INFORMATION TECHNOLOGY AND VALUE CREATION IN THE PUBLIC SECTOR ORGANIZATIONS

by

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DEDICATION

I dedicate this work to my parents. Thanks to them, I have never felt away from home.

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One of the things that I have learned during my Ph.D. program is that writing a paper is like a journey. It is a pleasant, but long, hard one. There were many hills and mountains to climb and big rivers and oceans to cross. It is therefore no doubt that I could not have completed this journey without those who have provided me with maps, streetlights, bridges, and guideposts along the way.

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ABSTRACT

In this dissertation, I study the performance impact of information technology (IT) investments in the public sector. IT has been one of the key assets in public administration since the early MIS era. Even though the information systems (IS) discipline has witnessed a considerable amount of research efforts on the subject of IT business value for the last couple of decades, the study on IT value in governments has not been as extensive as in the for-profit domain. A broad range of literature search in the areas of IS, public administration, public economics, and political sciences shows that there have been a limited number of quantitative empirical studies on the performance impact of IT in public organizations. To fill this gap in the literature, the dissertation presents three studies with distinctive theoretical examining the IT value in the public sector.

In the first study, drawing upon the public value management perspective from public administration and the literature on IT resources in the IS discipline, I lay a theoretical foundation for the mechanism in which IT resources contribute to the generation of public value. Specifically, I argue that IT resources create public value by facilitating the four key organizational capabilities in governments - operational capability, communication capability, partnering capability, and innovative capability.

In the second study, I empirically measure the cost efficiency effect of IT investments in the context of U.S. state governments. Estimation with a stochastic

frontier estimation approach with the cost function framework shows that there is a significant efficiency improvement effect of IT in state governments.

In the third study, the performance effect of IT is analyzed from the government growth perspective. Theories on government growth in political sciences and public economics provide theoretical predictions on the influence of IT on government expenditures as well as a basis for empirical estimation. I find that IT investments are associated with smaller expenditure size in U.S. state governments.

Overall, this dissertation contributes to the literature by offering a theoretical framework, empirical methodologies, and conclusive evidence showing the value creation effect of IT in the public sector.

CHAPTER 1.
GENERAL INTRODUCTION

1.1. Research Background

A vast range of research has been conducted in the information systems (IS) discipline for the last couple of decades to find out whether information technologies (IT) provide sufficient payoff, be it tangible or intangible, that can justify enormous investments in IT in the private sector (Brynjolfsson 1993, Bharadwaj et al. 1999, Melville et al. 2004). A large body of studies has provided evidence that IT does contribute to considerable performance improvement and value creation within organizations as well as throughout the entire value chain (Barua et al. 1995, Rai et al. 2005, Banker et al. 2006). However, most studies in the IT value literature, except for ones focusing on healthcare organizations (e.g. Devaraj and Kohli 2000, 2003), have mainly centered on the for-profit business organization context.

While several works have studied IT value in the public sector (e.g. Norris and Kraemer 1996, Lehr and Lichtenberg 1998, Lee and Perry 2002), the literature has not paid as much attention to the performance impact of IT in this sector as in the for-profit sector. I consider this an opportunity for new research for the following reasons. First, the size of the public sector as well as its influence on the overall economy has continued to grow for the last several decades. The ratio of total government spending in the U.S. to gross domestic product (Larkey et al. 1980, North 1985) has grown from approximately 30% in 1970 to 38% in 2008[1].

Second, a vast amount of spending in IT has been made in recent years in this sector. In order to show how the public sector organizations invest in IT compared to for-profit firms, I compare two datasets, as shown in Table 1. For the public sector, *the NASCIO Compendium of Digital Governments in States* published in 2005 provides the entire IT budget (in both central IT functions and executive branches) in 20 U.S. states in the fiscal year 2004. For the private sector, InformationWeek 500 survey in 2005 collects IT budgets per sales in 337 large U.S. firms. Table 1 suggests that IT spending accounts for as significant a portion of expenditures in the public sector organizations as in for-profit firms within the same order of magnitude.

Table 1. Comparison of Private and Public Sector IT Investments

Measure	U.S. State Governments (1) (NASCIO Compendium)	For-Profit Firms (InformationWeek 500)
Annual IT expenditures (thousands $)	337,351	373,339 (3)
IT expenditures per employee ($)	6,793.93	14,738.35 (4)
IT expenditures per revenue (%)	5.00 (2)	3.66 (5)

(1) 20 states; (2) IT expenditures per tax revenues; (3) 337 firms; (4) 201 firms; (5) 248 firms, IT expenditures per sales

The trend that information technologies have become a strategic resource in governments takes place not just in the U.S. but around the world. Delivery of public services via IT and the Internet has been a prevalent phenomenon in European nations. eGovernment Benchmark Survey published by the European Commission evaluates the

[1] http://www.usgovernmentspending.com/charts.html

level of online availability of core 20 public services[2] in 27 member states (European Commission 2010). According to the survey, the online availability[3] of the core 20 services has increased from 20% to 75% from 2001 to 2009.

This is the case in the developing countries as well. The Global E-Government Surveys conducted by United Nations Department of Economics and Social Affairs have reported e-Government Indexes for the entire member counties since 2003. The e-Government Index evaluates the application of IT in governments for better access and delivery of services to citizens and enhanced interactions with citizens and business (United Nations 2010)[4]. Figure 1 illustrates that there is an upward trend from 2003 to 2008 in e-Government Index across the continents outside of North American and Europe, while the indexes in North America and Europe relatively stagnate for the same time period. This illustrates governments in the developing nations are increasingly recognizing the strategic importance of IT in improving government administration and delivery of public services.

A wide range of anecdotal evidence demonstrates that IT in governments creates value to the public in many aspects, in both developed and developing countries. Minnesota's Program Integrity Network (PIN) is a case in point (NASCIO 2006). The State of Minnesota introduced a business intelligence and data warehouse system to its Family Investment Program, a $55 million-a-year public assistant program. PIN's analytic capability enables program administrators to easily discover fraudulent cases of

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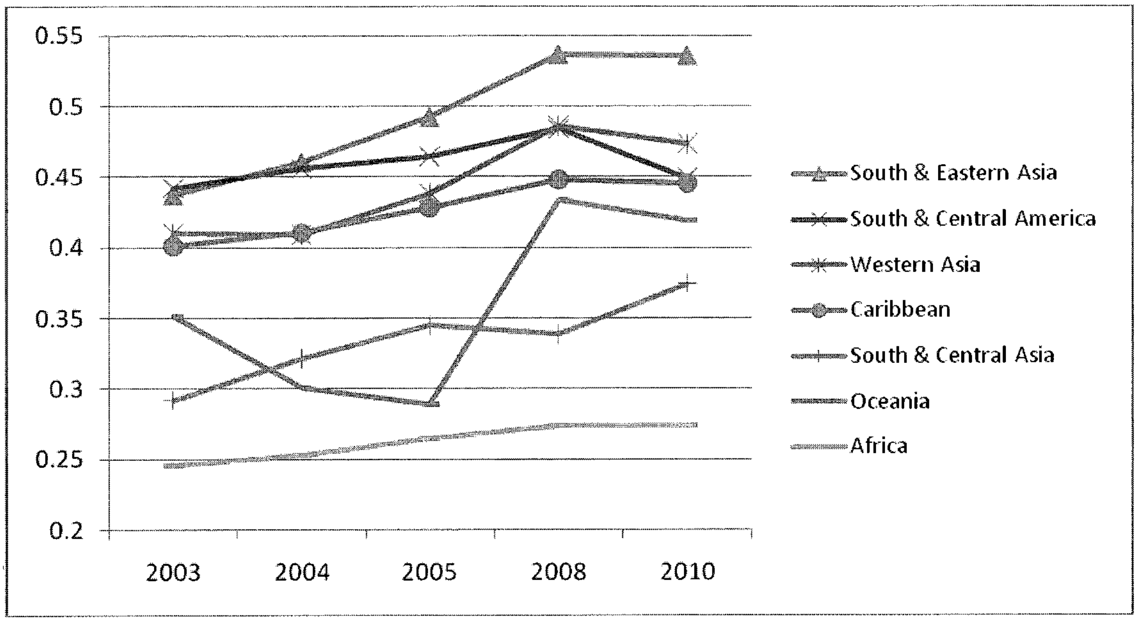
[2] The core 20 public services include social security benefits, income tax filing, and customs declaration and encompass those for both individual services and businesses.
[3] The survey measures online availability by the extent to which a user can access to information on a specific public service and execute a full transaction on an online basis.
[4] It consists of evaluation for government Web sites, telecommunication infrastructures, human capital, and participation of citizens via online channels.

welfare provision, detecting $12.2 million of wrongful benefit provision in 2006. According to the state, it also leads to a substantial amount of labor cost savings in benefit investigations.

Figure 1. The UN Global E-Government Index Excluding North America and Europe



Source: United Nations Global E-Government Surveys, 2003-2010
(http://www.unpan.org/egovkb/global_reports/08report.htm)

e-Government initiatives in developing countries provide the underprivileged with a variety of means and opportunities to economic prosperity. For instance, the State of Karnataka, India launched a project name “Bhoomi” in 2004, which computerizes about 20 million records of land ownership of 6.7 million farmers (Monga 2008). This system automates the maintenance of land ownership records, cropping patterns, and other agriculture-related information and the processes of transaction and approval of land transfer and registration, which had been conducted manually by state officials and used to be as lengthy as several months or years. The introduction of Bhoomi system resulted in a wide range of values to the state and farmers including not only saves in costs and time of farmers and increased revenues to the state but also enhanced accuracy in land records. More importantly, the system creates value in transparency and accountability by eliminating corruption riddled in record management, in which before Bhoomi system, farmers had been required to pay bribes for faster processes.

Given the increasing important of IT in public administration and the massive amount of spending in IT in governments at all levels, it is imperative to understand whether and how IT contributes to the performance of public administration and value creation to the public. However, as the literature search in the next subsection reveals, there is a lack of empirical studies in the IS field as well as the public administration, economics and political sciences discipline. Thus, this dissertation aims at providing a theoretical ground and quantitative empirical evidence for the impact of IT on organizational performance and value creation in the public sector.

It should be noted that there are several crucial differences between the private and the profit sector. First and fundamentally, there is absence of profit motives and competitive pressures in the government area. Thus, by definition, profitability is not an objective, and neither are increasing revenues necessarily a desired outcome. In addition, productivity metrics in the for-profit sector are usually based on a notion of value-added that is closely linked to profitability outcomes, which may not directly apply in the public sector. Second, while for-profit organizations pursue a few performance goals such as profitability, market share, or growth, public organizations usually seek to achieve a much broader range of objectives, as stressed by the institutional perspective of public value management (Section 2.3.3). For instance, Bailey (2004, p. 27) states that public organizations aim at accomplishing the greater 4Es – equity, efficiency, economy, and effectiveness. U.S. state governments are required by federal and state laws to fulfill multiple objectives such as providing quality public education, facilitating economic development, and offering a safety net for the underprivileged. In many occasions, pursuing one goal comes with sacrificing another (Downs and Larkey 1986, p. 3). Not only does it take multiple years for governments to achieve objectives for public interests, but it is by no means straightforward to quantify the fulfillment of such goals in a reliable manner. Last, as governments intend to accomplish a range of goals, decision makings in the public sector usually involve a far more diversity of stakeholders including politicians, businesses, not-for-profit organizations, and ordinary citizens. These differences beg the following questions. (i) Is the mechanism in which IT creates value in the public sector different from the business sector? (ii) Are the theories and the methodologies for the private sector IT value studies appropriate and adequate for the public sector context study? This dissertation delves into answering these questions.

1.2. Literature Search on IT in Governments

In order to examine the status quo of IT value research in the public sector, I conducted a comprehensive literature search for refereed journal articles in a broad range of fields. Academic disciplines in consideration span from information systems to economics, public administration, and political sciences.

Broadly, I intend to understand where research interests in government IT center around. Thus, I searched research articles that deal with *IT artifacts within governments.*

Thus, research topics include not only IT value but also IT adoption and use, IT management and development, and IT-driven collaboration and decision making. In selecting articles, I excluded studies with a nominal view of technology (Orlikowski and Iacono 2001), which do not directly consider IT artifacts within governments. Such studies include government policies in technology industries, R&D, copyrights, or computer securities (e.g. Chen and Png 2003, Gal-Or and Ghose 2005). I do not consider such topics as my primary interest is the performance effect of IT within governments.

First, in the Information System field, I scanned articles in leading IS journals including *Management Science*, *MIS Quarterly*, and *Information Systems* published from Jan. 1990 to Jun. 2010. I searched titles, abstracts, and keywords that contain any of the following terms – government, public organization, public sector, or public employee. The initial search yielded only 11 articles. Thus, I decided to expand the scope of the literature search to the top 10 IS journals identified by Lowry et al. (2004) and Rainer and Miller (2005). The list of journals is available in Appendix 1.1. I excluded journals targeted for practitioners such as *Harvard Business Review* or *Sloan Management Review*. This expanded search generated 51 articles in total (Table 2).

Table 2. Literature Search and Classification Based on Sidorava et al. (2008)

	IT and Individuals	IT and Groups	IT and Organization	IT and Markets	IS Development	Total
IS Journals						
MIS Quarterly	1		6	1		8
Information Systems Research	1		2			3
Journal of Management Information Systems (JMIS)	1	1	4	1	1	8
Decision Support Systems (DSS)	3	3	5		3	14
Information & Management	7		11			18
IS Journals Total	13	4	28	2	4	51
Non-IS Journals						
Journal of Public Administration Research and Theory (J-PART)	1		9	2	1	13
Public Administration Review (PAR)	2		24	6	1	33
Governance				3		3
American Review of Public Administration	5		9			14
Public Administration			2	1	2	5
Journal of Industrial Economics (JIE)			1			1
Non-IS Journals Total	8		45	12	4	69
Total	21	4	73	14	8	120

In order to search papers in the Economics field, I referred to Thomson-Reuter Journal Citation Report (JCR) 2009 Social Science Edition. I chose top 10 journals in economics category in terms of the 5-year impact factor. The journal chosen is also listed in Appendix 1.1. In addition to these top 10 journals, I also included public economics and industrial organization journals within top 100 economics journals[5]. Papers were searched with the keywords of computer, digital, information technology, information

[5] *Rand Journal of Economics* (Rank 39), *Journal of Public Economic* (Rank 44), *Journal of Urban Economics* (Rank 55), *Journal of Industrial Economics* (Rank 63), *International Journal of Industrial Economics* (Rank 83), *Journal of Economics & Management Strategy* (Rank 85)

system, e-government in the period of Jan. 1990 to Jun. 2010. Only articles that focus on the public sector IT were chosen. I also referred to JCR 2009 Social Science Edition to select journals in public administration and political sciences. For each discipline, I select top 10 journals, as listed in Appendix 1.1. The same timeframe and the same set of keywords were employed. In total, 69 articles were found in the non-IS journals (Table 2).

I find that the leading journals in IS, economics, public administration, and political sciences have published 120 papers in total that focus on IT and governments since 1990. Next, carefully reading abstracts and introductions, I categorized these papers using the classification of Sidorava et al. (2008), as shown in Table 2. The majority of studies are at the organizational-level (73 papers) with the issues of organizational IT adoption and use, IT value, and information systems (IS) management. Studies on IT and individuals are popular as well, focusing on individual-level IT adoption and use, human resources (HR) issues, or decision support systems. Given that IT and markets are concerned with how IT use affects interorganizational relationships and markets (Sidorava et al. 2008), I classified such topics as the effect of IT on democracy, political processes, and government-citizen interactions as IT and markets.

Among the organizational-level studies, I selected IT value studies based on the definition of Kohli and Grover (2008). They define that an IT value study has to have two components – (i) IT variable, IT management variable or manifestation, and (ii) endogenous variable with IT economic impact. With this criterion, I discovered seven articles that are qualified for IT value research. Two are from IS journals (Mukhopadhyay et al. 1997, *DSS*, and Teo et al. 1997, *JMIS*), while the rest five are published in non-IS journals (Norris and Kraemer 1996, *PAR*, Lehr and Lichtenberg 1998, *JIE*, Nunn 2001, *PAR*, Lee and Perry 2002, *J-PART*, and Norris and Moon 2005, *PAR*).

Based on the production-function framework, Lehr and Lichtenberg (1998) discover the productivity improvement effect of IT assets in U.S. federal agencies. Also with the production-function framework, Lee and Perry (2002) find a positive impact of IT assets in U.S. state governments on state gross domestic product (GDP). Mukhopadhyay et al. (1997) discover an efficiency improvement in the toll collection process after the adoption of a new IT application in Pennsylvania Turnpike. Their study, however, considers their setting (the Pennsylvania Turnpike) as a context for finding the process-level effect and does not explicitly aim at examining the performance impact of IT in public organizations, unlike Lehr and Lichtenberg (1998) and Lee and Perry (2002).

In four of the seven studies, however, the impact of IT is only part of their research scope. For example, in a case study of Singapore Trade Development Board, Teo et al. (1997) report that the new EDI system, which interconnects traders with various government agencies related to trading and custom, significantly improved the effectiveness of trading declaration processes and the satisfactions of traders. Their study also covers changes in organizational structures and processes, and the performance improvement is not their main focus[6].

In sum, the literature search reveals that there are a limited set of studies for IT in governments that are published in mainstream research journals. Kraemer and Dedrick (1997) called for more research efforts in IT in the public sector, but I find that their proposal has not been embraced enthusiastically. Even though the articles I found may

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[6] Other three papers that are not mentioned here are Norris and Kraemer (1996), Nuun (2001), and Norris and Moon (2005),

not be exhaustive, I believe that the list of studies adequately represents major interests in government IT within the core IS and public administration disciplines. More significantly, I discover a dearth of studies in IT and organizational performance in the public sector, compared to other research topics in IT for the public sector and a cornucopia of IT value articles for the private sector (Melville et al. 2004). Moreover, among the seven IT value studies in the public sector, only three exclusively focus on the performance effect of IT, while such an effect is part of the scope in the rest of the studies. Therefore, the literature search illustrates an urgent need for more understanding of the relationship between IT and organizational performance within governments.

1.3. Summaries of the Chapters

In order to fill the gap in the prior literature discovered by the literature search, the present dissertation presents three studies with distinctive theoretical perspectives on IT value in governments – public value management perspective from public management, cost efficiency perspective from public economics, and government growth perspective from political sciences. Each chapter makes a unique contribution to the IS as well as the respective reference literature. This subsection summarizes the subsequent chapters.

In Chapter 2 entitled "IT Resources, Organizational Capabilities, and Value Creation in Public Organizations – Public Value Management Perspective," I lay a theoretical ground on the mechanism in which IT resources contribute to the generation of public value. Specifically, this chapter aims to identify the processes through which IT resources in public organizations contribute to value creation. I follow a process-level approach, suggesting that as in for-profit firms, the relationship between IT resources and organizational performance in governments is mediated by organizational capabilities (Barua et al. 1995, Ray et al. 2005, Rai et al. 2006, Banker et al. 2006). I develop a theoretical model that delineates the paths from IT resources to organizational performance in governments, drawing upon public value management theory (Moore 1995, Kelley et al. 2002, Stoker 2006, Alford and Hughes 2007). This perspective asserts that public managers, on behalf of the public, should strive to generate greater *public value*, as managers in the private sector seek to achieve greater *private value*, which in most cases represents monetary returns to shareholders. Based on the review of public value management literature, I suggest the four key organizational capabilities that may reside in the linkage between IT resources and public value – operational capability, communication capability, partnering capability, and innovative capability. I argue that IT resources in public organizations enable public managers to pursue greater public value by cultivating these four organizational capabilities.

In Chapter 3 entitled "Information Technology and Administrative Efficiency in U.S. State Governments – A Stochastic Frontier Approach," I investigate whether IT investments in state governments lead to greater cost-efficiency, which refers to the extent to which a government provides public goods and services with limited resources (Downs and Larkey 1986, p. 6, Stiglitz 2000, p. 149). I argue that the conventional approaches to measuring the performance impact of IT investments in for-profit firms, which directly relates performance measures to IT investment measures, are unsuitable in the government context for the following reasons. First, it is difficult to find an appropriate measure to gauge the collective amount of outputs that state governments produce. While in the for-profit context, such measures as sales or value-added can account for aggregate outputs that a firm supplies, any single measure can hardly represent a variety of public services such as education, transportation, and so forth. Second, in the government context, it is more reasonable to assume that the amount of public service outputs are exogenously given, in contrast to the production function framework in which the amount of output is considered to be endogenous (Brynjolfsson and Hitt 1996, Dewan and Kraemer 2000, Bresnahan et al. 2002). In this regard, I propose a translog cost function model with stochastic frontier estimation (Caves et al. 1980, Aigner et al. 1977) as a new empirical methodology for IT value studies in the public sector. Utilizing the IT budget data in state governments, the census data on state government expenditures, and a variety of information on public services states provide, I estimate technical cost efficiency, a proxy for administrative efficiency. The empirical analyses provide evidence for a significantly positive relationship between IT intensity and cost efficiency. The results indicate that all others being equal, on average, a $1 increase in per capita IT budget can lead to $4.18 efficiency gains. I also find that the relationship between IT intensity and cost efficiency is contingent upon several factors such as state gross domestic product (GDP), the size of state IT organizations, and the centrality of IT management.

In Chapter 4 entitled "Do Information Technology Investments Lead to Bigger or Smaller Governments? – Theory and Evidence in U.S. State Governments," I study a long-standing research question among public economists and political scientists and a concern for the general public – government growth (Larkey et al. 1981, Lybeck 1988, Tarschys 1975, North 1985). I investigate the impact of IT investments on government growth. While the prior IS studies have investigate the relationship between IT and organizational sizes in the for-profit context (Brynjolfsson et al. 1994, Hitt 1999, Wood et al. 2008), there has been a few studies at the organizational-level studies and also in the context of governments. Drawing on the literature on public economics, political sciences, and IT value (Fiorina and Noll 1978, Becker 1983, Banks 1989), I offer theoretical discussions and four mechanisms as to the relationship between IT investments and government expenditures, leading to two competing hypotheses that IT investments either expand or shrink the amount of government expenditures. Adopting the state government growth model of Garand (1988, 1989), I test which prediction prevails in the context of U.S. state governments. The empirical investigations support the hypothesis that greater IT investments are associated with smaller state government size, measured as a ratio of annual total expenditures to state gross domestic product.

Appendix 1.1

Table 3. The List of Journals

Information Systems	*Management Science* *MIS Quarterly* *Information Systems Research* *Journal of Management Information Systems* *Communication of the ACM* *Decision Sciences* *Decision Support Systems* *IEEE Transactions of Software Engineering* *Information & Management*
Economics	*Journal of Economic Literature* *Quarterly Journal of Economics* *Journal of Political Economy* *Journal of Economic Perspectives* *Econometrica* *Journal of Economic Growth* *Journal of Economic Geography* *Review of Economics and Statistics* *American Economic Review* *Rand Journal of Economics* *Journal of Public Economic* *Journal of Urban Economics* *Journal of Industrial Economics* *International Journal of Industrial Economics* *Journal of Economics & Management Strategy*
Public Administration	*Journal of Public Administration Research and Theory* *Philosophy & Public Affairs* *Public Administration Review* *Governance* *Journal of European Public Policy* *Journal of Policy Analysis and Management* *Public Administration* *Journal of European Social Policy* *Climate Policy* *American Review of Public Administration*

Table 3. The List of Journals (Continued)

Political Sciences	*American Political Science Review* *Political Analysis* *American Journal of Political Science* *Public Opinion Quarterly* *Annual Review of Political Science* *Journal of Conflict Resolution* *Political Geography* *European Journal of Political Research* *Journal of Peace Research* *International Studies Quarterly*

References

Aigner, D., Lovell, C.A.K., and Schmidt, P. "Formulation and Estimation of Stochastic Frontier Production Function Models," *Journal of Econometrics* (6:1) 1977, pp. 21-37.

Alford, J. and Hughes, O. "Public Value Pragmatism as the Next Phase of Public Management," *American Review of Public Management* (38:2) 2008, pp. 130-148.

Bailey, S.J. *Strategic Public Finance*, 2004, Hampshire, UK: Palgrave MacMillan.

Banker, R.D., Bardhan, I.R., Chang, H., and Lin, S. "Plant Information Systems, Manufacturing Capabilities, and Plant Performance," *MIS Quarterly* (30:2) 2006, pp. 315-337.

Banks, J.S. "Agency Budgets, Cost Information, and Auditing," *American Journal of Political Science* (33:3) 1989, pp. 670-699.

Barua, A., Kriebel, C.H., and Mukhopadhyay, T. "Information Technologies and Business Value: An Analytic and Empirical Investigation," *Information Systems Research* (6:1) 1995, pp. 3-23.

Becker, G.S. "A Theory of Competition Among Pressure Groups for Political Influence," *Quarterly Journal of Economics* (98:3) 1983, pp. 371-400.

Bharadwaj, A.S., Bharadwaj, S.G., and Konsynski, B.R. "Information Technology Effects on Firm Performance as Measured by Tobin's *q*," *Management Science* (45:7) 1999, pp. 1008-1024.

Bresnahan, T., Brynjolfsson, E., and Hitt, L. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *Quarterly Journal of Eonomics* (117:1) 2002, pp. 339-376.

Brynjolfsson, E. and Hitt, L. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4) 1996, pp. 541-558.

Brynjolfsson, E., Malone, T.W., Gurbaxani, V., and Kambil, A. "Does Information Technology Lead to Smaller Firms?," *Management Science* (40:12) 1994, pp. 1628-1644.

Caves, D.W., Christensen, L.R., and Tretheway, M.W. "Flexible Cost Functions for Multiproduct Firms," *Review of Economics and Statistics* (62:3) 1980, pp. 477-481.

Chen, Y.-N. and Png, I. "Information Goods Pricing and Copyright Enforcement: Welfare Analysis," *Information Systems Research* (14:1) 2003, pp. 107-123.

Devaraj, S. and Kohli, R. "IT Payoff in the Healthcare Industry: A Longitudinal Study," *Journal of Management Information Systems* (16:4) 2003, pp. 41-67.

Devaraj, S. and Kohli, R. "Performance Impacts of Information Technology: Is Actual Usage the Missing Link," *Management Science* (49:3) 2003, pp. 273-289.

Dewan, S. and Kraemer, K.L. "Information Technology and Productivity: Evidence from Country-Level Data," *Management Science* (46:4) 2000, pp. 548-562.

Downs, G.W. and Larkey, P.D. *The Search for Government Efficiency: From Hubris to Helplessness*, 1986, Philadelphia, PA: Temple University Press.

European Commission, *Smarter, Faster, Better eGovernment – 8th Benchmark Measurement, 2010*, 2010, available at: http://ec.europa.eu/information_society/eeurope/i2010/docs/benchmarking/egov_benchmark_2009.pdf, accessed on Apr. 13, 2011.

Fiorina, M.P. and Noll, R.G. "Voters, Bureaucrats and Legislatures: A Rational Choice Perspective on the Growth of Bureaucracy," *Journal of Public Economics* (9:2) 1978, pp. 239-254.

Gal-Or, E. and Ghose, A. "The Economic Incentive for Sharing Security Information," *Information Systems Research* (16:2) 2005, pp. 186-208.

Garand, J.C. "Explaining Government Growth in the U.S. States," *American Political Science Review* (82:3) 1988, pp. 837-849.

Garand, J.C. "Measuring Government Size in the American States: Implications for Testing Models of Government Growth," *Social Science Quarterly* (70:2) 1989, pp. 487-496.

Hitt, L. "Information Technology and Firm Boundaries: Evidence from Panel Data," *Information Systems Research* (10:2) 1999, pp. 134-149.

Kelly, G., Mulgan, G., and Muers, S. *Creating Public Value: An Analytic Framework for Public Service Reform*, 2002, Strategy Unit, U.K. Cabinet Office, available at http://webarchive.nationalarchives.gov.uk/20100416132449/http://www.cabinetoffice.gov.uk/strategy/seminars/public_value.aspx, accessed on Sep. 3rd, 2010.

Kraemer, L. and Dedrick, J. "Computing and Public Organization," *Journal of Public Administration Research and Theory* (7:1) 1997, pp. 89-112.

Kohli, R. and Grover, V. "Business Value of IT: An Essay on Expanding Research Directions to Keep up with the Times," *Journal of the Association for Information Systems* (9:2) 2008, pp. 23-39.

Lee, G., and Perry, J.L. "Are Computers Boosting Productivity? A Test of the Paradox in State Governments," *Journal of Public Administration Research and Theory* (12:1) 2002, pp. 77-102.

Lehr, W., and Lichtenberg, F.R. "Computer Use and Productivity Growth in US Federal Government Agencies, 1987-92," *Journal of Industrial Economics* (46:2) 1998, pp. 257-279.

Lowry, P., Romans, D., and Curtis, A. "Global Journal Prestige and Supporting Disciplines: A Scientometric Study of Information Systems Journals," *Journal of the Association for Information Systems* (5:2) 2004, pp. 29-75.

Lowery, D. and Berry, W.D. "The Growth of Government in the United States: An Empirical Assessment of Competing Explanations," *American Journal of Political Science* (27:4) 1983, pp. 665-694.

Lybeck, J.A. 1998. "Comparing Government Growth Rates: The Non-Institutional vs. the Institutional Approach," in *Explaining the Growth of Government*, Lybeck, J.A. and Henrekson, M. (eds.), Amsterdam, The Netherlands: Elsevier Science Publisers, pp. 29-27.

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

Monga, A. "E-Government in India: Opportunities and Challenges," *Journal of Administration & Governance* (3:2) 2008, pp. 52-61.

Moore, M.H. *Creating Public Value: Strategic Management in Government*, 1995, Cambridge, MA: Harvard University Press.

Mukhopadhyay, T., Javier Lerch, F., and Mangal, V. "Assessing the Impact of Information Technology on Labor Productivity: A Field Study," *Decision Support Systems* (19:2) 1997, pp. 109-122.

NASCIO, *2006 Best Practices in the Use of Information Technology in State Government*, 2006, available at: http://www.nascio.org/publications/documents/NASCIO-2006Awards.pdf, accessed on Mar. 21st, 2009.

Norris, D.F. and Kraemer, L. "Mainframe and PC Computing in American Cities," *Public Administration Review* (56:6) 1996, pp. 568-576.

Norris, D.F. and Moon, M.J. "Advancing E-Government at the Grassroots: Tortoise or Hare?," *Public Administration Review* (65:1) 2005, pp. 64-75.

North, D.C. "The Growth of Government in the United States: An Economic Historian Perspective," *Journal of Public Economics* (28:3) 1985, pp. 383-399.

Nunn, S. "Police Information Technology: Assessing the Effects of Computerization on Urban Police Functions," *Public Administration Review* (61:2), pp. 221-234.

Rai, A., Patnayakuni, R., and Seth, N. "Firm Performance Impacts of Digitally Enabled Supp.ly Chain Integration Capabilities," *MIS Quarterly* (30:2) 2006, pp. 225-246.

Rainer, K. and Miller, M. "Explaining Differences across Journal Rankings," *Communications of the ACM* (48:2) 2005, pp. 91-94.

Ray, G., Muhanna, W.A., and Barney, J.B. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4) 2005, pp. 625-652.

Sidorava, A., Evangelopoulos, N., Valacich, J.S., and Ramakrishnan, T. "Uncovering the Intellectual Core of the Information Systems Discipline," *MIS Quarterly* (32:3) 2008, pp. 467-482.

Stiglitz, J.E. *Economics of the Public Sector: Third Edition*, 2000, New York, NY: W.W. Norton & Company, Inc.

Stoker, G. "Public Value Management: A New Narrative for Networked Governance?," *American Review of Public Administration* (36:1) 2006, pp. 47-51.

Tarschys, D. "The Growth of Public Expenditures: Nine Modes of Explanation," *Scandinavian Political Studies* (10:A10) 1975, pp. 9-31.

Teo, H.-H., Tan, B.C.Y., and Wei, K.-K. "Organizational Transformation Using Electronic Data Interchange: The Case of TradeNet in Singapore," *Journal of Management Information Systems* (13:4), 1997, pp. 139-165.

Orlikowski, W.J. and Iacono, C.S. "*Research Commentary*: Disparately Seeking the "IT" in IT Research – A Call to Theorizing the IT Artifact," *Information Systems Research* (12:2) 2001, pp. 121-134.

United Nations. *United Nations 2010 Global e-Government Survey*, 2010, New York, NY: United Nations, available at: http://www.unpan.org/egovkb/global_reports/10report.htm, accessed on Apr. 13th, 2010.

Wood, C.A., Shin, H., and Devaraj, S. "Technology's Effect on Firm Size: Manufacturing vs. Service," *Proceedings of the Twenty Ninth International Conference on Information Systems*, R. Boland, M. Limayem, and B. Pentland (eds.), Association for Information Systems, Paris, France, Dec. 2008.

CHAPTER 2.

IT RESOURCES, ORGANIZATIONAL CAPABILITIES, AND VALUE CREATION IN PUBLIC ORGANIZATIONS – PUBLIC VALUE MANAGEMENT PERSPECTIVE

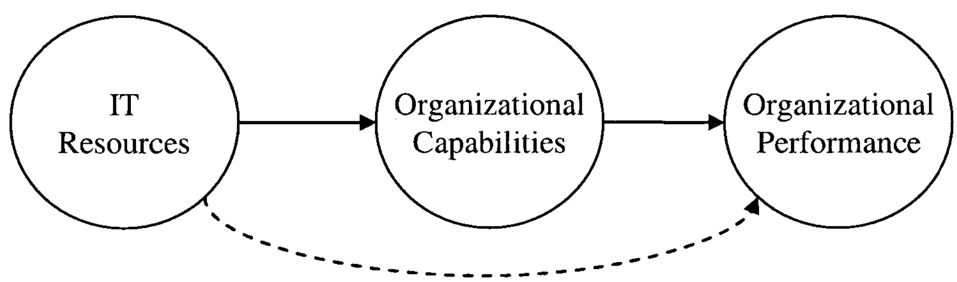
2.1. Introduction

It has been one of the primary research focuses in information systems (IS) literature for the last couple of decades to find *whether* information technology (IT) investments can lead an organization to generate greater value and achieve sustainable competitive advantages (Brynjolfsson 1993, Melville et al. 2004). To provide an answer to such a question, numerous IS researchers have presented a broad range of empirical evidence showing that information technology investments are positively associated with firm performance in terms of productivity, profitability, and market value (Hitt and Brynjolfsson 1996, Brynjolfsson and Hitt 1996, Bharadwaj et al. 1999, Kohli and Devaraj 2003, Anderson et al. 2006). A subsequent question raised by both scholars and practitioners is *how* investments in IT lead to greater organizational performance. This question leads IS researchers to shift their attention from the direct impact of IT on firm performance to under which mechanism IT contribute to firm performance (Piccoli and Ives 2005). In other words, they take an opening-the-black-box approach (Barua et al. 1995, Ray et al. 2005).

