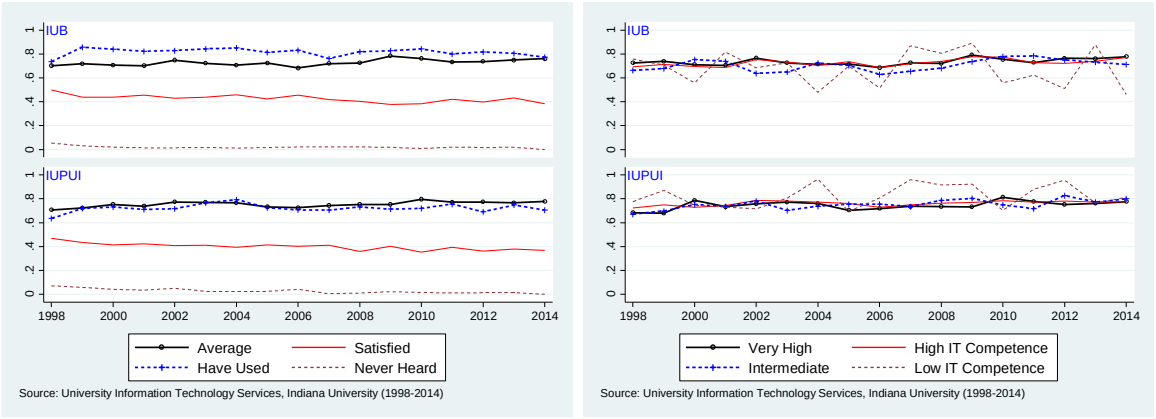


Figure 16. Library online catalog (summary, satisfaction score, usage rate, unawareness)



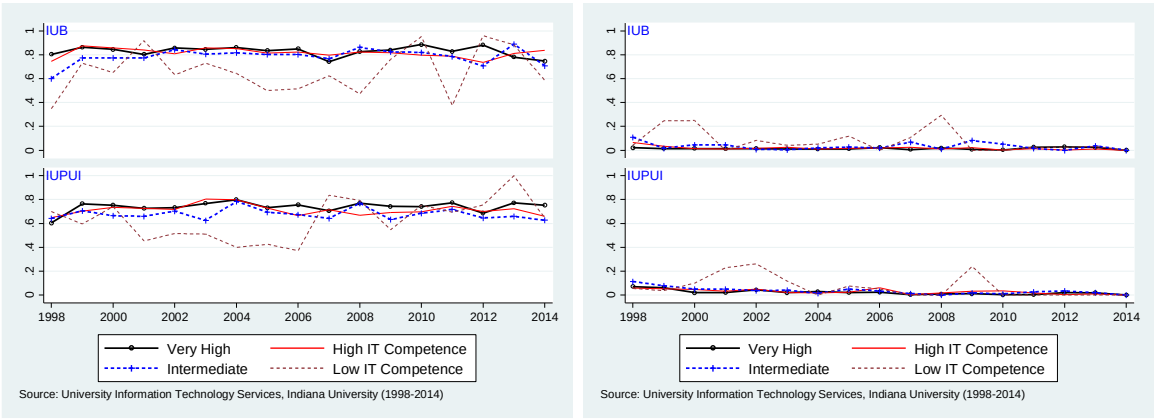
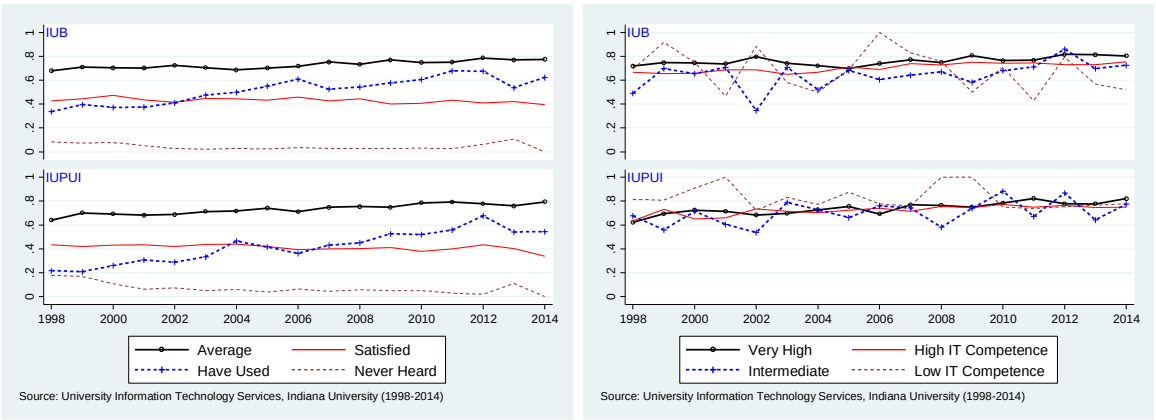


Figure 17. Knowledge base (summary, satisfaction score, usage rate, unawareness)



