# Politics and Information Technology Investments in the U.S. Federal Government in 2003-2016

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## Abstract

*What makes some federal agencies in the United States digitally advanced and others lagging? This study investigates how the national politics affects IT investment profiles in U.S. federal agencies. Drawing upon a range of the literature from the political sciences, public administration, and information systems (IS) disciplines, we hypothesize that a federal agency's capacity-building IT investments are associated with (i) legislative approval for the chief executive, (ii) government dividedness, and (iii) the agency's ideological characteristic. With a panel dataset from 135 federal agencies and bureaus in 2003-2016, our empirical analyses produce several intriguing findings. For instance, when both the U.S. Senate and the House of Representatives are controlled by the President's ruling party, federal agencies are predicted to invest approximately $8.32%-point more in new IT development and modernization than when the opposition party holds the majority in both chambers. We contribute to the IS literature by demonstrating that budget allocation decisions between IT development and maintenance in governments are affected by political environments. We offer several policy prescriptions in federal IT management for policymakers and practitioners in the public sector.*

**Keywords:** IT Investments, Politics, U.S. Federal Government, U.S. Congress

## 1. Introduction

Increasingly, information technologies (IT) have become an indispensable means to implement major public policy initiatives in the U.S. federal government. The Federal Health Insurance Marketplace (Healthcare.gov) is a case in point. It is one of the core components of the Affordable Care Act (ACA), the most profound policy reform of the Obama Administration and acts as an enabler for the so-called "individual mandate" clause, which is the centerpiece of the ACA. The U.S. Securities and Exchange Commission (SEC) is building the Consolidated Audit Trail, which is expected to become the largest database of financial information that would amass the entire transactional records of stocks, bonds, other financial products (*Businessweek* 2014). With this database, the SEC aims to improve its capabilities in its regulatory functions over the financial industries, such as detecting fraudulent trading or preventing market crashes. These examples show that just as IT resources provide necessary organizational capabilities in the business sector (Sambamurthy et al. 2003, Wade and Hulland 2004, Banker et al. 2006, Rai et al. 2006, Rai and Tang 2010), so do government organizations rely on digital technologies for effective policy execution and public service delivery.

Indeed, the U.S. federal government spends a considerable amount of tax revenues in IT every year. The Federal IT Dashboard (http://itdashboard.gov/) reports that in recent years, the federal government has spent more than $75 billion in IT annually, which is approximately $236 per U.S. population. Hence, taxpayers, who pay for these IT expenditures, would ask whether these investments are being well made. To the best of our knowledge, however, information systems (IS) researchers to date have paid little attention to what influences IT investments and management in the government sector (*reference anonymized for blind review*), an issue that would be significant to policy makers and the public in general as well as private-sector IT industries.

While several federal agencies invest in IT in a forward-looking manner to build new organizational capabilities for implementation of public policy programs, anecdotal evidence illustrates that the federal government is operating numerous legacy information systems (*FCW* 2012). These

systems are not only technologically obsolete and expensive to maintain, but hamper both ongoing business operations and effective fulfillment of mandated policy missions. For example, recent reports on inadequate patient care by the Department of Veterans Affairs (VA) revealed that the VA hospitals are still using a patient scheduling system that was originally developed in 1985 (*The Washington Post* 2014). The Department of Defense is using an accounting and payroll system that was first developed in 1959 and consumes more than $1 billion a year for ongoing operation and maintenance (*Reuters* 2013). Many legacy systems in the federal government are still operating on 50-year-old COBOL, and federal agencies are struggling with recruiting new COBOL developers to replace a number of retiring federal IT workers who have been maintaining these systems (*FCW* 2009, 2012). These outdated systems constrain the federal agencies' ability to respond to emerging needs for public services in a flexible and agile manner. In a recent survey, federal IT managers stated that because of mounting maintenance expenses for legacy IT systems, they "do not have the ability to acquire new IT resources in a timely manner" (*FCW* 2013). In addition, there is a growing concern among senior federal officials and lawmakers on security vulnerability in legacy systems (*FCW* 2015, *NextGov* 2015).

**Figure 1. Share of Development, Modernization, and Enhancement (DME) to Total IT Spending in U.S. Federal Agencies in 2003-2016**

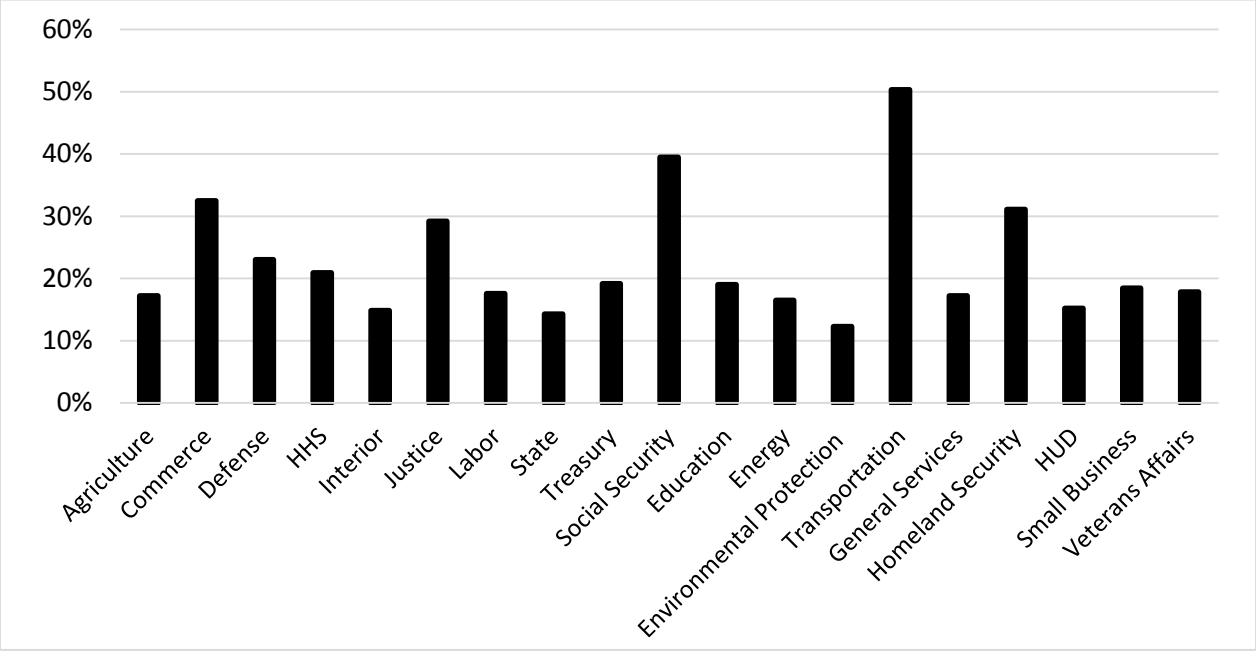

Figure 1 shows the share of IT investments in major development, modernization, and enhancement (DME) to total IT spending in the U.S. federal agencies in 2003-2016. During this period, on average, they have spent as much as 23.86% of their IT spending in new IT development and the rest in ongoing maintenance of existing systems. Figure 1 reveals, however, that there is wide variation across the agencies. For instance, the Department of Transportation (DOT) has spent more than 50% of its IT expenditures in DME, while the Department of State and the Environmental Protection Agency (EPA) spent less than 15%. This begs a question – What explains this variation in the IT investment profiles of the federal agencies?

We theorize that the national politics significantly affects IT investments in the federal government. Drawing upon the political science theories such as separation of political powers or political control of bureaucracy (Weingast 1984, Moe 1984, 1987, McCubbins et al. 1987, 1989, Wood and Waterman 1991, Hammond and Knott 1996), we discuss how the U.S. Congress influences federal IT investments. We put forth that in order to make more capacity-building IT investments, a federal agency needs more policy directives, greater political support and legitimacy, and sufficient resource endowment from Congress. Based on this theoretical ground, we hypothesize that IT investment profiles of a federal agency are related to the following three factors that indicate the degree of policy mandates and political support from Congress – (i) legislative approval for the agency head, (ii) federal government dividedness, and (iii) the agency's ideological characteristics.

**Table 1. Examples of Federal Agencies and Bureaus**

| Level | | Name |
|---|---|---|
| A Cabinet Agency | | Department of Justice (DOJ) |
| | Bureaus under the DOJ | U.S. Marshals Service |
| | | Federal Bureau of Investigation |
| | | Drug Enforcement Administration |
| A Cabinet Agency | | Department of Transportation (DOT) |
| | Bureaus under the DOT | Federal Aviation Administration |
| | | Federal Highway Administration |
| | | Federal Motor Carrier Safety Administration |
| Independent Agencies | | U.S. Agency for International Development (USAID) |
| | | National Science Foundation (NSF) |
| | | National Aeronautics and Space Administration (NASA) |

We test our hypotheses with a large-scale dataset of IT investments in the U.S. federal government from 2003 to 2016. Our dataset covers federal agencies such as those in Table 1 and their sub-agency bureaus such as the Federal Aviation Administration (under the DOT) or the Drug Enforcement Administration (under the DOJ). We built a panel of 1,596 agency-year observations.