Unlike many firm-level studies which examine the association between IT resources and firm performance, a number of relatively recent studies take a process-level approach. This approach argues that IT resources, which consist of IT assets and capabilities (Wade and Hilland 2004), do not directly lead to greater organizational performance, but they do so through intermediate organizational processes such as manufacturing, marketing, customer service, and supply chain management (Barua et al. 1995, Ray et al. 2005, Rai et al. 2006, Banker et al. 2006). It also contends that mere existence of hardware, software, or other technology assets does not necessarily contribute to higher firm performance. The effective use, management, and leverage of IT resources by managers in developing actual organizational processes and capabilities can lead to value creation (Pavlou and El Sawy 2006).

Based on this process-level approach, the present study aims to identify through which process IT resources in public organizations contribute to value creation. I hereby suggest that as in for-profit firms, the relationship between IT resources and organizational performance in governments is mediated by organizational capabilities (Figure 2). In other words, effective use and deployment of IT resources foster organizational capabilities, which in turn create greater value for organizations and the public.

Figure 2. The Relationship between IT Resources, Organizational Capabilities, and Organizational Performance



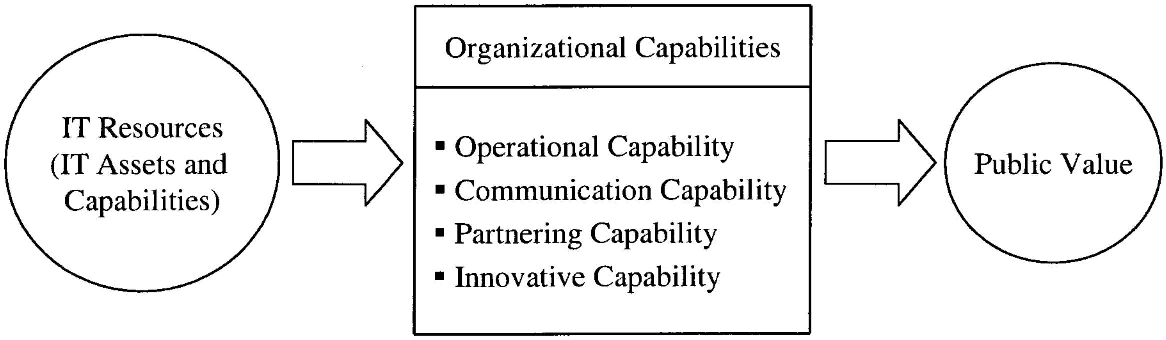
In contrast to some studies that draw on economics theories (Brynjolfsson and Hitt 1996, Barua and Lee 1997, Melville et al. 2007), several studies adopt resource-based view (RBV) (Wade and Hulland 2004) or dynamic capability theory (Teece et al. 1997, Pavlou and El Sawy 2006) from strategic management literature as a theoretical background to find out which IT resources and organizational capabilities help firms achieve long-term competitive advantages. For instance, a major thrust of RBV is that differences in firm performance originates from heterogeneous resources possessed by firms rather from their strategic positioning in industries, and those that own resources that are value, rare, inimitable, and non-substitutable can attain sustained value creation (Barney 1991). IS scholars have maintained that some IS resources, such as the ability to manage IS-business relationship, have such four attributes and thus contribute to firms' competitive advantages (Melville et al. 2004, Wade and Hulland 2004). They also argue that IT resources contribute to greater firm performance by helping develop organizational resources that have value, rarity, non-inimitability, and non-substitutability characteristics.

Here, drawing upon public value management theory, I develop a theoretical model that delineates the paths from IT resources to organizational performance in the public sector organizations. Public value management theory asserts that public managers, on behalf of the public, should strive to generate greater *public value*, as managers in the private sector, entrusted by shareholders, seek to achieve greater *private value*, which in most cases represents monetary returns to shareholders (Moore 1995). Thus, in the public-sector context, organizational performance is gauged by how the organization creates public value for the citizens it serves (Alford and O'Flynn 2009, Moore and

Benington 2011). My review of public value management literature, which is presented in detail in Section 2.3, suggests the four key organizational capabilities that are paramount to public value creation – operational capability, communication capability, partnering capability, and innovative capability (Moore 1995, Stoker 2006, Alford and Hughes 2008, Alford and O'Flynn 2009). Subsequently, in Section 2.4, I explain the linkages between IT resources, the four organizational capabilities, and public value. I argue that IT resources in public organizations enable public managers to pursue greater public value by cultivating these four organizational capabilities, as described in Figure 3.

The remainder of this chapter is organized as follows. The next section reviews the previous literature on IT resources and organizational capabilities in the private sector. Section 2.3 summarizes the literature on public value management literature and compares it to prior public management paradigms (traditional public management and new public management). Section 2.4 provides a detailed discussion of the relationship between IT resources, organizational capabilities, and public value creation. Section 2.5 concludes the discussion.

Figure 3. The Theoretical Framework



2.2. IT Resources, Organizational Capabilities, and Organizational Performance

There are varying definitions and categorizations in the IS literature concerning organizational IT assets, resources, and capabilities (e.g. Ross et al. 1996, Feeny and Willcocks 1998). Among them, I rely on the definition proposed by Wade and Hulland (2004), who define IT resources as IT assets and IT capabilities. IT assets refer to anything tangible or intangible related to IT that can be used in organizational processes for creating, producing, and offering products and services. IT assets may include hardware, software, network infrastructure, or human resources in IT functions. IT capabilities refer to repeatable patterns of actions in the use of IT assets. In a similar vein, Bharadwaj (2000) define IT capability as a firm's "ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities" (p. 171). Pavlou and El Sawy (2006) explain that IT capabilities have three key dimensions – the acquisition of IT assets, deployment of IT assets through tight IT-business relationships, and leveraging of IT assets in formulating business strategies.

The literature on IT resources consistently emphasizes that not all IT resources matter to business value creation. Some IT resources such as IT infrastructure and technical skills can be relatively easily acquired from the market, imitated by competitors, and substitutable with similar resources. Hence, such capabilities are rarely considered a source of business success (Wade and Hulland 2004). Only IT resources that are inimitable, non-substitutable, and imperfectly immobile can be a lever for competitive advantages. Such IT resources may include IT management skills or the alignment of IT and business processes.

The literature on IT resources has two related, but distinctive views on the relationship between IT resources, organizational capabilities, and performance – the complementarity view and the process view (Table 4). In the first view, IT assets and capabilities contribute to organizational performance *in conjunction with* other organizational capabilities. A major argument of this perspective is that IT assets and capabilities are complement to organizational processes such as human resource management and customer service. To put it differently, when accompanying with development in organizational capabilities, IT resources are associated with firm performance to a greater extent. For example, Bresnahan et al. (2002) demonstrate that IT assets lead a firm to achieve a greater level of productivity when it has a more decentralized workplace organization and a higher level of employees' skills. Bharadwaj et al. (2007) demonstrate that integrated IS capability, which is defined as the degree to which a firm's information systems provide integrated data and process integration, moderates the impact of coordination capabilities in manufacturing, marketing, and supply chain on manufacturing performance.

Table 4. Summary of IT Resources and Organizational Capabilities Literature

Research	IT Resource Construct	Organizational Capability Construct	Performance Construct
Complementarity View [1]			
Francalanci and Galal (1998)	IT Investments	Workforce Composition	Productivity
Bresnahan et al. (2002)	IT Assets	Workplace Reorganization	Productivity
Brynjolfsson et al. (2002)	IT Investments	Computer-Enabled Organizational Changes	Market Value
Ray et al. (2005)	Flexible IT Infrastructure	Shared Knowledge between Line and IT Manager	Customer Service Performance
Bharadwaj et al. (2007)	Integrated IS Capability	Manufacturing-Market Coordination / Manufacturing-Supply Chain Coordination	Manufacturing Performance
Process View [2]			
Sambamurthy et al. (2003)	IT Competence	Digital Options, Customer/Partnering/ Operational Agility	Competitive Actions Firm Performance
Tippins and Sohi (2003)	IT Competency	Organizational Learning	Firm Performance
Rai et al. (2006)	IT Infrastructure Integration for SCM	Supply Chain Process Integration	Firm Performance
Pavlou and El Sawy (2006)	IT Leveraging Competence in New Product Development (NPD)	NPD Dynamic Capabilities / NPD Functional Competencies	Competitive Advantage in NPD
Pavlou and El Sawy (2010)		NPD Improvisational Capabilities	
Malthora et al. (2007)	Use of SEBIs	Collaborative Information Exchange	Mutual Adaptation / Adaptive Knowledge Creation
Barua et al. (2004)	System Integration / Online Information Capabilities	Supplier/Customer-Side Digitization	Firm Performance
Tanriverdi (2005)	IT Relatedness	Knowledge Management Capability	Firm Performance
Banker et al. (2006)	Plant Information Systems	Manufacturing Capabilities	Plant Performance
Rai and Tang (2010)	IT Integration IT Reconfiguration	Process Alignment Offering Flexibility Partnering Flexibility	Competitive Performance
Mithas et al. (2011)	Information Management Capability	Performance Management Customer Management Process Management	Customer-Focused / Financial / Human Resource / Organizational Effectiveness
This Study	IT Assets and Capabilities	Operational Capability Communication Capability Partnering Capability Innovative Capability	Public Value

[1] Organizational capabilities *moderate* the relationship between IT and organizational performance.
[2] Organizational capabilities *mediate* the relationship between IT and performance (Figure 2).

The second perspective – the process view – stresses that IT resources are associated with organizational performance indirectly via organizational capabilities. Barua et al. (1995) and Mukhopadhyay et al. (1997) are two of the early studies that develop this view. The major thrust of this view is that IT resources facilitate the development of superior organizational capabilities such as ones in marketing, operation, or supply chain management. These capabilities in turn positively affect firm performance and become a source of sustained competitive advantages, as illustrated in Figure 2. Ray et al. (2005) argue that a process level of analysis (as opposed to a firm level) is the most appropriate level of observing the strategic effects of IT (Pavlou and El Sawy 2006).

Among many studies with this view, Rai et al. (2006) show that IT infrastructure integration with suppliers and customers drives supply chain integration (organizational capability), which subsequently contributes to greater firm performance with respect to operational excellence, customer relationships, and revenue growth. Banker et al. (2006) find that the adoption of plant information systems such as resource planning systems (RPS), and electronic data interchange (EDI) applications contribute to firm performance by improving manufacturing capabilities in terms of just-in-time manufacturing and customer/supplier participation programs. In the e-business context, Barua et al. (2004) show that system integration within a firm accelerates online information exchange with suppliers and customers and increases the level of digitization of day-to-day business transactions with them. These organizational capabilities – online information exchange and digitized business transactions – lead to greater financial performance. Lastly, in a multi-business context, Tanriverdi (2005, 2006) finds that IT relatedness across business units, which refers to a shared, standardized IT infrastructure or IT management process, increases firm performance directly (Tanriverdi 2006) as well as indirectly via improved cross-unit knowledge management capability (Tanriverdi 2005). My theoretical model follows this process-view perspective, as explained in the subsequent sections.

2.3. Public Value Management Perspective

2.3.1. What is Public Value Management?

In explaining the value creation mechanism of IT in the public sector organizations, I adopt the public value management perspective as a theoretical basis. The basic tenet underlying this perspective is that public officials should strive to maximize public value, just as do managers in for-profit firms seek to maximize private value (Moore 1995). Here, public value broadly refers to the value created by government through services, laws, regulation, and other actions (Kelley et al. 2002). Researchers in this stream emphasize that rather than passively following the dictates of politicians and elected officials and meeting the given responsibilities of public service provisions, public managers need to play an active role in exploring new opportunities in public value creation, engaging in continuous dialogues with various stakeholders including politicians and citizens, and improving capabilities in public service delivery. In other words, to generate more public value, a public manager needs to become not a simple technician or a passive producer, but an entrepreneur with a clear strategic mission and vision, as do many managers in the private sector (Moore 1995, Alford and Hughes 2008).

Entrepreneurship is promoted in this literature, because like for-profit firms, governments are subject to increasingly dynamic and uncertain environments (Moore and Khagram 2004, Swilling 2011). Social and political circumstances surrounding governments continue to evolve, technological advances change and even sometimes disrupt business and society at large, and new risks and threats to citizens such as terrorisms, outbreaks of pandemic diseases, or global warming keep emerging. Therefore, citizens' needs, goals and expectation for governments are by no means constant. The public value literature, however, argues that existing democratic and political processes and public management systems, which value continuity and preservation of the status quo, are inadequate to deal with such a dynamic environment. It emphasizes that public managers, who may have extensive expertise and knowledge in policy making and public service delivery, need to play a more proactive role in sensing changing environments, in responding to new needs for legitimate government intervention, and in innovating public management for securing public value.

2.3.2. Comparison to Previous Public Management Models

The public value management perspective has recently emerged as an alternative management model to two public management paradigms that have dominated for several decades – traditional public management and new public management. Kelly et al. (2002), Stoker (2006), and O'Flynn (2007) provide excellent comparisons of the three models.

Traditional or progressive public management (PPM, Hood 1994, Dunleavy et al. 2006) can be characterized by bureaucracy, hierarchy, and standardization. In this model, public service provision is managed by bureaucratic government agencies that are equipped with a clearly defined division of labor, a rule-oriented administration, a full-time career structure of public officials with continuity and long-term advancement, and extensive expertise and knowledge in public service arena (Lane 2000, Stoker 2006).

New public management (NPM) gained popularity in the early 1980s in response to inherent inflexibility, inefficiency, and lack of response in bureaucratic public organizations (Alford and Hughes 2008). Rooted in the theory of bureaucracy, principal-agent theory, and transaction cost economics (O'Flynn 2007), NPM aims at instilling market mechanisms and business doctrines into public organizations, i.e. "running governments like corporations." Hence, in NPM, strict performance contract and management, pursuit to cost efficiency, and improvement in customer satisfaction are promoted. The privatization of public service production is advocated as a mechanism for public sector reform, and Lane (2000) even states that "under an NPM regime, government manages the public sector by means of a set of contracts" (p. 10).

Again, the appearance of public value management has been a response to criticisms of NPM. Such criticisms include deterioration in public service quality (Kelley et al. 2002), increased transaction costs (O'Flynn 2007), exacerbated organizational complexity (Dunleavy et al. 2006), and erosion of accountability and responsibility (O'Flynn 2007). Critics of NPM maintain that excessive emphasis on such values as efficiency and cost control undermines other fundamental values in public management such as fairness, justice, representation, and participation (deLeon and Denhardt 2000, Wu and He 2009). Hence, they argue that "a government is not a corporation" and should be managed in a different way, i.e. in a way to increase the collective value of the public.

For example, in NPM, private production of public services is considered one of the best ways to improve the effectiveness of public service offerings; whereas in public value management perspective, the choice of public or private delivery of services is guided by which venue is best suited for public value creation (Bozeman 2002, O'Flynn 2007, Alford and Hughes 2008).

It should be noted, however, that public value management is not free from criticisms, as summarized and addressed by Alford and O'Flynn (2009). Major criticisms include the vagueness in what public value means, the confusion as to whether the theory is empirical or normative, and the inappropriate emphasis on political roles of public managers. As the theory is still emerging and developing, consensus in the meaning of public value is yet to be come. Alford and O'Flynn (2009) clarify that public value theory is both an empirical theory and a normative prescription. It intends to explain what public managers actually do and to stipulate what they should do. Lastly, according to Alford and O'Flynn (2009), the prescription that public officials need to be active in political arena bothers some scholars that consider the clear distinction between politics and public administration to be sacred. However, Moore (1995) and Alford and O'Flynn (2009) defend that politicians are the final arbiter in marshaling policy development and formulating public service delivery, and the role of public managers should not go beyond advisors or counselors to elected officials by using their expertise in public management.

2.3.3. Two Research Strands in Public Value Management

According to the review by Davis and West (2009), there are two major research strands in the public value management literature. In the *institutional perspective*, researchers seek to find out what public value is, how it is defined, and what constitutes public value. In the *generative perspective*, scholars discuss and propose normative frameworks for appropriate behaviors of public managers who would like to secure greater public value.

The literature in the institutional perspective consistently highlights that public value is far more multi-faceted than private value, which in the business context usually refers to monetary profits. Public value not only includes direct benefits from public services such as education or public welfare that accrue to individual clients (Alford 2002), but also comprises goals or aspirations such as trust to governments, fairness, or national prides that are valued collectively by the public (Moore 1995, Alford and Hughes 2008, Alford and O'Flynn 2009). While for-profit firms may pursue multiple objectives such as sustainability, customer satisfaction, or safety, these objectives usually boil down to the ultimate goal in sustaining economic value creation to shareholders. In this vein, Davis and West (2009) argue that "the public interest cannot be reduced to singular, economic measures. The values that inhere in the public realm in both government processes and outputs are irreducibly plural" (p. 604).

Thus, in the institutional perspective, several studies examine what constitutes public value. For example, Beck Jørgensen and Bozeman (2007) attempt to construct a *constellation* of public values that classifies 72 value concepts identified by their review of public administration literature. This includes not only productivity and effectiveness in public administration but also broader goals concerned with the relationship between governments and society such as sustainability, responsiveness, or accountability. Kelley et al. (2002) argue that public values consist of three components – objective outcomes of public services, service qualities perceived by citizens, and trust in governments. Cresswell et al. (2006) enumerate six categories of public values – financial, political, social, strategic, ideological, and stewardship values. Benington (2009) categorizes public value as ecological value, political value, economic value, and social and cultural value. In an effect to clarify the meaning of public value, Alford and OF'lynn (2009) explain its difference with "public goods" or "public interest." They argue that public value has greater meaning than public goods, which indicate *outputs* that public organizations produce. Public value also encompasses *outcomes*, which refer to the impacts of outputs on those who consume the outputs. Simply put, if outputs are not valuable to the citizens who, unlike those in the private sector, sometimes are compelled to consume them, public value creation is limited.

It should be noted, however, that there is no absolute, universally applicable standard of public value (Alford and Hughes 2008, Alford and O'Flynn 2009). What is publicly valued depends on the needs and desires of the public as well as on social and environmental circumstances with which the public and public managers deal. From this institutional perspective, Stoker (2006) states that "public value is more than a summation of the individual preferences of the users or producers of public services. The judgment of public value is collectively built through deliberation involving elected and appointed government officials and key stakeholders" (p. 42). This literature stresses that two components are essential for true public values to be uncovered – democratic processes and active roles of public managers. Alford and Hughes (2008) state that the mechanism on which public managers rely for ascertaining what citizens want is the democratic political process. Kelley et al. (2002) argue that value is determined by citizens' preferences, which are expressed through a variety of means and reflected through the decisions of elected politicians.

This argument leads to the generative perspective. This literature points out that in increasingly unstable environments, public managers need to play a key role in discovering the desire of the public in devising public service offerings. In contrast to the traditional or new public management models, which draw a clear boundary between politics and public management that public managers are discouraged from crossing, public value management stresses that government officials need to consciously engage in political discussions and actively participate in discourses with politicians, citizens, not-for-profit organizations and businesses to discover how to advance public value (Hui and Hayllar 2010). Against this backdrop, the generative perspective attempts to provide prescriptions or guidelines for public managers. In a seminal work, Moore (1995) suggests that public managers can create greater public value by: (1) increasing the quantity or quality of public activities per resource expended; (2) reducing costs (in terms of money and authority) used to achieve current levels of production; (3) making public organizations better able to identify and respond to citizens' aspirations; (4) enhancing the fairness with which public sector organization operate; and (5) increasing their continuing capacity to respond innovate. Stoker (2006) lists four propositions for the pursuit of public values. First, he argues that government intervention is justified only when public values are delivered. Second, he asserts that the legitimacy of a wide range of stakeholders needs to be recognized. Third, an open-minded, relationship approach to service delivery is necessary. Lastly, public managers need to equip with an adaptable and learning-based approach to the challenge of public service delivery. Smith (2004) states that "public officials must engage political authority, collaborate with each other within and across institutional boundaries, manage efficiently and effectively, and engage with communities and users of services, and reflectively develop their own sense of vocation and public duty" (p. 69-70). The second, third, and fourth requirements correspond to the partnering, operational, and communication capabilities, respectively, which are discussed in the following section.

2.3.4. Comparison to Resource-Based View

Before concluding the review of public value management literature, I compare the literature with the resource-based view (RBV) in the strategic management, which has been a theoretical basis in numerous studies on IT business value and strategic IT management (Sambamurthy et al. 2003, Wade and Hulland 2004, Melville et al. 2004). The public value management has much in common with RBV. Particularly, both RBV and public value management emphasize the importance of organizational capabilities in value creation, even though the two theories consider the different realms of organizations. Table 5 provides a comparison between public value management and RBV.

Emerged as an alternative theoretical framework to competitive forces theory (Porter 1985), in which competitive advantages are shaped largely by positioning in a competitive industry (the logic of positioning as described by Sambamurthy et al. 2003), RBV stresses that variance in organizational performance can be explained by heterogeneity in resources held by organizations. Thus, firms that are equipped with superior resources and capabilities can achieve supernormal organizational performance (as in the logic of leverage in Sambamurthy et al. 2003). Likewise, as explained above, public value management maintains that value creation by public organizations depends upon the extent to which public managers and organizations foster internal organizational capabilities.

A key difference between the two perspectives, however, is that while the public value literature explains which organizational capability is necessary for public value generation, RBV discusses which *attribute* of organizational capability is important for sustained value creation and competitive advantages. In public value management, for example, such capabilities as operational capability or communication capability matter. In RBV, most representatively, Barney (1991) suggests the four key characteristics of organizational resources that contribute to competitive advantages – value, rarity, inimitability, imperfect mobility. A number of other studies in RBV propose alternative attributes (e.g. Dierickx and Cool 1989, Amit and Schoemaker 1993). Public value management, on the other hand, does not explicitly explain the necessary characteristics of organizational capabilities for value creation.

Another key difference between the two theories is unit of analysis. In RBV, it is an organization that possesses capabilities, but public value management discusses the capabilities that an *individual* public manager has to own. However, it would not be inappropriate to assume that the capabilities held by members in an organization collectively constitute organizational capabilities. For that matter, I believe that the public value management theory can be applied in the organizational level of research, as in Moore and Khagram (2004), who attempt to analyze corporate strategies in the business context with the lens of public value management.

Table 5. Comparison between Resource-Based View and Public Value Management

	Resource-Based View	Public Value Management
Discipline	Strategic Management	Public Management
Theme	The variance in organizations' performance can be explained by heterogeneity in resources held by the organizations.	Public officials should strive to maximize public value, just as do managers in for-profit firms seek to maximize private value.
Objective of Organizations	Achieve and sustain competitive advantages and supernormal economic rents	Create and maximize public value; does not specify which value to create
Alternative Views	Competitive forces (Porter 1985)	Traditional public management New public management
Capabilities	Does not specify which organizational capabilities are important for competitive advantages. It depends on industries or environments that a firm resides in	▪ Operational Capability ▪ Communication Capability ▪ Collaborative Capability ▪ Innovative Capability ▪ Political Capability
	▪ Value, Rarity, Inimitability, Imperfect mobility (Barney 1991) ▪ Scarcity, Appropriability, Inimitability, Imperfect substitutability, Limited tradability (Amit and Schoemaker 1993)	Does not specify which attribute of organizational resources matters
Unit of Analysis	Organization	Individual public managers, but applicable to organizational analysis
Exemplary Application	Wade and Hulland (2004) Melville et al. (2004) Piccoli and Ives (2005)	Kelley et al. (2002) Alford (2002) Stoker (2006)

Even though RBV has been a fertile theoretical framework on the IT business value literature, I find that the public value management literature is a more appropriate theoretical approach in the public sector IT value studies for several reasons. First, the foremost objective of firms in RBV is to attain competitive advantages against competing firms and to prevent them from eroding (Picolii and Ives 2005). In the public sector, however, such an aim is not as salient as in the private sector, even though the literature on competitive federalism argues that there still exist competitive environments between government agencies (Dye 1990, Breton 1991). Second, the resource-based view neither accounts for the plurality and multi-dimensionality of public value nor stresses the importance of the public manager's ability to discover and formulate the desired public value. Third and most importantly, as mentioned above, RBV does not suggest specifically which organizational capability is paramount to the value creation in the public sector organizations. It merely suggests the attributes of resources and capabilities that are essential to effective competition, which is in general not a significant concern in the public sector.

In the subsequent section, I discuss the theoretical model presented in Figure 3 in detail that combines the IS and public value management literatures.

2.4. The Link from IT Resources to Public Value

Following Bacharach (1989), the theoretical development in this manuscript aims at proposing a set of constructs and relationships among the constructs that explain the value creation mechanisms from IT resources and, to some extent, predict how future technological developments will advance public value in the public sector organizations. Therefore, the theory in this study is bounded in the context of governments. Figure 3 shows the three constructs in my theoretical development – IT resources, organizational capabilities, and organizational performance. This section outlines the relationships among these constructs, as crystallized into the four propositions below.

Based on the review on public value management literature, I suggest four key capabilities in public organizations that are pivotal in advancing public value generation – operational capability, communication capability, partnering capability, and innovative capability. I do not maintain that these capabilities represent the universe of public value management capabilities. For example, the literature highlights that it is imperative for public managers to equip with political savvy to engage in political processes (Moore 1995, Alford and Hughes 2008). But, I do not consider such an ability of political involvement in this study. I here theorize that as described in Figure 3, it is the set of four capabilities that play a mediating role between IT resources and pubic value creation.

2.4.1. IT Resources and Operational Capability

One of the primary ways to accomplish greater public value is to improve the efficiency and effectiveness of public service production. In other words, public value is enhanced when a government improves its operational capability by increasing the quality or quantity of public services with fewer inputs. As Moore (1995) puts it,

> "It is not enough to say that public managers create results that are valued; they must be able to show that the results are worth the cost of private consumption and unrestrained liberty forgone in producing the desirable results. Only then can we be sure that some public value has been created." (Moore 1995, pp. 57)

By the same token, Alford and Hughes (2008) argue that "although the term public *value* draws our attention to results or outcomes, it does not ignore inputs and processes. …

creating public value will mean maximizing within a constraint, that is, seeking the greatest possible benefit to the public within the available monetary or legal resources" (p. 3). This implies that lessening such a resource constraint, i.e. making administrative processes more efficient, also leads to greater public value.

The impact of IT resources on operational capability can be explained by the three strategic roles that IT resources play in business organizations – the *automate*, *informate*, and *transform* roles (Zuboff 1985, Chatterjee et al. 2001, Dehning and Richardson 2003, Anderson et al. 2006). The most essential and significant role of IT is to *automate* business processes that traditionally have been driven mostly by paper handling and therefore tended to be laborious and error-prone. It is estimated that automating one transaction saves approximately $154 in labor costs (Center for Digital Government 2006). Hence, given the large number of transactions a government agency usually handles, the value impact of automating business processes can be enormous. Automating processes can take place in the two fronts – internal administration processes and external service delivery to citizens (Moon 2002, Lim and Tang 2008).

Since the early MIS era, information systems have continued to play a key role in the public sector organizations in automating internal processes such as human resource and financial management (Danziger 1979, Kraemer and Dedrick 1997). For instance, the Department of Transportation in the State of North Carolina adopted a tablet PC-based mobile inspection system for state highways and roads (NASCIO 2009). Automating paper-based inspection processes for more than 21,000 bridges, culverts, and signs, the system drastically improves both the efficiency and accuracy of the processes. The system not only brings a cost saving but also enables timely maintenances of state infrastructures, enhancing the safety of statewide transportation systems. This example illustrates how IT resources (the new mobile inspection systems) improve the efficiency and effectiveness of the infrastructure maintenance process.

Moving public service delivery to citizens from a face-to-face basis to the electronic provision via the Internet may benefit both governments and citizens. Now in many jurisdictions, citizens are able to conduct activities on the Internet such as tax filings, license application and renewals, voter registration, and accessing to government records and information (Thomas and Strieb 2005, Norris and Moon 2005). Such online services create public value in two ways – by directly saving citizens time and effort to physically visit government offices and by improving the productivity of transactions (Cresswell et al. 2006). For example, the Motor Fuel Automation Project in the State of Michigan (NASCIO 2005), which includes electronic reporting and processing of fuel tax transactions, generates various benefits for both gas retailers and the state. Gas retailers can integrate their own financial systems with the tax filing systems via Web services, enhancing productivity and accuracy of tax processing. The State of Michigan earns both increased tax revenues and a higher quality of tax data for effective tax auditing.

With respect to the *informate* role, IT resources enable governments to utilize a vast range of information and data in an innovative manner. One of the most prominent uses of information in government administration is in the public safety area. A number of law enforcement agencies in the federal, state and local level strategically adopt business intelligence and data-mining systems. Digitized crime data and state-of-art analytic tools bring new intelligence to law enforcement agents, who used to rely mostly on their own insights and experiences in targeting offenders and solving crimes.

Analyzing and evaluating incident patterns and histories, the agencies are now able to conduct more proactive, predictive patrols and deployment of law enforcement personnel, specifically targeting on most likely neighborhoods or criminal groups. According to a report by Government Technology, the City of Memphis, Tennessee has achieved a 31% reduction in crimes and a 15.4% reduction in violent crimes since 2006 (Digital Communities 2010), representing an accomplishment of considerable public value.

Third, studies on public administration put forth that IT resources can *transform* public organizations by alleviating bureaucracy and red tapes. Red tapes, a manifestation of excessive bureaucracy (Welch and Pandey 2007), are defined as rules, regulations, and procedures that remain in force and entail a compliance burden but do not advance the legitimate purposes the rules were intended to serve (Bozeman 2000, Moon and Bretschneider 2002). Researchers in public administration have been interested in studying the relationship between IT resources and red tapes. There are two competing contentions regarding the relationship. On the one hand, the presence of significant red tapes in organizations provokes interests in technology adoption, a theory called the "demand pull" hypothesis (Pandey and Bretschneider 1997, Moon and Bretschneider 2002). On the other hand, the "technology push" hypothesis suggests that technology usages are related to a reduction in red tapes (Welch and Pandey 2007). Both of the hypotheses receive some empirical support. Researchers explain that IT resources make coordination and communications between employees or between groups more seamless and streamlined (Heintze and Bretschneider 2000). In addition, recording every activity and transaction promote officials' accountability, reducing the incentives of government officials to unnecessarily cause administrative delay. Thus, it is expected that IT can transform public organizations in such a way that decision making and information processing become faster and less deterred by excessive rules and regulations.

The aforementioned roles of IT resources in the public sector organizations thus explain that IT resources can have a substantial impact on the operational capacity of public organizations, which contributes to greater public value. Hence, I propose the following proposition.

Proposition 1. *IT resources contribute to creating public value by enhancing the operational capacity of public organizations.*

2.4.2. IT Resources and Communication Capability

One of the mantras in public value management is that the involvement of a large number of stakeholder groups in policy decision and service delivery is crucial. As Stoker (2006) elaborately puts it,

> Politicians and officials have a particular legitimacy given the government is elected, but there are other valid claims to legitimacy from among others, including business partners, neighborhood leaders, those with knowledge about services as professionals or users, and those in a position of oversight or regulators. … The public value management paradigm relies on a stakeholder conception of legitimacy in its governance arrangements. The fundamental idea is that for a decision to be legitimate or for a judgment to be made, it is necessary to have all the stakeholders involved. (Stoker 2006, p. 47)

Such a claim stressing the involvement of a broad range of actors is also presented by the network governance literature (e.g. Bogason and Musso 2006, Benington 2011). This literature argues that decisions on policies and public services are increasingly being made not by governments alone, but via deliberation and negotiations involving governments, non-governmental organizations (NGO), and individual citizens, given the increasing size and complexity in public administration.

In many cases, however, it is by no means straightforward to lure various stakeholders in participating in decision making. Ordinary citizens tend to be busy and preoccupied with their own everyday lives. Engaging in decision markings in such ways as attending meetings, writing formal feedback, and responding to surveys may require significant time commitment (Ho 2002). In this respect, IT resources provide an alternative venue for a broad range of participation and dialogues from as many relevant stakeholders as possible. Stoker (2006) continues to argue that "new information and communication technologies offer a range of further opportunities to get people's participation in ways that are flexible, attractive to them, and not too time-consuming" (p. 48). Such an advance materializes as e-Government initiatives, which refer to the delivery of government information and services online through the Internet or other digital means (West 2004). According to the e-Government evolution models proposed by Moon (2002) and West (2004), one of the key features of e-Governments is a two-way communication. Government Web sites can not only unilaterally publish information or execute automated transactions, but also make citizens' voices to be heard, enabling direct access to governments. In this way, governments can actively seek opinions of the public on policy issues (Chadwick and May 2003). Tools for two-way communication include online public forum, online voting, and so on. In addition, studies in public administration present preliminary empirical evidence showing that two-way communications between governments and citizens may improve attitudes and trust to governments (West 2004, Welch et al. 2004, Tolbert and Mossberger 2006), which are among the key public value elements (Kelley et al. 2002).

Recently, governments at all levels are using Web 2.0 technologies to solicit citizens' ideas for government administration. In 2008, the Office of the President-Elect Obama set up Citizen's Briefing Book site, collecting policy recommendations from ordinary citizens for the new administration. State and local governments such as the State of California[7] or the City of Manor, Texas (Vander Veen 2010) are also operating similar platforms where residents can submit suggestions and evaluate ones submitted by peer citizens. Thus, Web 2.0 tools offer governments the ability to make sense of what the public wants and concerns and to engage in close, real-time deliberation with citizens (Hui and Hayllar 2010).

It is also stressed that in order to ensure broad participations in deliberation processes and to increase the acceptance of public services, public officials should be active in public information campaigns (Weiss and Tschirhart 1994) or what Moore (1995) calls "public sector marketing" or "strategic communication" (p. 185). These aim at convincing citizens the importance and legitimacy of public services and policy decisions. Weiss and Tschirhart (1994) also explain that despite some adverse effects of public information campaigns, they "can enrich the possibilities for democratic participation. Better-informed citizens may participate more knowledgeably and effectively in all democratic processes" (p. 99). Again, e-Government initiatives can be an effective vehicle in such an effort. IT resources and the use of the Internet can increase the effectiveness of public information campaigns by targeting right audiences and offering a variety of mediums and formats. Weiss and Tschirhart (1994) argue that a way

[7] http://www.govtech.com/dc/744503

to mitigate negative consequences of a public information campaign such as suppressing the expression of the public's opinion is to incorporate a venue for reply, discussion, or debate from the target audience, a feature that e-Government initiatives can offer.