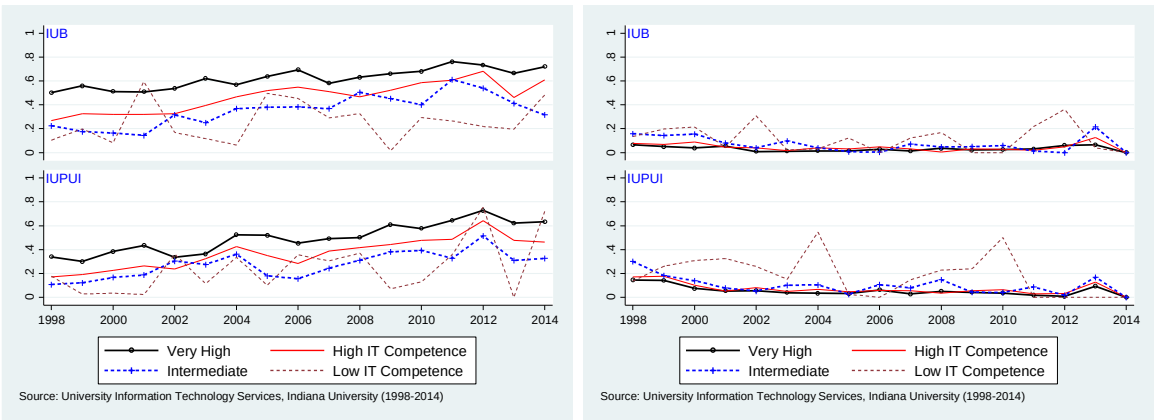


Figure 18. Software download (summary, satisfaction score, usage rate, unawareness)

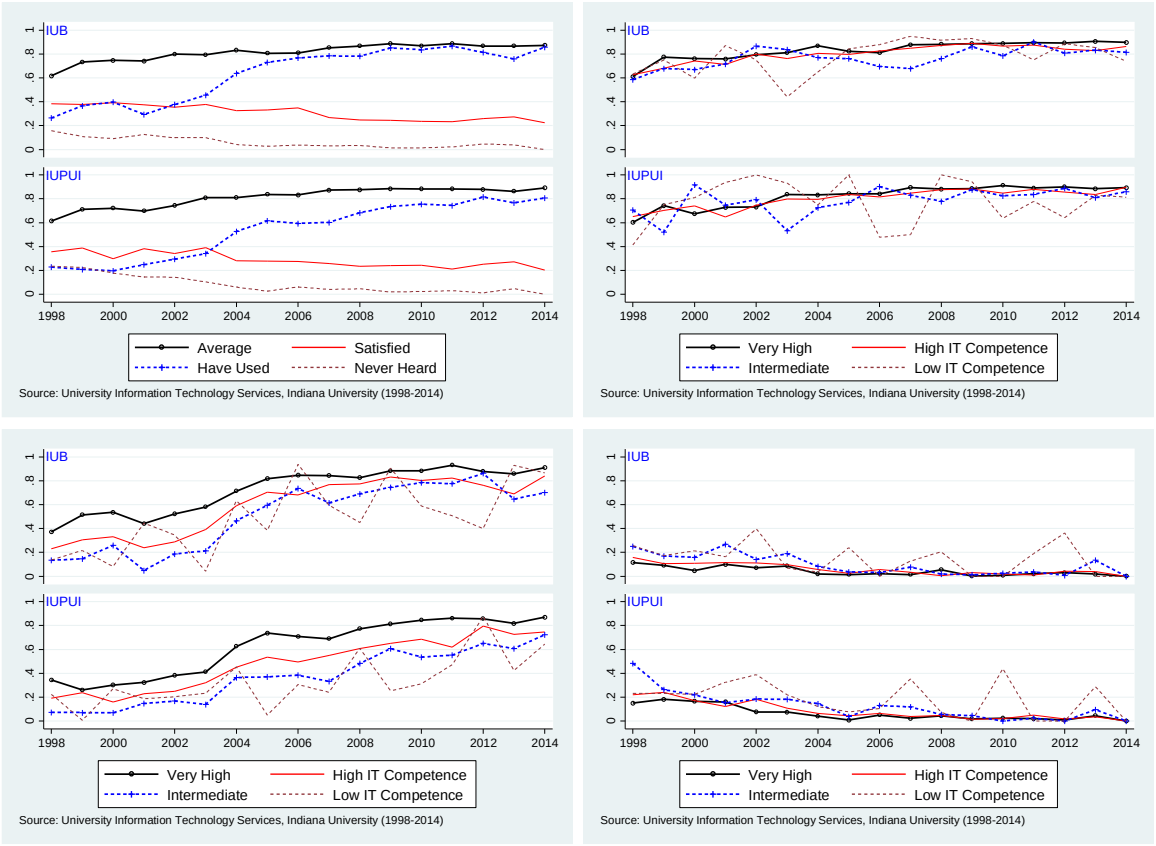


Figure 19. Web site hosting (summary, satisfaction score, usage rate, unawareness)