Our empirical analyses produce several intriguing findings. For instance, we find that federal agencies' capacity-building IT investments are negatively related to government dividedness. It is predicted that when both the Senate and the House of Representatives are controlled by the President's ruling party, the share of investments in new IT development to total IT expenditures is 8.32%-point higher than when the opposition party holds the majority in both chambers. We also find that when the head of a federal agency is not confirmed by the Senate for more than one year, the share of new IT development is 4.97%-point lower than otherwise. Our analysis also shows that the more ideologically extreme a federal agency is, the more it spends in IT maintenance.

This study makes a unique contribution to the IS literature by examining the political antecedents for IT investments in the U.S. federal government. Several prior studies in IS devoted to identifying the predictors for the amount of IT investments and the decision processes for IT investments (e.g. Brynjolfsson et al. 2002, Xue et al. 2008, Mithas et al. 2012). The literature in public administration (PA) has also studied what antecedent drives governments' IT adoption (e.g. Pandey and Bretschneider 1997, Moon and Bretschneider 2002, Li and Feeney 2014). To the best of our knowledge, little prior work in IS or PA so far has studied how politics affects IT investments, adoption, or management in the public-sector organizations. Toward this end, we draw upon the political sciences and public administration literature, with which the IS discipline has had little intellectual collaboration.

This study is also new in the IS literature in that we study the antecedents for investment allocation between new IT development and maintenance for existing systems. To the best of our knowledge, little research in IS, if any, has dealt with a balance between the two. IT managers believe that adopting new technologies is crucial for organizations' long-term success (*ZDNet* 2010, *NextGov* 2015), be they in the private or the public sector. At the same time, however, maintenance expenses of legacy

systems limit investments in new, state-of-the-art technologies, and IT managers are struggling with how to contain increasing maintenance spending (Austin et al. 2009, *Computerworld* 2013). To the best of our knowledge, ours is the first to directly tackle this matter.

This study also provides ample policy implications. We show that political gridlocks are detrimental to organizational capabilities of federal agencies by constraining capacity-building IT investments. Thus, we contend that if the federal government is to be agile, flexible, and efficient, so should be Congress. Toward that end, we advocate that Congress streamline legislative and confirmation processes. We also argue that one of the reasons for the federal agencies' reluctance to make capacity-building IT investments is that IT governance in the federal government is heavily decentralized. We prescribe that the rank of the U.S. Chief Information Officer (CIO) be elevated to that of a cabinet-level secretary and his/her authority and responsibilities over government-wide IT management be expanded, so that the CIO can play a spearheading role in digital transformation of the federal government.

## 2. Theoretical Development and Hypotheses

### 2.1. Political Influences on Federal IT Investments

To explain the political impacts on federal IT investment profiles, we build our theoretical model based on four points. First, we present anecdotal evidence that IT is a key enabler for major public policy initiatives. Second, the political sciences literature argues that the U.S. Congress plays an influential role in formulation and implementation of public policies. Third, the IS literature documents that large-scale IT development projects entail substantial risks of failures. Fourth, the public administration literature shows that public-sector employees are risk-averse and value job security.

In recent major public policy programs, integral is development of new, large-scale information systems, which provide necessary capabilities for implementation and operation of the policy programs. For instance, in 2008, the U.S. Immigration and Custom Enforcement initiated the Secure Communities program, which aims to deport illegal aliens who are detained for criminal activities. Among the central

pieces of this immigration policy is the Automated Biometric Identification System,[1] which integrates the databases in the federal, state, and local law enforcement agencies to share information on criminal aliens. Another major public policy project that heavily relies on IT is NextGen, in which the Federal Aviation Administration (FFA) is developing a new, nationwide air traffic control system. The FAA is phasing out the decades-old radar-based air traffic control system and installing GPS-based control and digital communication systems throughout the airports and the control centers around the country.

While federal agencies are in charge of implementation and execution of public policies such as Secure Communities and NextGen, the U.S. Congress exerts considerable influence on policy inception and formulation in various ways, according to the congressional dominance theory (Weingast and Moran 1983, McCubbins et al. 1989, Epstein and O'Halloran 1994, Seidenfeld 1999, Clinton et al. 2014). First, Congress enacts legislation, which provides federal agencies a formal authority to implement policy programs. For instance, NextGen is authorized by the Century of Aviation Reauthorization Act. Section 709-(c) of this law stipulates that the goals of NextGen are to "improve the level of safety, security, efficiency, quality, and affordability" of the U.S. airspace. Another mechanism in which Congress influences policy execution is budget appropriation. The Budget and Accounting Act of 1921 provides Congress with the authority to approve the President's budget proposals. All spending in the federal agencies, including IT expenditures, is bounded by laws and appropriation bills enacted by Congress.

The IS literature extensively studies risk factors in large-scale IT projects and investments (Wallace et al. 2004, Kutsch and Hall 2005, Benaroch et al. 2007, Dewan et al. 2007, Dewan and Ren 2007, 2011). For instance, Dewan et al. (2007) find that IT capital investments affect risks in firm performance to a greater extent than other non-IT capital investments. As the case of Healthcare.gov demonstrates, large-scale capacity-building IT investments in the federal sector entail a range of risks such as project delays, budget overrun, and technical failures. The Government Accountability Office (GAO) lists the management of IT acquisitions and operations as one of the high risk management areas

[1] http://www.ice.gov/criminal-alien-program/, accessed on Oct. 1, 2014

and states that "federal IT investments too frequently fail to be completed or incur cost overruns and schedule slippages while contributing little to mission-related outcomes" (GAO 2015, p. 37).

The public service motivation theory from the public administration literature puts forth that government employees are risk-averse (Bellante and Link 1981, Pfeifer 2011, Buurman et al. 2012) and value stable income and job security (Houston 2000, Lewis and Frank 2002). For instance, Bellante and Link (1981) find that the more risk-averse a person is, the more likely he or she is to work in the public sector than in the private sector. Houston (2000) shows that the public sector employees value job security more than the private sector counterparts do. Aryee (1992) and Sousa-Poza and Hennberger (2004) also show that public employees have a significantly lower turnover intention. Moreover, the theory on political control of bureaucracy posits that the primary interest of a bureaucrat is to maximize his or her budgets (Miller and Moe 1983, Banks 1989, Banks and Weingast 1992), the size of which he or she oversees represents his or her power, prestige, and legitimacy (Weingast and Moran 1983, Epstein and O'Halloran 1994, Olson 1995). Hence, government officials are afraid of budget cuts and elimination of policy programs that they are in charge of.

This explains why many federal agencies stick to decades-old legacy systems. Federal officials are reluctant to replace old COBOL-based systems because "those COBOL systems handle such a huge part of the transactional load that they are not easy to replace when so much vital traffic passes through daily" (*FCW* 2009). They are unlikely to proactively make substantial investments in risky capacity-building IT development, whose failure may lead to punishment against them in such forms as budget reduction, elimination of programs or positions, or congressional hearings that would tarnish their power and reputation. For instance, after the revelation of the $170-million project failure in the Virtual Case File of the Federal Bureau of Investigation (FBI), which was intended to modernize its case databases but produced no acceptable project outcome after spending $170 million, a key FBI IT official in charge of the project management had to leave the agency (*IEEE Spectrum* 2005). It is also reported that after the Healthcare.gov launch, several officials in the Department of Health and Human Services were intensely investigated by Congress and some of them resigned from their positions (*FCW* 2014).

Therefore, this prospect of sanctions that would follow IT failures leads federal officials to forgo making necessary IT investments for organizational capabilities. Without clear policy mandates from Congress, federal officials would not voluntarily seek to secure legislative approval and budget appropriation for capacity-building IT investments. Instead, they would prefer maintaining the status of quo by keeping existing legacy systems up and running well, unless Congress demands otherwise. This is in accordance with Moon and Bretschneider (2002), who find that risk propensity of high-ranking officials is positively associated with perceived degree of digitization in governments.

In sum, the political influence on federal IT management can be explained by the four points that we have discussed so far. IT provides federal agencies with essential organizational capabilities for effective implementation of major public policies. The U.S. Congress holds dominant power for policy execution. A challenge for the federal agencies, however, is that most large-scale IT investments carry considerable risks of failures. Given that public officials tend to be risk-averse and have a strong desire for job security and political prestige, they would not voluntarily embark upon major large-scale IT investments, whose failure would jeopardize their interests, unless Congress provides sufficient political support and compelling policy directives that require new capacity-building IT investments.

### 2.2. Hypotheses

Based on the theoretical foundation in the preceding section, we identify three indicators that measure the degree of policy mandates and political support from Congress – legislative approval for the agency head, government dividedness, and agency ideology characteristic. Specifically, we propose that a federal agency can receive more policy directives from Congress, thus making more capacity-building IT investments; (i) when its chief executive receives legislative approval for nomination; (ii) when the federal government is more united; and (iii) when it is ideologically more moderate.

We argue that the IT investment profiles of federal agencies are affected by whether agency chief executives are appointed with legislative approval from the Senate. Most senior executives such as cabinet secretaries are required to be confirmed by the Senate to be sworn in (Gilmour and Lewis 2006,

Lewis 2011, Gallo and Lewis 2012). A Senate confirmation is also required for many assistant- or deputy-level secretaries and top officials of sub-agency bureaus such as the Census Bureau or the FBI. However, a nominee often has to go through a time-consuming and politically-charged confirmation process (Calvert et al. 1989, Wood and Waterman 1991, Lewis 2011). The Senate often delays or refuses confirmation of certain nominees for an extended period of time (Dull and Roberts 2009). For example, a nominee for the Director of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) had not been confirmed by the Senate since November 2010 until July 2013. Likewise, the Administrator of General Services (the head of the General Services Administration) remained unconfirmed by the Senate between October 2004 and July 2005 and between June 2008 and February 2010. In such cases, the position is assumed by a person on a provisional basis with an "acting" or "interim" title.