Transparency and accountability in government administration, especially budgeting and financial management, are also considered to be part of public value (Beck Jørgensen and Bozeman 2007), and studies on e-Governments regard IT and the Internet as a great tool for facilitating such values. Accountability in public organizations can be met when the behavior and performance of public managers fulfill or exceed the expectation of citizens and their representatives (Justice et al. 2006). Transparency is considered to be a necessary condition for accountability, as citizens and stakeholders have to be able to assess the performance and compliance of administration. Governments can utilize IT resources and the Internet to ensure the transparency and accountability. Nowadays, many governments post budgeting and finance information on their Web sites ranging from comprehensive annual financial reports (CARF) to detailed breakdown information on budgets and interactive tools for analyses (Rodríguez Bolívar et al. 2004, Justice et al. 2006). These practices enrich openness and accessibility of information on government administration by allowing citizens, especially those without expert knowledge on the administration, to evaluate how public managers use resources that citizens provide in delivering public services.

As laid out so far, IT resources can improve the communication capacity of public organizations in many ways. Public officials can employ IT resources in facilitating bilateral communications with citizens and other stakeholders. By bilateral communications, it means that a government can deliver messages to broader and targeted audiences; at the same time, it can solicit their opinions and suggestions and attract as many of them as possible to join in the deliberation for policy formulation and public service delivery. IT resources can enhance the ability of the government to make information more open and accessible to the general public, creating public value in transparency and democratic accountability. In sum, I propose the following proposition.

Proposition 2. *IT resources contribute to creating public value by enhancing the communication capacity of public organizations.*

2.4.3. IT Resources and Partnering Capability

Management of public organizations driven by public value necessitates the development of partnering capacity with peer government agencies as well as outside private organizations. Stoker (2006) stresses that effective provision of public services requires an open-minded approach to identify the best supplier, be it in the public, private, or voluntary sector. He continues to argue that the choice of the supplier should be based not on ideological or political consideration but on the judgment on which best fulfills the goal of public value creation. Kelley et al. (2002) advocate the presence of multiple suppliers in the public and private sector for a single service, so that citizens can self-select based on their preferences. Following this proposition, Alford and Hughes (2007) suggest the four service delivery models – in-house production, service agency, partnering, and classical contracting.

The literature also emphasizes that in an increasingly dynamic environment, provision of a certain public service by a single organization may not be enough to fulfill changing needs and aspirations of the public. Broussine (2003) stresses that "in order to solve complex problems, public leaders have to be able to initiate concerted action not only within their own organizations but among a set of stakeholders with different and competing interests" (p. 175). Thus, co-production by multiple government agencies or public-private hybrid production may be necessary. There is also a recently emerging research stream on collaborative public management (Alford and Hughes 2007) or hybrid governance, in which the lines between the public, non-profit, and private sectors are being blurred (Klitgaard and Treverton 2004). This literature states that collaborative public management has become an emerging and increasingly prominent form of governing, thanks to decentralized power structures in many societies and increased complexity in many public affair issues that a single government organization can hardly handle alone. I below argue that IT resources play a crucial role in enabling such cooperation transcending traditional organizational boundaries.

IT resources such as tightly integrated inter-organizational systems (IOS), seamless information sharing, and advance communication technologies facilitate collaboration and cooperation between government agencies. For example, Waukesha County, Wisconsin established Waukesha County Communication Center (WCC), the county-wide emergency call and dispatch headquarter (Schulz and Tuma 2007). This project was initiated by the county sheriff but driven by the collaboration of several local municipality agencies including police and fire departments. Among the objectives was to improve the quality of public safety services throughout the county, which had been fragmented by municipality boundaries. By consolidating the call centers of small local governments into one entity and coordinating county-wide dispatch functions, WCC could achieve economies of scale in operation and staffing, reduce the burden of local governments, and proactively adopt advanced, yet expensive technologies such as wireless 911 systems or computer-aided dispatch tools. DeMarie (2004) studies the use of communication technologies by geographically disperse teams in the Radioactive Waste Management Project of Nevada Department of Energy. This project is involved by a variety of professions such as scientists, engineers, and community relation managers as well as government officials from several agencies in U.S. Department of Energy and the State of Nevada. Moreover, they are located in six different states including California, Nevada, and Washington, D.C. This case study reports that the use of such collaboration technologies as groupware and video-conferencing improves team performance in many aspects, which are both tangible and intangible, including improved productivity, reduced costs, enhanced work quality, and attraction and retention of competent project participants.

As IT resources are a key ingredient in integration and cooperation between suppliers, producers, and customers in the private sector (Barua et al. 2004), can government agencies utilize IT resources in cooperating with private sector organizations, be they not-for-profit or for-profit. Luna-Reyes et al. (2007) chronicle a case of the Bureau of Housing Services (BHS) of the State of New York, which provides homeless support services in a partnership with local governments and not-for-profit organizations such as the Salvation Army and the American Red Cross. Such local organizations manage shelters and assist programs and thus directly interact with the homeless, while the BHS provides funding to the local organizations and oversees their programs and facilities. This partnership emerges as either governments or not-for-profit organizations alone cannot effectively manage the support programs for homeless people. Local organizations, especially small mom-and-pop facilities, lack of financial resources and thus need guidance from the authority, while the state government does not have direct, hand-on knowledge on local needs (Agranoff 2004). It is stressed in the case that for the effective management of the program, integration and sharing of information resources that are fragmented and dispersed throughout various state agencies and organizations was imperative. Each state agency and supporting group has own information repositories on beneficiaries, their medical or criminal histories, facilities, and programs. The case illustrates the integration process of the Homeless Information Management System for effective and successful collaboration in delivering homeless assistance programs. In addition to information, for this type of collaboration to succeed, sharing of knowledge and technical expertise among participating organizations is pivotal (McGuire et al. 2011), and inter-organizational knowledge exchange and collaborative tools (Majchrzak et al. 2000) facilitate such knowledge sharing.

Like for-profit firms, public organizations are increasingly needed to develop the ability to cooperate and collaborate with peer agencies and outside private-sector organizations. Anecdotal evidence and academic studies consistently point out that to develop such an ability, governments need to make a smart use of IT resources for more seamless information sharing and process integration. This discussion leads me to propose the following proposition.

Proposition 3. *IT resources contribute to creating public value by enhancing the partnering capacity of public organizations.*

2.4.4. IT Resources and Innovative Capability

Conventional wisdom may suggest that innovation in the public sector is an oxymoron (Borins 2002). This originates from the absence of competitive pressures and profit motives, the presence of bureaucratic public managers and outdated management structure, and so on. However, recent research in public administration including public value management recognizes the importance of innovation in public management, and it is found that public managers can play a key role in initiating and leading innovation. For instance, Borins (2002) conducted a quantitative analysis with innovation awards in several countries that are given to agencies that successfully completed innovation projects. The analysis reveals that the majority of innovation projects were initiated by public organization leaders or middle managers, rather than by politicians or citizens.

The prior public management models (traditional public management and new public management) assume that surrounding environments in which governments operate are stable and unchanging. Thus, the responsibility of public managers is to simply maintain the status quo and follow the predefined rules and procedures suited to existing environments. Public value management model challenges this assumption, and Moore (1995) emphasizes the innovative capability of public organizations for value creation in changing environments. He states that

> It is not enough that managers simply maintain the continuity of their organizations, or even that the organizations become efficient in current tasks. It is also important that the enterprise be adaptable to new purposes and that it be innovative and experimental. (Moore 1995, p. 55)

Thus, the literature stresses that governments be vigilant over understanding evolving circumstances and sensing changing needs and aspirations of various stakeholders. Governments need to become flexible and agile in coping with emerging challenges (Dunleavy et al. 2006). I here argue that IT resources can develop the innovative capability by enabling public managers to drastically redefine existing public services or to create a whole new sort of public services (Hartley 2011) that would not have been impossible to offer without IT.

A public management model that describes the fundamental redefinition of public services is termed as 'borderless governments' (Miszewski 2007) or 'Government-as-a-Service' (Center for Digital Government 2006), in which public agencies are organized not by functions or jurisdictions but by citizens' needs, and the boundaries between agencies become more invisible to the public. Ho (2002) suggests a 'one-stop service center' model. A one-stop service center is an umbrella organization that operates on top of existing functional departments and is intended to maximize the convenience and satisfaction of users through service integration. The use of IT resources is crucial in this model, in that officials in such a service center needs to seamlessly coordinate several departments for provision of integrated services. Similarly, Dunleavy et al. (2006) suggest 'client-based or need-based reorganization', in which government agencies that serve similar purposes are reintegrated.

Michigan Business Portal is a case in point (NASCIO 2006). This system intends to serve the purpose of simulating economic growth within the state in a changing environment represented by the decline in the state's automotive industry. Here, all services, processes, and information relevant to starting a new business such as registration or tax payment are consolidated into a single Web site, so that processes for business start-ups are drastically simplified. Thus, business owners do not need to contact multiple state agencies individually. Enabled by IT resources, this one-stop service center model can augment citizens' satisfaction and thus generate public value by "preventing bureaucracies from sending the citizen back and forth from pillar to post, which still is one of the main complaints about the functioning of public bureaucracies" (Snellen 2000, p. 220).

IT resources can also play a pivotal role in inventing a new public service model. For example, IT resources are an indispensable component in Illinois National Electronic Disease Surveillance System (I-NEDSS) (NASCIO 2005). This system aims at identifying and tracking an outbreak of infectious diseases that might escalate to a statewide emergency. It interconnects local healthcare providers and state and federal agencies such as Center for Disease Control and Prevention. This initiative is a response to the continuous emergence of new types of pandemic diseases such as H1N1 and the increasing threat of biological terroristic attacks. The real-time detection and response system to outbreaks could not be operated without the state-of-the-art network infrastructure and data analytic systems.

The literature on public value management asserts that innovation should not be a term that only appears in the private sector. Public organizations also need to continuously innovate themselves to navigate a turbulent environment and keep delivering values to the public. The arguments on IT resources and the innovative capability in public organizations can be summarized in the following proposition.

Proposition 4. *IT resources contribute to creating public value by enhancing innovative capacity of public organizations.*

Table 6 summarizes the discussions in Section 2.4.

Table 6. Summary of Propositions

Path	Mechanisms
Proposition 1: IT resources → Operational Capabilities → Public Value	*Automate* manual, paper-based organizational processes *Informate* public employees for better decision making and innovative provision of public services *Transform* bureaucratic organizations into responsive, agile ones
Proposition 2: IT resources → Communicational Capabilities → Public Value	Make public information campaigns more effective Solicit involvement of stakeholders in policy decisions and public service delivery Promote accountability and democratic processes by making information open and accessible
Proposition 3: IT resources → Partnering Capabilities → Public Value	Enable collaboration and cooperation between governments or with private-sector organizations
Proposition 4: IT resources → Innovative Capabilities → Public Value	Redefine the boundary and scope of public services and organizations Create a whole new kind of public services

2.5. Conclusion

Taking the process-level approach from the literature on IT resources and value and drawing on the emerging public value management perspective, this study develops a theoretical model that explains how IT resources in governments contribute to organizational performance as measured by public value creation. With prior studies in public administration and anecdotal evidence, I explicate that IT resources help public organizations nurture the four crucial organizational capabilities – operational, communication, partnering, and innovative capabilities. In turn, an improvement in these organizational capabilities contributes to greater public value creation.

In future studies, I will provide an answer to in what context IT resources contribute to greater public value. I will attempt to find key moderating factors in the relationship between IT resources, organizational capabilities, and public value creation. Such factors can be grouped in four categories – (i) leadership of top management (legislatures, elected officials, and high-ranking appointed officials) in IT management, (ii) organizational acceptance and effective use of IT, (iii) citizens' acceptance of IT-driven changes and public services, and (iv) government-business partnerships. I will explain them in detail in future studies.

References

Agranoff, R. 2004. "Leveraging Networks: A Guide for Public Managers Working across Organizations," in *Collaboration: Using Networks and Partnerships*, Kamensky, J.M. and Burlin, T.J. (eds.), Lanham, MD: Rowman & Littlefield Publishers, pp. 61-102.

Amit, P. and Schoemaker, P.J.H. "Strategic Assets and Organizational Rent," *Strategic Management Journal* (14:1) 1993, pp. 33-46.

Anderson, M.C., Banker, R.D., and Ravindran, S. "Value Implications of Investments in Information Technology," *Management Science* (52:9) 2006, pp. 1359-1376.

Alford, J. "Defining the Client in the Public Sector," *Public Administration Review* (62:3) 2002, pp. 337-346.

Alford, J. and Hughes, O. "Public Value Pragmatism as the Next Phase of Public Management," *American Review of Public Management* (38:2) 2008, pp. 130-148.

Alford, J. and O'Flynn, J. "Making Sense of Public Value: Concepts, Critiques and Emergent Meanings," *International Journal of Public Administration* (32:3) 2009, pp. 171-191.

Bacharach, S.B. "Organizational Theories: Some Criteria for Evaluation," *Academy of Management Review* (14:4) 1989, pp. 496-515.

Banker, R.D., Bardhan, I.R., Chang, H., and Lin, S. "Plant Information Systems, Manufacturing Capabilities, and Plant Performance," *MIS Quarterly* (30:2) 2006, pp. 315-337.

Barney, J. "Firm Resources and Sustained Competitive Advantage," *Journal of Management* (17:1) 1991, pp. 99-120.

Barua, A., Konana, P., and Whiston, A.B. "An Empirical Investigation of Net-Enabled Business Value," *MIS Quarterly* (28:4) 2004, pp. 585-620.

Barua, A., Kriebel, C.H., and Mukhopadhyay, T. "Information Technologies and Business Value: An Analytic and Empirical Investigation," *Information Systems Research* (6:1) 1995, pp. 3-23.

Beck Jørgensen, T. and Bozeman, B. "Public Values: An Inventory," *Administration & Society* (39:3) 2007, pp. 354-381.

Benington, J. "Creating the Public in Order to Create Public Value?," *International Journal of Public Administration* (32:3) 2009, pp. 232-249.

Benington, J. 2011. "From Private Choice to Public Value?," in *Public Value Theory and Practice*, Benington, J. and Moore, M.H. (eds.), Palgrave Macmillan: Houndmills, UK, pp. 31-51.

Bharadwaj, A.S. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1) 2000, pp. 169-196.

Bharadwaj, A.S., Bharadwaj, S.G., and Konsynski, B.R. "Information Technology Effects on Firm Performance as Measured by Tobin's *q*," *Management Science* (45:7) 1999, pp. 1008-1024.

Bharadwaj, S., Bharadwaj, A., and Bendoly, E. "The Performance Effects of Complementarities Between Information Systems, Marketing, Manufacturing, and Supp.ly Chain Processes," *Information Systems Research* (18:4) 2007, pp. 437-453.

Bogason, P. and Musso, J.A. "The Democratic Prospects of Network Governance," *American Review of Public Administration* (36:1) 2006, pp. 3-18.

Borins, S. "Leadership and Innovation in the Public Sector," *Leadership & Organization Development Journal* (28:8) 2002, pp. 467-476.

Bozeman, B. "Public-Value Failure: When Efficient Markets May Not Do," *Public Administration Review* (62:2) 2002, pp. 145-161.

Bozeman, B. *Bureaucracy and Red Tape*, 2000, Upper Saddle River, N.J.: Prentice-Hall.

Bresnahan, T.F., Brynjolfsson, E., and Hitt, L.H. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *The Quarterly Journal of Economics* (117:1) 2002, pp. 339-376.

Breton, A. 1991. "The Existence and Stability of Interjusrisdictional Competition," in *Competition among States and Local Governments*, Kenyon, D.A. and Kincaid, J. (eds.), Washington D.C.: The Urban Institute Press, pp. 37-56.

Broussine, M. 2003. "Public Leadership," in *Public Management and Governance*, Bovarid, T. and Loffler, E. (eds.), London, UK: Routledge, pp. 175-187.

Brynjolfsson, E. "The Productivity Paradox of Information Technology," *Communication of the ACM* (36:12) 1993, pp. 67-77.

Brynjolfsson, E. and Hitt, L. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4) 1996, pp. 541-558.

Brynjolfsson, E., Hitt, L.M., and Yang, S. "Intangible Assets: Computers and Organizational Capital," *Brookings Papers on Economic Activity* (1:1) 2002, pp. 137-181.

Center for Digital Government, *Prove IT – The Disciplines of Harvesting Value from Public Sector Information Technology,* 2006, available at http://www.govtech.com/gt/papers/220, accessed on Sep. 20th, 2010.

Chadwick, A. and May, C. "Interaction between States and Citizens in the Age of the Internet," *Governance: An International Journal of Policy, Administration, and Institutions* (16:2) 2003, pp. 271-300.

Chatterjee, D., Richardson, V., and Zmud, R. "Examining the Shareholder Wealth Effects of New CIO Position Announcements," *MIS Quarterly* (25:1) 2001, pp. 43-70.

Cresswell, A.M., Burke, G.B., and Pardo, T.A., *Advancing Return on Investment Analysis for Government IT – A Public Value Framework,* 2006, available at http://www.ctg.albany.edu/publications/reports/advancing_roi, accessed on Sep. 20th, 2010.

Danziger, J.N. "Technology and Productivity: A Contingency Analysis of Computers in Local Government," *Administration & Society* (11:2) 1979, pp. 144-171.

Davis, P. and West, K. "What Do Public Values Mean for Public Action? Putting Public Values in Their Plural Place," *American Review of Public Management* (39:6) 2009, pp. 602-618.

deLone, L. and Denhardt, R.B. "The Political Theory of Reinvention," *Public Administration Review* (60:2) 2000, pp. 89-97.

DeMarie, S.M. "Using Virtual Teams to Manage Complex Projects: A Cast Study of the Radioactive Waste Management Project," in *Collaboration: Using Networks and Partnerships*, Kamensky, J.M. and Burlin, T.J. (eds.), Lanham, MD: Rowman & Littlefield Publishers, pp. 150-170.

Dierickx, I. and Cool, K. "Asset Stock Accumulation and Sustainability of Competitive Advantage," *Management Science* (35:12) 1989, pp. 1504-1511.

Digital Communities, Memphis Cracks Crime Trend with Forecasting Technology, 2010, available at: http://www.govtech.com/dc/articles/766661, accessed on Oct. 12th, 2010.

Dunleavy, P., Margetts, H., Bastow, S., and Tinker, J. "New Public Management Is Dead – Long Live Digital-Era Governance," *Journal of Public Administration Research and Theory* (16:3) 2006, pp. 467-494.

Dye, T.R. *American Federalism: Competition Among Governments*, 1990, Lexington, MA: Lexington Books.

Francalanci, C., and Galal, H. "Information Technology and Worker Composition: Determinants of Productivity in the Life Insurance Industry," *MIS Quarterly* (22:2) 1998, pp. 227-241.

Feeny, D. F., and Willcocks, L. P. "Core IS Capabilities for Exploiting Information Technology," *Sloan Management Review* (39:3), 1998, pp. 9-21.

Hartley, J. 2011. "Public Value through Innovation and Improvement," in *Public Value Theory and Practice*, Benington, J. and Moore, M.H. (eds.), Palgrave Macmillan: Houndmills, UK, pp. 171-184 .

Heintze, T., and Bretschneider, S. "Information Technology and Restructuring in Public Organizations: Does Adoption of Information Technology Affect Organizational Structures, Communications, and Decision Making?," *Journal of Public Administration Research and Theory* (10:4) 2000, pp. 801-830.

Hitt, L.M., and Brynjolfsson, E. "Productivity, Business Productivity, and Consumer Surplus: Three Different Measures of Information Technology Value," *MIS Quarterly* (20:2) 1996, pp. 121-142.

Ho, A.T.-K. "Reinventing Local Governments and the E-Government Initiatives," *Public Administration Review* (64:4) 2002, pp. 434-444.

Hood, C. *Explaining Economic Policy Reversals*, 1994, Buckingham, UK: Open University Press.

Hui, G. and Hayllar, M.R. "Creating Public Value in E-Government: A Public-Private-Citizen Collaboration Framework in Web 2.0," *Australian Journal of Public Management* (69:S1) 2010, pp. S120-S131.

Justice, J.B., Melitski, J., and Smith, D.L. "E-Government as an Instrument of Fiscal Accountability and Responsiveness: Do the Best Practitioners Employ the Best Practices?," *American Review of Public Administration* (36:3) 2006, pp 301-322.

Kelly, G., Mulgan, G., and Muers, S. *Creating Public Value: An Analytic Framework for Public Service Reform*, 2002, Strategy Unit, U.K. Cabinet Office, available at http://webarchive.nationalarchives.gov.uk/20100416132449/http://www.cabinetoffice.gov.uk/strategy/seminars/public_value.aspx, accessed on Sep. 3rd, 2010.

Klitgaard, R. and Treverton, G.F. 2004. "Assessing Partnerships: New Forms of Collaboration," in *Collaboration: Using Networks and Partnerships*, Kamensky, J.M. and Burlin, T.J. (eds.), Lanham, MD: Rowman & Littlefield Publishers, pp. 21-59.

Kohli, R., and Devaraj, S. "Measuring Information Technology Payoff: A Meta-Analysis of Structural Variables in Firm-Level Empirical Research," *Information Systems Research* (14:2) 2003, pp. 127-145.

Kohli, R. and Grover, V. "Business Value of IT: An Essay on Expanding Research Directions to Keep Up with the Times," *Journal of the Association for Information Systems* (9:2) 2008, pp. 23-39.

Kraemer, K.L. and Dedrick, J. "Computing and Public Organization," *Journal of Public Administration Research and Theory* (7:1) 1997, pp. 89-112.

Lane, J.-E. *New Public Management*, 2000, London, U.K.: Routledge.

Lee, G., and Perry, J.L. "Are Computers Boosting Productivity? A Test of the Paradox in State Governments," *Journal of Public Administration Research and Theory* (12:1) 2002, pp. 77-102.

Lehr, W., and Lichtenberg, F.R. "Computer Use and Productivity Growth in US Federal Government Agencies, 1987-92," *Journal of Industrial Economics* (46:2) 1998, pp. 257-279.

Lim, J.H. and Tang, S.-Y. "Urban E-Government Initiatives and Environmental Decision Performance in Korea," *Journal of Public Administration Research and Theory* (18:1) 2008, pp. 109-138.

Luna-Reyes, L.F., Pardo, T.A., Ochoategui, F.B., and Sanabria, R.M. 2007. "Bureau of Housing Service (BHS)," in *Case Studies on Digital Government*, Rocheleau, B. (ed.), Hershey, PA: Idea Group Publishing, pp. 247-255.

Majchrzak, A., Rice, R.E., King, N., Malhotra, A., and Ba, S. "Computer-Mediated Inter-Organizational Knowledge-Sharing: Insights from a Virtual Team Innovating Using a Collaboration Tool," *Information Resource Management Journal* (13:1) 2000, pp. 44-53.

Malhotra, A., Gosain, S., and El Sawy, O.A. "Leveraging Standard Electronic Business Interfaces to Enable Adaptive Supp.ly Chain Partnerships," *Information Systems Research* (18:3) 2007, pp. 260-279.

McGuire, M., Agranoff, R., and Silvia, C. *Putting the "Public" Back Into Collaborative Public Management*, 2011, available at http://www.maxwell.syr.edu/pmrc2011.aspx?id=77309416873, accessed on Jun. 16th, 2011.

Melville, N., Gurbaxani, V., and Kraemer, K.L. "The Productivity Impact of Information Technology across Competitive Regimes: The Role of Industry Concentration and Dynamism," *Decision Support Systems* (43:1) 2007, pp 229-242.

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

Miszewski, M. 2007. "State of Wisconsin IT: Destroying the Barriers to Borderless Government," in *Case Studies on Digital Government*, Rocheleau, B. (ed.), Hershey, PA: Idea Group Publishing, pp. 1-22.

Mithas, S., Ramasubbu, N., and Sambamurthy, V. "How Information Management Capability Influences Firm Performance," *MIS Quarterly* (35:1) 2011, pp. 237-256.

Moon, M.J. "The Evolution of E-Government among Municipalities: Rhetoric or Reality?," *Public Administration Review* (62:4) 2002, pp 424-433.

Moon, M.J., and Bretschneider, S. "Does the Perception of Red Tape Constrain IT Innovativeness in Organizations? Unexpected Results from a Simultaneous Equation Model and Implications," *Journal of Public Administration Research and Theory* (12:2) 2002, pp. 273-291.

Moore, M.H. *Creating Public Value: Strategic Management in Government*, 1995, Cambridge, MA: Harvard University Press.

Moore, M.H. and Benington, J. 2011. "Conclusions: Looking Ahead," in *Public Value Theory and Practice*, Benington, J. and Moore, M.H. (eds.), Palgrave Macmillan: Houndmills, UK, pp. 256-274.

Moore, M.H. and Khagram, S. "On Creating Public Value: What Business Might Learn from Government about Strategic Management," 2004, Corporate Social Responsibility Initiative Working Paper, No. 3, Cambridge, MA: John F. Kennedy School of Government, Harvard University.

Mukhopadhyay, T., Javier Lerch, F., and Mangal, V. "Assessing the Impact of Information Technology on Labor Productivity: A Field Study," *Decision Support Systems* (19:2) 1997, pp. 109-122.

Mukhopadhyay, T., Rajiv, S., and Srinivasan, K. "Information Technology Impact on Process Output and Quality," *Management Science* (43:12) 1997, pp. 1645-1659.

NASCIO, *2005 Best Practices in the Use of Information Technology in State Government*, 2005, available at http://www.nascio.org/publications/documents/NASCIO-2005NASCIOAwards.pdf, accessed on Sep. 20th, 2010.

NASCIO, *2009 Best Practices in the Use of Information Technology in State Government*, 2009, available at http://www.nascio.org/publications/documents/NASCIO-2009Awards.pdf, accessed on Sep. 20th, 2010.

Norris, D.F. and Kraemer, K.L. "Mainframe and PC Computing in American Cities: Myths and Realities," *Public Administration Review* (56:6) 1996, pp. 568-575.

Norris, D.F. and Moon, M.J. "Advancing E-Government at the Grassroots: Tortoise or Hare?," *Public Administration Review* (65:1) 2005, pp. 64-75.

Nuun, S. "Police Information Technology: Assessing the Effects of Computerization on Urban Police Functions," *Public Administration Review* (61:2) 2001, pp. 221-234.

O'Flynn, J. "From New Public Management to Public Value: Paradigmatic Change and Managerial Implications," *Australian Journal of Public Management* (66:3) 2007, pp. 353-366.

Orlikowski, W.J. and Iacono, C.S. "Research Commentary: Desperately Seeking "IT" in IT Research – A Call to Theorizing the IT Artifact," *Information Systems Research* (12:2) 2001, pp. 121-134.

Pavlou, P.A., and El Sawy, O.A. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* (17:3) 2006, pp. 198-227.

Pavlou, P.A., and El Sawy, O.A. "The Third-Hand: IT-Enabled Competitive Advantage in Turbulence through Improvisational Capabilities," *Information Systems Research* (21:3) 2010, pp. 443-471.

Piccoli, G., and Ives, B. "*Review*: IT-Dependent Strategic Initiatives and Sustained Competitive Advantage: A Review and Synthesis of the Literature," *MIS Quarterly* (29:4) 2005, pp. 747-776.

Porter, M. *Competitive Advantage*, 1985, New York, NY: The Free Press.

Rai, A. and Tang, X. "Leveraging IT Capabilities and Competitive Process Capabilities for the Management of Interorganizational Relationship Portfolios," *Information Systems Research* (21:3) 2010, pp. 516-542.

Rai, A., Patnayakuni, R., and Seth, N. "Firm Performance Impacts of Digitally Enabled Supp.ly Chain Integration Capabilities," *MIS Quarterly* (30:2) 2006, pp. 225-246.

Ray, G., Muhanna, W.A., and Barney, J.B. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4) 2005, pp. 625-652.

Rodríguez Bolívar, M.P., Perez, C.C., and Hernandez, A.M.L. "E-Government and Public Fianncial Reporting," *American Review of Public Administration* (37:2) 2007, pp. 142-177.

Ross, J.W., Beath, C.M., and Goodhue, D.L. "Develop Long-Term Competitiveness through IT Assets," *Sloan Management Review* (38:1), 1996, pp. 31-42.

Sambamurthy, V., Bharadwaj, A., and Grover, V. "Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2) 2003, pp. 237-263.

Schultz, J.A. and Tuma, R. 2007. "A Collaborative Communications Center and Public Safety Data Systems," in *Case Studies on Digital Government*, Rocheleau, B. (ed.), Hershey, PA: Idea Group Publishing, pp. 256-280.

Smith, R.F.I. "Focusing on Public Value: Something New and Something Old," *Australian Journal of Public Management* (63:4) 2004, pp. 68-79.

Snellen, I. "Public Service in an Information Society," in *Governance in the Twenty-first Century: Revitalizing the Public Service*, Peters, B.G. and Savoie, D.J. (eds.), Montreal, Canada: McGill-Queen's University Press, pp. 209-243.

Stoker, G. "Public Value Management: A New Narrative for Networked Governance?," *American Review of Public Administration* (36:1) 2006, pp. 47-51.

Swilling, M. 2011. "Greening Public Value: The Sustainability Challenge," in *Public Value Theory and Practice*, Benington, J. and Moore, M.H. (eds.), Palgrave Macmillan: Houndmills, UK, pp. 89-111.

Tanriverdi, H. "Information Technology Relatedness, Knowledge Management Capability, and Performance of Multibusiness Firms," *MIS Quarterly* (29:2) 2005, pp. 311-334.

Tanriverdi, H. "Performance Effects of Information Technology Synergies in Multibusiness Firms," *MIS Quarterly* (30:1) 2006, pp. 57-77.

Teece, D.J., Pisano, G., and Shuen, A. "Dynamic Capabilities and Strategic Management," *Strategic Management Journal* (18:7) 1997, pp. 509-533.

Teo, H.-H., Tan, B.C.Y., and Wei, K.-K. "Organizational Transformation Using Electronic Data Interchange: The Case of TradeNet in Singapore," *Journal of Management Information Systems* (13:4), 1997, pp. 139-165.

Thomas, J.C. and Streib, G. "E-Demoncracy, E-Commerce, and E-Research: Examining the Electronic Ties Between Citizens and Governments," *Administration & Society* (37:3) 2005, pp. 259-280.

Tippins, M.J., and Sohi, R.S. "IT Competency and Firm Performance: Is Organizational Learning a Missing Link?" *Strategic Management Journal* (24:8) 2003, pp. 745-761.

Tolbert, C.J., and Mossberger, K. "The Effects of E-Government on Trust and Confidence in Government," *Public Administration Review* (66:3) 2006, pp 354-369.

Trogen, P.C. 2005. "Public Goods," in *Handbook of Public Sector Economics*, Robbins, D. (ed.), Boca Raton, FL: CRC Press, pp. 169-208.

Turner, C. 2007. "GovBenefits.gov: A Case Study in Government-to-Citizen Interaction," in *Case Studies on Digital Government*, Rocheleau, B. (ed.), Hershey, PA: Idea Group Publishing, pp. 156-177.

Vander Veen, C. "City 2.0," *Government Technology* (23:5) 2010, pp. 20-24.

Wade, M., and Hulland, J. "*Review*: The Resource-Based View and Information Systems Research: Review, Extension, and Suggests for Future Research," *MIS Quarterly* (28:1) 2004, pp. 107-142.

Weiss, J.A. and Tschirhart, M. "Public Information Campaigns as Policy Instruments," *Journal of Policy Analysis and Management* (13:1) 1994, pp. 82-119.

Welch, E.W., Hinnant, C.C., and Moon, M.J. "Linking Citizen Satisfaction with E-Government and Trust in Government," *Journal of Public Administration Research and Theory* (15:3) 2004, pp. 371-391.

Welch, E.W., and Pandey, S.K. "E-Government and Bureaucracy: Toward a Better Understanding of Intranet Implementation and Its Effect on Red Tape," *Journal of Public Administration Research and Theory* (17:3) 2007, pp. 379-404.

West, D. "E-Government and the Transformation of Service Delivery and Citizen Attitudes," *Public Administration Review* (64:1) 2004, pp. 15-27.

Wu, X. and He, J. "Paradigm Shift in Public Administration: Implication for Teaching in Professional Training Programs," *Public Administration Review* (69:S1) 2009, pp. S21-S28.

Zuboff, S. "Automate/Informate: The Two Faces of Intelligent Technology," *Organizational Dynamics* (14:2) 1985, pp. 5-18.

CHAPTER 3.

INFORMATION TECHNOLOGY AND ADMINISTRATIVE EFFICIENCY IN U.S. STATE GOVERNMENTS – A STOCHASTIC FRONTIER APPROACH

3.1. Introduction

To do more with less, governments go digital.

- Steve Lohr, *The New York Times*, October 10th, 2009

The purpose of this chapter is to provide empirical evidence that supports Proposition 1 in Chapter 2 that IT resources create public value by improving the operational capability of the public sector organizations. In addition, this chapter is motivated by my perspective that the approach to measure the value effect of IT investments in the private sector that has been adopted in the prior literature may not be directly applicable in the government context.

The differences between the private and public sector that I have laid out in Section 1.1 necessitate the use of alternative empirical approaches for the public sector research. Most importantly, I find that the production function framework, which has been a *de facto* approach since 1990s (e.g. Hitt and Brynjolfsson 1996, Brynjolfsson and Hitt 1996, Dewan and Kraemer 2000), may not be directly applicable in the context of this study. State governments produce a range of goods and services that not only have diverse objectives but are hard to be quantified into a single measure such as profits in the commercial business. I was not able to find an aggregate measure for government outputs that corresponds to sales or value-added in the private sector. More subtly, the production function assumes that outputs are endogenous, i.e. firms maximize the amount of outputs for a given level of input used. I believe, on the other hand, that in the public sector context, it is more appropriate to assume that government outputs are exogenously given, and government agencies minimize expenditures for a given level of public services to produce. Consequently, I adopt the stochastic frontier estimation as a baseline empirical approach (De Borger and Kerstens 1996, Geys 2006) that I expect to be more suitable in the current context. A detailed explanation on the choice of empirical technique is to follow in the subsequent sections.

I choose U.S. state governments as the focal context to study IT value in the public sector organizations for the following reasons. State governments have used information technologies extensively for the internal administration as well as for the delivery of public services such as education, social welfare, healthcare, and law enforcement. Like for-profit firms, many state governments strategically adopt IT to achieve greater efficiency and to provide more responsive public services (NASCIO 2005). For the last several years, an e-Government initiative, whose main purpose is to provide the public with greater access to governments via the Internet, has become a major movement in the government sector (West 2004, Robbins and Miller 2005). In addition, IT is considered an important means to facilitate seamless collaborations among state, federal, and local government agencies (NASCIO 2007a). Therefore, it is a legitimate question from the perspective of taxpayers whether these efforts indeed generate sufficient value to the states and the taxpayers.