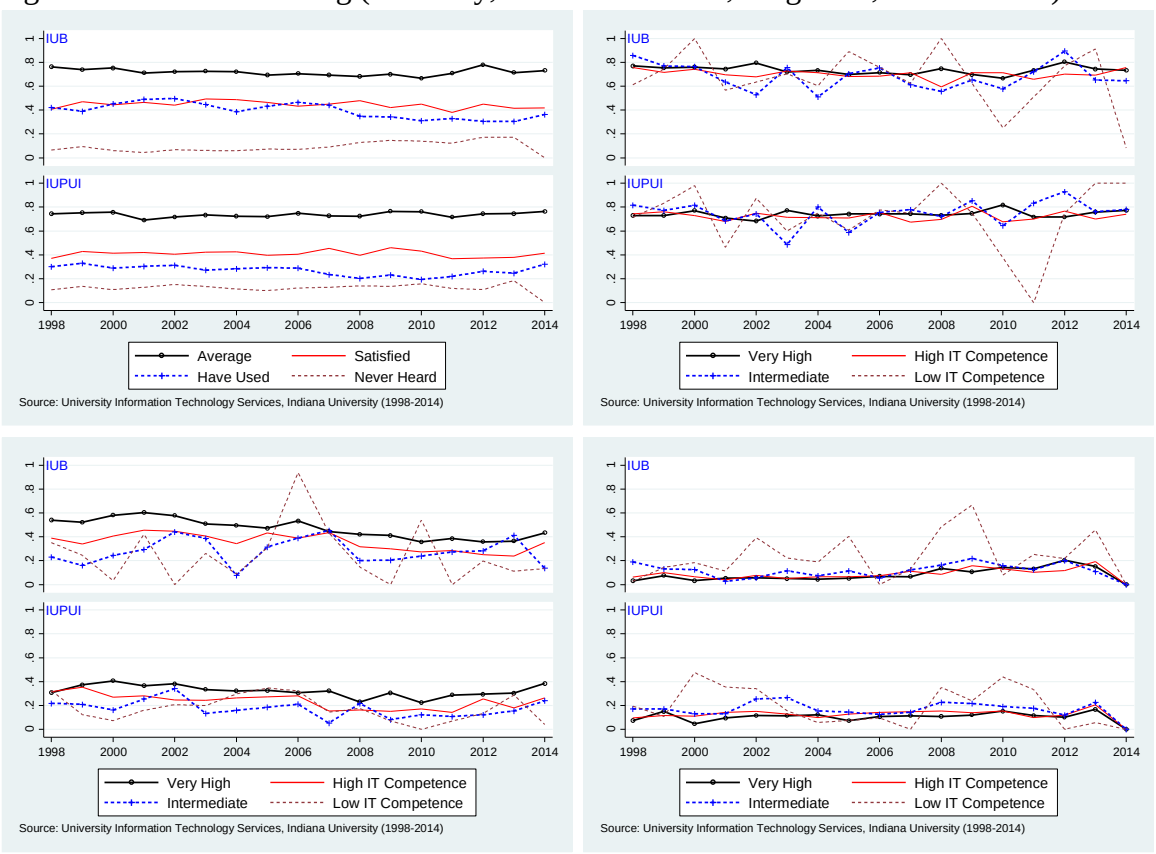
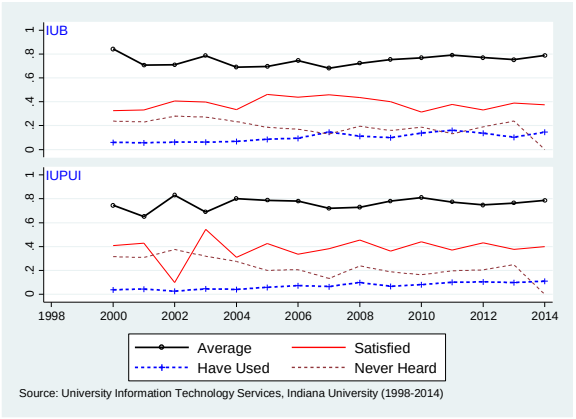
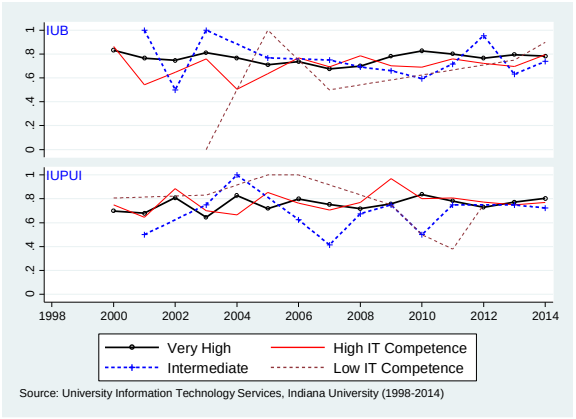
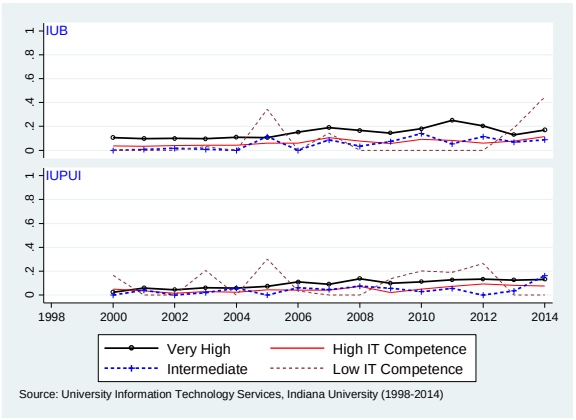


Figure 20. Network storage (summary, satisfaction score, usage rate, unawareness)