Congress is unlikely to offer strong political and adequate policy support to a federal agency whose chief executive assumes his or her position without its approval. The political science theories posit that legislative approval for presidential appointees is determined by policy differences between the President and Congress (Calvert et al. 1989, McCubbins et al. 1989, Hammond and Hill 1993), and a nominee is difficult to be approved by the Senate without political support and policy consensus. King and Riddlesperger (1991) find that the majority (79%) of opposition to presidential nominees by Congress in 1945-1989 was due to policy disagreement between nominees and senators. Hence, even when the President appoints an agency head unilaterally on a permanent basis despite the Senate opposition, an approach called a recess appointment (Corley 2006, Black et al. 2007), Congress would not provide political legitimacy and support to the agency. When its senior officials does not have sufficient legal and political authority, the federal agency would have more difficulty in performing its duties and executing policy implementation. Congress would not be willing to grant major policy programs, which would be supported by capacity-building IT investments, to an agency that Congress considers to be lack of formal leadership.

In addition, as discussed above, capacity-building IT investments carry considerable risks of failures. A chief executive who assumes a position without legislative approval would be more reluctant

to initiate large-scale IT projects, whose failure could do more damages to his or her career. A Senate confirmation takes a considerable amount of time and agency resources (Dull and Roberts 2009, Lewis 2011). Therefore, even in case of IT failures, an agency official who was blessed with a Senate confirmation would be difficult to be dismissed by the President. On the other hand, a chief executive who did not earn legislative approval for nomination is easier to be dismissed after an IT failure. Furthermore, Congress is unlikely to bestow a large amount of funding for major IT projects to an agency that is led by an official unconfirmed by the Senate. Therefore, with legislative confirmation, he or she can be more proactive in making major capacity-building IT investments.

***Hypothesis 1.*** *Capacity-building IT investments by a federal agency are positively associated with legislative approval for its chief executive.*

We propose that federal agencies spend less in capacity-building IT development when the federal government is more divided. By divided, it means that the legislative and the executive branches are controlled by different parties (Huber et al. 2001).

The theory on separation of power posits that under a divided government, with different ideological preferences and divergent policy directions, the two branches constantly restrain each other in order to advance the political agenda of each and to block the counterpart's policy proposals (Moe 1984, Weingast 1984, McCubbins et al. 1987, Wood and Waterman 1991, Bawn 1995, Seidenfeld 1999). Consequently, under a divided government, major policy proposals are less likely to be codified into a law than under a unified government. If Congress passes a bill for policy initiatives that are at odds with the President's political agenda, the President can wield his or her veto power to block the bill from being enacted. Likewise, Congress is less likely to approve legislative proposals put forth by the President, and if a policy program is created by an executive order unilaterally, it would not be willing to endow funding to the program. For instance, in 2011, the Obama Administration could get both the Affordable Care Act and the Dodd-Frank Wall Street Reform Act passed because the Democratic Party controlled both chambers of Congress. Otherwise, these sweeping policy reforms would be less likely to be enacted into

laws. After the mid-term election in 2012, the Republican Party currently holds the majority in the House of Representatives, which continues to block the President's major policy agenda such as immigration or environmental protection. Thus, under a divided government, there will be fewer policy mandates that warrant large-scale IT investments for policy execution capabilities.

In addition, under a divided government, federal agencies are under more intense scrutiny from Congress, and sanctions against federal officials for failures in large-scale IT investments are more severe. When the opposition party controls Congress, it is more likely to use IT failures as a political advantage, and federal agencies could endure more intense scrutiny, larger budget cuts, and greater damages to their political legitimacy. Consequently, under a divided government, federal bureaucrats would become more risk-averse and are likely to refrain from making capacity-building IT investments. Thus, we propose the following hypothesis.

***Hypothesis 2.*** *Capacity-building IT investments by a federal agency are negatively associated with federal government dividedness.*

Next, we theorize that a federal agency makes more capacity-building IT investments when its ideology is not too extreme, i.e. neither too liberal nor too conservative.

The political sciences literature measures the ideological characteristics of federal executive agencies (Nixon 2004, Clinton and Lewis 2008, Bertelli and Grose 2011, Clinton et al. 2012) with such information as its primary policy responsibilities, the party that created it, and expert opinions. For example, agencies such as the Department of Labor or the EPA, both of which aim to advance social or regulatory policies, are evaluated to be liberal (Clinton and Lewis 2008). Agencies such as the Department of Homeland Security and the Department of Defense are considered to be conservative.

In Congress, while the minority party has weaker power than the majority, it still exercises considerable influence on policy formulation and budget allocation (Gailmard and Jenkins 2007). For example, any U.S. senator has the power to suspend a legislative process at any given time indefinitely, a tactic called a filibuster. The Senate rule requires that 60% or more of the senators agree to break a

filibuster and to move the process forward. Therefore, unless the majority party achieves a "super majority" (60%) that can break a filibuster by itself, it still needs support or consent from the minority party to pass a bill. Even in the House of Representatives, in which passing a bill requires a simple majority, members of the minority party still exert some degree of power that influences legislative procedures and budget appropriation.[2]

Therefore, whichever party holds the majority in Congress, it is challenging to enact ideologically extreme policy agendas that would provide policy imperatives to either very liberal or very conservative agencies. Major policy initiatives that would empower ideologically moderate agencies are more likely to be enacted cooperatively by both parties, and ones that would be implemented by liberal or conservative agencies are likely to face stronger opposition from either party. This leads ideologically extreme federal agencies to invest less in capacity-building IT projects. Thus, we propose the following hypothesis.

***Hypothesis 3.*** *Capacity-building IT investments by a federal agency are negatively associated with extreme ideological characteristics. It is less likely to makes more capacity-building IT investment when it is ideologically too conservative or too liberal.*

## 3. Empirical Methods

This section explains our measures, data sources, and analysis approach. The unit of analysis in our study is U.S. federal agencies and bureaus. Agencies include cabinet agencies and independent agencies (Table 1).[3] Cabinet agencies supervise several bureaus, which perform more specialized functions. Thus, observations include cabinet and independent agencies and bureaus under cabinet agencies. We build an unbalanced panel dataset of 1,596 observations from 135 federal agencies and bureaus.

[2] For example, the minority party can collude with an underrepresented coalition of the majority party to advance the minority party's agenda or to block the majority party's legislative proposals (Finocchiaro and Rohde 2008, Jenkins and Monroe 2012).
[3] More information on sample population is available in Online Appendix A.

**Table 2. Variable Definitions and Data Sources**

| Variable | Definition | Data Sources |
|---|---|---|
| *Dependent Variable* | | |
| DME_INV | The proportion of investments in Development, Modernization, and Enhancement (DME) to total IT investments | - Federal IT Dashboard<br>- Budget of the United State Government |
| *Independent Variables* | | |
| CONFIRM (H1) | 0 if the position of bureau chief executive does not require Senate confirmation or its nominee has not confirmed by the Senate for more than one year at the time of budget proposal,<br>1 otherwise | - U.S. Plum Book<br>- Presidential Nomination Records<br>- Federal Vacancy Records |
| DIVIDED (H2) | 0 = Both the Senate and the House controlled by the ruling party<br>1 = Either the Senate and the House controlled by the opposition party<br>2 = Both the Senate and the House controlled by the opposition party | Federal Election Records (Federal Election Commission) |
| IDEO (H3) | Federal agency and bureau ideology scores | Clinton and Lewis (2008) |
| *Control Variables* | | |
| ITINV | Log (total IT investments) | Federal IT Dashboard |
| BUDGET | Log (total agency/bureau expenditures in million $) | Budget of the United State Government |
| INCREASE | Increase in budget approval from FY *t* - 1 to FY *t* | |
| DIVERSE | 1 – (Herfindahl index of agency/bureau budget) | |
| EMP | Log (number of agency/bureau employees) | Federal HR Database (Office of Personnel Management) |
| AGE | Age of agency/bureau (current year – established year) | Federal Register |
| CABINET | 1 if a cabinet agency or a bureau belongs to a cabinet agency, 0 otherwise | |
| PAPPOINT | 1 if the head position is appointed by the President, 0 otherwise | U.S. Plum Book |
| AGENCY | 1 if an agency observation excluding bureau data, 0 otherwise | |
| DEF | The share of defense-related budget to total agency/bureau budget | Budget of the United State Government |
| WEL | The share of welfare-related budget | |
| LAW | The share of law enforcement-related budget | |
| MGT | The share of general government management budget | |
| REG | 1 if bureau performs a regulatory function as defined by Dudley and Warren (2013), 0 otherwise | Dudley and Warren (2013) |
| ADMIN | 1 if the President is a Republican, 0 otherwise | |
| SENATE | The proportion of Republican senators in the Senate | Federal Election Records |
| HOUSE | The proportion of Republican representatives in the House | |

Table 2 describes the measures and the data sources. Our dependent variable as a measure for capacity-building IT investments is DME_INV, which is the share of investments in development, modernization, and enhancement (DME) to total IT spending. DME investments include "costs for projects leading to new IT assets/systems and projects that change or modify existing IT assets to: substantively improve capability or performance; implement legislative or regulatory requirements; or to meet an agency leadership request."[4] The rest of IT investments are for operations and maintenance. Federal IT investment figures were obtained from two sources – the Budget of the United States published by the U.S. Government Printing Offices (GPO) and Federal IT Dashboard.