As this study is one of the early studies for IT value in the public sector, among many research issues, I choose to study the impact of IT on state governments' administrative efficiency, which refers to the extent to which a government provides public goods and services with limited resources (Downs and Larkey 1986, p. 6, Stiglitz 2000, p. 149). Utilizing the IT budget data from the National Association of State CIOs, the census data on state government expenditures, and a variety of information on public services that state governments supply, I estimate the relationship between IT intensity (Bharawaj et al. 1999, Anderson et al. 2006) and technical cost efficiency, a proxy for administrative efficiency. The empirical analyses provide evidence for this relationship to be positive and statistically significant. That is, higher IT investments are related to greater efficiency in the states. All others being equal, the results indicate that a $1 increase in per capita IT budget is associated with a $4.18 decline in per capita cost in operation and capital depreciation. Further analyses show that this sizeable effect persists over a period of time. In addition, I also conducted a series of robustness checks through the use of alternative functional specifications and measures for outputs and input prices. Overall, the results remain consistent under these robustness checks. Finally, I find that the contribution of IT investments to efficiency is contingent upon the size of state gross domestic product (GDP), the centrality of IT management in state governments, and the size of a central IT organization.

The present research contributes to the literature by expanding the scope of IT value studies to an area that to the best of my knowledge, few previous works in the IS discipline have dealt with. I discover a meaningful performance impact of IT in the government sector, where competitive pressure for profits is not the major motive. This study provides quantitative evidence that IT enables governments to do more with less in the apparent absence of desire for efficiency and profit. The secondary contribution is to introduce the use of an empirical approach for measuring IT value that is not frequently used in the IS field – the translog cost function model with stochastic frontier estimation. I believe that this approach can be used in studying the performance effect of IT in other not-for-profit sector contexts.

The remainder of this chapter proceeds as follows. The following section offers hypothesis development and empirical model. Section 3.3 explains data sources and measures. Section 3.4 presents the main result followed by a series of sensitivity analyses to check the robustness of the result. The chapter concludes with discussions, limitations, and future research directions.

3.2. Hypothesis and Empirical Model

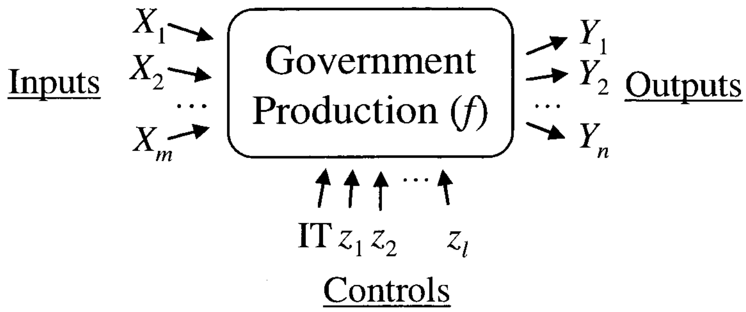
3.2.1. Hypothesis

As laid out above, this study investigates the cost efficiency effect of IT investments. The IS literature extensively documents the cost reduction effect. For example, Mitra and Chaya (1996) show that firms with greater spending on IT report lower costs of goods sold (COGS) and selling and general administration (SGA) expenses. Santhanam and Hartono (2003) also provide evidence supporting that firms identified as IT leaders demonstrate significantly lower COGS, SGA expenses, and operating expenses than industry averages. In another study, Zhu (2004) reveals that in the retail industry, higher IT infrastructure investments are associated with lower COGS per employee, a relationship that is greater when a firm has better e-commerce capability. Aral and Weill (2007) also show that greater investments on transactional information systems are associated with lower COGS. While the effect of IT on costs of goods sold may not be directly applicable to the public sector, overall efficiency benefits of IT do apply in this context, since government agencies are usually expected to deliver necessary services to citizens with as little revenues (or tax-collection) as possible. Therefore, as discussed earlier, cost-efficiency outcomes are a more appropriate starting point to examine the economic contribution of IT in the public sector.

In the economic literature, studies by public economists on government efficiencies treat government organizations as a producer of multiple public goods using a number of inputs (e.g. Fiorina and Noll 1978, Bewley 1981, Bergstrom et al. 1986), as described in Figure 4. In this model, a government purchases m inputs and transforms them with a certain production technology f to produce n outputs. In this context, several efficiency factors (z_1, z_2, ..., z_l) may contribute to the productivity or efficiency in this production process. In this study, based on the prior theory and anecdotal evidence discussed above, I consider IT investments by state governments as one factor. Therefore, drawing on the *automate* and *informate* role of IT, I hypothesize a positive association between state IT intensity (i.e. a relative measure of IT investments by the state government) and administrative efficiency.

Hypothesis*: IT intensity is positively associated with administrative efficiency in U.S. state governments.*

Figure 4. State Government Production Function



(See Fiorina and Noll 1978, Bewley 1981, Bergstrom et al. 1986)

3.2.2. Empirical Model

I estimate the impact of IT investments on administrative efficiency with a two-stage estimation approach based on a multi-product translog cost function (Caves et al. 1980, Caves et al. 1981). This specification has been used in the prior literature in public economics (Geys 2006, De Borger and Kersten 1996, Worthington 2000). In the first stage, I estimate cost inefficiency of each state-year observation with a stochastic frontier model (Aigner et al. 1997). I treat this efficiency as a proxy for administrative efficiency. In the second stage, the estimated cost efficiency is regressed on IT intensity and other exogenous factors that the literature has identified to influence inefficiency in governments.

Although many prior IT value studies have adopted a production function model to study the impact of IT in the for profit business setting (Brynjofsson and Hitt 1996, Dewan and Min 1997, Dewan and Kraemer 2000), I believe that a multi-product translog cost function is more suitable in my context for the three reasons – the unavailability of an aggregate measure for the state government outputs, the exogeneity of the outputs, and the absence of short-term effects of IT on the outputs.

First, to the best of my knowledge, it is difficult to find an appropriate measure to gauge the collective amount of outputs that state governments produce. While in the for-profit context, such measures as sales or value-added can account for aggregate outputs that a firm supplies, to the best of my knowledge, the literature has not established a single measure that represents a variety of public services that state governments offer such as education, transportation, and so forth. In addition, in my context, there may be various measures for the output of a single public service (e.g. dropout rate for public education), but I would underestimate the contribution of IT to the productivity of public service delivery if I were to estimate the impact on one service area. Using the production function model, Lee and Perry (2002) relate IT assets in U.S. state governments to state GDP, a proxy they use for state government productivity, and find a positive impact of IT on state GDP. However, I do not believe that state GDP represents outputs produced by the state government, as it also accounts for outputs from the private sector.

Second, the prior literature in economics has pointed out that outputs can be considered exogenous under some conditions, and thus the cost function approach may be more appropriate to study efficiency in the following contexts – (i) when production is regulated (Caves et al. 1981), (ii) when production is price-inelastic (Ray 1982), or (iii) when outputs cannot be stored (Kumbharkar and Lovell 2000). Kumbharkar and Lovell (2000) note that theoretically, a production and a cost function are equivalent, but in effect, the two functions have divergent behavioral assumptions. To put it differently, under the circumstances described above, an efficient producer minimizes the use of inputs, given the amount of outputs to be produced. The provision of public services by state governments shares almost all the characteristics mentioned above.

With respect to (i), state government production is regulated by various federal and state laws, policies, and statutes, and thus most of the public services are entitlement programs. For example, the Social Security Act requires every state to provide a healthcare benefit program to residents with limited incomes. Also, state governments are in charge of maintaining the Interstate Highway System within each jurisdiction under the Federal-Aid Highway Act of 1956. Thus, state governments are bounded by an exogenous factor, which is the federal laws, and for such outputs, it is outside of the state governments' purview to change the amount of outputs[8]. In terms of (ii), as production is regulated, state governments should maintain the provision of the services, even when input prices (labor or capital) or output prices (tax revenues) change. Even for outputs whose provision is under jurisdiction of state governments such as education, adjusting the extent of provision due to price changes such as a reduction in tax revenues requires policy making by executive branches, deliberation among stakeholders and interests groups, and legislative processes, all of which usually take several months or years. Thus, it makes sense to consider that state government production is price-inelastic, at least in the short-run, which this study deals with. Lastly, for (iii), state government outputs such as education or public safety are certainly consumed immediately after production. As there is essentially no inventory for state outputs, states need to maintain the stability of production, which once again renders outputs exogenous.

Third and relatedly, I do not expect that IT investments to have an impact on the amount of state government outputs, especially in the short run. It is likely that IT

[8] Medicaid is a healthcare program administered by state governments, and it is discretion of a state to determine the eligibilities and extent of benefits. But, as its funding is largely provided by the federal government, states have to certain follow requirements established by Center for Medicare and Medicaid Services.

improves the productivity of public service delivery, but it is unlikely that such improvement immediately leads to an increase in the amount of public service production. As I just mentioned above, adjusting the amount of outputs in governments requires policy making, negotiation, and legislative processes that are lengthy. Provided that the focus is on the relatively short term effect of IT investments in state governments, it makes sense that the amount of government outputs is exogenous with respect to IT investments.

As stated in this section, in contrast to the production function model where output is assumed to be endogenous, in my context, I believe that it is more appropriate to assume that most outputs are determined exogenously and state governments attempt to limit the use of inputs[9]. Thus, I adopt a multi-product translog cost function. This function is particularly suitable as it allows me to include multiple outputs measures in the estimation that are difficult to be aggregated and models the provision of government outputs, each of which has different objectives.

3.3. Data and Methods

3.3.1. Two Stage Estimation Using Stochastic Frontier Model

I use a stochastic cost frontier model to estimate administrative efficiency. This model is widely used in the public sector context for measuring efficiencies. For example,

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[9] It may be the case that state government outputs are endogenous to the extent that state government production is determined by the availability of input resources. In other words, they may not entirely be exogenous. However, if we consider a continuum of exogeneity and endogeneity, we believe that state government outputs are closer to exogeneity, compared to the private sector goods. In other words, the extent to which outputs are endogenous is less that that of private goods. In addition, such an extent may render our estimation with a cost function biased and inconsistent, but we do not believe that such bias and inconsistency would change our primary results drastically.

Davis and Hayes (1993) estimate the efficiency of police departments in 141 Illinois municipalities based on the production function framework with stochastic frontier estimation. Grossman et al. (1999) and Conroy and Arguea (2003) adopt a similar approach in estimating efficiencies in 49 U.S. metropolitan cities and Florida public elementary schools, respectively. In measuring efficiencies of city administration in 304 Flemish local governments, Geys (2006) employs the translog cost function with a stochastic frontier model. A similar model is used by De Borger and Kersten (1996) and Worthington (2000). An approach that relates efficiency to IT has also been taken in an IT productivity study by Lee and Barua (1999), who find that IT intensity is positively associated with technical and scale efficiency obtained from a stochastic frontier estimation with a production function model.

Note that in the context of this study, state government efficiencies may be affected by various unobserved factors that are organizational or political in nature. In addition, even though states produce a wide range of public goods and services, I may not include all the measures for such outputs in the estimations. For this reason, I choose a stochastic frontier model rather than deterministic frontier models such as data envelopment analysis (e.g. Charnes et al. 1978) or goal programming models (Aigner and Chu 1968). Deterministic models do not account for random factors, measurement errors and unobserved state heterogeneity, which get lumped into the inefficiency measures (Lovell 1993). It is also argued that the absence of stochastic factors in the deterministic models makes it hard to conduct statistical testing and inferences (Kumbharkar and Lovell 2000).

A typical stochastic frontier for a producer using multiple inputs as shown in Figure 4 is illustrated in Figure 5. Formally, Koopmans (1951) defines this producer as being *technically efficient* if and only if it cannot increase the production of an output without increasing any input or decreasing any other outputs. Following the definition by Kumbharkar and Lovell (2000, Figure 5), I define a feasible production set *GR* as

$$GR = \{(\mathbf{y}, \mathbf{x}): \mathbf{x} \text{ can produce } \mathbf{y}.\},$$

where **x** and **y** refers to an input and an output vector, respectively. In Figure 5, *GR* is represented by a region below the curve *a-c-f-b*. I also define an input set $L(\mathbf{y})$ and an output set $P(\mathbf{x})$ as follows.

$$L(\mathbf{y}) = \{\mathbf{x}: (\mathbf{y}, \mathbf{x}) \text{ in } GR\}$$

$$P(\mathbf{x}) = \{\mathbf{y}: (\mathbf{y}, \mathbf{x}) \text{ in } GR\}$$

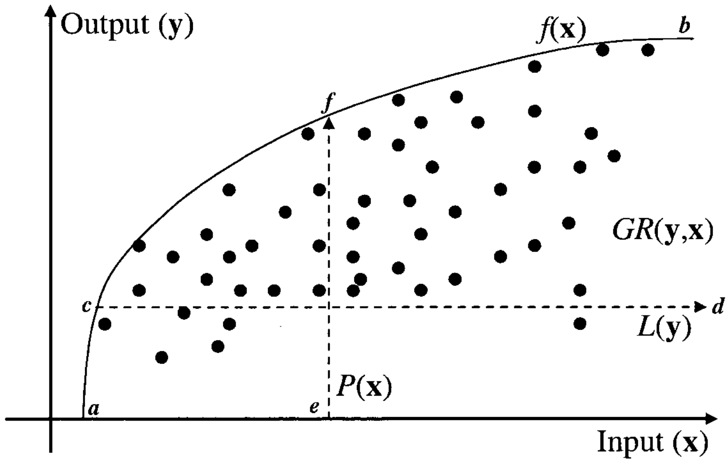
The line *c-d* and *e-f* in Figure 5 indicate $L(\mathbf{y})$ and $P(\mathbf{x})$, respectively. A production frontier $f(\mathbf{x})$ and a cost frontier $c(\mathbf{y}, \mathbf{w})$ given an input price vector **w** are respectively defined as

$$f(\mathbf{x}) = \max\{\mathbf{y}: \mathbf{y} \text{ in } P(\mathbf{x})\}, \text{ and}$$

$$c(\mathbf{y}, \mathbf{w}) = \min_{\mathbf{x}}\{\mathbf{w}^T\mathbf{x}: \mathbf{x} \text{ in } L(\mathbf{y})\}.$$

Intuitively, (**x**, **y**) is in the production frontier if **y** is a maximum output that can be produced by **x** (the curve *a-c-f-b* in Figure 5). Also (**x**, **y**) is on the cost frontier if **x** is the least expensive set of inputs that can produce **y**. Here, technical cost inefficiency is defined as the ratio of actual cost to the cost on the cost frontier. I estimate this technical cost inefficiency with a stochastic frontier model.

Figure 5. A Definition of Frontier (Kumbharkar and Lovell 2000)



Each dot represents an actual observation of input-output.

In the present context, I have a panel data of state government production. The multi-product cost function for state governments with *n* outputs and *m* input prices (as shown in Figure 5) is given by

$$\ln C_{k,t} = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Y_{i,k,t} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \alpha_{ij} \ln Y_{i,k,t} \ln Y_{j,k,t} + \sum_{i=1}^{m} \beta_i \ln w_{i,k,t}$$
$$+\frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m} \beta_{ij} \ln w_{i,k,t} \ln w_{j,k,t} + \sum_{i=1}^{m}\sum_{j=1}^{n} \gamma_{ij} \ln w_{i,k,t} \ln Y_{j,k,t} + \varepsilon_{k,t} \qquad (1)$$

where *k* and *t* are subscripts for state and year, respectively. $C_{k,t}$ is the total cost of state *k* at year *t*, $Y_{i,k,t}$ indicate the amount of outputs, and $w_{i,k,t}$ are the input prices. The interaction terms in Eq. 1 are used for estimating economics of scale or input price elasticity, which are outside the scope of this research. In estimation, the constraints for homogeneity of degree one in price have to be imposed (Caves et al. 1981, Ray 1982, Hardwick 1990).

$$\sum_{i=1}^{m} \beta_i = 1,\ \sum_{j=1}^{m} \beta_{ij} \ln w_j = 0,\ \text{and}\ \sum_{j=1}^{n} \gamma_{ij} \ln Y_j = 0\ \text{ for } i = 1, 2, \ldots, n \qquad (2)$$

These constraints ensure that when all input prices w_i are multiplied by x, the total cost C is multiplied by x as well, making the cost function homogenous with a degree of one. This is a reasonable assumption in the case of state government and public organizations (Geys 2006, De Borger and Kersten 1996).

In the stochastic frontier model, a frontier is considered to be stochastic, based on a rationale that even maximum production levels may be influenced by various unobserved factors, random shocks, or statistical noise. A model suggested by Aigner et al. (1977) and Meeusen and van den Broeck (1977) assumes that a residual $\varepsilon_{k,t}$ in Eq. 1 consists of two parts.

$$\varepsilon_{k,t} = v_{k,t} + u_{k,t} \qquad (3)$$

Here, $v_{k,t}$ represents a random error and is assumed to follow a normal distribution of $N(0, \sigma_v^2)$. On the other hand, $u_{k,t}$ refers to a technical inefficiency factor, which in nature is greater than or equal to zero. Thus, it is assumed to follow an exponential distribution. Aigner et al. (1977) explain that $v_{k,t}$ represents random factors that influence production but are outside of a firm's control. Also, $v_{k,t}$ is thought to be part of the cost frontier. On the other hand, $u_{k,t}$ is considered to be under the firm's control and originate from such causes as mismanagement or organizational slacks. The parameters in Eq. 1 along with the standard deviation of the two error terms ($v_{k,t}$ and $u_{k,t}$) can be estimated using Maximum Likelihood Estimation, and the details are presented in Aigner et al. (1997).

Based on the estimated parameters (the coefficients of Eq. 1 and σ_v and σ_u), an unbiased estimate of the inefficiency of each observation can be obtained using the approach presented in Jondrow et al. (1982). They propose the following unbiased estimator for $u_{k,t}$.

$$E(u_{k,t} \mid \varepsilon_{k,t}) = \sigma_v \left[\frac{f(A_{k,t})}{1 - F(A_{k,t})} - A_{k,t} \right] \tag{4}$$

where $A_{k,t} = \frac{\varepsilon_{k,t}}{\sigma_v} + \frac{\sigma_v}{\sigma_u}$, and $f(.)$ and $F(.)$ refer to the probability and cumulative density function of a exponential distribution, respectively. However, for ease of interpretation, I am more interested in estimating technical cost inefficiency (the ratio of actual cost to cost in the frontier), rather than $u_{k,t}$ itself. Since the cost function in Eq. 1 is expressed in logarithm of cost, $\exp(u_{k,t})$ represents technical inefficiency that I seek to measure. Battese and Coelli (1988) suggest an estimator for the technical inefficiency $TE_{k,t}$ of state k at year t as follows.

$$TE_{k,t} = E(\exp\{u_{k,t}\} \mid \varepsilon_{k,t}) = \left[\frac{1 - \Phi(\sigma_v - \mu_{k,t} / \sigma_v)}{1 - \Phi(-\mu_{k,t} / \sigma_v)} \right] \exp\left\{ \mu_{k,t} + \frac{1}{2}\sigma_v^2 \right\} \tag{5}$$

where $\mu_{k,t} = \varepsilon_{k,t} - \frac{\sigma_v^2}{\sigma_u}$ and $\Phi(.)$ is the cumulative distribution function of a standard normal distribution.

In the second-stage of the estimation, I use this technical efficiency for each observation to assess the impact of IT. Here, I can estimate the impact of IT intensity on technical efficiency by regressing $1 - TE_{k,t}$ on IT intensity and control variables (z). Consistent with prior research (Brynjolfsson 1993), I use a lagged IT variable in the model shown below[10].

$$1 - TE_{k,t} = g(\delta_0 + \delta_{IT} IT_{k,t-2} + \sum \delta_{zi} z_{i,k,t}) + \xi_{k,t} \tag{6}$$

[10] We use different lag lengths in robustness checks and find that the results are consistent with different lag lengths.

As noted in the hypothesis, the primary parameter of my interest is δ_{IT}. I will examine whether δ_{IT} is positive and significant. Note that in my specification, $TE_{k,t}$ is a truncated variable, since it can only have values greater than 1. Hence I estimate Eq. 6 with OLS as well as Tobit regression.

3.3.2. Measures and Data Sources

In the first-stage estimation with the cost function (Eq. 1), I include two input measures (m = 2) and four output measures (n = 4). First, the total cost (C) is the sum of per capita annual operation expense and capital depreciation (buildings and equipments). Operation expense is defined as "direct expenditure for compensation of own officers and employees and for supplies, materials and contractual services" (U.S. Census Bureau 2006, p. 126) and acquired from annual State Government Finances by the U.S. Census Bureau (Table 7). Annual capital depreciation data is acquired from Comprehensive Annual Financial Reports (CAFR) posted at states' Web sites. Capital depreciation is reported from fiscal-year 2001 to 2008, and some states do not post all eight-year reports at their Web sites, limiting the sample size to 377 state-years. Detailed information on data collection and measures is available in Appendix 1. All dollar terms are adjusted for 2005 dollar with the price indexes for GDP provided by Bureau of Economic Accounts.

Table 7. Data Sources

Source	Data	Variable
National Association of State CIOs	Compendium of Digital Governments in the States (2002, 2005)	IT Intensity (IT1 and IT2)
U.S. Census Bureau	State Government Finances	Operation expense (C), Capital price (w_2), Federal grant (z_4)
	State Government Employment & Payroll	Labor price (w_1)
	State Annual Population Estimate	Population (z_1)
	State Household Income	Household income (z_2)
State governments' Web sites	Comprehensive Annual Financial Reports (CAFR)	Capital depreciation (C) Alternative capital price (w_2)
Bureau of Economic Accounts	State Gross Domestic Product (GDP)	GDP (z_3)
	Price Indexes for GDP	
National Conference of State Legislature	State legislature and gubernatorial election results	Governor (z_5), Legislature (z_6)
State Higher Education Executive Officers	State Higher Education Finance Survey	Education (Y_1)
Centers for Medicare & Medicaid Services	National Health Expenditure Data by State of Resident	Public Welfare (Y_2)
Federal Highway Administration	Annual Highway Statistics	Transportation (Y_3)
Federal Bureau of Investigation	Crime in the Unite States	Public Safety (Y_4)

Table 8. Variable Definition and Summary Statistics for the First-Stage Estimation

Variables	N	Avg.	Std. Dev.	Min.	Max.
Cost (C)	377	2876.4820	1018.5970	1565.5770	8750.4340
	The sum of per capita annual current operation expense and capital depreciation (building and equipments, in thousand dollar)				
Education (Y_1)	377	33.3656	6.7645	17.7785	57.6503
	The number of enrolled students in public postsecondary educational institutions per thousand population[11]				
Public Welfare (Y_2)	377	130.2905	43.3478	53.4522	261.7774
	The number of Medicaid recipients per million population (De Borger and Kerstens 1996)				
Transportation (Y_3)	377	4155.9530	3768.1730	267.6599	18941.6400
	The length (mile) of state-maintained highways and roads per million population (Taylor 1995, Worthington 2000)				
Public Safety (Y_4)	377	37643.8500	9494.6240	18089.3500	63999.0000
	The number of crime incidents per million population (Hoyt 1990, Gyourko and Tracy 1991, Davis and Hayes 1993)				
Labor Price (w_1)	377	3662.6640	518.9191	2918.6020	5231.4000
	The monthly total payroll ($) divided by the number of fulltime-equivalent employees (David and Hayes 1993, Worthington 2000)				
Capital Price (w_2)	377	5.0030	0.8918	3.0647	8.7823
	The annual interest payments divided by mean debt level (average of beginning-of-fiscal-year debt and end-of-fiscal-year debt) (Davis and Hayes 1993, Worthington 2000)				

Fiscal year 2001-2008; Annual capital depreciation (part of C) is missing at 23 state-year observations.

Table 9. Correlation Table for the First-Stage Estimation

	C	Y_1	Y_2	Y_3	Y_4	w_2
Y_1	-0.1507*					
Y_2	0.1734*	0.0526				
Y_3	0.2106*	0.3588*	0.0258			
Y_4	-0.1053	0.0936	0.2386*	-0.2230*		
w_1	0.1801*	-0.3281*	-0.1298	-0.5329*	-0.2439*	
w_2	0.1617*	-0.0797	-0.0366	-0.0869	0.0870	-0.0178

* $p < 0.5$ in pairwise correlation

[11] Even though primary and secondary (K-12) education is a bigger part of state education system, it is largely provided by local governments or school districts, not state governments themselves directly. Thus, expenses on K-12 education are not accounted for our cost (C) measure. Since our focus is on the effect of IT on state government efficiency, not that of local governments, we choose the higher education enrollment for the education measure.

For output measures, I choose the four most representative public services U.S. state governments supply – education, public welfare, transportation, and public safety. Although state governments may provide a wide range of public goods and services, from an estimation perspective, it may not be feasible to include all these variables in the frontier model. This is because adding more output variables (Y_i) to Eq. 1 will lead to more regressors and interaction terms, thus decreasing the degrees of freedom. In addition, beyond a threshold, I may find collinearity in state output variables, leading to other challenges with estimations. Thus, I am faced with a tradeoff in selecting output variables to capture the primary objectives of state governments and at the same time balancing the number of variables to manage feasibility in estimations. I decided on the top four state government outputs rated on the average state expenditure across the states. According to State Government Finances Census from the U.S. Census Bureau, the four service sectors occupy as much as 65% of the total state general expenditures in fiscal year 2008. I selected four proxy variables for each area as shown in Table 8, following prior studies in public economics. I also selected two input price measures in the cost function estimation – capital and labor (Table 8). The correlations across the variables are presented in Table 9.

The measures that are used in the second-stage estimation (Eq. 6) are shown in Table 10. IT intensity, the key independent variable, is measured by per capita IT budget of central IT offices (IT1) and the ratio of IT budget to total general expenditure (IT2). These figures were obtained from *the NASCIO Compendium of Digital Governments in States* published in 2003 and 2005. This publication reports IT budget (central IT office and executive branches) in more than 40 states from the fiscal year 2001 to 2005.

However, there are many missing values in executive branch IT budgets[12]. Thus, I use the IT budget of central IT organizations for the IT intensity measures. IT budget figures are available in 193 state-years between 2001 and 2005, but combining them with the sample in the first-stage estimation leaves 185 state-year observations. *t*-tests indicate that with respect to population, GDP and total expenditures, the states in the sample do not differ significantly from those that are not in the sample.

The public economics literature provides economic, sociological, and political factors affecting technical inefficiency in government administration. Davis and Hayes (1993) and Grossman et al. (1999) control for the size of jurisdiction with population, though they do not provide specific prediction regarding the direction of association. Geys (2006) argues that per capita income level is related to efficiency. Gey's study claims a positive relationship, arguing that high-income citizens have greater demand for more efficient governments. On the other hand, De Borger and Kersten (1996) predict that higher income can be a greater tax revenue source, opening a room for inefficiency in administration. Therefore, I include household income and per capita GDP as control variables in the estimation of Eq. 6 in the second-stage of the estimation. The fiscal illusion hypothesis (Geys 2006, Grossman et al. 1999) suggests that as state governments become more dependent upon grants from the federal government, more services may be provided than needed, and thus inefficiency may increase. This can occur because citizens may underestimate the price of public services and may demand for more public services than would have been demanded without the federal support. Hence, I also

[12] Executive branch IT budgets are available only for about 20 states. Measuring IT intensity with the total IT budget in both a central IT organization and executive branches leaves us 98 observations in the second stage estimation. The coefficient of IT intensity is not statistically significant.

control for per capita federal government grants to each state government in the estimation of Eq. 6.

Table 10. Variable Definition and Summary Statistics for the Second-Stage Estimation

Variables	N	Avg.	Std. Dev.	Min.	Max.
TE	185	-0.2272	0.3128	-2.0250	-0.0145
	The ratio of actual cost to the cost in the frontier				
Population (z_1)	185	5.8545	6.2962	0.5065	35.9903
	Annual state population estimate (in millions)				
Household Income (z_2)	185	46.4493	7.1465	32.6138	65.7097
	State median household income (in thousand dollar)				
GDP (z_3)	185	39.2285	6.2065	26.7714	57.0583
	Per capita state annual gross domestic product (in thousand dollar)				
Federal Grant (z_4)	185	1.4170	0.4356	0.6854	3.6973
	Per capita annual intergovernmental revenues from the federal government (in thousand dollar)				
Governor (z_5)	185	0.5405	0.4997	0	1
	1 if governor is Republican, 0 otherwise				
Legislature (z_6)	185	0.9837	0.3195	0.2438	1.6143
	The sum of the proportion of Republican lawmakers in state senate and that of state house of representatives				
IT1	185	19.8044	17.5104	0.0411	89.2275
	Per capita central IT office budget (in dollar)				
IT2	185	5.0226	4.5635	0.0139	25.3875
	% of a central IT office budget to total general expenditure				

Fiscal year 2003-2007 with a two-year lag of IT intensity (2001-2005).

Table 11. Correlation Table for the Second-Stage Estimation

	TE	z_1	z_2	z_3	z_4	z_5	z_6	IT1
z_1	0.2065*							
z_2	-0.3645*	0.0765						
z_3	-0.1591*	0.2811*	0.6479*					
z_4	-0.0912	-0.1839*	-0.3602*	-0.0614				
z_5	-0.1944*	0.0063	0.1262	0.0496	-0.0100			
z_6	0.4694*	0.0139	-0.1652*	-0.1481	-0.0506	-0.1092		
IT1	0.1076	-0.2595*	-0.1515*	0.0097	0.1859*	0.1350	0.2273*	
IT2	0.1608*	-0.2025*	-0.1586*	-0.0222	0.0400	0.1134	0.2453*	0.9594*

* $p < 0.5$ in pairwise correlation

Next, I include Garand's (1988) political indicators – governor's party affiliation, and party control of legislatures – because they represent important political and institutional factors that may affect state government efficiency. I control for state geographic location in the second-stage estimation. Geys (2006) discovers a spatial pattern in local government efficiency, in which technical inefficiency of a municipality is strongly correlated with that of municipalities that share the border, illustrating the existence of policy competition and interdependence between neighboring municipalities. To account for such an effect, I include eight geographic division variables as shown in Column 2 of Table 12. This geographic division is from 2000 U.S. Census. Lastly, I include year dummies in the second-stage estimation to account for nation-wide changes in economies and political trends. Table 10 and 11 show summary statistics and correlations in the second-stage estimation.

Table 12. States in the Sample

Region	Division	States
Northeast	(1) New England	Maine(4), New Hampshire(5), Vermont(3), Massachusetts(5), Rhode Island(5), Connecticut(3)
	(2) Mid-Atlantic	New York(5), Pennsylvania(2), New Jersey(3)
Midwest	(3) East North Central	Wisconsin(4), Michigan(5), Indiana(3), Ohio(5)
	(4) West North Central	Missouri(5), North Dakota(5), South Dakota(5), Kansas(5), Minnesota(5), Iowa(5)
South	(5) South Atlantic	Maryland(5), Virginia(3), West Virginia(2), North Carolina(5), South Carolina(3), Georgia(4), Florida(2)
	(6) East South Central	Kentucky(5), Tennessee(5), Mississippi(5), Alabama(5)
	(7) West South Central	Oklahoma(2), Texas(5), Arkansas(5)
West	(8) Mountain	Idaho(5), Montana(5), Wyoming(3), Nevada(5), Utah(3), Arizona(5), New Mexico(5)
	(9) Pacific	Washington(5), Oregon(3), California(3), Hawaii(5)

The number in parentheses next to a state is the number of years that the state appears in the sample. Geographic region and division are from 2000 U.S. Census.

3.4. Results

3.4.1. The Baseline Estimation

Table 13 shows the results of the first-stage stochastic frontier estimation. Column (1) shows the estimation of the cost function without interaction terms. The coefficients of the two outputs (public welfare and transportation) and the input prices are positive as expected and significant at the 1% level. A negative coefficient of public safety (Y_4) implies that achieving a lower crime rate requires greater expenditures on public safety[13]. The coefficient of education (Y_1) in Column (1) is not significant, but that of (log Y_1 log Y_1) (Column 2) is positive and significant, suggesting the presence of diseconomy of scale. The models both with and without interaction terms are significant according to Wald statistics, and a log-likelihood test rejects the hypothesis of $\sigma_u = 0$ in the two estimations, indicating the presence of technical inefficiencies in the sample.

Table 14 presents the second-stage estimation for technical inefficiency with exogenous factors (Eq. 6). From the OLS estimation of Eq. 6, I find that both White's general test (greater than 170, significant at the 0.1% level) and Breusch-Pagan test (greater than 180, significant at the 0.1% level) detect the presence of heteroskedasticity. To address this issue, I estimate Eq. 6 with White heteroskedasticity-consistent estimation. Technical inefficiencies are regressed only on control variables in Column (1). The coefficient of population is positive, meaning that states with a larger population demonstrate greater cost efficiency. This illustrates a notion of "economy of scale" in monitoring government administration (Davis and Hayes 1993). I find that the coefficient

[13] When using per capita number of inmates in state prisoners for public safety measure (Y_4) instead of crime rates, the coefficient of Y_4 in Column (1) of Table 13 becomes positive and significant, and the coefficient of IT intensity (Table 14) is still positive and statistically significant.

of household income is negative and significant. This is consistent with the findings in prior economic literature on government efficiency (Geys 2006) that a large base on tax revenues may become a source of inefficiency. The two political variables offer a contrasting result. States in which Republican lawmakers have more control in legislatures demonstrate higher cost efficiency, while a Republican governor is associated with less cost efficiency. As expected, more federal grants are associated with less technical efficiency.

When I include IT intensity variables into the estimation (Column 2 and 3), I find that the coefficients of IT intensity are positive and significant at the 5% and 10% level, respectively, providing evidence for a significant impact of IT investments on cost efficiency. From the coefficient of IT1 (per capita IT budget) and summary statistics in Table 8 and 10, I calculate the average contribution of IT investment to cost efficiency of state governments in the following way. I first calculate the cost frontier of each of the 377 observations by dividing the actual cost by the estimated technical inefficiency. For example, if the actual cost is $1,500 and the estimated inefficiency is 1.5, the cost frontier of this state is $1,000. From this, I can obtain the average cost frontier for all observations, which becomes $2,316.34. The coefficient of IT1 in Column (2) of Table 14 is 0.0018, meaning that all others being equal, a $1 increase in per capita IT budget is associated with a 0.18%-point decrease in cost inefficiency, which amounts to $2,316.34 × 0.0018 = $4.18. This illustrates the potential for a sizeable contribution of IT investments to cost savings in U.S. state governments.