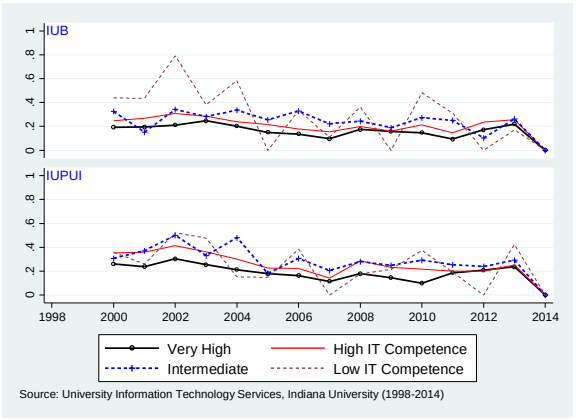
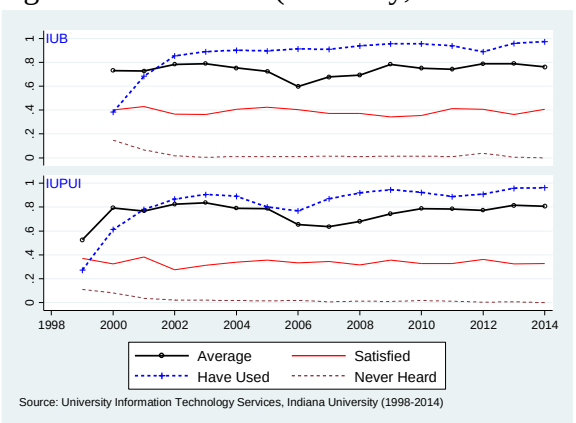
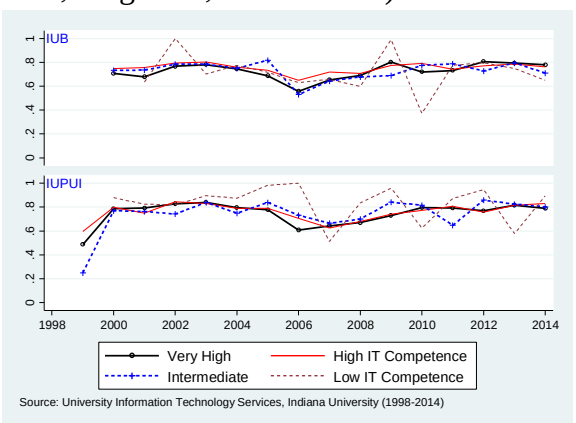
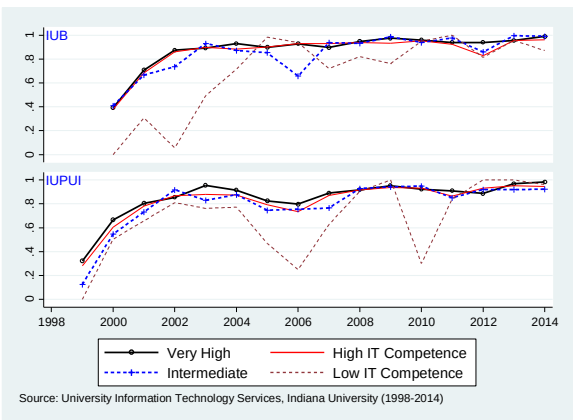


Figure 21. OnCourse (summary, satisfaction score, usage rate, unawareness)







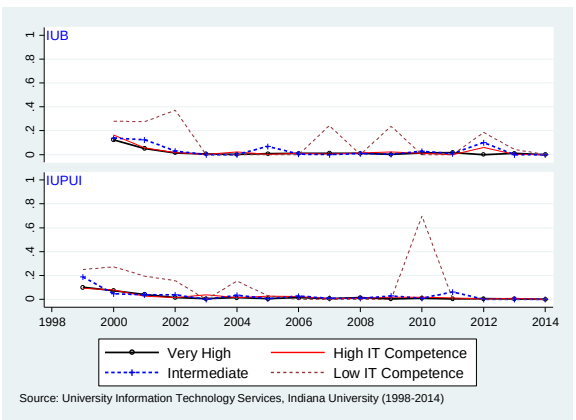
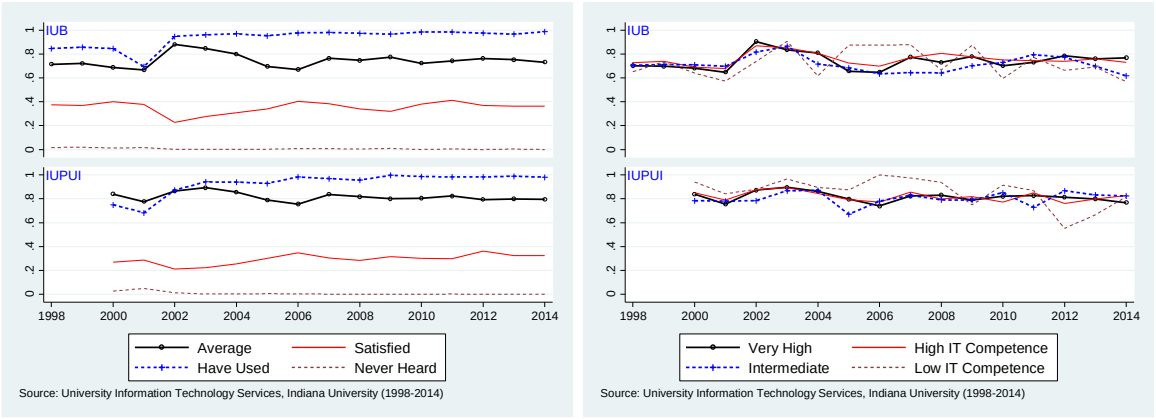