We test our hypotheses with the following measures. For legislative approval for a chief executive (H1), CONFIRM is a dummy variable that is equal to *zero* if a chief executive position does not require a Senate confirmation or its nominee was not confirmed by the Senate for more than one year at the time of the Presidential budget proposal in February.[5] CONFIRM is one otherwise. We chose a one-year window since it represents leadership vacuum for an extended period of time. We checked whether a position requires a Senate confirmation from U.S. Government Policy and Supporting Document published by Congress.[6] For a position that requires confirmation, we resorted to two sources – the Presidential Nomination Records maintained by the Library of Congress and the Federal Vacancy Records from the GAO. We coded government dividedness (DIVIDED, H2) as follows. DIVIDED is 0 when the President's ruling party holds the majority (more than 50% of the seats) in both the Senate and the House of Representatives. DIVIDED is coded as 1 if the opposition party holds majority in either one of the Senate or the House. It is equal to 2 if the opposition holds the majority in both chambers.

[4] http://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/fy13_guidance_for_exhibit_300_a-b_20110715.pdf, accessed on Oct. 8, 2014

[5] For example, the head of the ATF remained unconfirmed between November 2010 and July 2013. The position was unconfirmed for more than one year in February 2012 and 2013, in which the budget proposals for FY 2013 and 2014 were made, respectively. Hence, we coded CONFIRM for the ATF as 0 in 2013 and 2014.

[6] Some agency officials do not require a Senate confirmation to assume their positions. Such positions include the Under Secretary of Homeland Security for Infrastructure Protection and the Director of National Cancer Institute (U.S. House of Representatives 2012).

**Table 3. Descriptive Statistics (*N* = 1,596)**

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| DME_INV | 0.2218 | 0.2046 | 0 | 1 |
| ITINV | 4.1067 | 2.3067 | -6.2146 | 10.4494 |
| BUDGET | 14.5417 | 2.2238 | 6.9078 | 21.0833 |
| INCREASE | 0.0565 | 0.3168 | -1.0000 | 4.6153 |
| DIVERSE | 0.1560 | 0.2401 | 0 | 0.9992 |
| EMP | 7.8692 | 1.8564 | 0 | 12.8092 |
| AGE | 63.4016 | 52.7711 | 0 | 241 |
| CABINET | 0.9135 | 0.2811 | 0 | 1 |
| PAPPOINT | 0.7419 | 0.4378 | 0 | 1 |
| AGENCY | 0.2218 | 0.4156 | 0 | 1 |
| DEF | 0.0078 | 0.0696 | 0 | 1 |
| WEL | 0.3296 | 0.4455 | 0 | 1 |
| LAW | 0.1185 | 0.3115 | 0 | 1 |
| MGT | 0.0526 | 0.2010 | 0 | 1 |
| REG | 0.3070 | 0.4614 | 0 | 1 |
| ADMIN | 0.4762 | 0.4996 | 0 | 1 |
| SENATE | 0.4804 | 0.0445 | 0.4000 | 0.5500 |
| HOUSE | 0.5087 | 0.0518 | 0.4069 | 0.5658 |
| CONFIRM | 0.6723 | 0.4695 | 0 | 1 |
| DIVIDED | 0.9317 | 0.7098 | 0 | 2 |
| IDEO | 0.0283 | 0.9118 | -1.43 | 2.21 |

We use the agency ideology measure (IDEO) of Clinton and Lewis (2008) for Hypothesis 3. They devise the ideology measure of 82 federal agencies and bureaus. They collected ideology evaluation of several experts in politics from academia, media, and Washington think tanks. Combining their perceived ideology of federal agencies with objective information such as the agencies' primary functions and the party and the President that created them, Clinton and Lewis (2008) estimate the latent ideology scores by using a Bayesian method. Their measures are widely used by many studies in political sciences and public administration (e.g. Stone et al. 2010, Lavertu and Moynihan 2013, Clinton et al. 2014, Hollibaugh et al. 2014). The more positive its score is, the more conservative an agency is, and the more negative, the more liberal it is.[7] For instance, the ideology scores of the Department of Labor (a liberal agency) and the DHS (a conservative agency) are -1.43 and 0.88, respectively.

[7] Clinton and Lewis (2008) do not measure ideology of many of the sub-agency bureaus. For these cases, we use the parent agency's ideology score instead. Also they do not measure the ideology of the Smithsonian Institution. Carefully reading the agency description, we consider it a non-partisan agency and assign 0 to its ideology score.

Online Appendix A provides detailed information on the control variables. Tables 3 and A1 (in Online Appendix A) present the descriptive statistics and the correlation tables, respectively.

The following equations show our estimation model.[8]

$$\begin{aligned}\text{DME\_INV}_{it} = f(&\beta_0 + \beta_1\,\text{ITINV}_{it} + \beta_2\,\text{BUDGET}_{it} + \beta_3\,\text{INCREASE}_{,t} + \beta_4\,\text{DIVERSE}_{i,t} + \beta_5\,\text{EMP}_{it} \\ &+ \beta_6\,\text{AGE}_{it} + \beta_7\,\text{CABINET}_i + \beta_8\,\text{PAPPOINT}_i + \beta_9\,\text{AGENCY}_i + \beta_{10}\,\text{DEF}_{it} + \beta_{11}\,\text{WEL}_{it} \\ &+ \beta_{12}\,\text{LAW}_{it} + \beta_{13}\,\text{MGT}_{it} + \beta_{14}\,\text{REG}_i + \beta_{15}\,\text{ADMIN}_{t\text{-}1} + \beta_{16}\,\text{SENATE}_{t\text{-}1} + \beta_{17}\,\text{HOUSE}_{t\text{-}1} \\ &+ \beta_{18}\,\text{CONFIRM}_{i,t\text{-}1} + \beta_{19}\,\text{DIVIDED}_{t\text{-}1} + \beta_{20}\,\text{IDEO}_i + \beta_{21}\,\text{IDEO}_i^2 + v_i + w_t + \varepsilon_{it}). \qquad \text{(Eq. 1)}\end{aligned}$$

Subscripts *i* and *t* represent an agency/bureau and federal fiscal year, respectively. We test H3 by testing whether the coefficient of $\text{IDEO}^2$ is negative and significant.

Since the dependent variable (DME_INV) is a fractional variable ranging between 0 and 1, a linear estimation that does not account for this range such OLS can be biased and inconsistent (Papke and Wooldridge 1996). In addition, we needed to control for agency-specific unobserved heterogeneity ($v_i$) in our estimation. Hence, we followed the approach of Papke and Wooldridge (2008) to estimate a panel model with a fractural dependent variable. Eq. 1 was estimated by a generalized estimating equation (GEE) with a logit transformation and a binominal-family function for residuals. This approach is widely used for panel estimation with a fractional dependent variable (e.g. Phelps 2010, Adegbesan and Higgins 2010, Eickelpasch and Vogel 2014). We included year dummies ($w_t$) in Eq. 1 to account for nationwide changes in political and economic environments.

## 4. Results

Table 4 presents the estimation results. Columns 1 and 2 show our baseline results with a panel-data GEE estimation, and Columns 3-6 present results with alternative estimation specifications as robustness checks.

[8] We adopt one-year lagged variables of CONFIRM and DIVIDED, since a budget proposal by the President and enactment by Congress for FY *T* take a place in the calendar year of *T*-1.