Table 13. The First-Stage Stochastic Cost Frontier Estimation Results

Stochastic Frontier Estimation (Dependent Variable: log C)					
Model w/o Interaction Terms		**Model with Interaction Terms**			
	(1)		(2)		(3)
$\ln Y_1$	-0.0195 (0.0514)	$\ln Y_1$	0.7682 (3.6401)	$\ln w_1$	0.9472 (1.3688)
$\ln Y_2$	0.3483*** (0.0261)	$\ln Y_2$	-26.515*** (3.6342)	$\ln w_2$	0.0528 (1.3688)
$\ln Y_3$	0.1337*** (0.0118)	$\ln Y_3$	-3.7928*** (1.1897)	$\ln w_1 \ln w_1$	0.2138** (0.1695)
$\ln Y_4$	-0.2556*** (0.0335)	$\ln Y_4$	23.4128*** (4.2742)	$\ln w_2 \ln w_2$	0.0561 (0.1331)
$\ln w_1$	0.8246*** (0.0479)	$\ln Y_1 \ln Y_1$	0.2176*** (0.1517)	$\ln w_1 \ln w_2$	-0.1349** (0.1202)
$\ln w_2$	0.1754*** (0.0479)	$\ln Y_1 \ln Y_2$	-0.1111** (0.0997)	$\ln w_1 \ln Y_1$	-0.8799*** (0.2865)
const.	0.6870 (0.5673)	$\ln Y_1 \ln Y_3$	0.0595* (0.0636)	$\ln w_1 \ln Y_2$	2.1580*** (0.2936)
		$\ln Y_1 \ln Y_4$	0.2065*** (0.1408)	$\ln w_1 \ln Y_3$	0.3394*** (0.0951)
		$\ln Y_2 \ln Y_2$	0.0885*** (0.0528)	$\ln w_1 \ln Y_4$	-1.6175*** (0.2931)
		$\ln Y_2 \ln Y_3$	0.1819*** (0.0456)	$\ln w_2 \ln Y_1$	-0.3640** (0.1766)
		$\ln Y_2 \ln Y_4$	0.2471*** (0.1214)	$\ln w_2 \ln Y_2$	0.0864 (0.1573)
		$\ln Y_3 \ln Y_3$	0.0123* (0.0140)	$\ln w_2 \ln Y_3$	0.0793** (0.0399)
		$\ln Y_3 \ln Y_4$	-0.0746** (0.0612)	$\ln w_2 \ln Y_4$	0.1983 (0.1333)
		$\ln Y_4 \ln Y_4$	-0.3204*** (0.1272)	const.	-43.6625** (17.7586)
σ_v 1)	0.0945*** (0.0100)	σ_v 1)	0.0324*** (0.0109)		
σ_u 2)	0.2104*** (0.0163)	σ_u 2)	0.1877*** (0.0149)		
$\ln L$	72.1153	$\ln L$	194.0932		
Wald χ_2	616.98***	Wald χ_2	2902.38***		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; $N = 377$; Standard errors are in parentheses;

1) The variance of idiosyncratic errors ($v_{k,t}$);

2) The variance of technial inefficiency terms ($u_{k,t}$, significance from a log-likelihood test)

Table 14. The Second-Stage Estimation Results (Baseline Estimation)

Dependent Variable – Technical Efficiency							
Method	**White Robust Estimation**			**Random-Effects Estimation**		**Tobit Regression**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Population	0.0216*** (0.0031)	0.0188*** (0.0050)	0.0182*** (0.0050)	0.0190*** (0.0062)	0.0188*** (0.0062)	0.0188*** (0.0030)	0.0182*** (0.0029)
GDP	-0.0008 (0.0022)	0.0035 (0.0032)	0.0037 (0.0033)	-0.0010 (0.0055)	-0.0011 (0.0055)	0.0035 (0.0036)	0.0037 (0.0037)
Income	-0.0210*** (0.0032)	-0.0178*** (0.0043)	-0.0180*** (0.0044)	-0.0066* (0.0034)	-0.0066* (0.0034)	-0.0178*** (0.0038)	-0.0180*** (0.0038)
Federal Grant	-0.2954*** (0.0493)	-0.1903*** (0.0335)	-0.1789*** (0.0331)	-0.2103** (0.0530)	-0.2113 (0.0533)	-0.1903*** (0.0376)	-0.1789*** (0.0377)
Governor	-0.0559** (0.0222)	-0.1026*** (0.0262)	-0.0982*** (0.0259)	-0.0085 (0.0170)	-0.0077 (0.0171)	-0.1026*** (0.028)	-0.0982*** (0.0280)
Legislature	0.1368** (0.0528)	0.2988*** (0.0515)	0.3056*** (0.0518)	0.0382 (0.0751)	0.0359 (0.0757)	0.2988*** (0.0551)	0.3056*** (0.0551)
IT1		0.0018** (0.0007)		0.0008** (0.0004)		0.0018* (0.0009)	
IT2			0.0052* (0.0028)		0.0026** (0.0013)		0.0052# (0.0034)
Div 1 [1)]	0.9046*** (0.0975)	0.7520*** (0.1443)	0.7473*** (0.1442)	0.6701*** (0.2567)	0.6702*** (0.2572)	0.7520*** (0.0596)	0.7473*** (0.0597)
Div 2	0.7125*** (0.0871)	0.5361*** (0.1252)	0.5304*** (0.1254)	0.5489** (0.2165)	0.5495** (0.2170)	0.5361*** (0.0744)	0.5304*** (0.0746)
Div 3	0.6386*** (0.0916)	0.4663*** (0.1143)	0.4669*** (0.1146)	0.5974*** (0.2181)	0.5981*** (0.2184)	0.4663*** (0.0677)	0.4669*** (0.0680)
Div 4	0.7889*** (0.0964)	0.5715*** (0.1281)	0.5706*** (0.1280)	0.7002*** (0.2416)	0.7021*** (0.2417)	0.5715*** (0.0675)	0.5706*** (0.0679)
Div 5	0.5879*** (0.0939)	0.4946*** (0.1196)	0.4860*** (0.1189)	0.5463** (0.2182)	0.5428** (0.2184)	0.4946*** (0.0606)	0.4860*** (0.0608)
Div 6	0.6417*** (0.0985)	0.5489*** (0.1307)	0.5369*** (0.1293)	0.6319** (0.2461)	0.6285** (0.2470)	0.5489*** (0.0729)	0.5369*** (0.0727)
Div 7	0.5611*** (0.0980)	0.4429*** (0.1251)	0.4404*** (0.1257)	0.5111** (0.2268)	0.5101** (0.2275)	0.4429*** (0.0779)	0.4404*** (0.0783)
Div 8	0.7305*** (0.1013)	0.5611*** (0.1333)	0.5496*** (0.1319)	0.7034*** (0.2523)	0.7035*** (0.2528)	0.5611*** (0.0685)	0.5496*** (0.0682)
const.	0.2802*** (0.2444)	0.2516* (0.1495)	0.2440 (0.1503)	0.2594 (0.2724)	0.2685 (0.2673)	0.4123** (0.2066)	0.3946* (0.2087)
N	377	185	185	185	185	185	185
F	15.71***	5.92***	5.84***	78.56*** [2)]	75.75*** [2)]	216.5*** [4)]	21.96*** [4)]
R^2	0.7405	0.6897	0.6871	0.5783 [3)]	0.5728 [3)]	61.2670 [5)]	60.4906 [5)]
RMS	0.2083	0.1840	0.1848				

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$, #$p < 0.1$ (one-tail test);
year dummies are omitted; standard errors are in parentheses;
[1)] Geographic division (Table 12); [2)] Wald Statistics; [3)] Overall R^2; [4)] Likelihood Ratio; [5)] Log-likelihood

Even though the first-stage estimation may account for state-specific heterogeneity in white error terms ($v_{k,t}$), I suspect that there are still state-specific factors in technical inefficiency that remain unaccounted for. To deal with this concern, I estimate Eq. 6 with a random-effect model with heteroskedasticity-consistent standard errors, as shown in Columns 4 and 5. The results show that the coefficients of IT intensity are significant at the 5% level, although the magnitude of the coefficients reduces to some extent. A Hausman test does not reject the null hypothesis that the random-effect estimation does not differ significantly from the estimation with fixed-effect model. Also, a Breusch and Pagan Lagrange multiplier test does not reject the null hypothesis that variances of groups in the random-effect model are zero.

The fact that technical inefficiency (*TE*) is bounded below at one may make OLS estimation inconsistent, because OLS assumes that observed values of *TE* can take any real value. (Kennedy 2003). To deal with this concern, I re-estimated truncated models (Eq. 6) with Tobit regression (Columns 6 and 7 in Table 14). The basic results do not change significantly. The coefficient of IT1 (per capita IT budget) is still significant at the 10% level, and the sign and significance of other control variables are qualitatively similar to those of the baseline estimations.

Table 15. The Second-Stage Estimation Results with Different Lag Effects

Dependent Var. – Technical Inefficiency (White Robust Estimation)								
Lag	1-Year Lag		2-Year Lag		3-Year Lag		4-Year Lag	
Population	0.0180*** (0.0052)	0.0176*** (0.0052)	0.0188*** (0.0050)	0.0182*** (0.0050)	0.0188*** (0.0050)	0.0183*** (0.0050)	0.0193*** (0.0055)	0.0188*** (0.0054)
GDP	0.0061* (0.0035)	0.0062* (0.0035)	0.0035 (0.0032)	0.0037 (0.0033)	0.0021 (0.0030)	0.0023 (0.0030)	0.0015 (0.0032)	0.0015 (0.0033)
Income	-0.0187*** (0.0041)	-0.0187*** (0.0042)	-0.0178*** (0.0043)	-0.0180*** (0.0044)	-0.0189*** (0.0042)	-0.0188*** (0.0042)	-0.0197*** (0.0042)	-0.0195*** (0.0043)
Federal Grant	-0.1888*** (0.0349)	-0.1786*** (0.0342)	-0.1903*** (0.0335)	-0.1789*** (0.0331)	-0.1947*** (0.0334)	-0.1806*** (0.0320)	-0.2001*** (0.0363)	-0.1848*** (0.0340)
Governor	-0.0869*** (0.0274)	-0.0847*** (0.0272)	-0.1026*** (0.0262)	-0.0982*** (0.0259)	-0.1057*** (0.0287)	-0.1024*** (0.0283)	-0.1047*** (0.0328)	-0.1020*** (0.0323)
Legislature	0.3150*** (0.0516)	0.3198*** (0.0517)	0.2988*** (0.0515)	0.3056*** (0.0518)	0.3043*** (0.0509)	0.3109*** (0.0513)	0.3075*** (0.0567)	0.3137*** (0.0570)
IT1	0.0014* (0.0007)		0.0018** (0.0007)		0.0020** (0.0008)		0.0019** (0.0009)	
IT2		0.0040# (0.0026)		0.0052* (0.0028)		0.0062** (0.0030)		0.0062* (0.0032)
const.	0.2907* (0.1765)	0.2838 (0.1770)	0.2516* (0.1495)	0.2440 (0.1503)	0.4677*** (0.1775)	0.4345** (0.1750)	0.4787** (0.1837)	0.4419*** (0.1791)
N	180	180	185	185	187	187	152	152
F	6.02***	5.95***	5.92***	5.84***	6.01***	6.05***	5.76***	5.66***
R^2	0.6961	0.6945	0.6897	0.6871	0.6802	0.6797	0.6921	0.6902
MSE	0.1847	0.1852	0.1840	0.1848	0.1846	0.1852	0.1832	0.1837

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$, #$p < 0.1$ (one-tail test);
Standard errors are in parentheses.; Geographic and year dummies are omitted.

3.4.2. Robustness Checks

In this chapter, I conducted a series of sensitivity analyses with alternative measures and specifications. So far, in Eq. 6, I have regressed technical efficiency on IT intensity with a two-year behind lag. However, I am also interested in seeing how different lag effects change the result I have in Table 14. Table 15 shows the estimation results with varying lag effects from a one-year to a four-year lag and offers an interesting pattern. The significance of IT1 is shown to be at the 5% and 10% level across Table 15, and the coefficient of IT2 is marginally significant but consistently positive.

I also checked for robustness of the results to the alternative measures for outputs. I changed output measures with alternative measures. For example, I estimated Eq. 1 and 6 with the proportion of primary and secondary public school students to population for education variable (Y_1) instead of higher education enrollment, with other variables unchanged. I find that when employing K-12 enrollment, the coefficient of IT1 variable in the second-stage estimation is positive but insignificant, while that of IT2 is still significant at the 5% level. I went through a similar process for public welfare (Y_2) and public safety variables (Y_4) and found the results to be consistent.

I estimated Eq. 1 and 6 with an alternative capital price (w_2) as suggested by Hardwick (1990). The coefficient of IT2 is positive at the 5%-level significance. Lastly, following Garand (1988), I collected the price indexes for government consumption and expenditures from Bureau of Economic Accounts and used in calculating real dollar terms in order to account for a difference in growth rate between private and public sectors. Again, both coefficients of IT intensities are significant.

I detected several influential observations. First, I find that Alaska and Hawaii demonstrate unusually high technical inefficiency (greater than 4σ above mean). This explains why the coefficients of geography dummies are significantly positive in Table 14. I attempted to exclude the two states in estimating Eq. 1. The first-stage estimation still rejects the hypothesis of $\sigma_u = 0$ with the 0.1%-level significance, and the coefficients of IT1 and IT2 in the second-stage estimation are positive and significance at the 5% and 10% level, respectively. Second, I note that the IT spending figure of Delaware is unusually high (greater than 6σ above mean), leading me to exclude the state in the baseline estimation (Table 14).

In contrast to the two-stage approach, Kumbharkar et al. (1991) and Fenn et al. (2008) use a one-stage approach, in which the distribution of $u_{k,t}$ is modeled as a function of exogenous factors (z) and one ML estimation generates both the coefficients in Eq. (1) and (6). Wang and Schmidt (2002) argue for this one-stage estimation because of potentially substantial bias in the two-stage approach. However, in the present research setting, the two-stage technique is advocated. First, using the one-stage approach, in which IT intensity measure is incorporated in the frontier estimation, limits the number of available sample to 185 observations, while the two-stage estimation can utilize all 377 available. Thus, I can use the two-stage approach to obtain more consistent estimates for states' technical inefficiency. Second, the two-stage approach allows to address the endogeneity of IT intensity with 2SLS estimation, which I wil discuss below. Furthermore, it permits to account for state-specific factors by estimating the second stage with the random-effects model as shown in Columns (4) and (5) of Table 14, an approach that is not feasible with the one-stage estimation. For a comparison, however, I did estimate the model with the one-stage estimation, and the result appears in Appendix 4.2. It shows that the coefficient of IT intensity is significant.

The cost function in Eq. 1 is a total cost function. However, it may be argued that on a year by year basis, a variable cost function model may be more appropriate. For example, Caves et al. (1981) suggest a variable cost function that models a producer which minimizes variable costs given the size of fixed capital. The variable cost function with n outputs and m input prices can be expressed as

$$\ln CV_{k,t} = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln Y_{i,k,t} + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij} \ln Y_{i,k,t} \ln Y_{j,k,t} + \sum_{i=1}^{m} \beta_i \ln w_{i,k,t}$$
$$+ \frac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{m} \beta_{ij} \ln w_{i,k,t} \ln w_{j,k,t} + \sum_{i=1}^{m} \sum_{j=1}^{n} \gamma_{ij} \ln w_{i,k,t} \ln Y_{j,k,t} \qquad (7)$$
$$+ \beta_K \ln K_{k,t} + \sum_{i=1}^{m} \beta_{iK} \ln w_{i,k,t} \ln K_{k,t} + \sum_{j=1}^{n} \gamma_{Kj} \ln K_{k,t} \ln Y_{j,k,t} + v_{k,t} + u_{k,t}$$

where $CV_{k,t}$ and $K_{k,t}$ are the variable cost and the value of fixed capital, respectively. As in Eq. 1, homogeneity of degree one in price constraints have to be imposed.

$$\sum_{i=1}^{m} \beta_i = 1,\ \sum_{j=1}^{m} \beta_{ij} \ln w_j = 0,\ \text{and}\ \beta_{iK} + \sum_{j=1}^{n} \gamma_{ij} \ln Y_j = 0\ \text{for}\ i = 1, 2, \ldots, n \qquad (8)$$

Since m = 1 (labor) in the current context, Eq. 8 leads to $\beta_1 = 1$ and $\beta_{11} = 0$. I also estimated this variable cost model, and find the results to still hold, although the magnitude of IT impact in this model is relatively lower.

Since the dataset consists of multi-year observations across states, I am able to employ a stochastic frontier model with panel data. I adopt a time-invariant stochastic frontier model offered by Pitt and Lee (1981), in which $u_{k,t}$ is state-specific u_k and follows a truncated normal distribution of $N^+(0, \sigma_u^2)$. The purpose of this model is that by incorporating multiple-years of cost and output information, one can obtain a more consistent estimation for technical inefficiency. Using Pitt and Lee's model does not produce a significantly different result. I also estimated the models with the allocative and technical inefficiency estimation model of Kumbharkar (1991), and I still find a significant relationship between IT intensity and technical efficiency.

Lastly, in addition to enhancing technical efficiency in the state government production, IT may be considered an input factors and substitute for other input factors (labor and capital) (Dewan and Min 1997). To account for this effect, I add an IT price variable (w_3) and accompanying interaction terms into the cost function (Eq. 1) and re-estimate the cost frontier. I obtained IT price measures from Producer Price Indexes (PPI, Jorgenson 2001) available from Bureau of Labor Statistics[14]. Table 19 in Appendix 3.2 shows the first-stage cost frontier estimation with IT price. From this estimate, I re-estimated technical efficiency of state governments and conducted the second-stage estimation as shown in Table 20. The coefficient of IT intensity is still negative and marginally significant in the random-effects estimation, although the significance decreases to some extent compared to Table 14.

So far, I have presented a range of sensitivity analyses with various substitute measures for outputs and input prices, and alternative specifications such as the variable cost function. These investigations consistently demonstrate a positive relationship between IT intensity and technical cost efficiency, confirming robustness of the findings in support of the hypothesis that greater IT investments in U.S. state governments are associated with greater administrative efficiency.

One might raise a concern of casual relationships in the estimations, specifically in the second-step estimation. A positive association between IT intensity and cost efficiency (Table 14) may imply that more efficient states are likely to invest more in IT than other states. One way this endogeneity is addressed in the literature is through a use of lag variables. However, the demand-push hypothesis discussed in Section 2.4.1 suggests otherwise in that inefficiencies in governments may induce demands for IT within organizations. However, this demand-push hypothesis does not completely rule

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[14] I obtained Producer Price Index from 2001 to 2008 in the category of Computer and Electronic Product Manufacturing (334). We assume that this IT price is common to all state governments, as it is hardly the case that one state government purchases IT products or services in a significantly higher or lower price than others.

out the endogeneity issue. To address this concern, I estimate Eq. 6 with the two-stage least square (2SLS) technique. I use the following variables as instruments – the lagged value of IT intensity ($IT_{k,t-3}$), two variables that represent the IT governance structure in state governments[15], a variable that measures the centrality of IT management[16], and per capita IT product shipments in the private sector within the state boundary[17]. I expect that these instrumental variables are correlated with the IT intensity measures but not necessarily with cost efficiency measures. For example, the more centralized IT management is, the more budgets a central IT organization is likely to have. But, it is unlikely that the centrality of IT management is associated with statewide efficiency. Likewise, it is expected that states with a bigger IT industry in the private sector are likely to invest more in IT, but the size of IT industry is not likely to affect state government efficiency. I find that estimating Eq. 6 with 2SLS does not produce a substantially different result.

3.4.3. Estimations with Contextual Effects

In addition to a direct effect of IT investments to cost effijciency, I examine some contextual effects. I seek to determine in which context IT investments are most associated with administrative efficiency in U.S. state governments. I estimated the model in Eq. 6 with interaction terms of three contextual measures including per capita GDP size and IT organization factors with IT intensity variables. Table 16 presents the

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[15] NASCIO Compendium provides information on (i) whether a state legislature has IT-related legislative committee and (ii) whether a state government has an independent IT department. Two dummy variables are used as instrumental variables.
[16] The description for the IT centrality measure is available in Section 3.4.3.
[17] This information is available from Bureau of Economic Accounts. IT product shipments include "computer and electronic product manufacturing," "information and data processing services," and "computer systems design and related services."

estimation result with the three interaction terms. Figure 6 illustrates how the expected amount of cost reduction from $1 per capita IT investments changes in per capita state GDP, the size of a central IT organization, and the centrality of IT management.

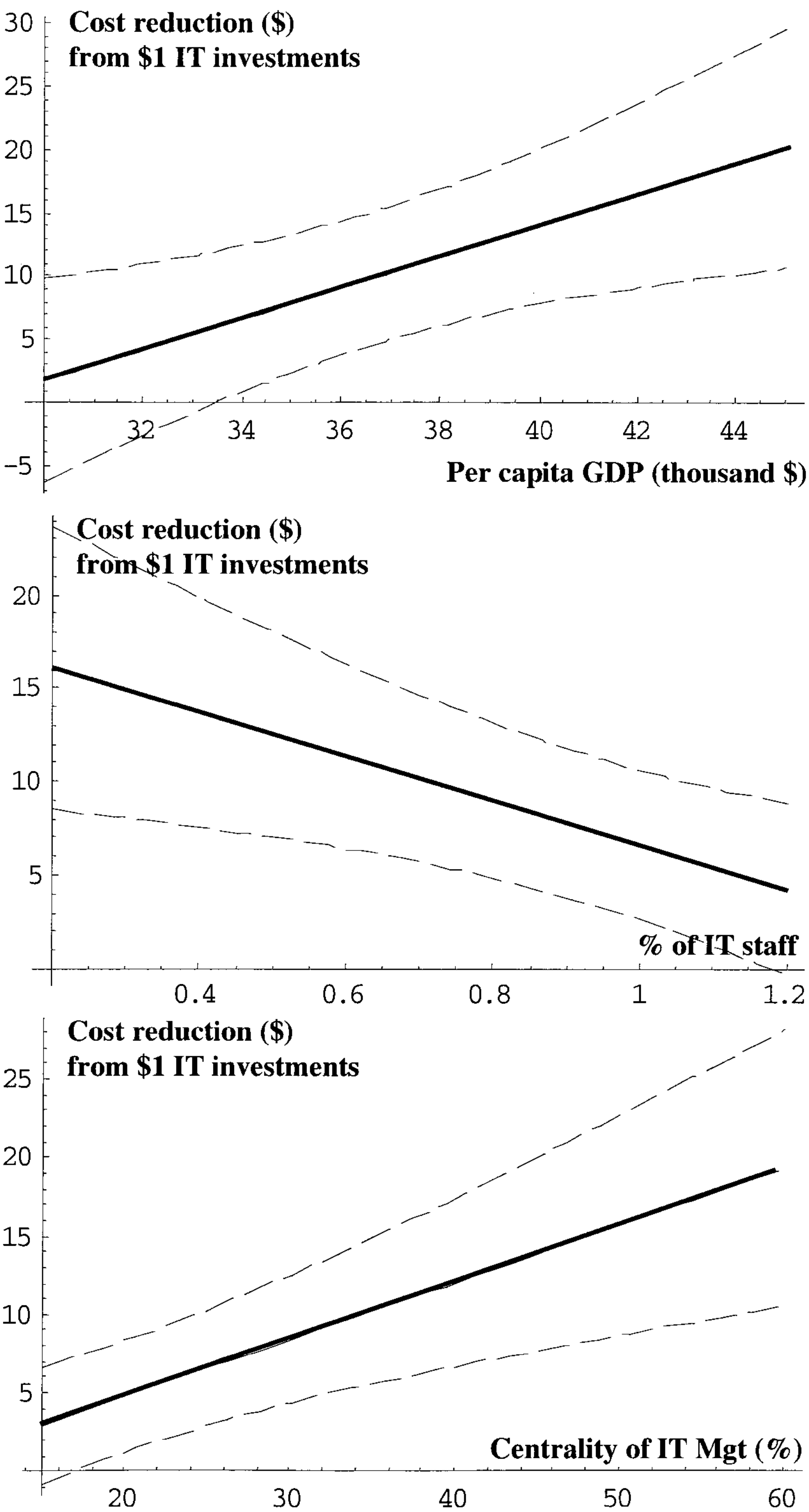
Table 16 demonstrates that the interaction term of IT intensity and per capita state GDP (IT1×GDP, IT2×GDP) is positive and statistically significant, implying that the relationship between IT intensity and efficiency increases with state GDP. This effect also exists when I use the private sector GDP (state GDP net of state and local government expenditures) in lieu of overall GDP. Furthermore, Figure 6 demonstrates that taking the mean value of other variables, the expected amount of cost reduction from a $1 IT budget increase is as much as $7.85 if per capita state GDP is $35,000, while it is $13.97 when GDP is $40,000. This scale economy in efficiency gains for larger states may be because the contribution of IT investments to administrative efficiency in state governments becomes greater in states with larger per capita GDP. States with larger per capita GDP are also more likely to be advanced economies relative to other states. This finding can be interpreted as follows. First, on the supply side, state governments with a larger economy may have access to more advanced, sophisticated technologies as well as to a better pool of talent. Second, on the demand side, given that state governments with larger GDP are more likely to have complex administrative processes, the potential *automate* and *informate* effects of IT discussed earlier may be higher. That is, these states may have more opportunities to realize benefits from automation and integration enabled by IT investments. This result is also in accordance with a country level study of Dewan and Kraemer (2002), who find that return on IT investments is greater in developed countries than in developing countries.

Table 16. The Second-Stage Estimation Results with Interaction Terms

Dependent Variable – Technical Efficiency		
Method	**White Robust Estimation**	
	(1)	(2)
Population	0.0252*** (0.0054)	0.0233*** (0.0053)
GDP	-0.0127* (0.0067)	-0.0090 (0.0065)
Income	-0.0171*** (0.0045)	-0.0173*** (0.0046)
Federal Grant	-0.2152*** (0.0360)	-0.1734*** (0.0334)
Governor	-0.1162*** (0.0275)	-0.1044*** (0.0264)
Legislature	0.2182*** (0.0595)	0.2409*** (0.0556)
IT1	-0.0195** (0.0075)	
IT2		-0.0705* (0.0360)
IT-EMP [1)]	0.0050 (0.0044)	0.0044 (0.0044)
MGT [2)]	-0.0146* (0.0070)	-0.0114 (0.0070)
IT1 × GDP	0.0005** (0.0002)	
IT1 × IT-EMP	-0.0005*** (0.0001)	
IT1 × MGT	0.0012*** (0.0003)	
IT2 × GDP		0.0019* (0.0010)
IT2 × IT-EMP		-0.0018** (0.0008)
IT2 × MGT		0.0040*** (0.0014)
const.	0.9052*** (0.2698)	0.7320*** (0.2500)
F	6.35***	5.86***
R^2	0.7236	0.7142
RMS	0.1763	0.1793

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; $N = 185$;
Year and geograpic dummies are omitted; Standard errors are in parentheses;
[1)] The percentage of a central IT organization staff to total state employees;
[2)] The number of IT management areas that a state CIO directly is in charge of (max = 13)

Figure 6. The Impact of Per Capita GDP, Size of IT Staff, and Centrality of IT Management on Cost Efficiency Effect of IT Investments



Dashed lines represent 95% confidence intervals. Mean values of per capita GDP, IT staff, and, and centrality of IT management are 37.12, 0.95, 24.32, respectively.

The data from NASCIO also provides additional information on IT organization in state governments. Specifically, I use information on the size of a central IT organization that a state CIO directly oversees and its *statewide* IT management responsibilities. *The NASCIO Compendium* publishes the headcount of a central IT staff and the number of IT management areas that a state CIO is in charge of among thirteen areas such as IT architecture or IT training. Table 16 shows that the coefficient of IT intensity and the size of IT function (measured by the ratio of central IT staff to total state employees) (IT1×IT-EMP, IT2×IT-EMP) is negative and significant. This indicates that the relationship between IT intensity and cost efficiency *decreases* with the size of a central IT organization. Figure 6 demonstrates that the expected amount of cost reduction is as much as $12.53 if the size of central IT function is 0.5%, while it is $6.62 when its size is 1%.

In contrast, I find that the relationship between IT intensity and efficiency *increases* with the centrality of IT management, which is measured by the number of statewide IT management area a state CIO is responsible for. Table 16 shows that the coefficient of IT intensity and the centrality of IT management (IT1×MGT, IT2×MGT) is positive and significant. Figure 6 demonstrates that when a central IT function is in charge of 20% of the IT management areas, the expected cost reduction is $4.76, while it increases to $12.04 if the centrality is 40%. This finding suggests that as state executive branches and agencies assume more responsibilities in IT management, thereby decentralizing the IT function, the efficiency effect of IT investments diminishes. This finding is also consistent with the literature on IT governance, which argues that a centralized IT governance mode is likely to be adopted in an organization which seeks cost-effective use of IT (Weill and Ross 2004) and inter-business unit synergies (Tanriverdi 2006, Gu et al. 2008). Nonetheless, my finding suggests that such a benefit from centralized IT management is likely to diminish with an increase in the size of central IT organization. The result suggests that the association between IT investments and cost efficiency is greatest when a central IT organization manages state-wide IT operations with less staff.

3.5. Discussions and Conclusion

I believe that the findings of this study provide significant implications for policy makers, managers and government officials. A key finding of the study is that more IT spending is associated with greater administrative efficiency in U.S. governments. The empirical model and choice of measures are drawn from the literature on public economics, and the baseline estimation as well as a range of sensitivity analyses offers strong support to the main hypothesis. In addition, according to my estimation, the relationship between IT intensity and cost efficiency endures over a period of years. I also find that the efficiency effect of IT investments increases with per capita state GDP and the centrality of IT management, while it decreases with the size of a central IT office.

The analysis so far has indicated that every $1 additional investments on the average can lead to approximately $4.18 in cost efficiency benefits. This order of savings is not unprecedented in real projects. For example, as discussed earlier, for the central HR system deployed by the State of Michigan, the total investment in the project by the State was $4.6 million, while the state estimates up to $28 million direct savings from a HR staff reduction in the 5-year period (State of Michigan 2007). This saving estimate does not account for benefits and productivity improvements of the entire state employees from efficient HR operations. Similarly the online tuition assistance program by the State of New York (e-TAP) discussed earlier retuned in cost savings over three times the investments in the IT application (NASCIO 2006b).

This study provides a meaningful managerial implication to elective officials and managers in the public sector. It is reported that due to budget shortfalls prevalent in many state and local governments across the U.S. in recent years, IT budgets have become an early target for budgetary cuts. A survey conducted by the Public Technology Institute and Input in 2010 reports that IT budgets of 50% of the local governments are expected to be cut in order to close government-wide budget caps (Government Technology 2010). Likewise, an NASCIO report shows that 64% of the state CIOs expect to face a decline in IT budgets in fiscal years 2011 to 2013 (NASCIO 2010). These reports deliver a concern of IT managers that such reductions in IT investments may in fact jeopardize the efforts to improve the efficiency of government administration in the long run. The result of our study confirms their concern and suggests that governments rather need to leverage information technologies as a tool to overcome fiscal crises.

The major contribution of this study to the research literature is to explore the performance impact of IT in the public sector. Not only does the public sector continue to grow, but its significance over the entire economy cannot be underestimated. Furthermore, as in the private sector, the size of IT spending in the public sector organizations is significant. Given the emerging technologies and pervasive nature of IT in every aspect of governments, IT is expected to play a wider role in improving and innovating administrative processes and public service delivery. Hence, it is imperative for policy makers to understand the impact of IT investment on the efficiency of public organizations. However, to the best of my knowledge, few quantitative empirical studies have addressed this role of IT in a scientific and rigorous manner. I believe that this study fills this gap in the literature and offers substantive evidence that IT can create value even in the absence of profit motives and competitive pressures, a new insight for IT business value researchers.

Also, I introduce a different empirical approach to measure the value creation effect of IT in the public sector. Based on my understanding of the differences between the private and the public sector, I believe that the cost function framework is more suitable than the production function, a *de facto* approach in the IT value studies in the IS literature. Considering that my interest lies in whether IT improves the overall efficiency in government administration, and there is no straightforward way to measure overall productivity in the context, I find that the multi-product translog cost function is more useful in my study. Moreover, I find that it is appropriate to regard the amount of public service outputs as exogenously given and to consider IT a factor that improves efficiency in producing such outputs. It is my belief that this approach is useful in other not-for-profit contexts such as healthcare or education. This provides opportunities for future research. I also believe, however, that there is an opportunity for adopting the production framework to study the performance impact of IT in specific public service areas where it is possible to focus on a specific output that can be measured in a quantitative term.

There is no doubt, however, that the present study is not without limitations. First, this study shares the weaknesses of stochastic frontier estimation. For example, the frontier model is sometimes prone to specification errors (Lovwell 1993). I cannot ensure that the specifications are free from such errors, even though I employed several alternative specifications in the estimations. Also, the estimate for individual technical inefficiency by Battese and Coelli (1988) is not consistent measures (Kumbharkar and Lovell 2000). Another limitation of the estimation approach is that exogenous factors I identified to have an impact on efficiency in the second-stage estimation may be correlated with output and input price measures in the first-stage estimation, possibly causing biases in the coefficients I get. I addressed some of these concerns in Section 4.2, but I still cannot completely rule out any possibility of biases. While I believe my analyses control for almost all of the significant, but unobserved state heterogeneities that may affect the cost (in Eq. 1) or the technical efficiency (in Eq. 6), it is always possible that some additional sources of heterogeneity remain unaccounted for. Third, the estimation in the present study does not account for the quality of services state governments offer. Therefore, I cannot rule out the possibility that IT investments reduce costs by deteriorating the quality of services. Future research may study how IT investments affect the quality of public services. Finally, even though the focus is on the efficiency of overall state administration, the IT intensity measures only include IT budgets of central IT functions, not of all other executive branches, the latter of which I was able to access in only a few states. Thus, it might be the case that the effect is either under- or over-estimated in this study.

Since this is one of the few studies for IT value in the public sector, there are numerous ways to extend this study. First, this study can be replicated in other contexts such as municipal or federal governments, or other public organizations. It would be also interesting to study IT value impact in the international context. Second, in the present study, I have focused on the cost efficiency effect of IT in state governments via the *automate* and *informate* role of IT, because they are the most primary strategic roles of IT and can be measured quantitatively in a more straightforward manner. However, it is also a significant issue to see whether IT plays a *transform* role in public organizations. I expect that IT will transform public organizations from bureaucratic, silo organizations to leaner, more transparent, and agile organizations with tighter coordination between agencies and rapid, timely responses to public needs. Future research can explore this role of IT in the public sector.

Appendix 3.1. Description of Measures

Total Cost (*C*) – Current Operation Expense

From State Government Finance published by the U.S. Census Bureau, we took current operation expense, divided it by annual population estimate, and adjusted it for 2005 dollar with the price index for GDP provided by the Bureau of Economic Accounts.