Figure 22.Student self-service (summary, satisfaction score, usage rate, unawareness)



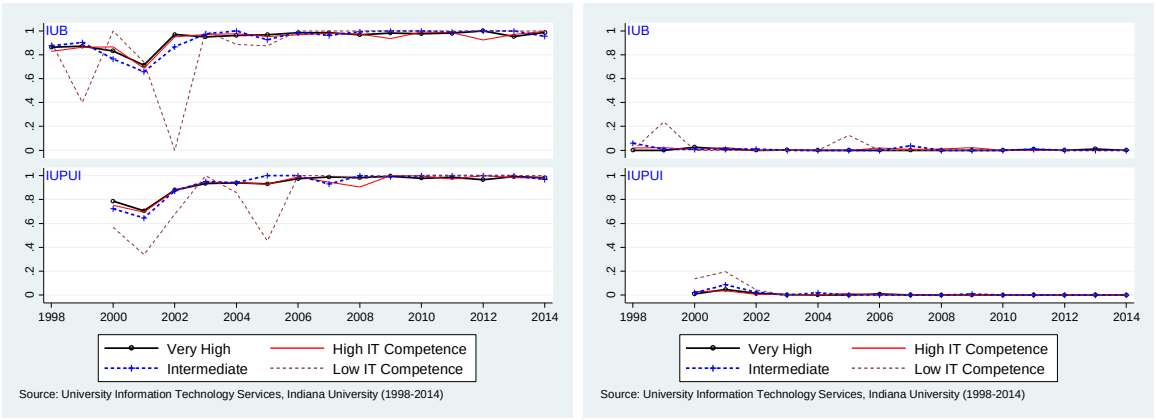
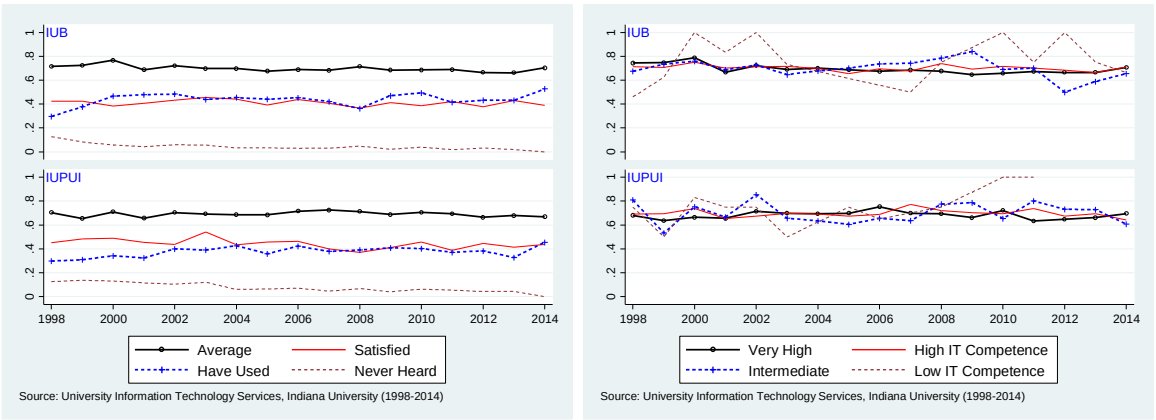


Figure 23. Kuali financial information service (summary, score, usage rate, unawareness)



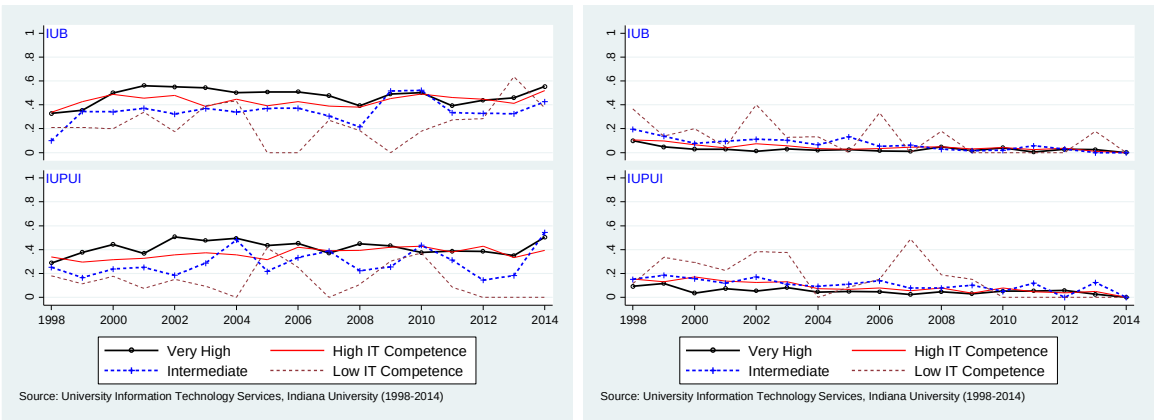
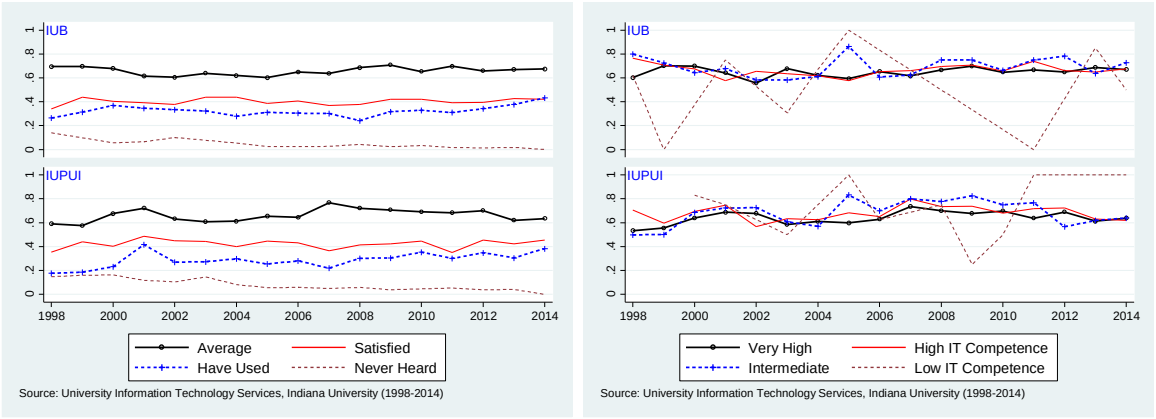