**Table 4. Estimation Results**

| Dep. Var. | DME_INV (The Proportion of DME to Total IT Investments) | | | | | |
|---|---|---|---|---|---|---|
| **Method** | **Panel GEE for Fractional Variable** | | **OLS** | **Random Effects** | **Random Effects with AR1** | **FGLS for Panel-Specific AR1** |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| ITINV | 0.1383** | 0.1415** | 0.0151*** | 0.0213** | 0.0263*** | 0.0151*** |
| | (0.0631) | (0.0629) | (0.0046) | (0.0095) | (0.0047) | (0.0029) |
| BUDGET | -0.0084 | -0.0078 | 0.0011 | 0.0042 | 0.0000 | -0.0011 |
| | (0.0395) | (0.0405) | (0.0030) | (0.0055) | (0.0047) | (0.0026) |
| INCREASE | 0.0803 | 0.0805 | 0.0255 | 0.0133 | 0.0005 | -0.0022 |
| | (0.0751) | (0.0759) | (0.0185) | (0.0145) | (0.0103) | (0.0062) |
| DIVERSE | 0.2390 | 0.1778 | 0.0379* | 0.0440 | 0.0424 | 0.0003 |
| | (0.2728) | (0.2614) | (0.0219) | (0.0414) | (0.0324) | (0.0157) |
| EMP | -0.0397 | -0.0532 | -0.0071* | -0.0130 | -0.0150** | -0.0066** |
| | (0.0532) | (0.0530) | (0.0040) | (0.0094) | (0.0066) | (0.0033) |
| AGE | -0.0024** | -0.0023* | -0.0004*** | -0.0004** | -0.0003 | -0.0003*** |
| | (0.0012) | (0.0012) | (0.0001) | (0.0002) | (0.0002) | (0.0001) |
| CABINET | -0.0504 | 0.0297 | -0.0318** | -0.0347 | -0.0366 | -0.0138 |
| | (0.3993) | (0.3537) | (0.0132) | (0.0348) | (0.0417) | (0.0144) |
| PAPPOINT | -0.2699 | -0.2742 | -0.0477*** | -0.0356 | -0.0234 | -0.0470*** |
| | (0.1939) | (0.1880) | (0.0179) | (0.0289) | (0.0296) | (0.0169) |
| AGENCY | -0.7394*** | -0.6685*** | -0.0730*** | -0.0839*** | -0.0825** | -0.0382*** |
| | (0.1952) | (0.1938) | (0.0135) | (0.0293) | (0.0323) | (0.0136) |
| DEF | -0.9001** | -0.6994* | -0.0049 | -0.0757 | -0.0358 | 0.0459 |
| | (0.3738) | (0.3827) | (0.0449) | (0.0615) | (0.0799) | (0.0398) |
| WEL | 0.0193 | 0.3015 | 0.0999*** | 0.0877** | 0.0914*** | 0.1033*** |
| | (0.2434) | (0.2734) | (0.0170) | (0.0434) | (0.0352) | (0.0187) |
| LAW | 0.1980 | 0.1827 | 0.0311* | 0.0277 | 0.0361 | 0.0359** |
| | (0.1656) | (0.1680) | (0.0161) | (0.0247) | (0.0310) | (0.0153) |
| MGT | -0.0436 | -0.0218 | 0.0113 | 0.0039 | -0.0015 | 0.0137 |
| | (0.3515) | (0.3395) | (0.0239) | (0.0414) | (0.0428) | (0.0260) |
| REG | 0.1364 | 0.1218 | 0.0271** | 0.0242 | 0.0236 | 0.0233** |
| | (0.1400) | (0.1350) | (0.0110) | (0.0222) | (0.0225) | (0.0115) |
| ADMIN | 2.6783*** | 2.6801*** | 0.1980*** | 0.1975*** | 0.2007*** | 0.1633*** |
| | (0.3705) | (0.3730) | (0.0170) | (0.0166) | (0.0162) | (0.0104) |
| SENATE | -10.699*** | -10.722*** | -0.9433* | -0.9624** | -1.0053*** | -1.0345*** |
| | (2.4509) | (2.4653) | (0.4989) | (0.3872) | (0.3477) | (0.2089) |
| HOUSE | -6.1919*** | -6.1799*** | 0.0951 | 0.0846 | 0.1208 | 0.1543 |
| | (2.1935) | (2.1813) | (0.4198) | (0.3246) | (0.3070) | (0.1865) |
| CONFIRM (H1) | 0.3212** | 0.3299** | 0.0701*** | 0.0497** | 0.0387* | 0.0498*** |
| | (0.1482) | (0.1427) | (0.0158) | (0.0221) | (0.0227) | (0.0128) |
| DIVIDED (H2) | -0.6166*** | -0.6168*** | -0.0418*** | -0.0416*** | -0.0415*** | -0.0354*** |
| | (0.0985) | (0.0990) | (0.0099) | (0.0054) | (0.0061) | (0.0036) |
| IDEO | -0.0456 | 0.0038 | 0.0315*** | 0.0256 | 0.0250 | 0.0317*** |
| | (0.1222) | (0.1304) | (0.0071) | (0.0175) | (0.0154) | (0.0064) |
| $IDEO^2$ (H3) | | -0.2294** | -0.0331*** | -0.0318** | -0.0321** | -0.0378*** |
| | | (0.0937) | (0.0054) | (0.0131) | (0.0130) | (0.0058) |
| F / Wald | 365.26*** | 351.30*** | 36.68*** | 523.02*** | 412.70*** | 731.12*** |
| $R^2$ | | | 0.2056 | 0.1992 | 0.1953 | |

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$; $N$ = 1,596, # of Groups = 135

Robust standard errors are in parentheses; Year dummies are omitted.

Hypothesis 1 predicts a positive relationship between a Senate confirmation and agency DME investments. It is supported at the 5%-level significance (Columns 1-2). Hypothesis 2 argues that federal agencies and bureaus are less likely to invest in new IT development under a divided government. It is strongly supported (Columns 1-2); the coefficients of DIVIDED are negative and statistically significant. Hypothesis 3 proposes that ideologically moderate federal agencies invest more in DME. It is supported as well. In Column 1, the coefficient of IDEO is insignificant, but when $IDEO^2$ is added to the model (Column 2), its coefficient is negative and statistically significant. The stationary point with respect to IDEO in Column 2 is 0.008,[9] which falls within the range of IDEO (between -1.43 and 2.21). Thus, the predicted value of DME_INV becomes an inversed U-shaped function of IDEO in this range. It appears that ideologically moderate agencies are predicted to spend more in new IT development than more conservative (IDEO > 0) or more liberal (IDEO < 0) ones.

The GEE estimation used in Columns 1-2 are a non-linear model, in which it is not straightforward to interpret coefficients. Alternatively, we estimate the model in Eq. 1 with linear models as shown in Columns 3-4. The OLS estimation in Column 3 presents very similar results with Column 2, and so does a random-effects estimation (Column 4) that accounts for agency-specific heterogeneity. The coefficient of CONFIRM (H1) in Column 4 demonstrates that when the head of a federal agency is confirmed by the Senate, it is predicted to invest 4.97%-point more in DME than otherwise. We find from Column 4 that when both chambers of Congress are controlled by the ruling party (DIVIDED = 0), federal agencies invest 8.32%-point more in major IT development and modernization than when the majority in the two chambers are held by the opposition party (DIVIDED = 2).

It could be the case that residuals in Eq. 1 are serially correlated, as capacity-building IT investments in prior years could require more maintenance spending in subsequent years.[10] To account for this possibility, we estimate the model (Eq. 1) with a random-effects regression with autocorrelation in residuals (AR1) (Table 4, Column 5) and a feasible generalized least square (FGLS) for panel-specific

[9] $0.0038 / (2 \times 0.2294) = 0.0082$

[10] We thank an anonymous reviewer and the Associate Editor for this insightful point.

autocorrelation (Column 6). These estimations generates very similar results with Columns 2-5. We further conducted robustness checks with alternative specifications, datasets, and variables. Details are available in Online Appendix B.

One might wonder how the absolute amount of IT investments are affected by political factors. To find this out, we regressed a logarithm of total IT expenditures, DME spending, and maintenance (O&M) spending on the explanatory and control variables. Random-effects estimations with these alternative dependent variables, presented in Online Appendix C, show that among the three explanatory variables, only the coefficient of DIVIDED in Column 2 is negative and significant, and others are found to be insignificant. This finding is in accordance with our theoretical proposition that politics has a significant impact on federal IT investments by influencing risk-averse officials' behaviors in allocating IT budgets between capacity-building IT investments and IT maintenance. It implies that under unfavorable political environments, federal officials shy away from making risk investments in new IT systems and allocate more budgets on keeping lights on.

## 5. Discussions and Conclusion

### 5.1. Key Findings

While some U.S. federal agencies are actively investing in advanced digital technologies for new public policy programs, why are others struggling with maintaining aging legacy systems that stifle flexibility, agility, and innovation? Our empirical analyses demonstrate that the national politics has a significant impact on their IT investment profiles. We find that a federal agency is more likely to make capacity-building IT investments when its chief executive is blessed with legislative approval, when the federal government is more united, and when it is ideologically more moderate. In sum, our study supports the central proposition that in order to invest more in major capacity-building IT development, the federal agencies need to secure compelling policy mandates and political legitimacy from Congress for implementation of strategic policy initiatives.

We believe that our findings are applicable to other government systems. For instance, the U.S. federal government and the state governments share similar political systems. In U.S. states, the governors and the state legislators are directly elected by constituents, as is the case in the federal government, and the state legislatures perform comparable functions to those of the U.S. Congress. Hence, the federal and the state governments are under similar political environments, which we expect affect state IT investments in the same manner. In 2014, the total spending of the U.S. federal and state governments combined is 31.16% of the U.S. gross domestic product, demonstrating value and significance of our findings. We expect that our results also hold in other national governments with a presidential system such as Brazil, France, and South Korea.

### 5.2. Contribution to the Literature

The U.S. federal government remains an unchartered territory for IS researchers, even though its policies and public services profoundly affect the U.S. economy and the daily lives of all citizens. As in the private sector, well-functioning IT systems are indispensable for effective government operation and public service delivery. As discussed above, a range of anecdotal evidence illustrates that IT is a key enabler for major public policy implementation. At the same time, however, outdated legacy systems can disrupt ongoing business operations and limit flexibility and responsiveness in the federal sector, costing a significant sum of tax revenues without much value-added. Therefore, it is a legitimate issue for IS researchers to examine how the U.S. federal government invests in IT and what antecedent affects its IT investment profiles. To the best of our knowledge, however, the IS literature to date has not shed as much light on IT investment profiles in the public-sector organizations as in the business sector, even though they are among the largest consumers of IT that have substantial impacts on the private-sector IT industries, one of the key audiences of IS research.