Total Cost (*C*) – Capital Depreciation

We referred to 'Notes to Financial Statements' section in states' comprehensive annual financial reports (CAFR) to obtain annual capital depreciation. Among several capital asset categories, only buildings and equipments and related asset categories such as fixtures or vehicles were considered, as states have discretion in reporting the depreciation of other types of capital assets. For example, some states categorize infrastructure as depreciable assets, while others consider it non-depreciable. Also, we include the asset of primary governments and exclude that of discretely presented component units, since many states do not report the capital figure of such units. Per capita capital depreciation was calculated and adjusted for 2005 dollar.

Labor Price (w_l)

State Government Employment & Payroll data published by the U.S. Census Bureau contains the monthly payroll for full-time and part-time staff employed by state governments. We took the sum of full-time and part-time payroll and divided it by the number of full-time equivalent (FTE) employees.

Capital Price (w_2)

From State Government Finances, "interest on general debt" was divided by mean debt level (the average of "debt at end of fiscal year" at the same year and that of the previous fiscal year).

Education (Y_1)

From State Higher Education Finance Survey, the number of students enrolled in public post-secondary educational institutions was divided by population estimate.

Public Welfare (Y_2)

From Medicaid Summary Table provided by the Center for Medicare & Medicaid Services, the enrollee population was divided by population estimate.

Transportation (Y_3)

From Highway Statistics published by the Federal Highway Administration, we took the length (miles) of rural and urban roads owned and maintained by state highway agency and divided it by population estimate.

Public Safety (Y_4)

From crime statistics provided by the Federal Bureau of Investigation, we divided the total number of both violent and property crime incidents by population estimate.

IT Intensity (IT1 and IT2)

2002 NASCIO Compendium of Digital Governments in States provides the actual IT budget figure in 2001 and 2002, and the expected budget in 2003. *2004 Compendium* covers the actual budget in 2003 and 2004, and the expected budget in 2005. The correlation between the expected 2003 budget in 2002 Compendium and the actual 2003 budget in 2004 Compendium is 0.66. We took the actual 2003 budget from 2004 Compendium and if it is missing, took the expected budget from 2002 Compendium.

IT1 was calculated by dividing IT budget by population estimate. IT2 was derived by dividing IT budget by "general expenditure" from State Government Finances.

Federal Grant (z_4)

From State Government Finances, "intergovernmental revenue from federal government" was divided by population estimate.

Party Control of Legislatures (z_6)

We calculated the ratio of Republican state representatives in state house and Republican state senator in senate, respectively and took the sum of two. For Nebraska, which has a unicameral legislature, we multiplied the percentage of Republican by two.

Appendix 3.2. Additional Estimation Results

Table 17. Kumbharkar et al. (1991) One-Stage Estimation with Per Capita IT Budget

Stochastic Frontier Estimation (Dependent Variable: log C)					
Cost Function Estimation				Estimation for Inefficiency	
$\ln Y_1$	21.2789*** (3.7286)	$\ln w_1$	1.9762* (0.9329)	Population	-0.3329* (0.1793)
$\ln Y_2$	-3.4091 (2.7066)	$\ln w_2$	-0.9762 (0.9329)	GDP	-0.1468** (0.0709)
$\ln Y_3$	-2.5868** (1.0601)	$\ln w_1 \ln w_1$	-0.0163 (0.1228)	Income	0.0798 (0.0620)
$\ln Y_4$	5.5718* (3.2035)	$\ln w_2 \ln w_2$	0.0476 (0.1979)	Federal Grant	3.2324*** (0.8178)
$\ln Y_1 \ln Y_1$	-0.3525*** (0.2000)	$\ln w_1 \ln w_2$	-0.0156 (0.1162)	Governor	0.2955 (0.4966)
$\ln Y_1 \ln Y_2$	-0.2970*** (0.1612)	$\ln w_1 \ln Y_1$	-0.3108 (0.3313)	Legislature	-3.8691*** (0.7402)
$\ln Y_1 \ln Y_3$	-0.0467 (0.0795)	$\ln w_1 \ln Y_2$	0.7167*** (0.2382)	IT1	-0.0514*** (0.0182)
$\ln Y_1 \ln Y_4$	-0.5744*** (0.1406)	$\ln w_1 \ln Y_3$	0.0913 (0.0984)	const.	-1.4075 (2.1845)
$\ln Y_2 \ln Y_2$	-0.0903** (0.0755)	$\ln w_1 \ln Y_4$	-0.4972 (0.3116)		
$\ln Y_2 \ln Y_3$	0.0054 (0.0435)	$\ln w_2 \ln Y_1$	-0.3786** (0.1817)		
$\ln Y_2 \ln Y_4$	0.0588 (0.1136)	$\ln w_2 \ln Y_2$	0.1981 (0.1820)		
$\ln Y_3 \ln Y_3$	0.0380*** (0.0143)	$\ln w_2 \ln Y_3$	0.0834 (0.0581)		
$\ln Y_3 \ln Y_4$	0.0511** (0.0463)	$\ln w_2 \ln Y_4$	0.0970 (0.1269)		
$\ln Y_4 \ln Y_4$	0.0288 (0.0842)	const.	-43.4855*** (9.5006)		
σ_v [1)]	0.0238*** (0.0012)	$\ln L$	224.8630	Wald χ_2	4077.13***

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; $N = 185$; Standard errors are in parentheses;
Geographic and year dummies are omitted; [1)] The variance of idiosyncratic errors ($v_{k,t}$);

Table 18. Kumbharkar et al. (1991) One-Stage Estimation with the Ratio of IT Budget

Stochastic Frontier Estimation (Dependent Variable: log C)					
Cost Function Estimation				Estimation for Inefficiency	
$\ln Y_1$	20.6235*** (3.6896)	$\ln w_1$	1.8269* (0.9327)	Population	-0.2933* (0.1721)
$\ln Y_2$	-2.5036 (2.7370)	$\ln w_2$	-0.8269 (0.9327)	GDP	-0.1523** (0.0693)
$\ln Y_3$	-2.1527** (1.0926)	$\ln w_1 \ln w_1$	-0.0097 (0.1215)	Income	0.0735 (0.0622)
$\ln Y_4$	5.4446* (3.1626)	$\ln w_2 \ln w_2$	0.0581 (0.1958)	Federal Grant	3.0605*** (0.8300)
$\ln Y_1 \ln Y_1$	-0.3647*** (0.2035)	$\ln w_1 \ln w_2$	-0.0242 (0.1145)	Governor	0.3883 (0.5223)
$\ln Y_1 \ln Y_2$	-0.3040*** (0.1669)	$\ln w_1 \ln Y_1$	-0.2286 (0.3297)	Legislature	-3.8757*** (0.7846)
$\ln Y_1 \ln Y_3$	-0.0423 (0.0807)	$\ln w_1 \ln Y_2$	0.6259*** (0.2395)	IT1	-0.2285*** (0.0767)
$\ln Y_1 \ln Y_4$	-0.5669*** (0.1424)	$\ln w_1 \ln Y_3$	0.0581 (0.1008)	const.	-0.8244 (2.3278)
$\ln Y_2 \ln Y_2$	-0.0867** (0.0724)	$\ln w_1 \ln Y_4$	-0.4555 (0.3090)		
$\ln Y_2 \ln Y_3$	0.0022 (0.0441)	$\ln w_2 \ln Y_1$	-0.3627* (0.1874)		
$\ln Y_2 \ln Y_4$	0.0502 (0.1146)	$\ln w_2 \ln Y_2$	0.2004 (0.1870)		
$\ln Y_3 \ln Y_3$	0.0359*** (0.0145)	$\ln w_2 \ln Y_3$	0.0673 (0.0614)		
$\ln Y_3 \ln Y_4$	0.0465** (0.0472)	$\ln w_2 \ln Y_4$	0.0950 (0.1299)		
$\ln Y_4 \ln Y_4$	0.0252 (0.0854)	const.	-45.0117*** (9.4873)		
σ_v [1)]	0.0262*** (0.0043)	$\ln L$	250.7070	Wald χ_2	4121.09***

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$; $N = 185$; Standard errors are in parentheses;
Geographic and year dummies are omitted; [1)] The variance of idiosyncratic errors ($v_{k,t}$);

Table 19. The First-Stage Cost Frontier Estimation with IT Price

Stochastic Frontier Estimation (Dependent Variable: log C)					
$\ln Y_1$	28.4165*** (9.2435)	$\ln w_1$	-5.2605** (2.0398)	$\ln w_2 \ln Y_1$	-0.5199*** (0.1970)
$\ln Y_2$	-26.8697*** (4.7073)	$\ln w_2$	0.6922 (2.8469)	$\ln w_2 \ln Y_2$	-0.1145 (0.1767)
$\ln Y_3$	-12.9557*** (2.2619)	$\ln w_3$	5.5683* (3.1860)	$\ln w_2 \ln Y_3$	-0.0661 (0.0833)
$\ln Y_4$	6.9188 (5.5893)	$\ln w_1 \ln w_1$	0.7063*** (0.2186)	$\ln w_2 \ln Y_4$	0.7006*** (0.2148)
$\ln Y_1 \ln Y_1$	0.1984* (0.2282)	$\ln w_2 \ln w_2$	0.1671* (0.1815)	$\ln w_3 \ln Y_1$	-0.0644 (0.1750)
$\ln Y_1 \ln Y_2$	-0.4045*** (0.1397)	$\ln w_3 \ln w_3$	-0.1977** (0.1715)	$\ln w_3 \ln Y_2$	-0.0333 (0.1131)
$\ln Y_1 \ln Y_3$	-0.3570*** (0.0864)	$\ln w_1 \ln w_2$	0.0699 (0.3750)	$\ln w_3 \ln Y_3$	-0.0012 (0.0670)
$\ln Y_1 \ln Y_4$	-0.0605 (0.2144)	$\ln w_1 \ln w_3$	-0.1327 (0.3459)	$\ln w_3 \ln Y_4$	0.0989 (0.1600)
$\ln Y_2 \ln Y_2$	0.0662* (0.0692)	$\ln w_2 \ln w_3$	-0.6130** (0.2571)	const.	-57.1823 (35.4721)
$\ln Y_2 \ln Y_3$	0.4230*** (0.0497)	$\ln w_1 \ln Y_1$	-3.6563*** (0.5944)	σ_v 1)	0.0809*** (0.0226)
$\ln Y_2 \ln Y_4$	0.7651*** (0.1321)	$\ln w_1 \ln Y_2$	2.3313*** (0.3504)	σ_u 2)	0.2200*** (0.0325)
$\ln Y_3 \ln Y_3$	0.0787*** (0.0254)	$\ln w_1 \ln Y_3$	1.3778*** (0.2093)	$\ln L$	181.2084
$\ln Y_3 \ln Y_4$	0.1017 (0.0808)	$\ln w_1 \ln Y_4$	-0.0527 (0.4539)	Wald χ_2	1267.02
$\ln Y_4 \ln Y_4$	-0.2907*** (0.1514)				

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$; $N = 377$; Standard errors are in parentheses;
1) The variance of idiosyncratic errors ($v_{k,t}$);
2) The variance of technial inefficiency terms ($u_{k,t}$, significance from a log-likelihood test)

Table 20. The Second Stage Estimation with IT Price

Dependent Variable – Technical Efficiency				
Method	White Robust Estimation		Random-Effects Estimation	
	(1)	(2)	(3)	(4)
Population	0.0087*** (0.0024)	0.0084*** (0.0025)	0.0083** (0.0033)	0.0081** (0.0033)
GDP	0.0036* (0.0020)	0.0039* (0.0020)	0.0049 (0.0034)	0.0049 (0.0034)
Income	-0.0087*** (0.0024)	-0.0089*** (0.0025)	-0.0094** (0.0037)	-0.0094** (0.0037)
Federal Grant	-0.1188*** (0.0210)	-0.1160*** (0.0207)	-0.1316*** (0.0366)	-0.1289*** (0.0372)
Governor	-0.0311** (0.0138)	-0.0287** (0.0137)	-0.0010 (0.0161)	-0.0002 (0.0162)
Legislature	0.1554*** (0.0335)	0.1594*** (0.0336)	0.0532 (0.0558)	0.0534 (0.0562)
IT1	0.0005 (0.0005)		0.0008* (0.0005)	
IT2		0.0008 (0.0020)		0.0026# (0.0018)
const.	-0.0264 (0.0873)	-0.0252 (0.0878)	0.1435 (0.1601)	0.1419 (0.1618)
F	9.88***	9.81***	68.56*** 1)	67.63*** 1)
R^2	0.6434	0.6418	0.6084 2)	0.6046 2)
RMS	0.1032	0.1034		

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$, $^{\#}p < 0.1$ (one-tail test); N=185

Geographic and year dummies are omitted; standard errors are in parentheses;

1) Wald Statistics; 2) Overall R^2

References

Aigner, D. and Chu, S.F. "On Estimating the Industry Production Function," *American Economic Review* (58:4) 1968, pp. 826-839.

Aigner, D., Lovell, C.A.K., and Schmidt, P. "Formulation and Estimation of Stochastic Frontier Production Function Models," *Journal of Econometrics* (6:1) 1977, pp. 21-37.

Anderson, M.C., Banker, R.D., and Ravindran, S. "Value Implications of Investments in Information Technology," *Management Science* (52:9) 2006, pp. 1359-1376.

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

Banker, R., Bardham, I., Chang, H., and Lin, S. "Plant Information Systems, Manufacturing Capabilities, and Plant Performance," *MIS Quarterly* (30:2) 2006, pp. 315-337.

Barua, A., Kriebel, C.H., and Mukhopadhyay, T. "Information Technologies and Business Value: An Analytic and Empirical Investigation," *Information Systems Research* (6:1) 1995, pp 3-23.

Battese, G.E. and Coelli, T.J. "Prediction of Firm-Level Technical Efficiencies with a Generalized Frontier Production Function wand Panel Data," *Journal of Econometrics* (38:3) 1988, pp. 387-399.

Bergstrom, T., Blume, L., and Varian, H. "On the Private Provision of the Public Goods," *Journal of Public Economics* (29:1) 1986, pp. 25-49.

Bewley, T. "A Critique of Tiebout's Theory of Local Expenditures," *Econometrica* (49:3) 1981, pp. 713-740.

Bharadwaj, A.S., Bharadwaj, S.G., and Konsynski, B.R. "Information Technology Effects on Firm Performance as Measured by Tobin's *q*," *Management Science* (45:7) 1999, pp. 1008-1024.

Bharadwaj, S., Bharadwaj, A., and Bendoly, E. "The Performance Effects of Complementarities Between Information Systems, Marketing, Manufacturing, and Supply Chain Processes" *Information Systems Research* (18:4) 2007, pp. 437-453.

Bresnahan, T., Brynjolfsson, E., and Hitt, L. "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *Quarterly Journal of Eonomics* (117:1) 2002, pp. 339-376.

Breusch, T.S. and Pagan, A.R. "A Simple Test for Heteroscedasticity and Random Coefficient Variation," *Econometrica* (47:5) 1979, pp. 1287-1294.

Brynjolfsson, E. "The Productivity Paradox of Information Technology," *Communication of the ACM* (36:12) 1993, pp. 67-77.

Brynjolfsson, E. and Hitt, L. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4) 1996, pp. 541-558.

Caves, D.W., Christensen, L.R., and Tretheway, M.W. "Flexible Cost Functions for Multiproduct Firms," *Review of Economics and Statistics* (62:3) 1980, pp. 477-481.

Caves, D.W., Christensen, L.R., and Swanson, J.A. "Productivity Growth, Scale Economies, and Capacity Utilization in U.S. Railroads," *American Economic Review* (71:5) 1981, pp. 994-1002.

Charnes, A., Cooper, W.W., and Rhodes, E. "Measuring the Efficiency of Decision-Making Units," European Journal of Operational Research (6:2) 1978, pp. 429-444.

Chatterjee, D., Richardson, V., and Zmud, R. "Examining the Shareholder Wealth Effects of New CIO Position Announcements," *MIS Quarterly* (25:1) 2001, pp. 43-70.

Conroy, S.J. and Arguea, N.M. "An Estimation of Technical Efficiency for Florida Public Elementary Schools," *Economics of Education Review* (27:6) 2008, pp. 655-663.

Davis, M.L. and Hayes, K. "The Demand for Good Government," *Review of Economics and Statistics* (75:1) 1993, pp. 148-152.

De Borger, B. and Kerstens, K. "Cost Efficiency of Belgian Local Governments: A Comparative Analysis of FDH, DEA, and Econometric Approaches," *Regional Science and Urban Economics* (26:2) 1996, pp. 145-170.

Devaraj, S. and Kohli, R. "IT Payoff in the Healthcare Industry: A Longitudinal Study," *Journal of Management Information Systems* (16:4) 2003, pp. 41-67.

Devaraj, S. and Kohli, R. "Performance Impacts of Information Technology: Is Actual Usage the Missing Link," *Management Science* (49:3) 2003, pp. 273-289.

Dewan, S. and Min, C. "The Substitution of Information Technology for Other Factors of Production: A Firm Level Analysis," *Management Science* (43:12) 1997, pp. 1660-1675.

Dewan, S. and Kraemer, K.L. "Information Technology and Productivity: Evidence from Country-Level Data," *Management Science* (46:4) 2000, pp. 548-562.

Downs, G.W. and Larkey, P.D. *The Search for Government Efficiency: From Hubris to Helplessness*, 1986, Philadelphia, PA: Temple University Press.

Fenn, P., Vencappa, D., Diacon, S., Klumpes, P., and O'Brien, C. "Market Structure and the Efficiency of European Insurance Companies," *Journal of Banking and Finance* (32:1) 2008, pp. 86-100.

Fiorina, M.P. and Noll, R.G. "Voters, Bureaucrats and Legislatures: A Rational Choice Perspective on the Growth of Bureaucracy," *Journal of Public Economics* (9:2) 1978, pp. 239-254.

Francalanci, C. and Galal, H. "Information Technology and Worker Composition: Determinants of Productivity in the Life Insurance Industry," *MIS Quarterly* (22:2) 1998, pp 227-241.

Garand, J.C. "Explaining Government Growth in the U.S. States," *American Political Science Review* (82:3) 1988, pp. 837-849.

Garicano, L. and Heaton, P. "Information Technology, Organization, and Productivity in the Public Sector – Evidence from Police Departments," *Journal of Labor Economics* (28:1) 2010, pp. 167-201.

Geys, B. "Looking Across Borders: A Test of Spatial Policy Interdependence Using Local Government Efficiency Ratings," *Journal of Urban Economics* (60:3) 2006, pp. 443-462.

Government Technology, CIOs Project Continued Local Government IT Budget Cuts, 2010, available at: http://www.govtech.com/budget-finance/CIOs-Project-Continued-Local-Government-IT-Budget-Cuts.html, accessed on Apr. 2nd, 201.

Grossman, P.J., Mavros, P., and Wassmer, R.W. "Public Sector Technical Inefficiency in Large U.S. Cities," *Journal of Urban Economics* (46:2) 1999, pp. 278-299.

Gyourko, J. and Tracy, J. "The Structure of Local Public Finance and the Quality of Life," *Journal of Political Economy* (99:4) 1991, pp. 774-806.

Gu, B., Ling, X., and Ray, G. "IT Governance and IT Investment Performance: An Empirical Analysis," *Proceedings of Twenty Ninth International Conference on Information Systems*, R. Boland, M. Limayem, and B. Pentland (eds.), Association for Information Systems, Paris, France, Dec. 2008.

Gurbaxani, V. and Whang, S. "The Impact of Information Systems on Organizations and Markets," *Communications of the ACM* (34:1) 1991, pp. 59-73.

Hardwick, P. "Multi-Product Cost Attributes: A Study of U.K. Building Societies," *Oxford Economic Papers* (42:2) 1990, pp. 446-461.

Hoyt, W.H. "Local Government Inefficiency and the Tiebout Hypothesis: Does Competition among Municipalities Limit Local Government Inefficiency?," *Southern Economic Journal* (57:2) 1990, pp. 481-496.

Jondrow, J., Lovell, C.A.K., Materov, I.S., and Schmidt, P. "On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," *Journal of Econometrics* (19:2/3) 1982, pp. 233-38.

Jorgenson, D.W. "Information Technology and the U.S. Economy," *American Economic Review* (91:1) 2001, pp. 1-32.

Kennedy, P. (2003), *A Guide to Econometrics, Fifth Edition*, Cambridge, MA: The MIT Press.

Koopmans, T.C. (1951), "An Analysis of Production as an Efficient Combination of Activities," in *Activity Analysis of Production and Allocation*, Koopmans, T.C. (ed.), New York: John Wiley and Sons, Inc.

Kumbharkar, S.C. "The Measurement and Decomposition of Cost-Inefficiency: The Translog Cost System," *Oxford Economic Papers* (43:3) 1991, pp. 667-683.

Kumbharkar, S.C., Ghosh, S., and McGuckin, J.T. "A Generalized Production Frontier Approach for Estimating Determinants of Inefficiency in U.S. Dairy Farms," *Journal of Business & Economic Statistics* (9:3) 1991, pp. 279-286.

Kumbharkar, S.C. and Lovell, C.A.K. (2000), *Stochastic Frontier Analysis*, New York: Cambridge University Press.

Larkey, P.D., Stolp, C., and Winer, M. "Theorizing About the Growth of Government: A Research Assessment," Journal of Public Policy (1:2) 1981, pp. 157-220.

Lee, B. and Barua, A. "An Integrated Assessment of Productivity and Efficiency Impacts of Information Technology Investments: Old Data, New Analysis, and Evidence," *Journal of Productivity Analysis* (12:1) 1999, pp. 21-43.

Lee, G. and Perry, J.L. "Are Computers Boosting Productivity? A Test of the Paradox in State Governments," *Journal of Public Administration Research and Theory* (12:1) 2002, pp. 77-102.

Lehr, W. and Lichtenberg, F.R. "Computer Use and Productivity Growth in US Federal Government Agencies, 1987-92," *Journal of Industrial Economics* (46:2) 1998, pp. 257-279.

Lovell, C.A.K. (1993), "Production Frontiers and Productive Efficiency," in *The Measurement of Productive Efficiency*, Fried, H.O, Lovell, C.A.K, and Schmidt S.S. (eds.), pp. 3-67, New York: Oxford University Press.

Meeusen, W. and van den Broeck, J. "Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error," *International Economic Review* (18:2) 1977, pp. 435-444.

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

Mitra, S. and Chaya, A.K. "Analyzing Cost-Effectiveness of Organizations: The Impact of Information Technology Spending," *Journal of Management Information Systems* (13:2) 1996, pp. 29-57.

Moon, M.J. and Bretchneider, S. "Does the Perception of Red Tape Constrain IT Innovativeness in Organizations? Unexpected Results from a Simultaneous Equation Model and

Implications," *Journal of Public Administration Research and Theory* (12:2) 2002, pp. 273-291.

NASCIO, *NASCIO 2004-05 Compendium of Digital Governance in the States*, 2005, Lexington, KY.

NASCIO, *2006 Best Practices in the Use of Information Technology in State Government*, 2006a, Lexington, KY, available at: http://www.nascio.org/publications/documents/NASCIO-2006Awards.pdf, accessed on Mar. 21st, 2009.

NASCIO, *Compendium of 2006 Best Practices in the Use of Information Technology in State Government*, 2006b, Lexington, KY.

NASCIO, *Connecting State and Local Government: Collaboration through Trust and Leadership*, 2007a, Lexington, KY, available at: http://www.nascio.org/publications/documents/NASCIO-Cross%20BoundaryNov2007.pdf, accessed on Mar. 21st, 2009.

NASCIO, *2007 Best Practices in the Use of Information Technology in State Government*, 2007b, Lexington, KY, available at: http://www.nascio.org/publications/documents/NASCIO-2007Awards.pdf, accessed on Mar. 21st, 2009.

NASCIO, *The 2010 State CIO Survey*, 2010, Lexington, KY, available at: http://www.nascio.org/publications/documents/NASCIO-2010StateCIOSurvey.pdf, accessed on Apr. 1st, 2011.

North, D.C. "The Growth of Government in the United States: An Economic Historian's Perspective," *Journal of Public Economics* (28:3) 1985, pp. 383-399.

Pandey, S.K. and Bretchneider, S. "The Impact of Red Tape's Administrative Delay on Public Organizations' Interest in New Information Technologies," *Journal of Public Administration Research and Theory* (7:1) 1997, pp. 113-129.

Pitt, M. and Lee, L.F. "The Measurement and Sources of Technical Inefficiency in the Indonesian Weaving Industry," *Journal of Development Economics* (9:1) 1981, pp. 43-64.

Poterba, J.M. "State Reponses to Fiscal Crises: The Effect of Budgetary Institutions and Politics," *Journal of Political Economy* (102:4) 1994, pp. 799-821.

Rai, A., Patnayakuni, R., and Seth, N. "Firm Performance Impacts of Digitally Enabled Supply Chain Integration Capabilities," *MIS Quarterly* (30:2) 2006, pp. 225-246.

Ray, S.C. "A Translog Cost Function Analysis of U.S. Agriculture, 1939-77," *American Journal of Agricultural Economics* (64:3) 1982, pp. 490-498.

Robbins, D. and Miller, G.J. 2005. "E-Government Expenditures," in *Handbook of Public Sector Economics*, Robbins, D. (ed.), Boca Raton, FL: CRC Press, pp. 407-421.

Santhanam, R. and Hartono, E. "Issues in Linking Information Technology Capability to Firm Performance," *MIS Quarterly* (27:1) 2003, pp. 125-153.

State of Michigan, *HR Best Practices – Positioning HR as a Strategic Business Partner & Establishing an HR Service Center*, available at http://www.nascio.org/events/webinars/NASCIO-Michigan%20HR%20Optimization%20Presentation.pdf.

Stiglitz, J.E. *Economics of the Public Sector: Third Edition*, 2000, New York, NY: W.W. Norton & Company, Inc.

Tanriverdi, H. "Performance Effects of Information Technology Synergies in Multibusiness Firms," *MIS Quarterly* (30:1), 2006, pp.57-77.

Taylor, L.L. "Allocative Inefficiency and Local Government," *Journal of Urban Economics* (37:2) 1995, pp. 201-211.

U.S. Census Bureau, *Government Finance and Employment Classified Manual*, 2006, available at: http://ftp2.census.gov/govs/class06/2006_classification_manual.pdf, accessed on Jun. 11th, 2009.

Wang, H.-J. and Schmidt, P. "One-Step and Two-Step Estimation of the Effects of Exogenous Variables on Technical Efficiency Levels," *Public Administration Review* (64:1) 2004, pp. 15-27.

Weill, P. and Ross, J. *IT Governance: How Top Performers Manage IT Decision Rights for Superior Results*, 2004, Boston, MA: Harvard Business Press.

West, D. "E-Government and the Transformation of Service Delivery and Citizen Attitudes," *Public Administration Review* (64:1) 2004, pp. 15-27.

White., H. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* (48:4) 1979, pp. 817-838.

Worthington, A.C. "Cost Efficiency in Australian Local Governments: A Comparative Analysis of Mathematical Programming and Econometric Approaches," *Financial Accountability and Management* (16:3) 2000, pp. 201-224.

Zhu, K. (2004) "The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of Their Business Value," *Journal of Management Information Systems* (21:1) 2004, pp. 167-202.

Zuboff, S. "Automate/Informate: The Two Faces of Intelligent Technology," *Organizational Dynamics* (14:2) 1985, pp. 5-18.

CHAPTER 4.

DO INFORMATION TECHNOLOGY INVESTMENTS LEAD TO BIGGER OR SMALLER GOVERNMENTS? – THEORY AND EVIDENCE IN U.S. STATE GOVERNMENTS

4.1. Introduction

Since the nineteenth century, public economists and political scientists have long been interested in the growth of governments (Larkey et al. 1981). Witnessing a significant growth in governments over the recent several decades and concomitant frustration of the general public with 'big governments,' numerous researchers have studied why governments continue to grow. Inquires have examined a variety of questions including which factors cause governments to grow; under what mechanisms government expenditures are determined; and what impact government growth has upon the overall economy. The literature on this issue is so wide and extensive that Lybeck (1988) classified the literature into twelve theories, and Tarschys (1975) suggested nine broad categories and 25 explanations for government growth, although both authors admit that their coverage is by no means exhaustive.

One of the key factors behind government growth identified by this literature is technological development (Tarschys 1975, North 1985). Specifically, the industrial revolution fueled by technological advances and accompanying societal changes such as urbanization have led governments to expand their influence on the economy. Against this backdrop, I propose another technological factor that may influence the growth of governments in the post-industrial era – information technology (IT). In this chapter, I aim at exploring whether IT investments made by governments can change or keep the course of government growth.

The relationship between IT investments and organization size in the for-profit context is among the key research interests in the information systems (IS) literature. For example, an industry-level analysis by Brynjolfsson et al. (1994) shows that the level of industry IT stock is related to a smaller size of firms as measured by the number of employees, sales, and value added per establishment. Also in an industry-level study, Wood et al. (2008) find that the relationship varies across the industry sectors; IT investments are associated with smaller firm size in manufacturing industries and with larger firm size in retail and service industries. One of the few studies at the organizational level, Hitt (1999) finds that increased use of IT is associated with an increase in vertical integration and a decrease in diversification. However, few studies, if any, in IS and public economics paid much attention to the effect of IT investments on government size. In a study for the transportation industry, Baker and Hubbard (2004) find that adoption of onboard computers (OBC) in trucks is associated with an increase in asset (truck) ownership by shippers and a decrease in ownership by independent drivers (contractors). They suggest that the adoption of OBC reduces a shipper's monitoring costs of driving records, making it more attractive for the shipper to own trucks compared to contracting with independent drivers who own trucks.

To fill this gap, I offer theoretical arguments and empirical evidence regarding the role of IT in government growth at the context of U.S. state governments. Based on the three theoretical models from political science and public economics literature (Fiorina and Noll 1978, Becker 1983, Banks 1989), I give four explanations for the impact of IT on government growth. First, on the supply side, automating manual, labor-intensive administrative processes enables governments to produce public goods and services with a smaller amount of input. In other words, IT improves the productivity of public good production (Brynjolffson and Hitt 1996, Dewan and Kraemer 2000). Consequently, IT investments can be expected to lead to smaller governments, provided that the demand of public goods remains unchanged. Second, more digitalized, transparent administrative processes and increased availability of information on governments' actions and decision making alleviate the information asymmetry problem between principals (voters and legislatures) and agents (bureaucrats) (Horn 1995). This effect can make the monitoring activities of legislatures (Bendor et al. 1985, Banks 1989) more effective and thereby curb the power of bureaucrats, which may lead to excessive government expenditures (Niskanen 1968, Miller and Joe 1983).

On the demand side, enhanced communication between citizens and government officials promoted by e-Government initiatives (West 2004) helps citizens and interest groups become well-informed about government administration, facilitating their monitoring role on governments. In turn, this further assists the checks-and-balances mechanism of legislatures (Banks and Weingast 1992), again leading to smaller governments. Finally, more efficient production of public goods and more effective administrative processes may reduce the price of public goods. A reduction in tax price may increase the demand for public goods and lead to the expansion of governments. These contrasting arguments pose a significant challenge in predicting how IT affects the size of governments. Instead of making a specific prediction, therefore, I offer two competing hypotheses that greater use of IT and digitization in governments either expands or shrinks government expenditures.

Next, adopting the state government growth model proposed by Garand (1988, 1989) as an empirical framework, I examine the effects of IT investments in the context of U.S. state governments. I utilize data from a variety of sources. I obtained the 5-year data on IT expenditures and IT organizations in state governments from the *NASCIO Compendium of Digital Governments in the States*. I also gathered data on state expenditure, tax revenue, payroll and so forth from the U.S. Census Bureau. The primary independent variable in the empirical analyses is IT intensity (Bharawaj et al. 1999, Anderson et al. 2006), which is measured in two ways – the ratio of IT budget to state gross domestic product (GDP), and per capita IT budget. I choose the proportion of annual expenditures to state GDP, one of the common measures of government size in the public economics literature (e.g. Lowery and Berry 1983, Borcherding 1985, Saunders 1993), as a dependent variable. I build a 5-year unbalance panel consisting of 190 observations in 44 states.

The empirical analysis confirms the hypothesis that more IT investments in state governments are associated with smaller government size. Estimations with the dynamic panel-data model provided by Blundell and Bond (1998) find a negative relationship between IT intensity and state government expenditures at the 1%-level of significance. Specifically, the result shows that if the proportion of IT budget to state GDP increases by one percentage point, the ratio of state expenditures to GDP decreases by approximately 3.49 percentage points. In a numeric term, a $1 increase in per capita IT budget is associated with as much as $3.68 a reduction in per capita general expenditures. I also find that this pattern is consistent with a use of different measures for government size, alternative functional specifications, and estimation techniques.

This work contributes to the IS and public economics literature by suggesting a new technological factor for government expenditures. This study is also among few studies that examine the relationship between IT spending and organization size, especially at the organizational level, compared to industry-level studies (Brynjolfsson et al. 1994, Woods et al. 2008).

The remainder of this chapter is organized as follows. The subsequent section offers a theoretical discussion and develops the hypotheses. Section 4.3 describes data sources, measures, and methodology. In Section 4.4, the results from empirical investigations are presented. The chapter concludes with discussions, limitations, and future research directions.

4.2. Theoretical Development

This section provides the theoretical arguments regarding the relationship between IT investments and government size. I draw on three theoretical models on government size from the public economy and political science literature to derive the hypotheses.

4.2.1. The Production of Public Goods with Legislative Facilitation Model

Fiorina and Noll (1978) provide a public good production model that incorporates bureaucracy costs and legislative facilitation services. In their model, to request the production of public goods that they desire, citizens may incur an external cost in dealing with bureaucrats, and this external cost can be reduced by legislators who offer facilitation services. Among such external costs are those associated with discovering the appropriate entry point to the bureaucrats, with communicating with the bureaucrats, and with sending information on the public good demand to the bureaucrats. In facilitation services, legislators provide constituents with a support in dealing with the bureaucrats[18].