Figure 24. Purchasing & accounts payable (summary, score, usage rate, unawareness)



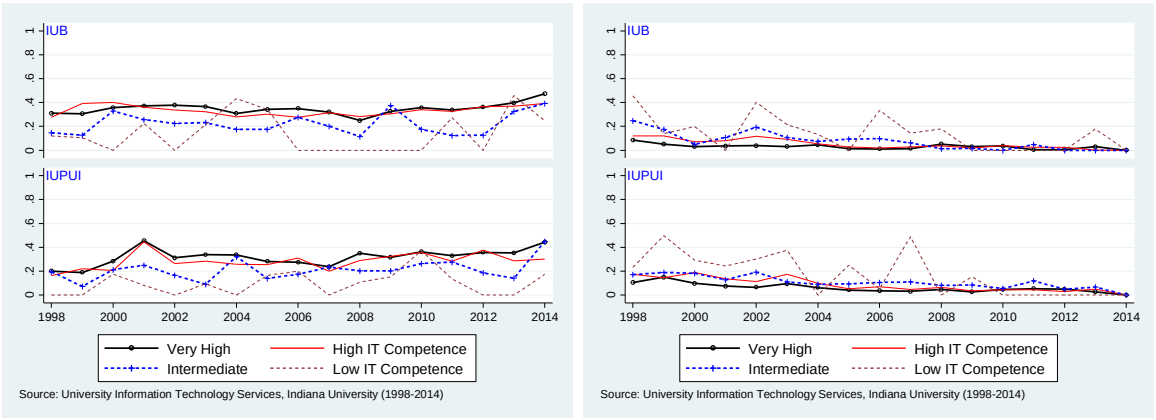
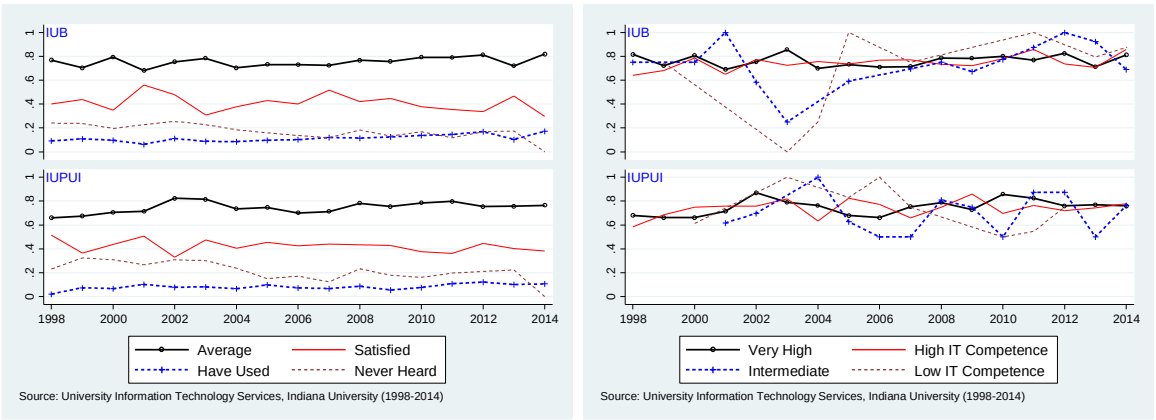


Figure 25. Supercomputer (summary, satisfaction score, usage rate, unawareness)