We believe that our study is one of the first studies to regard politics as a factor that influences IT investments. To understand the role of the national politics in federal IT investment decisions, we draw on various theories from the political sciences and public administration literature and couple them with IS

research. To the best of our knowledge, this is our unique theoretical approach that few prior studies in IS have attempted. We also contribute to the IS literature by tackling the issue of a balance between IT investments for new capacities and IT maintenance for ongoing business operations, which has received a scant attention in the IS literature. Investing in new technologies while maintaining existing systems has been a continuing dilemma for IT practitioners in both the public and the private sector. They express a concern that while IT innovation is critical for organizations' success, IT operation limits their ability to secure adequate capacity-building IT investments (*ZDNet* 2010, *NextGov* 2015). The present study fills this critical gap in the IS literature.

### 5.3. Policy Proposals

We offer ample implications for policymakers and practitioners in the public sector as follows. Our findings illustrate that political gridlocks limit federal agencies' organizational capabilities, as shown in a decrease in capacity-building IT investments under a divided government (H2) or in absence of legislative approval for chief executives (H1). The public sector organizations are increasingly required to be flexible, entrepreneurial, and innovative in addressing societal and economic challenges (Moore 1995, Stoker 2006, Alford and Hughes 2008). To do so, government agencies need to develop necessary organizational capabilities, for which advanced digital resources are pivotal. Our study shows that political stalemates are detrimental to federal agencies' endeavors to achieve such goals.

We argue that if federal agencies are to become flexible and innovative, so should be the U.S. Congress. Toward that end, we call for more streamlined, efficient legislative processes in Congress, so that it can provide sufficient legal authority and budgets to federal agencies for policy implementation in a swift, agile manner. For instance, we endorse an increasing call for the U.S. Senate to relax its arcane filibuster rule, which is not codified in any legislation but only an arbitrary, internal procedure (Gold and Gupta 2004). As scholars are debating whether the filibuster is constitutional and necessary to protect minorities' voice (Gerhardt 2004, Chafetz 2011, Magliocca 2011, Bell 2013), we offer our own perspective to shape this debate. Likewise, the House of Representatives can simplify and standardize

legislative processes and limit application of special rules by the House Rules Committee that slow down the passage of a bill (Dion and Huber 1996). We also propose a requirement that the Senate approve or disapprove presidential appointees within a certain period of time. We expect that such a change will minimize leadership vacuum in federal agencies, which we show limits capacity-building IT investments.

We call for creation of legislative committees in the Senate and the House of Representatives that are dedicated to supervising the federal IT investments and management.[11] Considering the fact that IT is a critical means for effective policy implementation, it is incumbent upon Congress to ensure that IT plays an enabling, not hindering, role in the federal government. We also recommend that Congress approve multi-year budget appropriation for capacity-building IT investments. Currently, federal IT budgets are required to be approved every year, but it is reported that this requirement hinders a long-term, strategic planning for large-scale IT development projects (*NextGov* 2015). Federal officials are reluctant to initiate multi-year IT investments when they are uncertain if they can secure budgets in the coming years. Thus, we endorse a proposal for multi-year budget approvals for IT development and modernization, which would incentivize more capacity-building IT investments.

Federal IT management needs to be streamlined as well. Currently, IT management and governance in the federal government is heavily decentralized. The Federal Information Technology Acquisition Reform Act of 2014 has substantially increased authority and power of CIOs in individual federal agencies with respect to IT investment, strategic planning, and procurement, a step that we believe is in the right direction. However, it stopped short of empowering the U.S. federal CIO, who is an administrator of the Office of E-Government and IT, a sub-office within the OMB. Consequently, the federal CIO has very limited legal and hierarchical authority to oversee IT investments and projects in peer federal agencies, to enforce government-wide IT policies, and to drive modernization of legacy IT systems across the federal government. For instance, the U.S. CIO was not able to get involved in the development of Heathcare.gov until its technical failures have become under intense political scrutiny in

[11] Currently, the Senate Committee on Homeland Security and Governmental Affairs and the House Committee on Oversight and Government Reform oversee the federal IT management.

2013. It has become fully operational only after he brought an emergency team of technical experts from the private sector and had them fix the system only in a few months (*Time* 2014). In 2009, the Obama Administration issued an executive directive that encourages federal agencies to adopt cloud computing. However, as of 2014, the spending in cloud computing shares only 1% of the total federal IT investments (GAO 2014). This is due to the U.S. CIO's lack of power to enforce the directive.

We propose expanding the legal authority and control of the U.S. CIO over federal government-wide IT management and to elevate the rank of the position so that it is on par with secretaries of cabinet agencies or directors of independent agencies. Just as the OMB, the OPM, and the General Services Administration are independent agencies that have government-wide responsibilities over financial, personnel, and acquisition management, respectively, so should the Office of E-Government and IT become a standalone agency that manages IT throughout the federal government. With expanded statutory and hierarchical power, the U.S. CIO would be able to compel federal officials, who could otherwise be too bureaucratic and risk-averse, to increase capacity-building IT investments. He or she should be able to exercise more control in managing high-risk, high-stake development projects such as Healthcare.gov.

We also urge the federal government to attract more IT talent from the private sector. In order to effectively manage risky capacity-building IT investments and mitigate IT project failures, the federal government needs to improve its IT management capabilities. Hence, it is imperative to hire IT officials who have strong expertise in state-of-the-art digital technologies, experiences in leading large IT organizations, and access to knowledge and professional networks in the private-sector IT industries. One of the biggest obstacles, however, is a rigid salary scale in the federal government. According to the federal pay scales mandated by the OPM, annual base salaries of senior executives including agency CIOs in 2016 range between $150,000 and $205,000.[12] This figure is substantially lower than salaries of several CIOs in Fortune 500 companies (*Networkworld* 2015) and thus acts as a hindrance to attract private-

[12] https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/16Tables/exec/html/EX.aspx, accessed on Feb. 8, 2016

sector IT professionals to the public sector (*Government Technology* 2011, *Nextgov* 2014). We advocate more flexible pay scales and sufficient incentives for IT professionals in the public sector.

### 5.4. Limitations and Future Research Directions

This research is by no means free from limitations. First, even though our dataset includes the 14 years of IT investments in federal agencies (2003-2016), it covers only two administrations (Bush and Obama). Thus, a dataset with a longer timeframe would have allowed us to draw a more comprehensive picture in political influences on IT. Second, to test Hypothesis 4, we use the agency ideology measures of Clinton and Lewis (2008), who do not measure the ideology of many sub-agency bureaus. As explained, we instead use the parent agency's ideology scores, since we do not have a reason to believe that a federal bureau would perform functions that are ideologically distant from the parent agency. Lastly, despite our efforts to rule out possible alternative explanations in our estimations, there might still be unaccounted factors or unobserved heterogeneity that may affect federal IT investments, potentially leading to omitted variable bias. For instance, we were not able to obtain granular information on the amount of existing IT stock, which requires maintenance for ongoing operations.

The public sector offers abundant future research opportunities for the IS community. For instance, IS researchers can examine the performance effects of federal IT investments, i.e. how federal IT spending improves agency performance and what kind of value IT investments create to the public. As discussed above, IT projects in the government sector are subject to high risks of failures and mismanagement. Taking unique factors in the public sector such as political environments, bureaucratic administration, and pursuit of diverse values (Caudle et al. 1991, Molina and Spicer 2004), research on IT project management, IT outsourcing, and IT governance at the federal government context will produce interesting findings and fruitful theoretical insights. Future research can also look at the impact of public-sector IT investments on specific public policy areas such as education, national security, environmental protection, or healthcare. How does the emergence of new digital technologies affect formulation and

implementation of major public policy programs? These efforts will expand the influence of IS research toward the political sciences and public policy disciplines and bring new audiences to the IS discipline.

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**Online Appendix A – More Details on Empirical Methods**

Sample Population

Our dataset covers all federal agencies and bureaus that are subject to supervision of the OMB, according to the Chief Financial Officer Act of 1990 (CFO Act). These agencies include all cabinet agencies (e.g. the Department of Energy) and several independent agencies, which are collectively called CFO Act agencies. E-Government Act of 2002 requires the OMB to collect and publish IT investment data from all CFO Act agencies. Some independent agencies are not included in the dataset, since they are not part of the CFO Act and the OMB does not collect IT investment figures from them. They are (i) national security agencies such as the Central Intelligence Agencies, (ii) agencies that are required to have more political independence such as the Federal Election Commission, and (iii) several small minor agencies. The budgets of the federal agencies in the sample in 2014 share more than 80% of the entire federal government budget.

Dependent Variable – DME_INV

IT investment figures of federal agencies were obtained from two sources – the Budget of the United States published by the U.S. Government Printing Offices (GPO, fiscal year 2003 – 2007) and Federal IT Dashboard (FY 2009 – 2016). The U.S. fiscal year of *T* runs from October 1 of year *T* -1 to September 30 of year *T*. Each February of calendar year *T*, the Office of Management and Budget (OMB) publishes the President's budget proposal of the fiscal year T+1 to Congress, which includes the actual expenditures of FY *T* -1, the enacted budgets of FY *T* approved by Congress, and the proposed budgets of FY *T* +1. We were able to obtain the actual figures of IT expenditures in FY 2003-2005 and 2007-2015. However, neither the GPO nor Federal IT Dashboard publishes the actual IT spending in FY 2006, and at the time of our data collection in February 2016, the actual IT spending figures in FY 2016 were not available. For FY 2006 and 2016, we instead use the enacted IT budget figures.