In a formal model, there are *m* districts, each of which *n* voters reside in. Each district is represented by a legislator. A voter is endowed with income y_{ij} ($i=1,...,n$, $j=1,...,m$), where *i* and *j* indicates a voter and a district, respectively. She consumes the private good z_{ij} and the public good *K* produced by a government agency. Her utility function is given by $U^{ij}(z_{ij},K)$. She pays a tax t_{ij} and incurs the external bureaucracy cost $C(B,F_{ij})$, where *B* is the size of the agency and F_{ij} indicates the amount of facilitation services offered by the legislator who represents the district *j*. *C* is increasing in *B* and decreasing in F_{ij}. Thus, the voter's budget constraint is given by,

$$y_{ij} = z_{ij} + t_{ij} + C(B,F_{ij}) \qquad (9)$$

The production of public good *K* requires two inputs – the agency *B* and other inputs *X*. The prices of the two inputs are P_B and P_X, respectively, and the production function is given by $f(B,X)$. The purchase of the two inputs is appropriated to by tax

[18] Fiorina and Noll (1978) state that "the oversight function of the legislature give it (the legislature) influence with bureaucrats and information on how the bureaucracy works, both of which are potentially of value to citizens who come in contact with the agency" (p. 241).

revenue. In addition, part of the tax revenue is spent in generating facilitation services, whose price is P_f. Therefore, the tax revenue must be equivalent to the sum of the purchase of inputs and facilitation services as follows.

$$\sum_{i,j} t_{ij} = P_B B + P_X B + P_f \sum_{i,j} F_{ij} \tag{10}$$

Fiorina and Noll (1978) solve three maximization problems in their work, depending on who a decision maker is – a social welfare maximization problem; a decentralization decision problem which maximizes the median voter's welfare[19]; and a budget maximization problem in which bureaucrats are interested in maximizing budget. For example, the social welfare maximization problem is given by

$$\max \sum_{i,j} U^{ij}(z_{ij}, K) \tag{11}$$

$$\text{subject to } K = f(B, X) \tag{12}$$

$$\begin{aligned} \sum_{i,j} y_{ij} &= \sum_{i,j} z_{ij} + \sum_{i,j} C(B, F_{ij}) + \sum_{i,j} t_{ij} \\ &= \sum_{i,j} z_{ij} + \sum_{i,j} C(B, F_{ij}) + P_B B + P_X X + P_f \sum_{i,j} F_{ij} \end{aligned} \tag{13}$$

by Eq. 10.

With respect to the effects of IT in the context of the above problem, some implications can be derived. First, as predicted by the literature of IT business value, the use of IT will improve the productivity of public good production. This implies that given the amount of public goods K to be produced, the use of inputs B and X can be reduced. Thus, as long as K remains unchanged, the budget size $P_B B + P_X X$ may decrease in IT investments.

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[19] Median voter theory dictates that when political inclination of voters can be described by a horizontal line and two political parties compete for political support, a median voter, who resides in the center of the horizontal line, is a decisive voter. This implies that the demand of such a median voter becomes a representative demand for a whole constituency.

Second, the use of IT and the Internet may decrease the bureaucracy cost C. An example is TampaGov Customer Service Center in Tampa, Florida (Cantler 2007). This Web site provides citizens with a one-point contact point to city-wide agencies and departments. Among other tools, it features a communication tool for submitting service requests and inquiries, a self-service payment system for utility and tax, and a self-service public records search tool. Each inquiry or request submitted to the system is automatically re-directed to city officials who are in charge of it, and a requestor can track the processing progress with a unique tracking number on this site. This example illustrates that automated administrative processes and online communication with citizens assist constituents in dealing with the agencies. Consequently, IT investments may lead to a reduction in C, which in turn may increase the citizens' willingness to pay (t_{ij}) for the public goods, as given by Eq. 9. Therefore, it can be expected that a reduction in C may lead to an increase in the budget size $P_B B + P_X X$.

4.2.2. Political Control of Bureaucracy Model

Banks (1989) proposes a political control model of bureaucracy in the presence of information asymmetry and conflicts of interests. His work models a budget decision game between a legislature and a bureaucratic agency. The legislature has an authority to approve the budget proposed by the agency, but has limited information on the actual cost of administration. The agency is interested in maximizing the budget size (b), while the legislature's interest is to maximize the benefit to voters net of the budget ($v - b$).

In his model, the benefit of a certain public good is v and is known to both the legislature and the agency. On the other hand, the cost of production c is known only to the agency, while the legislature is only aware of the distribution of the cost, $f(c)$. The budget decision game proceeds as follows. Discovering the true cost c, the agency submits a budget request b to the legislature. The legislature has three options. With a probability of α_1, it accepts this budget request. With a probability of α_2, it conducts an audit with a cost of k and discovers the true value of c. The budget size becomes c after the audit. With a probability of $1-\alpha_1-\alpha_2$, the legislature rejects the budget request. Banks (1989) derives the sequential equilibrium strategies of the legislature and the agency as follows.

If $k < k^*$, where k^* is the solution of $\int_0^v c \cdot f(c)dc \Big/ \int_0^v f(c)dc = v - k$, (14)

The size of the budget request is $b^*(c) = \begin{cases} c+k & \text{if} \quad c \in [0, c'] \\ v & \text{if} \quad c \in (c', v] \end{cases}$ (15)

The legislature accepts the request with a probability of

$$\alpha_1^*(b) = \begin{cases} 1 & \text{if} \quad b < k \\ \exp\{(k-b)/k\} & \text{if} \quad b \in [k, k+c'] \\ 0 & \text{if} \quad b \in (k+c', v] \\ k\exp(-c'/k)/(v-c') & \text{if} \quad b = v \end{cases} \tag{16}$$

The legislature audits the request with a probability of $\alpha_2^*(b) = 1 - \alpha_1^*(b)$ (17)

where c' is the solution of $\int_{c'}^v c \cdot f(c)dc \Big/ \int_{c'}^v f(c)dc = v - k$

If $k > k^*$, $b^*(c) = v$, $\alpha_1^*(b) = 1$, and $\alpha_2^*(b) = 0$. (18)

According to this equilibrium, the auditing is too costly (if $k > k^*$), the legislature has no incentive to audit the budget request and thus accepts any budget request. Also, if $k < k^*$

and c is sufficiently low ($c < c'$), the agency reveals its true cost. Under the equilibrium strategy, the expected budget size is given by

$$B(v,c,k) = \begin{cases} c + k\exp(-c/k) & \text{if} \quad k < k^* \quad \text{and} \quad c \in [0, c'] \\ c + \dfrac{k(v-c)\exp(-c'/k)}{v-c'} & \text{if} \quad k < k^* \quad \text{and} \quad c \in (c', v] \\ v & \text{if} \quad k > k^* \end{cases} \tag{19}$$

Based on this model, a prediction can be made regarding the impact of IT investments on the expenditure size. First, automation and digitization by IT systems in production processes brings a reduction in the production cost c. Second, even though the legislature cannot observe the true cost c, it can still expect the cost reduction from IT investments. Therefore, the legislature's prior cost distribution $f(c)$ is shifted to the left[20]. This shift in turn increases both k^*, so that the auditing becomes more feasible (Eq. 14). Third, digitized administration processes can collect most information regarding costs and decision making, enabling the legislature to conduct an audit with a less cost. Thus, IT investments may lead to a smaller k. All these three effects contribute to a decline in the expected budget $B(v,c,k)$. Appendix 4.2 provides a proof for this proposition.

Continuing his work, Banks and Weingast (1992) explain the role of constituency and pressure groups in this model. They argue that "politicians cannot hope to monitor hundreds of agencies by themselves and instead rely on their constituents to do so" (p. 519). Thus, constituents who are organized and well-informed about agencies' administration can contribute to a reduction in the auditing cost k by "conveying relevant information to politicians" (p. 519). Once again, digitized administrative processes can facilitate constituency's monitoring activities, leading to a reduction in k and thereby the

[20] Formally, F is a cumulative distribution function, t is the amount of IT investments, and $\frac{\partial F}{\partial t} \geq 0$.

budget size $B(v,c,k)$. For instance, the National Taxpayers Union was able to discover illegitimate expenditures in State of Missouri agencies via the Missouri Accountability Portal (http://mapyourtaxes.mo.gov) (Government Technology 2008a). This Web site publishes comprehensive financial records of the state agencies on a daily basis. This database helps both citizens and legislatures monitor bureaucrats' activities and curb their unnecessary use of tax revenue. The City of New York also operates a similar Web site called NYCStat (http://www.nyc.gov/html/ops/nycstat/) that posts a variety of information related to city-wide services, including city agency performance records and customer satisfaction reports (Public CIO 2009). In sum, the model of Banks (1989) and Banks and Weingast (1992) provides a prediction that more IT investments in governments are associated with a smaller size of government expenditures.

4.2.3. Pressure Group Competition Model

Becker (1983) presents a model of competition among pressure groups for political influence. He asserts that "individuals belong to particular groups that are assumed to use political influence to enhance the well-being of their members, and competition among these pressure groups for political influence determines the equilibrium structure of taxes, subsidies and other political factors." (p. 372) In this regard, he models how political influences[21] exercised by pressure groups determine the size of income redistribution, one of the primary role of governments (Stiglitz 2000) and how group size and efficiency of influence activities affect on the size of redistribution.

[21] Political influences can take various forms such as campaign contributions, voluntaries in campaigns, or political advertising.

His analytic model considers two pressure groups – taxpayers (t) and recipients (s). The population of two groups is n_t and n_s, respectively. Each taxpayer pays R_t, while each recipient receives a subsidy of R_s. The total size of subsidy is governed by the following function.

$$n_t F(R_t) = S = n_s G(R_s) \quad (20)$$

Here, F represents a tax collection function. In the model, $F(R_t) \le R_t$, $F' \le 1$, and $F'' \le 0$, indicating the presence of deadweight costs in tax collection. By the same token, G refers to a redistribution function, and $G(R_s) \ge R_s$, $G' \ge 1$, and $G'' \ge 0$, again representing the deadweight costs in distribution. The two pressure groups exercise political influence I_t and I_s, respectively, and both R_t and R_s are functions of I_t and I_s. In turn, I_t and I_s are determined by the size of corresponding groups (n_t and n_s) and the amount of resources (money, time, and other efforts) each group spends in galvanizing political influences. Becker (1983) solves the optimal amount of resources each group spends in producing political influence and finds that the political effectiveness of a group is determined by its relative efficiency in organizing pressures and controlling free-riding.

Another key finding of his model is that an increase in deadweight costs reduces the equilibrium subsidy (S) (Proposition 2 in p. 381). Here, an increase in deadweight costs is represented by a decrease in F' or an increase in G'. When it comes to IT investments, this finding implies that enhanced, streamlined processes in tax collection or subsidy payment resulting from the use of IT reduce deadweight costs associated with F and G and thus expand the size of subsidy. For instance, at the distribution side, some U.S. states such as California and Tennessee are using IT systems to reduce illegitimate Medicaid payments (Government Technology 2008). Software such as data mining and analytic solutions is adopted in detecting fraudulent or unnecessary payment cases. At the tax collection side, Franklin County, Ohio, adopts address verification software to reduce the number of undelivered tax bills, collecting millions of unpaid taxes (Government Technology 2010). Therefore, the model of Becker (1983) provides a prediction that government IT investments lead to an expansion of government expenditures.

Table 21. Summary of Explanations

Explanation	Predicted Effect on Government Expenditures	Background Theory
Supply-Side Explanation		
Automated administrative processes improve the productivity of production of public goods and services.	Negative	Fiorina and Noll (1978), Banks (1989)
Greater use of IT facilitates the monitoring role of legislatures.	Negative	Banks (1989)
Demand-Side Explanation		
Citizens are more-informed via e-Governments initiatives and more engaged in monitoring administration.	Negative	Banks (1989), Banks and Weingast (1992)
More efficient production of public goods increases the demand for the public goods.	Positive	Fiorina and Noll (1978), Becker (1983)

4.2.4. The Relationship between IT Investments and Government Size

The discussions above have suggested mixed relationships between IT investments and government size, as summarized in Table 21. According to the model of Banks (1989), government size is negatively related to IT investments, while Becker (1983) illustrates a positive impact of IT. The model of Fiorina and Noll (1978) implies the presence of both effects. In sum, greater IT investments may enhance the productivity of public good production and make the monitoring activities of citizens and legislatures less costly, leading to a smaller government. At the same time, enhanced efficiency and effectiveness of administrative processes imply that the price of public goods decreases, and thus the demand for public goods may become greater, as long as the price elasticity of public goods is positive. In a similar vein, Dunleavy et al. (2005) predict that in what they call the "digital-era governance," government functions that have been privatized under the "new public management" doctrine for the last several decades will be reintegrated into the public sector organizations. This raises a possibility that IT investments are associated with a bigger government.

Thus, rather than making a specific prediction, I offer the two competing hypotheses and try to investigate which effect prevails in the context of U.S. state governments.

Hypothesis 1A*: Greater IT investments made by governments are associated with smaller government expenditures.*

Hypothesis 1B*: Greater IT investments made by governments are associated with bigger government expenditures.*

4.3. Empirical Methods

I adopt the state government growth model proposed by Garand (1988, 1989) as a basis for my empirical analyses. Table 22 describes the variables and data sources. The detailed description of some of the variables is available in Appendix 4.1.

My measure of government size is the ratio of state government expenditures to state GDP given by

$$\text{GOVSIZE}_t = \frac{\text{EXPEND}_t}{\text{GDP}_t}, \tag{21}$$

where EXPEND_t is state general expenditures in year t. State expenditure data were acquired from annual State Government Finance surveys published by the U.S. Census Bureau.

I acquired IT investments and IT organization information from the *NASCIO Compendium of Digital Governments in States* published in 2003 and 2005. IT intensity (Bharawaj et al. 1999, Anderson et al. 2006), the key independent variable, is measured in two ways – per capita budget of a central IT organization (IT1) and the ratio of the budget to state GDP (IT2). By a central IT organization, I mean a central IT office, division, or department which a state CIO directly oversees[22]. The *NASCIO Compendium* provides the IT budget figures in 193 state-years from 2001 to 2005. I find, however, that the State of Delaware reports unusually high figures of IT budgets (greater than 6σ above mean) for the fiscal years of 2003-2005. Considering these influential observations, I drop them in the estimations[23]. This results in a 5-year unbalanced panel with 190 observations from 44 states. Table 23 shows the list of states and the number of appearances in the dataset. t-tests do not reject the hypotheses that the states in the sample and those that are not do not differ significantly with respect to population, GDP, and total expenditures.

Garand (1988, 1989) lists several explanatory variables for state government size (Table 22). First, Wagner's Law (Lybeck 1988, Gemmell 1993) suggests that government size is a function of industrialization, economic affluence and population growth. To

[22] The NASCIO Compendium also reports the IT budget figures of executive branches, but I do not include them as there are many missing figures for executive branch IT budgets.
[23] In estimation with including Delaware in the estimations, the coefficients of IT intensity are significant at the 10%-level of significance.

account for this effect, Garand chooses income and population as explanatory variables. The sign of these variables is expected to be positive. Second, the fiscal illusion hypothesis suggests that certain tax and finance systems may in effect hide the real costs of public good production. This leads taxpayers to underestimate the true prices and thus to demand more production of public goods than they would if they are aware of the true prices. Such a tax system includes withholding provisions (personal income tax), indirect taxes (corporate income taxes), and complex tax systems. Also, a large level of debt service and intergovernmental grants from the federal government may also contribute to fiscal illusion (Grossman et al. 1999, Geys 2006). I control for five variables of tax and fiscal systems in the estimations as shown in Table 22. I expect that the sign of INDTAX, CORPTAX, DEBT, and FEDGRANT is positive, while that of COMPLEX is negative, as a high Herfindahl index indicates a simple tax system.

Table 22. Description of Variables

Variable	Description	Theory	Sources
Dependent Variable			
$GOVSIZE_t$	State general expenditure divided by state gross domestic product (GDP) (%)		U.S. Census Bureau
IT Intensity Variables			
IT1	Per capita IT budget of a central IT organization ($)		NASCIO
IT2	IT budget divided by state GDP (%)		
Control Variables			
$GOVSIZE_{t-1}$	Lagged measure of government size		U.S. Census Bureau
INCOME	State median household income ($thousand)	Wagner's Law	
POPUL	State total population (in millions)		
INDTAX	Total state personal income taxes divided by total state revenue (%)	Fiscal Illusion Hypothesis	
CORPTAX	Total state corporate income taxes divided by total state revenue (%)		
COMPLEX	Herfindahl index of revenue concentration		
DEBT	Mean debt level per capita ($thousand)		
FEDGRANT	Per capita federal intergovernmental-in-aid ($thousand)		
GOVERNOR	1 = Republican governor, 0 = otherwise	Party Control	National Conference of State Legislature
LEGIS	The sum of the proportion of Republican lawmakers in state senate and house of representatives		
PROGBUD	1 = state adopts program budgeting; 0 = otherwise		NASBO
INCBUD	1 = state adopts incremental budgeting; 0 = otherwise		

Table 23. States in the Sample

Region	Division	States
Northeast	New England	Maine(4), New Hampshire(5), Vermont(3), Massachusetts(5), Rhode Island(5), Connecticut(3)
	Mid-Atlantic	New York(5), Pennsylvania(2), New Jersey(3)
Midwest	East North Central	Wisconsin(4), Michigan(5), Indiana(3), Ohio(5)
	West North Central	Missouri(5), North Dakota(5), South Dakota(5), Kansas(5), Minnesota(5), Iowa(5)
South	South Atlantic	Maryland(5), Virginia(3), West Virginia(2), North Carolina(5), South Carolina(3), Georgia(5), Florida(2)
	East South Central	Kentucky(5), Tennessee(5), Mississippi(5), Alabama(5)
	West South Central	Oklahoma(2), Texas(5), Arkansas(5)
West	Mountain	Idaho(5), Montana(5), Wyoming(5), Nevada(5), Utah(5), Arizona(5), New Mexico(5)
	Pacific	Washington(5), Oregon(3), California(3), Hawaii(5)

The number in parentheses next to a state is the number of years that the state appears in the sample. Geographic region and division is from 2000 U.S. Census.

Third, the party control explanation tells that "government growth is systematically related to control of governmental policy-making institutions by the liberal party within the state political system" (Garand 1988, p. 839). This suggests that a political control by the Democratic Party is related to greater growth of governments. I control for two variables that represent the political control in state governments and legislatures. Lastly, though not included in Garand (1988) model, budgeting processes may affect the size of government expenditure. According to the National Association of State Budget Officers (NASBO), two budgeting processes are most widely used – program budgeting and incremental budgeting (NASBO 2002). The former refers to a budgeting based on program goals and objectives, and the latter is based on incremental changes in budgets from previous fiscal years and appropriation trends. I include two dummy variables for budgeting processes. I obtained state budgeting information from *Budgeting Process in States* published by NASBO.

The following equations show the complete empirical model.

$$GOVSIZE_{i,t} = \alpha + \beta_1\ GOVSIZE_{i,t-1} + \beta_2\ INCOME_{i,t} + \beta_3\ POPUL_{i,t} + \beta_4\ INDTAX_{i,t} + \beta_5\ CORPTAX_{i,t} + \beta_6\ COMPLEX_{i,t} + \beta_7\ DEBT_{i,t} + \beta_8\ FEDGRANT_{i,t} + \beta_9\ GOVERNOR_{i,t} + \beta_{10}\ LEGIS_{i,t} + \beta_{11}\ IT\_INTENSITY_{i,t-2} + v_i + \varepsilon_{i,t} \quad (22)$$

where i and t represents a state, year, respectively, and IT_INTENSITY = IT1 or IT2. Also v_i and $\varepsilon_{i,t}$ are terms for state-specific unobserved heterogeneity and idiosyncratic errors, respectively. I choose a two-year lag of IT intensity measure, as the impact of IT investments is not likely to materialize immediately due to organizational learning and adjustment effects (Brynjolfsson 1993). However, I estimate the models with different lag lengths, and the main results do not change considerably.

Tables 24 and 25 provide summary statistics and correlations between variables, respectively.

Table 24. Summary Statistics

Variables		Avg.	Std. Dev.	Min.	Max.
GOVSIZE	Government Size	11.4532	2.6126	6.7524	18.7217
INCOME	Income	46.5584	7.1084	32.6138	65.7097
POPUL	Population	5.7770	6.2498	0.4994	35.9903
INDTAX	Personal Tax	2.5173	1.6694	0	10.0801
CORPTAX	Corporate Tax	14.7870	8.8417	0	32.1842
COMPLEX	Tax Complexity	0.4160	0.1089	0.2260	0.7320
DEBT	Debt	2.3357	1.7655	0.0062	9.6415
FEDGRANT	Federal Grant	1.4389	0.4993	0.6866	4.0388
GOVERNOR	Governor	0.5421	0.4995	0	1
LEGIS	Legislature	0.9937	0.3229	0.2438	1.6143
PROGBUD	Program Budget	0.8316	0.3752	0	1
INCBUD	Inc. Budget	0.6842	0.4661	0	1
IT1	Per capita IT budget	21.3060	19.0304	0.0438	92.8539
IT2	Ratio of IT budget to GDP	0.0495	0.0449	0.0001	0.2203

Fiscal year 2003-2007 with a two-year lag of IT intensity (2001-2005).

Table 25. Correlation Table

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(12)	(13)	(14)
GOVSIZE	(1)	1												
INCOME	(2)	-0.3626*	1											
POPUL	(3)	-0.3666*	0.0663	1										
INDTAX	(4)	-0.0802	0.2405*	0.0752	1									
CORPTAX	(5)	-0.0242	0.2456*	0.1217*	0.2233*	1								
COMPLEX	(6)	-0.4388*	-0.0349	0.1498*	-0.4520*	-0.4464*	1							
DEBT	(7)	0.1410*	0.3298*	-0.1339*	0.3834*	0.2420*	-0.2136*	1						
FEDGRANT	(8)	0.5498*	-0.2902*	-0.1948*	-0.2481*	-0.2620*	-0.2394*	0.0630	1					
GOVERNOR	(9)	0.0110	0.1322*	0.0129	-0.2063*	0.0073	0.1560*	0.0498	-0.0669	1				
LEGIS	(10)	-0.2309*	-0.1361*	-0.0085	-0.0595	-0.2924*	0.0609	-0.3860*	0.0244	-0.1062*	1			
PROGBUD	(12)	-0.0042	-0.0533	0.0876	-0.0906	0.1247*	0.0309	-0.0238	0.0653	0.1227*	-0.0739	1		
INCBUD	(13)	0.2649*	-0.1306*	-0.1251*	0.1020*	-0.2432*	-0.1274*	0.0107	0.3196*	-0.0789	0.0812	-0.0334	1	
IT1	(14)	0.0012	-0.1264*	-0.2734*	-0.1369*	-0.1793*	-0.0312	0.0555	0.3169*	0.0962	0.2636*	-0.0335	0.1865*	1
IT2	(15)	0.0784	-0.2181*	-0.2829*	-0.1330*	-0.1711*	-0.0620	0.0126	0.2804*	0.1227*	0.2393*	-0.0352	0.1849*	0.9792*

$N = 190$; * $p < 0.05$ in pairwise correlation

As government size may be affected by state-specific unobserved heterogenity (v_i) that may be correlated with explanatory variables, one may estimate the above model with the fixed-effect estimation. However, the fixed-effect estimation does not address the bias due to a correlation between v_i and the lagged measure of government size ($GOVSIZE_{t-1}$) (Kiviet 1995, Bond 2002). Hence, Eq. 22 has to be estimated by a dynamic panel data model (Roodman 2006). Specifically, I also adopt a two-step System Generalized Method of Moment (GMM) estimation outlined by Arellano and Bover (1995) and developed by Blundell and Bond (1998). I choose a System GMM approach over a Difference GMM model (Arellano and Bond 1991) because the former does not drop the first-year of observations. Therefore, a System GMM estimation increases a degree of freedom in the estimations[24]. Following the suggestion of Roodman (2006), I include year dummies in Eq. 22 to ensure that there is no autocorrelation between idiosyncratic disturbances. In addition, to address the issue of a large number of instruments, I follow Roodman (2009) by including only the first three lags of government size as instruments.

4.4. Results

Table 26 presents the estimation results of Eq. 22 with the System GMM model. Column 1 shows the estimation without IT intensity variables. The coefficient of INCOME suggests that contrary to the theoretic prediction in Garand (1988), the higher median household income is, the smaller state government expenditures become. This result can be explained by the theory of Meltzer and Richard (1981). Based on the

[24] In the following section, I show the result of the Difference GMM estimation.

median-voter theory, their theoretical model posits that as the ratio of mean income to median income increases, government spending expands as well. This is because a decisive voter with the median income demands more income redistribution as the voter's income decreases. Meltzer and Richard (1983) provide empirical support to this proposition, and it appears that the estimation of this study does as well.

Regarding fiscal illusion hypotheses, as expected, the coefficient of tax complexity (COMPLEX) is negative and statistically significant. Since a smaller Herfindahl index represents a more complex tax system, it appears that states with more complex tax systems demonstrate greater expenditure figures. Column 1 shows that a large amount of federal grants (FGRANT) and debts (DEBT) accelerates the expansion of government expenditures, as predicted by fiscal illusion hypothesis. The party control hypothesis is partially supported. States with more Republican state legislators (LEGIS) are likely to have a smaller size of expenditures.

Table 26. Estimation Results

Dependent Variable – GOVSIZE (State General Expenditures / State GDP)			
Model – Two-Step System GMM Estimation			
	(1)	(2)	(3)
$GOVSIZE_{t-1}$	0.8459*** (0.0417)	0.7347*** (0.0609)	0.7397*** (0.0574)
INCOME	-0.0163** (0.0080)	-0.0242** (0.0097)	-0.0264*** (0.0099)
POPUL	-0.0017 (0.0059)	-0.0223** (0.0087)	-0.0209*** (0.0080)
INDTAX	-0.0222 (0.0343)	-0.0040 (0.0485)	-0.0035 (0.0470)
CORPTAX	-0.0028 (0.0050)	-0.0032 (0.0071)	-0.0031 (0.0071)
COMPLEX	-1.7685** (0.7726)	-2.4704** (1.0895)	-2.5254** (1.0734)
DEBT	0.0516** (0.0253)	0.0294 (0.0331)	0.0292 (0.0318)
FEDGRANT	0.4080*** (0.0967)	0.7696*** (0.1314)	0.7184*** (0.1348)
GOVERNOR	0.1122 (0.0696)	0.1308* (0.0760)	0.1218 (0.0763)
LEGIS	-0.3501*** (0.1265)	-0.4377*** (0.1331)	-0.4658*** (0.1312)
PROGBUD	0.0298 (0.0717)	-0.0435 (0.0831)	-0.0288 (0.0837)
INCBUD	0.0312 (0.0684)	0.0950 (0.0760)	0.0870 (0.0709)
IT1 [1)]		-0.0094*** (0.0022)	
IT2 [2)]			-3.2089*** (0.7598)
Constant	3.0448** (1.2177)	4.8865*** (1.7273)	4.9786 (1.6898)
Wald Statistics	36745.08***	12546.27***	12234.43***
Hansen Test [3)]	0.164	0.152	0.164
Serial Corr. Test [4)]	0.383	0.196	0.194

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; N=190; standard errors are in parentheses; year dummies are omitted
Only the first three lags of GOVSIZE are used for instruments for $GOVSIZE_{t-1}$.
Fiscal year 2003-2007 with a two-year lag of IT intensity (2001-2005).; # of instrument variables = 34
[1)] Per capita IT budget; [2)] The ratio of IT budget to GDP;
[3)] p-value. The null hypothesis is that the instruments used are exogenous.;
[4)] p-value. Arellano-Bond test for AR(2). The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

The estimations with IT intensity variables in Table 26 show a negative relationship between IT intensity and state government size. The coefficients of two IT intensity variables are statistically significant at the 1% level in the System GMM estimations (Columns 2, 3). From the coefficient of IT1 in Column 2, I calculate that a $1 increase in per capita IT budget is associated with an approximate $3.68 reduction in per capita general expenditures[25]. The coefficient of IT2 in Column 3 implies that if the proportion of IT budget to state GDP increases by one percentage point, the ratio of state expenditures to GDP decreases by approximately 3.49 percentage points.

This result shows that greater IT investments are associated with smaller government expenditures, providing support to Hypothesis 1A. This finding suggests that in the context of U.S. state governments, the effect of improved productivity and effective bureaucracy control overwhelms the opposite effect of increasing demands for public services. To put it differently, the estimations with a two-year lag of IT intensity indicate that productivity improvement resulting from IT investments is realized in a relatively short period of time, but such improvement appears not to lead to an immediate increase in the demand for government services. When the lag length is varied from no lag to a four-year lag in the estimations (Table 27), the coefficients of IT intensity (IT1) model are consistently negative at the 10% level of significance, offering further support to Hypothesis 1A.

[25] In the dataset, the average per capita state GDP in 2005 dollar is $39,202.56. $4 is derived from $39,202.56 × 0.000094 (the coefficient of IT1 in Table 24, Column 5) = $3.6850

Table 27. Estimation Results with Different Lag Lengths

Dependent Variable – GOVSIZE (State General Expenditures / State GDP) Method – Two-Step System GMM Estimation								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag	No Lag		1 Year		2 Year		3 Year	
GOV SIZE$_{t-1}$	0.8696*** (0.0363)	0.8762*** (0.0350)	0.7996*** (0.0648)	0.8180*** (0.0610)	0.7347*** (0.0609)	0.7397*** (0.0574)	0.6649*** (0.0327)	0.6746*** (0.0320)
IN-COME	-0.0223*** (0.0071)	-0.0219*** (0.0070)	-0.0248*** (0.0086)	-0.0230*** (0.0083)	-0.0242** (0.0097)	-0.0264*** (0.0099)	-0.0302*** (0.0091)	-0.0320*** (0.0094)
POPUL	-0.0034 (0.0059)	-0.0025 (0.0057)	-0.0139* (0.0078)	-0.0118 (0.0072)	-0.0223** (0.0087)	-0.0209*** (0.0080)	-0.0283*** (0.0078)	-0.0265*** (0.0075)
IND-TAX	-0.0212 (0.0363)	-0.0143 (0.0353)	-0.0170 (0.0582)	-0.0090 (0.0552)	-0.0040 (0.0485)	-0.0035 (0.0470)	-0.0269 (0.0442)	-0.0217 (0.0441)
CORP-TAX	-0.0068 (0.0054)	-0.0063 (0.0054)	-0.0033 (0.0069)	-0.0027 (0.0066)	-0.0032 (0.0071)	-0.0031 (0.0071)	-0.0024 (0.0072)	-0.0017 (0.0071)
COM-PLEX	-2.0853*** (0.7343)	-1.9883*** (0.7175)	-2.1387* (1.1580)	-1.9529* (1.1130)	-2.4704** (1.0895)	-2.5254** (1.0734)	-3.1578*** (0.8028)	-3.0514*** (0.8003)
DEBT	0.0702*** (0.0257)	0.0646** (0.0252)	0.0379 (0.0387)	0.0314 (0.0361)	0.0294 (0.0331)	0.0292 (0.0318)	0.0064 (0.0317)	0.0046 (0.0313)
FED-GRANT	0.2074** (0.0817)	0.1952** (0.0803)	0.3508*** (0.1017)	0.3173*** (0.0977)	0.7696*** (0.1314)	0.7184*** (0.1348)	0.7979*** (0.1482)	0.7476*** (0.1419)
GOVER-NOR	0.0255 (0.0870)	0.0304 (0.0879)	0.1394* (0.0752)	0.1365* (0.0760)	0.1308* (0.0760)	0.1218 (0.0763)	0.1484 (0.0925)	0.1477 (0.0933)
LEGIS	-0.2921*** (0.0981)	-0.3069*** (0.0977)	-0.4348*** (0.1531)	-0.4375*** (0.1487)	-0.4377*** (0.1331)	-0.4658*** (0.1312)	-0.8098*** (0.1490)	-0.8360*** (0.1479)
PROG-BUD	0.1013 (0.0991)	0.1047 (0.0983)	0.0217 (0.1023)	0.0226 (0.0990)	-0.0435 (0.0831)	-0.0288 (0.0837)	-0.0574 (0.1365)	-0.0443 (0.1357)
INC-BUD	0.0570 (0.0695)	0.0539 (0.0687)	0.0743 (0.0863)	0.0620 (0.0820)	0.0950 (0.0760)	0.0870 (0.0709)	0.1429 (0.0938)	0.1362 (0.0935)
IT1 [1)]	-0.0029* (0.0015)		-0.0048** (0.0023)		-0.0094*** (0.0022)		-0.0070*** (0.0022)	
IT2 [2)]		-0.8387 (0.5546)		-1.4688** (0.7413)		-3.2089*** (0.7598)		-2.3376*** (0.8522)
Constant	4.3918*** (1.1819)	4.2618*** (1.1547)	4.3698** (1.8426)	4.0021** (1.7666)	4.8865*** (1.7273)	4.9786 (1.6898)	6.8318*** (1.1978)	6.7507*** (1.2050)
Wald statistics	14522.36***	14525.83***	12767.97***	18076.58***	12546.23***	12234.43***	15989.24***	15999.17***
Hansen Test [3)]	0.471	0.461	0.110	0.101	0.152	0.164	0.923	0.905
Serial Corr. Test [4)]	0.133	0.138	0.456	0.403	0.196	0.194	0.147	0.135

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; $N = 190$; standard errors are in parentheses; year dummies are omitted
In System GMM estimation, only the first three lags are used for instruments; # of instruments = 34
[1)] Per capita IT budget; [2)] The ratio of IT budget to GDP
[3)] *p*-value. The null hypothesis is that the instruments used are exogenous.;
[4)] *p*-value. Arellano-Bond test for AR(2). The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

Table 28. Estimation Results with Different Measures of Government Size

Method – Two-Step System GMM Estimation								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Per Capita General Expenditures (thousand $)		General Expenditures Per State Employee (thousand $)		The Ratio to GDP of Operation Expenses and Capital Outlays (%)		Ratio to GDP of Expenditures net of Operation and Capital(%)	
GOV SIZE$_{t-1}$	0.6662*** (0.0555)	0.6633*** (0.0559)	0.8268*** (0.0411)	0.8247*** (0.0411)	0.7197*** (0.0390)	0.7230*** (0.0374)	0.6463*** (0.0546)	0.6551*** (0.0575)
INCOME	0.0145*** (0.0021)	0.0139*** (0.0021)	0.2572 (0.1829)	0.2031 (0.1840)	-0.0199*** (0.0076)	-0.0204*** (0.0078)	-0.0111* (0.0065)	-0.0133** (0.0065)
POPUL	0.0042 (0.0037)	0.0042 (0.0037)	1.3033*** (0.3577)	1.3166*** (0.3564)	-0.0101* (0.0056)	-0.0090* (0.0054)	0.0096 (0.0059)	0.0089 (0.0060)
INDTAX	-0.0062 (0.0164)	-0.0053 (0.0164)	2.8204*** (0.8885)	2.7801*** (0.8873)	0.0130 (0.0221)	0.0140 (0.0220)	-0.0099 (0.0307)	-0.0016 (0.0321)
CORP-TAX	0.0015 (0.0025)	0.0015 (0.0025)	0.2914** (0.1313)	0.2770** (0.1328)	-0.0002 (0.0041)	-0.0007 (0.004)	-0.0021 (0.0064)	-0.0019 (0.0065)
COMP-LEX	-0.4851** (0.2387)	-0.4917** (0.2383)	16.8513 (10.4124)	14.3050 (10.6415)	-0.7745** (0.3232)	-0.8516** (0.3308)	-1.6627*** (0.6371)	-1.5944** (0.6585)
DEBT	0.0313** (0.0152)	0.0319** (0.0153)	0.8218 (0.8208)	0.8658 (0.8190)	0.0455** (0.0195)	0.0431** (0.0205)	-0.0189 (0.0260)	-0.0227 (0.0263)
FED-GRANT	0.4953*** (0.0553)	0.4945*** (0.0531)	13.512*** (2.3881)	12.603*** (2.3840)	0.4403*** (0.1552)	0.4231*** (0.1587)	0.2556** (0.1024)	0.2584*** (0.0979)
GOVER-NOR	0.0033 (0.0308)	0.0032 (0.0312)	-0.7752 (1.8963)	-0.5743 (1.9032)	0.1509*** (0.0567)	0.1477*** (0.0554)	-0.0615 (0.0569)	-0.0438 (0.0579)
LEGIS	-0.1528** (0.0648)	-0.1553** (0.0642)	7.5926** (3.8543)	6.9287* (3.7678)	-0.1184 (0.1027)	-0.1272 (0.1061)	-0.0291 (0.0981)	-0.0616 (0.1027)
PROG-BUD	0.0626 (0.0433)	0.0649 (0.0442)	2.5190* (1.4301)	2.7083* (1.4520)	-0.0378 (0.0686)	-0.0411 (0.0671)	-0.0196 (0.0914)	-0.0238 (0.0913)
INCBUD	0.0106 (0.0363)	0.0096 (0.0364)	-3.2006 (2.7761)	-3.1792 (2.7827)	-0.0691 (0.0613)	-0.0747 (0.0604)	0.0730 (0.0818)	0.0712 (0.0826)
IT1 [1)]	-0.0018** (0.0008)		-0.1625*** (0.0518)		-0.0047*** (0.0016)		-0.0043*** (0.0017)	
IT2 [2)]		-0.7730** (0.3285)		-64.328*** (19.9939)		-1.4636*** (0.6024)		-1.9055*** (0.6711)
Constant	0.2097 (0.2750)	0.2458 (0.2789)	-17.6950 (11.3602)	-12.2681 (12.0666)	1.9239*** (0.6811)	1.9722*** (0.6837)	2.3125*** (0.6658)	2.3645*** (0.6843)
Wald statistics	26778.01***	21107.35***	11919.06***	10875.14***	9900.12***	11288.21***	7670.78***	7926.83***
Hansen Test [3)]	0.164	0.155	0.125	0.128	0.217	0.212	0.037	0.044
Serial [4)] Corr. Test	0.210	0.211	0.250	0.254	0.485	0.455	0.060	0.056

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$; $N = 190$; standard errors are in parentheses; year dummies are omitted
In System GMM estimation, only the first three lags are used for instruments.
Fiscal year 2003-2007 with a two-year lag of IT intensity (2001-2005); # of instrumental variables = 35
[1)] Per capita IT budget; [2)] The ratio of IT budget to GDP
[3)] p-value. The null hypothesis is that the instruments used are exogenous.;
[4)] p-value. Arellano-Bond test for AR(2). The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

Following the approach of Levine et al. (2000), I conduct the specification tests for the dynamic panel data model. Hansen (1982) *J* test in Columns 2 and 3 of Table 26 show that the null hypotheses of over-identifying restrictions cannot be rejected with 16 degrees of freedom, supporting the assumption that the instrumental variables used are exogenous. In addition, Arelleno and Bond (1991) tests do not reveal the presence of second-order correlations in differenced error terms.