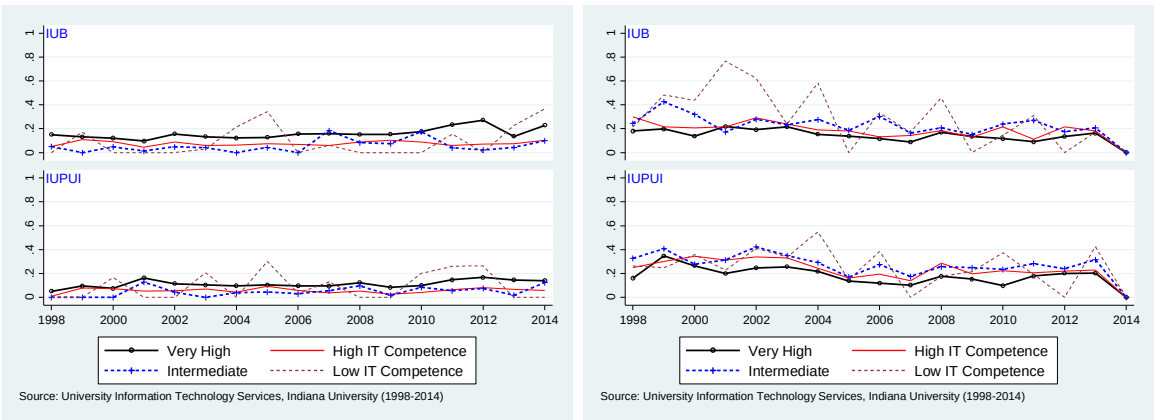
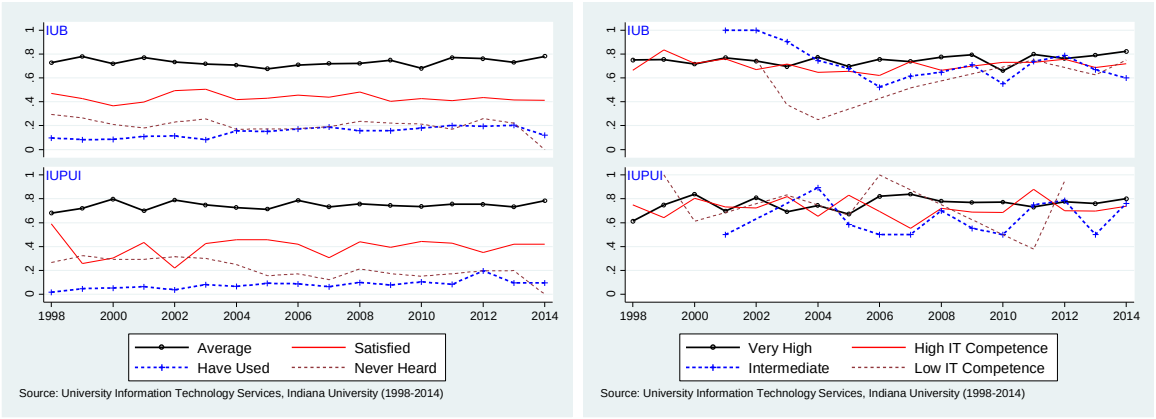


Figure 26. Statistical & mathematical computing (summary, score, usage rate, unawareness)



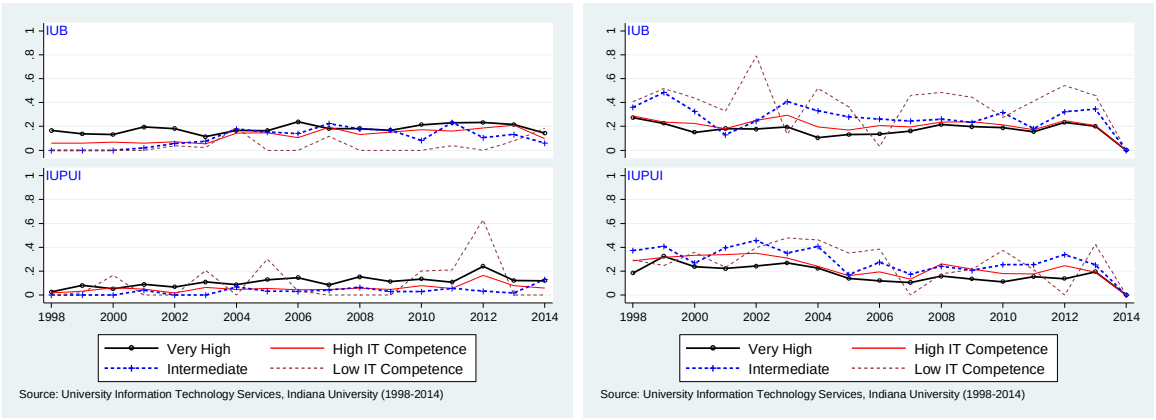
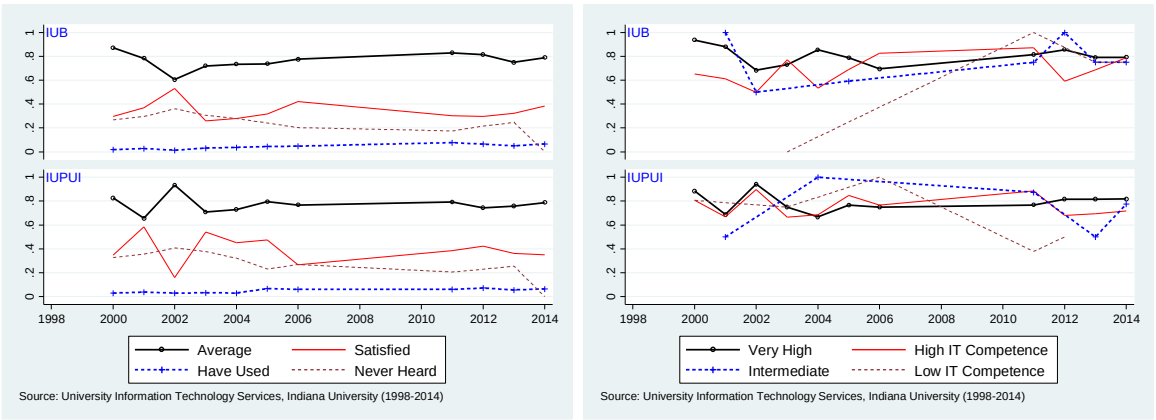