Control Variables

We control for the amount of total IT investments (ITINV) as well as the size of agencies and bureaus (BUDGET and EMP). As an indicator for policy mandates to federal agencies from Congress, we control for an increase in the amount of enacted budgets from FY *T*-1 to FY *T*. It is calculated by $(\text{Budget}_{T} - \text{Budget}_{T\text{-}1}) / \text{Budget}_{T\text{-}1}$. If an agency is given new policy mandates that require capacity-building IT investments, it would be accompanied with an increase in total agency budgets that support policy execution. We control for the diversity of federal agency functions, since it is expected that agencies with more diverse functions are under supervision of a more number of politicians, hindering

organizational capabilities for policy implementation (McCubbins and Schwartz 1984, Bawn 1997, Lavertu and Moynihan 2013, Clinton et al. 2013). The diversity is measured by the inverse of a Herfindahl index of budgets calculated from the federal budget (DIVERSE). For each budget item, the OMB designates a functional category such as national defense, law enforcement, or income security. Suppose that $b_i$ is the budget amount in category $i$, and $B$ is the total agency budgets ($B = \sum b_i$). DIVERSE is calculated by $1 - \sum \left(\frac{b_i}{B}\right)^2$. We include AGE, which measures how old an agency or a bureau is. It is expected that an older agency is likely to operate more legacy systems, investing less in DME.

We control for three measures of the agency or bureau's position in the federal government hierarchy (CABINET, PAPPOINT, and AGENCY). CABINET is equal to one for cabinet-level agencies and bureaus and zero for independent agencies. PAPPOINT is one if a chief executive is nominated by the President and zero if he or she is appointed internally. AGENCY is equal to one for cabinet agency observations.[1] We control for the agency or bureau functions (DEF, LAW, WEL, and MGT). These variables are measured by the ratio of budgets in each function to total agency/bureau budgets. The model includes REG, which is equal to one for agencies and bureaus that carry out regulatory functions, such as the EPA and the Nuclear Regulatory Commission, according to Dudley and Warren (2013). Finally, the estimation includes three variables for political environments in the executive and legislative branches (ADMIN, SENATE, and HOUSE).

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[1] The cabinet agencies observations are agency IT investments that are made for general department-wide administration such as financial or human resource management and not for sub-agency bureaus. For instance, in 2013, the total IT spending in the Department of Justice (DOJ) was $2.52 billion, $1.86 billion of which was spent by the bureaus under the DOJ such as the FBI or the DEA. The rest of the $660 million was used for IT investments and operation for general department-wide administration.

**Table A1. Correlation Table (*N* = 1,596)**

| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DME_INV | (1) | 1 | | | | | | | | | | | | | | | | | | | |
| ITINV | (2) | 0.047 | 1 | | | | | | | | | | | | | | | | | | |
| BUDGET | (3) | 0.038 | 0.608 | 1 | | | | | | | | | | | | | | | | | |
| INCREASE | (4) | 0.053 | 0.014 | 0.058 | 1 | | | | | | | | | | | | | | | | |
| DIVERSE | (5) | 0.020 | 0.251 | 0.195 | 0.036 | 1 | | | | | | | | | | | | | | | |
| EMP | (6) | 0.025 | 0.718 | 0.460 | 0.010 | 0.164 | 1 | | | | | | | | | | | | | | |
| AGE | (7) | -0.131 | 0.301 | 0.186 | -0.002 | 0.120 | 0.397 | 1 | | | | | | | | | | | | | |
| CABINET | (8) | -0.005 | -0.181 | -0.119 | 0.009 | -0.215 | -0.178 | -0.105 | 1 | | | | | | | | | | | | |
| PAPPOINT | (9) | 0.012 | 0.109 | 0.099 | -0.022 | 0.141 | 0.096 | 0.046 | -0.049 | 1 | | | | | | | | | | | |
| AGENCY | (10) | -0.071 | 0.442 | 0.278 | 0.001 | 0.491 | 0.336 | 0.251 | -0.501 | 0.225 | 1 | | | | | | | | | | |
| DEF | (11) | -0.044 | 0.096 | 0.055 | -0.023 | 0.117 | 0.041 | -0.018 | 0.032 | 0.026 | 0.031 | 1 | | | | | | | | | |
| WEL | (12) | 0.056 | -0.015 | 0.205 | -0.015 | -0.065 | -0.123 | -0.142 | 0.046 | -0.061 | -0.060 | -0.067 | 1 | | | | | | | | |
| LAW | (13) | 0.035 | 0.081 | -0.058 | 0.002 | -0.111 | 0.145 | 0.007 | 0.117 | 0.043 | -0.092 | -0.008 | -0.251 | 1 | | | | | | | |
| MGT | (14) | -0.007 | 0.037 | -0.123 | -0.013 | 0.145 | 0.012 | 0.056 | -0.265 | -0.020 | 0.157 | -0.027 | -0.160 | -0.092 | 1 | | | | | | |
| REG | (15) | 0.061 | -0.135 | -0.229 | 0.020 | -0.099 | -0.006 | -0.184 | 0.069 | -0.058 | -0.218 | -0.018 | -0.140 | -0.064 | -0.054 | 1 | | | | | |
| ADMIN | (16) | 0.240 | -0.070 | -0.020 | 0.056 | 0.012 | 0.008 | -0.038 | -0.019 | -0.002 | 0.026 | -0.107 | 0.018 | -0.036 | 0.032 | -0.031 | 1 | | | | |
| SENATE | (17) | -0.004 | -0.039 | -0.010 | -0.008 | 0.020 | -0.005 | -0.006 | -0.006 | -0.013 | 0.008 | 0.002 | 0.004 | -0.013 | 0.018 | -0.016 | 0.579 | 1 | | | |
| HOUSE | (18) | -0.080 | -0.007 | -0.009 | -0.089 | 0.027 | -0.009 | 0.011 | 0.002 | -0.023 | -0.005 | 0.084 | -0.009 | 0.013 | -0.013 | 0.008 | -0.031 | 0.604 | 1 | | |
| CONFIRM | (19) | 0.048 | 0.161 | 0.133 | -0.024 | 0.203 | 0.166 | 0.104 | -0.082 | 0.845 | 0.283 | 0.041 | -0.063 | -0.011 | -0.040 | -0.062 | 0.011 | -0.002 | -0.012 | 1 | |
| DIVIDED | (20) | -0.159 | 0.002 | 0.010 | 0.033 | 0.022 | -0.008 | 0.019 | 0.005 | -0.006 | -0.006 | 0.065 | -0.012 | -0.004 | 0.020 | -0.001 | 0.108 | 0.240 | 0.241 | -0.003 | 1 |
| IDEO | (21) | 0.010 | 0.095 | -0.126 | 0.011 | 0.110 | 0.175 | 0.202 | -0.070 | 0.025 | 0.064 | 0.061 | -0.713 | 0.241 | 0.156 | 0.113 | -0.015 | -0.003 | 0.000 | 0.050 | 0.002 |

**Online Appendix B – Robustness Checks**

We have conducted a series of alternative estimations as follows in order to demonstrate the robustness of our analyses.

First, we estimate the model with an aggregated agency level, in which observations are cabinet and independent agencies. In this estimation, a cabinet agency observation (e.g. the DOJ) includes all IT spending figures in the agency and all bureaus that it supervises (e.g. the U.S. Marshals Service, the FBI, the DEA, See Table 1). A random-effects estimation with AR1 shown in Table B1, Column 1 produces a consistent result with Table 4.

As explained above, our dataset includes IT investment profiles from cabinet and independent agencies. Since the two types of agencies are subject to different political supervision, the impact of political factors may vary. We estimated the model only with cabinet agency observations, excluding independent agencies such as the NSF or the NASA (Table B1, Column 2). Second, with respect to testing Hypothesis 1, CONFIRM measures two different cases together. It equals to zero either if an agency head position can be appointed without a Senate confirmation or if the head remains unconfirmed for more than one year. To separate these two cases, we estimated the model only with the agencies whose chief executive requires a Senate approval (Table B2, Column 3). The coefficients of CONFIRM, DIVDED, and IDEO are very similar to those in Table 4 with respect to signs and significance. Our dataset for the baseline estimation consists of actual IT expenditures in 2003-2005 and 2007-2015 and enacted IT budgets in 2006 and 2016. In Table B2, Column 4, we excluded the data in 2006 and 2016 and re-estimated Eq. 1 only with actual IT investment figures, producing a consistent result with our baseline estimation.

Our panel is fairly well-balanced. A fully balanced sample would have 1,890 observations (135×14), and our dataset has 1,597 observations, which is 85% of the balanced panel. However, the fully balanced panel would have produced more reliable estimates. In Table B1, Column 5, we present an estimation that excludes federal agencies that do not appear for all 14 years (2003-2016). Since it estimates a balanced panel, it allows us to use a Prais-Winsten estimation for panel-specific autocorrelation. Table B1, Column 5 produces a consistent result.