In order to check the robustness of the main result, I adopt alternative measures for state government size to estimate the effect of IT intensity. As Table 28 demonstrates, I use three different dependent variables for government size – per capita general expenditures, general expenditures per state employee, and the ratio to GDP of general expenditures net of current operation expenses and capital outlays. Table 28 reveals that a higher IT intensity is associated with smaller per capita government expenditures (Column 1 and 2) as well as with smaller expenditures per state employee (Column 3 and 4).

In Column 5 and 6, I investigate the impact of IT intensity on the ratio of capital outlays and current operation expenses, which include wages and salaries (U.S. Census Bureau 2006), to state GDP. Thus, the dependent variable here is given by $\frac{\text{CURRENT}_t + \text{CAPITAL}_t}{\text{GDP}_t}$. The results show that more IT investments are associated with a smaller amount of capital outlays and operation expenses, which can be considered to be cost parts of government expenditures[26]. In addition, I estimate the effect of IT on non-cost parts of state government expenditures as shown in Column 7 and 8. The

[26] I also estimate the effects of IT intensity on capital outlays, current operation expenses, and wages individually, but the coefficients are insignificant.

dependent variable is here calculated by $\frac{EXPEND_t - CURRENT_t - CAPITAL_t}{GDP_t}$. This measure accounts for subsidy and payments to welfare beneficiaries, intergovernmental grants to local governments, and contribution to employee pension systems. Column 7 and 8 show that IT intensity is also negatively associated with the size of total expenditures net of current operation expenses and capital outlays, suggesting that IT investments may reduce not only the cost components of expenditures but also the other components such as intergovernmental expenditures or direct subsidies[27].

The size of government expenditure may depend on other demographic and socioeconomic factors that are not accounted for in Eq. 22. Given that a major portion of state government expenditures are devoted to primary and secondary education and public welfare programs such as Medicaid, I include additional control variables such as the proportion of the elderly population, that of under 18, and poverty level. Including these variables does not change the main result significantly. In addition, some of the control variables may not be necessarily exogenous. For instance, state government employment or debt level may be influenced by the size of expenditures, possibly causing a simultaneity bias. I re-estimated Eq. 22 with the System GMM assuming that DEBT is endogenous. The coefficients of IT intensity are still negative and statistically significant.

I further conduct sensitivity analyses with alternative estimation and functional models. First, in lieu of the System GMM estimation (Blundell and Bond 1998), I estimate Eq. 22 with the Difference GMM (Arellano and Bond 1991). Column 1 of Table 29 demonstrates that the coefficient of IT1 is negative and significant at the 5%-level.

[27] I further estimate the relationship between IT investments and expenditures on individual government service areas including education, public welfare, and correction. The estimations show that the coefficients are insignificant.

Second, instead of regressing the government size measure on a lagged value of government size and control variables, I choose a change in government size (the difference between government size in a focal year and in the previous year) as a dependent variable, as given in Eq. 23.

$$\Delta \text{GOVSIZE}_{i,t} = \frac{\text{EXPEND}_{i,t}}{\text{GDP}_{i,t}} - \frac{\text{EXPEND}_{i,t-1}}{\text{GDP}_{i,t-1}}$$
$$= \alpha + \beta_2 \text{ INCOME}_{i,t} + \beta_3 \text{ POPUL}_{i,t} + \beta_4 \text{ INDTAX}_{i,t} + \beta_5 \text{ CORPTAX}_{i,t} + \beta_6 \text{ COMPLEX}_{i,t}$$
$$+ \beta_7 \text{ DEBT}_{i,t} + \beta_8 \text{ FEDGRANT}_{i,t} + \beta_9 \text{ GOVERNOR}_{i,t} + \beta_{10} \text{ LEGIS}_{i,t}$$
$$+ \beta_{11} \text{ IT\_INTENSITY}_{i,t-2} + v_i + \varepsilon_{i,t} \qquad (23)$$

As Eq. 23 does not contain a lagged value of the dependent variable in the RHS, I estimate Eq. 23 with the random-effects estimation. Columns 3 and 4 in Table 29 present the result, showing that the coefficient of IT intensity is still negative and statistically significant[28]. Third, I also employ a log-linear model for government size as shown in Eq. 24. Here, GOVSIZE, DEBT, and FEDGRANT are the absolute amount of general expenditures, debts, and intergovernmental aids from the federal government, respectively, rather than the relative amount normalized by GDP or population.

$$\text{Log(GOVSIZE)}_{i,t} = \alpha + \beta_1 \text{ Log(GOVSIZE)}_{i,t-1} + \beta_2 \text{ Log(INCOME)}_{i,t} + \beta_3 \text{ Log(POPUL)}_{i,t}$$
$$+ \beta_4 \text{ INDTAX}_{i,t} + \beta_5 \text{ CORPTAX}_{i,t} + \beta_6 \text{ COMPLEX}_{i,t} + \beta_7 \text{ Log(DEBT)}_{i,t}$$
$$+ \beta_8 \text{ Log(FEDGRANT)}_{i,t} + \beta_9 \text{ GOVERNOR}_{i,t} + \beta_{10} \text{ LEGIS}_{i,t} + \beta_{11} \text{ IT\_INTENSITY}_{i,t-2}$$
$$+ v_i + \varepsilon_{i,t} \qquad (24)$$

[28] With fixed-effect estimations, the coefficient of IT intensity turns out to be insignificant (p>0.1), but a Hausman test does not reject the null hypothesis that the difference in coefficients between fixed- and random-effect estimations is not systematic.

Table 29. Estimation with Alternative Models

Model	Eq. 22		Eq. 23 (ΔGOVSIZE)		Eq. 24 (Log GOVSIZE)		Eq. 22 - (Endogenous IT)	
Method	Two-Step Difference GMM		Random Effects		Two-Step System GMM Estimation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GOV SIZE$_{t-1}$	0.3668*** (0.1153)	0.3644*** (0.1141)			0.5109*** (0.1094)	0.4746*** (0.1073)	0.8863*** (0.0335)	0.8886*** (0.0304)
INCOME	-0.0376 (0.0396)	-0.0378 (0.0399)	0.0062 (0.0078)	0.0042 (0.0081)	0.2067*** (0.0396)	0.2070*** (0.0401)	-0.0067 (0.0064)	-0.0095 (0.0067)
POPUL	-0.6097* (0.3615)	-0.5984 (0.3684)	-0.0004 (0.008)	-0.0002 (0.0079)	0.2477*** (0.0630)	0.2626*** (0.0616)	-0.0080 (0.0064)	-0.0059 (0.0054)
INDTAX	-0.1611 (0.1453)	-0.1622 (0.1457)	0.0290 (0.0407)	0.0302 (0.0408)	-0.0109** (0.0050)	-0.0132*** (0.0049)	0.0674** (0.0261)	0.0621** (0.0278)
CORP-TAX	-0.1285* (0.0721)	-0.1346* (0.0734)	0.0043 (0.0066)	0.0040 (0.0066)	-0.0011* (0.0006)	-0.0013** (0.0006)	0.0091** (0.0046)	0.0086** (0.0043)
TAX COM-PLEX	-8.3394* (4.4989)	-8.8234* (4.5499)	0.2124 (0.5374)	0.1534 (0.5437)	-0.2440*** (0.0738)	-0.2793*** (0.0740)	-0.0401 (0.4758)	-0.2572 (0.4935)
DEBT	0.5256*** (0.1634)	0.5305*** (0.1629)	-0.0317 (0.0353)	-0.0311 (0.0355)	0.0357** (0.0152)	0.0406*** (0.0152)	-0.0049 (0.0182)	-0.0059 (0.0187)
FED-GRANT	1.4818*** (0.4977)	1.4451*** (0.5153)	0.5443*** (0.1681)	0.5201*** (0.1686)	0.2157*** (0.0407)	0.2271*** (0.0388)	0.6075*** (0.0969)	0.5292*** (0.0853)
GOVER-NOR	0.0362 (0.1388)	0.0228 (0.1406)	0.0299 (0.0986)	0.0349 (0.0993)	-0.0045 (0.0076)	-0.0025 (0.0073)	0.0350 (0.0564)	0.0147 (0.0591)
LEGIS	1.6219* (0.8379)	1.6294* (0.8419)	-0.1910 (0.1341)	-0.2063 (0.1338)	-0.0483*** (0.0182)	-0.0477*** (0.0179)	-0.2005** (0.0862)	-0.2741*** (0.0860)
PROG-BUD	0.4203*** (0.1396)	0.4324*** (0.1411)	0.0441 (0.1248)	0.0445 (0.1246)	0.0186 (0.0120)	0.0149 (0.0121)	-0.0502 (0.0518)	-0.0397 (0.0508)
INCBUD	-0.1271 (0.1674)	-0.1229 (0.1669)	0.0157 (0.0961)	0.0122 (0.096)	-0.0046 (0.0105)	-0.0003 (0.0111)	0.0498 (0.0465)	0.0469 (0.0373)
IT1 [1)]	-0.0064** (0.0027)		-0.0053** (0.0023)		-0.0035 (0.0026)		-0.0067*** (0.0021)	
IT2 [2)]		-1.8533* (1.0563)		-2.0771** (0.9637)		-0.3275*** (0.1022)		-0.9044 (1.3377)
Constant	13.577*** (4.0231)	13.794*** (4.0861)	-0.3921 (0.5974)	-0.2291 (0.6130)	-1.4712*** (0.3566)	-1.3700*** (0.3699)	0.9389 (0.8367)	1.2370 (0.8503)
N	146	146	190	190	190	190	190	190
Wald Statistics	438.46***	467.07***	95.40***	94.87***	210655.2***	181819.7***	216468.0***	109419.0***
R^2			0.4580	0.4564				
# of Instr. Variables	29	29			34	34	46	46
Hansen Test[3)]	0.487	0.380			0.118	0.127	0.366	0.370
Serial Cor Test [4)]	0.357	0.480			0.302	0.278	0.216	0.219

$^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; standard errors are in parentheses; year dummies are omitted
In System and Difference GMM estimation, only the first three lags are used for instruments.
Fiscal year 2003-2007 with a two-year lag of IT intensity (2001-2005).
[1)] Per capita IT budget; [2)] The ratio of IT budget to GDP
[3)] *p*-value. The null hypothesis is that the instruments used are exogenous.;
[4)] *p*-value. Arellano-Bond test for AR(2). The null hypothesis is that the errors in the first-difference regression exhibit no second-order serial correlation.

The estimation of Eq. 24 with the two-step System GMM is shown in Columns 5 and 6. Here, the impact of IT intensity is still negative at the 1%-level of significance.

Lastly, one might argue that there is an endogeneity issue in the current estimations in that state total government expenditures and IT budgets are simultaneously affected by unaccounted state heterogeneity, rendering the estimations possibly biased and inconsistent. To address this concern, I re-estimate Eq. 22 with the two-step system GMM assuming that IT intensity is endogenous. Here, I employ following instruments for IT intensity – IT governance and management variables[29], the average IT intensity in neighboring states, and the average size of per capita private sector IT industry in neighboring states. I choose the average IT intensity in neighboring states as an instrument, since I expect that the IT policy in a state is likely to be influenced by those in its neighboring states. Several prior studies in public economics theorize and empirically confirm 'spillover effects' in state expenditures, tax systems, and welfare policies (e.g. Case et al. 1993, Besley and Case 1995, Figlio et al. 1999, Baicker 2005)[30]. But, I do not expect that the IT intensity in the neighboring states has a significant impact on the total state expenditures. I also expect that the IT budget of a state government is related to the size of the private sector IT industry[31]. However, as it is likely that the bigger the IT industry in a state, the larger the state government expenditures are, I

[29] IT governance and management variables I adopt as instrumental variables include a dummy variable for whether a state legislative has an IT-related legislative committee; and a variable that measures the number of statewide IT management areas such as application architecture or security that a state central IT function directly manages. These variables are chosen based on the rationale that IT government and management affect the IT budget of the central IT function but is unlikely to be related to state government total expenditures. This information is available from *NASCIO Compendium*.

[30] For example, Figlio et al. (1999) find that states respond to changes in both an increase and a decrease in welfare benefits in neighboring states, an effect that they call 'welfare competition.' Baicker (2005) find that a dollar increase in spending in neighboring states is associated with a 90-cent increase in the focal state.

[31] This information is available from Bureau of Economic Accounts. The IT industry measure is the amount of shipments in "computer and electronic product manufacturing," "information and data processing services," and "computer systems design and related services."

instead use the size of IT industry in neighboring states. I define 'neighboring states' as those that share geographic borders with a focal state. The correlation between per capita IT budget of a focal state and of neighboring states is 0.23.

Column 7 and 8 of Table 29 demonstrate that the coefficient of IT1 is negative and statistically significant. Alternatively, I re-estimate Eq. 22 with regarding neighboring states as those that are in the same geographic division defined by U.S. Census Bureau as shown in Table 23[32], and the result does not change substantially. Thus, the robustness analyses demonstrate that even when IT intensity is considered to be endogenous, IT intensity is still negatively associated with state expenditure size.

Taken together, the empirical analyses confirm the theoretical argument that IT investments are associated with a productivity improvement in the production of public goods and a reduction in the monitoring cost incurred by legislatures and voters, resulting in smaller governments.

4.5. Conclusion

Motivated by the fact that government growth is a persistent, prevalent phenomenon in many industrialized nations (Saunders 1993), I investigate whether and how IT investments affect this trend. Based on the literature on public good production, bureaucracy, and public choices, I theorize the relationship between IT investments and government size.

[32] For instance, in Column 5 and 6 of Table 8, neighboring states of Pennsylvania are Delaware, Maryland, New Jersey, New York, Ohio, and West Virginia. In Column 7 and 8, neighboring states are New Jersey and New York.

The empirical analysis confirms the hypothesis that more IT investments in state governments are associated with smaller government size. Estimations with the dynamic panel-data model provided by Blundell and Bond (1998) find a negative relationship between IT intensity and state government expenditures. Specifically, the result shows that a $1 increase in per capita IT budget is associated with an approximate $3.69 reduction in per capita general expenditures. I also find that this result is robust to the use of different measures for government size such as per capita general expenditures or expenditures per employee (Table 28) as well as alternative functional models (Table 29).

Not only is this study one of the first studies on IT investments in governments, but it contributes to the literature by proposing a new perspective in IT value studies. To the best of my knowledge, few studies, if any, have examined the performance effect of IT investments in the public sector. In addition, not only is this study one of the few studies that investigate the impact of IT on organization size in the public sector, but it also identifies this impact with an organizational-level analysis, compared to industry-level studies including Brynjolfsson et al. (1994) and Wood et al. (2008).

The present study is not without limitations. First, on the theoretical side, the use of the theoretical models in Section 4.2 may not fully explain every aspect of government expenditures. I will further review the literature on government expenditures and attempt to build an integrative model that theorizes the effect of IT investments in government size. Second, on the empirical side, even though I consciously select control variables that may influence the size of state governments and an appropriate estimation technique, there must be other unaccounted factors in the estimations, which may cause the results to be biased or inconsistent. I will report further sensitivity analyses in future works.

As this is one of the early studies on the IT value in the public sector, there are numerous opportunities for future research. The present study discovers that IT investments reduce the size of government expenditures, but it is unclear whether such a reduction comes from decreasing or deteriorating public services such as education or infrastructure. An unanswered question thus is whether IT assets in governments generate value by improving the quality of public services. Researchers may study the relationship between IT investments and such quality measures for public services such as educational achievement, public safety, or healthcare quality. I expect that this study sparks interest on IT value in the public sector among IS scholars.

This study measures a relatively short-term effect of IT spending on government expenditures, which turn out to be negative. Future studies may investigate a long-term effect on government size. It may be the case that in the long-run, an improvement in efficiency and productivity of government production that is driven by greater IT use indeed increases the demand for public services, as predicted in Section 4.2. It would therefore be interesting to investigate how the short-term and the long-term influence of IT investments differ in the public sector.

Further, researchers may study the incentives of IT investments in governments. One might wonder why governments invest in IT in the apparent absence of profit-seeking motivation and competitive pressures. As I find, IT investments lead to smaller government, an effect that is in contrast to bureaucrats' interests, according to the bureaucracy theory (Niskanen 1968, Miller and Joe 1983). Which factors motivate government officials to spend part of their budget in IT? Future research can explore this research issue.

Appendix 4.1. Measures and Data Sources

IT Intensity (IT1 and IT2)

2002 NASCIO Compendium of Digital Governments in States provides the actual IT budget figure in fiscal year 2001 and 2002, and the expected budget in 2003. *2004-05 Compendium* covers the actual budget in 2003 and 2004, and the expected budget in 2005. I take the IT budgets in 2001 and 2002 from the 2002 Compendium and 2004 and 2005 budgets from the 2004-05 compendium. For the IT budget in 2003, I first take the actual 2003 budget from the 2004-05 Compendium. Second, if the actual 2003 budget is missing in the 2004-05 Compendium, I take the expected budget from the 2002 Compendium. For example, New Hampshire does not report its 2003 IT budget in 2004-05 Compendium. So I take its estimated 2003 budget from the 2002 Compendium. The correlation between the expected 2003 budget in the 2003 Compendium and the actual budget in 2004-05 Compendium is 0.66.

IT1 is calculated by dividing IT budget by population estimate. IT2 is derived by dividing IT budget by state gross domestic product provided by Bureau of Economic Accounts.

Tax Complexity (COMPLEX)

I calculated a Herfindahl index of seven tax categories – personal income tax, corporate income tax, property tax, sales tax, license tax, severance tax on extraction of natural resources, and other taxes. Suppose that t_i is the ratio of tax revenue in Category i to total tax collect. Then the Herfindahl index is calculated by $\sum_{i=1}^{7} t_i^2$.

Mean Debt Level (DEBT)

From State Government Finances, I take an average of the beginning- and end-level of state debt and divide it by state population.

Federal Grant (FEDGRANT)

From State Government Finances, I take intergovernmental revenue from federal government and divide it by state population.

Party Control of Legislatures (LEGIS)

I calculated the ratio of Republican state representatives in state house and Republican state senators in senate, respectively and added the two. Thus, LEGIS is between 0 and 2. For Nebraska, which has a unicameral legislature, I multiplied the ratio of republican by two.

Program Budgeting (PRODBUD) and Incremental Budgeting (INCBUD)

State budgeting process information is obtained from *Budgeting Processes in the States* published by the National Association of State Budget Officers in 2002 (page 45) and 2008 (page 51). Budgeting information from 2002 version is coded for observations from 2001 to 2006, and information from 2008 version is coded for observations from 2007 to 2008.

Appendix 4.2. The Effect of IT on the Expected Budget Size in Banks (1989) Model

Banks (1989) proves that the expected budget size $B(c,k,v)$ increases in c (Page 680) and k (Page 696, Corollary A2-1). Thus, a reduction in c or k will decrease the expected budget size. I prove here that the change in the legislature's prior distribution of the cost (f) from IT investments increases k^*, the upper boundary of k beyond which the legislature does not conduct an audit at all.

k^* is defined by

$$k^* = v - \int_0^v c \cdot f(c)dc \Big/ \int_0^v f(c)dc \qquad (25)$$

However, Banks (1989) stipulates that c is defined in $[0, v]$ (Page 674). Consequently, $\int_0^v f(c)dc = 1$ and

$$k^* = v - \int_0^v c \cdot f(c)dc\,. \qquad (26)$$

Suppose that F is a cumulative distribution function of c and t is the amount of IT investments. As more IT investments are made, the legislature can expect that the true cost is likely to be smaller, as represented by $\frac{\partial F}{\partial t} \geq 0$. By integrating by parts,

$$\int_0^v c \cdot f(c)dc = c \cdot F(c)\Big|_0^v - \int_0^v F(c)dc = v - \int_0^v F(c)dc \qquad (27)$$

as $F(v) = 1$ and $F(0) = 0$. Therefore,

$$k^* = v - \left(v - \int_0^v F(c)dc\right) = \int_0^v F(c)dc \qquad (28)$$

$$\frac{\partial}{\partial t}k^* = \int_0^v \frac{\partial}{\partial t}F(c)dc \geq 0 \qquad (29)$$

Intuitively, $\int_0^v c \cdot f(c)dc$ indicates the expected value of c possessed by the legislature. IT investments decrease this expected value of c, and by Eq. 18, increases k^*.

References

Anderson, M.C., Banker, R.D., and Ravindran, S. "Value Implications of Investments in Information Technology," *Management Science* (52:9) 2006, pp. 1359-1376.

Arellano, M. and Bond, S. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies* (58:2) 1991, pp. 277-297.

Arellano, M. and Bover, O. "Another Look at the Instrumental Variable Estimation of Error-Components Models," *Journal of Econometrics* (68:1) 1995, pp. 29-51.

Baicker, K. "The Spillover Effects of State Spending," *Journal of Public Economics* (89:2-3) 2005, pp. 529-544.

Baker, G.P. and Hubbard, T.N. "Contractibility and Asset Ownership: On-Board Computers and Governance in U.S. Trucking," *Quarterly Journal of Economics* (119:4) 2004, pp. 1443-1479.

Banks, J.S. "Agency Budgets, Cost Information, and Auditing," *American Journal of Political Science* (33:3) 1989, pp. 670-699.

Banks, J.S. and Weingast, B.R. "The Political Control of Bureaucracies under Asymmetric Information," *American Journal of Political Science* (36:2) 1992, pp. 509-524.

Becker, G.S. "A Theory of Competition Among Pressure Groups for Political Influence," *Quarterly Journal of Economics* (98:3) 1983, pp. 371-400.

Bendor, J., Taylor, S., and van Gaalen, R. "Bureaucratic Expertise versus Legislative Authority: A Model of Deception and Monitoring in Budgeting," *American Political Science Review* (79:4) 1985, pp. 1041-1060.

Blundell, R. and Bond, S. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models," *Journal of Econometrics* (87:1) 1998, pp. 115-143.

Bond, S. "Dynamic Panel Data Models: A Guide to Micro Data Methods and Practice," *Portuguese Economic Journal* (1:2) 2002, pp. 141-162.

Borcherding, T.E. "The Causes of Government Expenditure Growth: A Survey of the U.S. Evidence," *Journal of Public Economics* (28:3) 1985, pp. 359-382.

Brown, C.V. and Magill, S.L. "Alignment of the IS Functions with the Enterprise: Toward a Model of Antecendents," *MIS Quarterly* (18:4) 1994, pp. 371-403.

Brynjolfsson, E. "The Productivity Paradox of Information Technology," *Communication of the ACM* (36:12) 1993, pp. 67-77.

Brynjolfsson, E. and Hitt, L. "Paradox Lost? Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science* (42:4) 1996, pp. 541-558.

Brynjolfsson, E., Malone, T.W., Gurbaxani, V., and Kambil, A. "Does Information Technology Lead to Smaller Firms?," *Management Science* (40:12) 1994, pp. 1628-1644.

Cantor, S.M. "Tampa, Florida Internet-Based Customer Service Center," in *Case Studies on Digital Government*, Rocheleau, B. (ed.), Hershey, PA: Idea Group Publishing, pp. 178-194.

Case, A.C., Rose, H.S., and Hines, J.R. "Budget Spillovers and Fiscal Policy Interdependence: Evidence from the States," *Journal of Public Economics* (52:3) 1993, pp. 285-307.

Besley, T. and Case, A. "Incumbent Behavior: Vote-Seeking, Tax-Setting, and Yardstick Competition," *American Economic Review* (85:1) 1995, pp. 25-45.

Dewan, S., and Kraemer, K.L. "Information Technology and Productivity: Evidence from Country-Level Data," *Management Science* (46:4) 2000, pp. 548-562.

Dunleavy, P., Margetts, H., Bastow, S., and Tinkler, J. "New Public Management Is Dead – Long Live Digital-Era Governance," *Journal of Public Administration Research and Theory* (16:3) 2005, pp. 467-494.

Figlio, D.N., Kolpin, V.W., and Reid, W.E. "Do States Play Welfare Games?," *Journal of Urban Economics* (46:3) 1999, pp. 437-454.

Fiorina, M.P. and Noll, R.G. "Voters, Bureaucrats and Legislatures: A Rational Choice Perspective on the Growth of Bureaucracy," *Journal of Public Economics* (9:2) 1978, pp. 239-254.

Garand, J.C. "Explaining Government Growth in the U.S. States," *American Political Science Review* (82:3) 1988, pp. 837-849.

Garand, J.C. "Measuring Government Size in the American States: Implications for Testing Models of Government Growth," *Social Science Quarterly* (70:2) 1989, pp. 487-496.

Gemmell, N. 1993. "Wagner's Law and Musgrave's Hypotheses," in *The Growth of Public Sector – Theories and International Evidence*, Gemmell, N. (ed.), Hants, U.K.: Edward Elgar Publishing Limited, pp. 103-120.

Geys, B. "Looking Across Borders: A Test of Spatial Policy Interdependence Using Local Government Efficiency Ratings," *Journal of Urban Economics* (60:3) 2006, pp. 443-462.

Government Technology, *Missouri Accountability Portal Raises Spending Questions*, 2008a, available at: http://www.govtech.com/gt/404259, accessed on Mar. 21st, 2010.

Government Technology, *States Reduce Medicaid Costs with New Technology*, 2008b, available at: http://www.govtech.com/gt/366267, accessed on Mar. 21st, 2010.

Government Technology, *Franklin County, Ohio, Uses Address Verification Software to Collect Millions in Unpaid Taxes*, 2010, available at: http://www.govtech.com/gt/articles/748657, accessed on Mar. 21st, 2010.

Grossman, P.J., Mavros, P., and Wassmer, R.W. "Public Sector Technical Inefficiency in Large U.S. Cities," *Journal of Urban Economics* (46:2) 1999, pp. 278-299.

Hansen, L. "Large Sample Properties of Generalized Method of Moments Estimators," *Econometrica* (50:3) 1982, pp. 1029-1054.

Hitt, L. "Information Technology and Firm Boundaries: Evidence from Panel Data," *Information Systems Research* (10:2) 1999, pp. 134-149.

Horn, M.J. *The Political Economy of Public Administration: Institutional Choice in the Public Sector*, 1995, Cambridge, UK: Cambridge University Press.

Kiviet, J.F. "On Bias, Inconsistency, and Efficiency of Various Estimators in Dynamic Panel Data Models," *Journal of Econometrics* (68:1) 1995, pp. 53-78.

Larkey, P.D., Stolp, C., and Winer, M. "Theorizing About the Growth of Government: A Research Assessment," *Journal of Public Policy* (1:2) 1981, pp. 157-220.

Levine, R., Loayza, N., and Beck, T. "Financial Intermediation and Growth: Causality and Causes," *Journal of Monetary Economics* (46:1) 2000, pp. 31-77.

Lowery, D. and Berry, W.D. "The Growth of Government in the United States: An Empirical Assessment of Competing Explanations," *American Journal of Political Science* (27:4) 1983, pp. 665-694.

Lybeck, J.A. 1998. "Comparing Government Growth Rates: The Non-Institutional vs. the Institutional Approach," in *Explaining the Growth of Government*, Lybeck, J.A. and Henrekson, M. (eds.), Amsterdam, The Netherlands: Elsevier Science Publisers, pp. 29-27.

Meltzer, A.H. and Richard, S.F. "A Rational Theory of the Size of Government," *Journal of Political Economy* (89:5) 1981, pp. 914-927.

Meltzer, A.H. and Richard, S.F. "Tests of a Rational Theory of the Size of Government," *Public Choice* (41:3) 1983, pp. 403-418.

Miller, G.J. and Moe. T.M. "Bureaucrats, Legislators, and the Size of Government," *American Political Science Review* (77:2) 1983, pp. 297-322.

NASBO, *Budget Processes in the States – January 2002*, 2002, available at: http://www.nasbo.org/LinkClick.aspx?fileticket=t2nKFo8b%2b2M%3d&tabid=80, accessed on Jan. 14th, 2010.

NASCIO, *NASCIO 2004-05 Compendium of Digital Governments in the States*, 2005, Lexington, KY.

Niskanen, W.A. "Nonmarket Decision Making: The Peculiar Economics of Bureaucracy," *American Economic Review* (58:2) 1968, pp. 293-305.

North, D.C. "The Growth of Government in the United States: An Economic Historian Perspective," *Journal of Public Economics* (28:3) 1985, pp. 383-399.

Public CIO, *New York City's Accountability Tools Pay Off in Tracking Service to Citizens*, 2009, available at: http://www.govtech.com/pcio/articles/620039, accessed on Mar. 21st, 2010.

Roodman, D. "How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata," *Center for Global Development Working Paper No. 103*, 2006, available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=982943, accessed on Jul. 25th, 2010.

Roodman, D. "A Note on the Theme of Too Many Instruments," *Oxford Bulletin of Economics and Statistics* (71:1) 2009, pp. 135-158.

Sambamurthy, V. and Zmud, R.W. "Arrangement for Information Technology Governance: A Theory of Multiple Contingencies," *MIS Quarterly* (23:3) 1999, pp. 261-290.

Saunders, P. "Recent Trends in the Size and Growth of Government in OECD Countries," in *The Growth of Public Sector – Theories and International Evidence*, Gemmell, N. (ed.), Hants, U.K.: Edward Elgar Publishing Limited, pp. 17-33.

Stiglitz, J.E. *Economics of the Public Sector: Third Edition*, 2000, New York, NY: W.W. Norton & Company, Inc.

Tarschys, D. "The Growth of Public Expenditures: Nine Modes of Explanation," *Scandinavian Political Studies* (10:A10) 1975, pp. 9-31.

U.S. Census Bureau, *Government Finance and Employment Classified Manual*, 2006, available at: http://ftp2.census.gov/govs/class06/2006_classification_manual.pdf, accessed on Jun. 11th, 2009.

West, D. "E-Government and the Transformation of Service Delivery and Citizen Attitudes," *Public Administration Review* (64:1) 2004, pp. 15-27.

Wood, C.A., Shin, H., and Devaraj, S. "Technology's Effect on Firm Size: Manufacturing vs. Service," *Proceedings of the Twenty Ninth International Conference on Information Systems*, R. Boland, M. Limayem, and B. Pentland (eds.), Association for Information Systems, Paris, France, Dec. 2008.

CHAPTER 5.
CONCLUSION

In this dissertation, I study whether and how information technologies improve organizational capabilities and generate value in the public sector organizations, an issue that the literature search in Chapter 1 discovers that prior studies have given scant attention. The three studies in Chapter 2, 3, and 4 delve into this subject with unique, but interrelated research questions and diverse theoretical bases. Drawing upon the public value management theory in the public administration literature, Chapter 2 proposes how IT resources facilitate the development of organizational capabilities, which in turn lead to greater public value. My review of public value management suggests that the four organizational capabilities are pivotal for greater public value – operational capability, communication capability, partnering capability, and innovative capability. These four capabilities moderate the relationship between IT resources and public value generation. Continuing the discussion in Chapter 2, Chapter 3 intends to empirically confirm whether IT investments are associated with greater operational capability in U.S. state governments. Adopting a stochastic frontier estimation approach with a translog cost function, the empirical investigations demonstrate that larger IT investments in U.S. state governments are related with greater cost efficiency. Having found that IT investments are associated with cost reductions in state government production, Chapter 4 is concerned with examining whether IT investments reduce the amount of government expenditures by slashing costs or raise it by increasing the demand for public goods produced by governments. Empirical analyses in Chapter 4 reveal that the former effect outweighs the latter in U.S. state governments.