Figure 27. Visualization service (summary, satisfaction score, usage rate, unawareness)



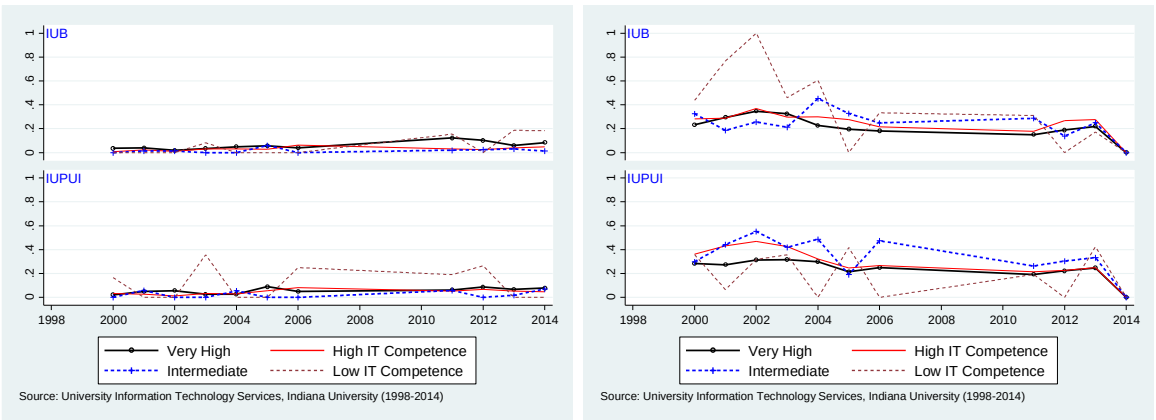
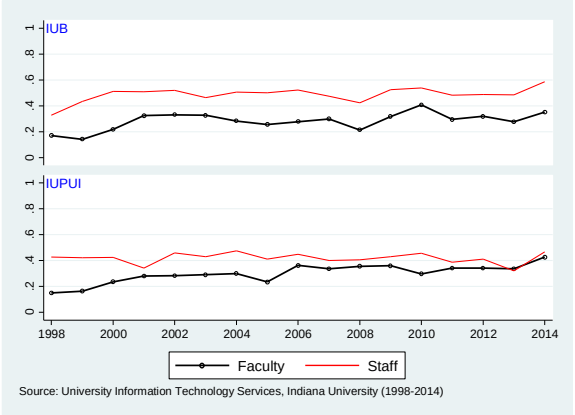
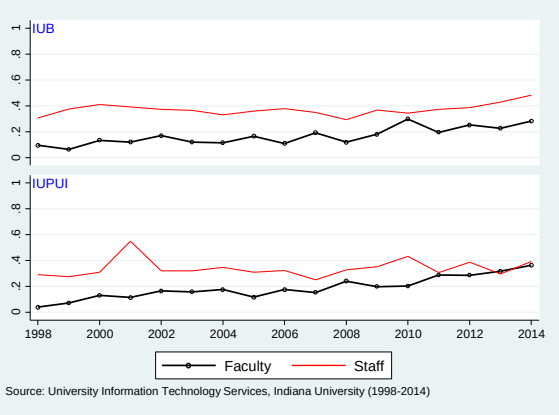


Figure 28. Financial information by group



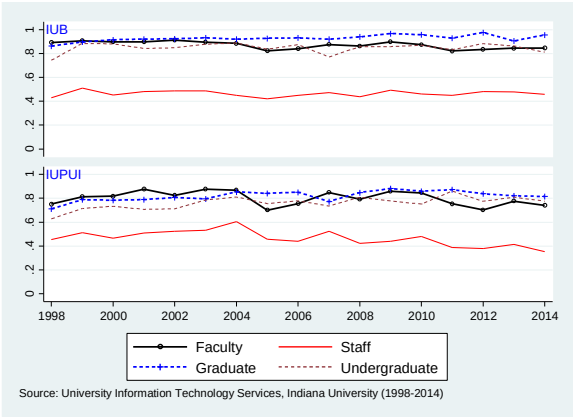
Source: University Information Technology Services, Indiana University (1998-2014)

Figure 29. Purchasing & accounts by group



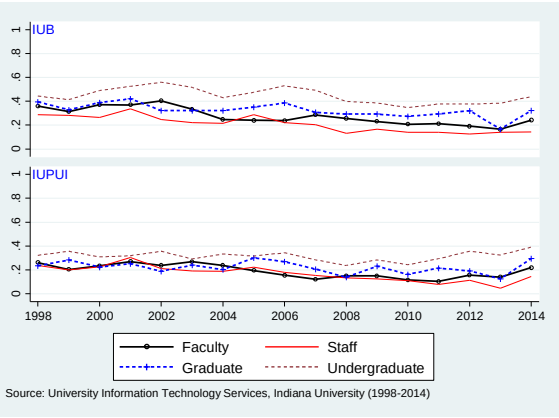
Source: University Information Technology Services, Indiana University (1998-2014)

Figure 30. Library online catalog by group



Source: University Information Technology Services, Indiana University (1998-2014)

Figure 31. Web site hosting service by group



Source: University Information Technology Services, Indiana University (1998-2014)