We conduct more robustness checks with alternative estimation methods as follows. While we estimated the model with a GEE (Table 4, Columns 1-2) and a random-effects estimation (Columns 4-5) to control for agency-specific factors, there still might be time-invariant unobserved heterogeneity unaccounted in our baseline estimation. Table B2, Column 1 presents a fixed-effects estimation, in which time-invariant variables such as CABINET and IDEO are dropped. The coefficient of DIVIDED is still negative and significant. The coefficient of CONFIRM is marginally significant at a two-tail test ($p$ =

0.113). Also, it might be the case that the fixed-effects and the random-effects linear model is biased since the dependent variable (DME_INV) is restricted between 0 and 1. Following Phelps (2010), we also adopt a log-odd transformation approach, in which we transformed DMV_INV by $\ln(\text{DME\_INV}) - \ln(1 - \text{DME\_INV})$,[2] so that the transformed value can take any value in $[-\infty, \infty]$, and estimat the model with a fixed-effects linear regression (Table B2, Column 2). The coefficient of DIVIDED remains negative and significant. Another source of unobserved heterogeneity is cross-sectional dependence. Since federal agencies are under the umbrella of the federal government, IT investments in the agencies are affected by common unaccounted factors; in other words, the residuals may be spatially correlated. To account for this possibility, we use the estimators of Driscoll and Kraay (2006) as in Table B2, Columns 3-4. We once again obtained consistent results.

We further checked the robustness of our estimation with alternative explanatory variables as in Table B3. First, in our baseline estimation, CONFIRM (Hypothesis 1) is zero if an agency head is unconfirmed by the Senate for more than one year at the time that the President proposes the budget. We changed this one-year window to six months and two years. While the coefficient of CONFIRM with the six-month window is insignificant, that of CONFIRM_2YR with the two-year window is positive and statistically significant, as shown in Table B3, Column 1. This is consistent with our point that the absence of formal leadership negatively affects capacity-building IT investments in federal agencies. One might argue that the effects of the Senate and the House of Representatives on federal IT investments may differ. In Table B3, Columns 2, we use alternative variables for government dividedness. SENATE_DIVIDED and HOUSE_DIVIDED are equal to 1 if the Senate and the House, respectively, are controlled by the opposition party. The coefficient of SENATE_DIVIDED is negative and significant, while that of HOUSE_DIVIDED is not. This seems to be due to a stronger influence of the Senate in budget appropriation processes. For Hypothesis 3, instead of using $\text{IDEO}^2$, we use the following two alternative variables to look at whether political influences on IT investments are different for liberal and conservative agencies. CONS is equal to IDEO if it is greater than 0 (conservative) and zero otherwise. LIBR is equal to |IDEO| if it is less than 0 (liberal) and zero otherwise. Thus, CONS and LIBR are positive only for conservative and liberal agencies, respectively. Table B3, Column 3 shows that the impact of extreme ideology (both liberal and conservative) is still negative and significant.

Finally, IT investments in large organizations such as banks or federal agencies can be path-dependent. Specifically, substantial investments in new IT systems necessitate large spending in maintenance in subsequent years. To account for this possibility, we estimate Eq. 1 with the amount of

[2] Since a log-odds transformation is not possible at DMV_INV = 0 and 1, we replace DMV_INV = 0 and 1 with 0.00001 and 0.99999, respectively.

DME investments in prior years as additional control variables. As shown in Table B4, the coefficients of CONFIRM, DIVIDED and $IDEO^2$ are statistically significant, even with a fewer number of observations.

**Table B1. Robustness Checks with Alternative Datasets**

| **Dep. Var.** | **DME_INV (The Proportion of DME to Total IT Investments)** | | | | |
|---|---|---|---|---|---|
| **Method** | **Random-Effects with AR1** | **Panel GEE for Fractional Variable** | | | **Prais-Winsten Panel** |
| **Data** | Agency Level | Cabinet Only | Senate Required | Actual Expenditures | Balanced Panel |
| | (1) | (2) | (3) | (4) | (5) |
| ITINV | 0.0449*** | 0.1273** | 0.1008 | 0.1331** | 0.0161** |
| | (0.0157) | (0.0625) | (0.0709) | (0.0580) | (0.0076) |
| BUDGET | 0.0230** | 0.0102 | -0.0141 | 0.0224 | -0.0040 |
| | (0.0113) | (0.0395) | (0.0444) | (0.0347) | (0.0057) |
| INCREASE | -0.0070 | 0.0778 | 0.1592 | 0.0989 | 0.0011 |
| | (0.0208) | (0.0797) | (0.1002) | (0.0812) | (0.0128) |
| DIVERSE | -0.0836** | 0.3905 | 0.0440 | 0.2541 | -0.0157 |
| | (0.0333) | (0.2939) | (0.2828) | (0.2380) | (0.0281) |
| EMP | -0.0283 | -0.0544 | 0.0031 | -0.0677 | -0.0032 |
| | (0.0190) | (0.0530) | (0.0594) | (0.0514) | (0.0041) |
| AGE | -0.0005** | -0.0027** | -0.0025* | -0.0023** | -0.0003** |
| | (0.0003) | (0.0013) | (0.0013) | (0.0011) | (0.0001) |
| CABINET | -0.0415 | | -0.0563 | -0.2353 | -0.0222 |
| | (0.0353) | | (0.3511) | (0.2195) | (0.0168) |
| PAPPOINT [1)] | | -0.2924 | | -0.2098 | -0.0064 |
| | | (0.1945) | | (0.1807) | (0.0254) |
| AGENCY | | -0.7525*** | -0.5237*** | -0.5738*** | -0.0426* |
| | | (0.2265) | (0.2011) | (0.1889) | (0.0238) |
| DEF | -0.0941 | -0.6166* | -0.4998 | -0.5050 | -0.0024 |
| | (0.0800) | (0.3628) | (0.4222) | (0.3365) | (0.0840) |
| WEL | -0.0022 | 0.3837 | 0.4553 | 0.4454* | 0.0948*** |
| | (0.0433) | (0.2810) | (0.2979) | (0.2293) | (0.0240) |
| LAW | 0.0606 | 0.1819 | 0.1996 | 0.1679 | 0.0509* |
| | (0.0823) | (0.1703) | (0.1849) | (0.1581) | (0.0276) |
| MGT | 0.1281* | -0.3185 | -0.3540 | 0.0293 | 0.1142** |
| | (0.0660) | (0.3024) | (0.6649) | (0.2935) | (0.0563) |
| REG | 0.0402 | 0.1196 | 0.1829 | 0.1302 | 0.0247 |
| | (0.0475) | (0.1400) | (0.1699) | (0.1321) | (0.0227) |
| ADMIN | 0.1758*** | 3.0951*** | 2.4259*** | -4.0077 | 0.1876*** |
| | (0.0203) | (0.3192) | (0.3884) | (2.9695) | (0.0066) |
| SENATE | -1.0037** | -12.115*** | -10.378*** | 12.623 | -0.8257*** |
| | (0.4261) | (2.3760) | (2.5405) | (11.266) | (0.1298) |
| HOUSE | 0.1420 | -8.0250*** | -5.2536** | 21.513* | -0.1190 |
| | (0.3723) | (2.2472) | (2.1457) | (12.045) | (0.1174) |
| CONFIRM (H1) | | 0.3281** | 0.3608** | 0.3004** | 0.0421* |
| | | (0.1488) | (0.1442) | (0.1402) | (0.0223) |
| DIVIDED (H2) | -0.0354*** | -0.7270*** | -0.5781*** | 1.0403 | -0.0367*** |
| | (0.0077) | (0.0790) | (0.1048) | (0.7515) | (0.0020) |
| IDEO | 0.0333 | 0.0787 | 0.0565 | 0.1181 | 0.0355*** |
| | (0.0203) | (0.1194) | (0.1434) | (0.0997) | (0.0082) |
| $IDEO^2$ (H3) | -0.0332** | -0.2246** | -0.2815** | -0.1987** | -0.0304*** |
| | (0.0143) | (0.1054) | (0.1093) | (0.0853) | (0.0100) |
| Controls | Year | Year | Year | Year | Year |
| *N* | 372 | 1,458 | 1,170 | 1,368 | 1,106 |
| # of groups | 28 | 125 | 95 | 135 | 79 |
| *F* / Wald Stat | 240.00*** | 312.50*** | 360.17*** | 149.58*** | 3749.18*** |
| $R^2$ | 0.4198 | | | | 0.3457 |

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$ in two-tail tests;

Robust standard errors are in parentheses; Year dummies are omitted.

[1)] Since all cabinet and independent agency heads are chosen by the President, PAPPOINT is excluded in Column 1.

**Table B2. Robustness Checks with Alternative Specifications**

| **Dependent Variable** | **DME INV** | **Log-odd Transformed DME_INV** | **DME INV** | **DME INV** |
|---|---|---|---|---|
| **Method** | Fixed-Effects | Fixed-Effects | OLS with Driscoll-Kraay S.E. | Fixed-Effects with Driscoll-Kraay S.E. |
| | (1) | (2) | (3) | (4) |
| ITINV | 0.0279* (0.0145) | 0.7117*** (0.2630) | 0.0151** (0.0066) | 0.0279*** (0.0052) |
| BUDGET | 0.0059 (0.0112) | 0.2365 (0.2295) | 0.0011 (0.0036) | 0.0059 (0.0065) |
| INCREASE | 0.0078 (0.0134) | 0.1329 (0.2787) | 0.0255*** (0.0085) | 0.0078 (0.0065) |
| DIVERSE | 0.0469 (0.0519) | 0.6757 (0.8888) | 0.0379 (0.0317) | 0.0469 (0.0333) |
| EMP | -0.0129 (0.0198) | -0.1175 (0.2209) | -0.0071 (0.0046) | -0.0129 (0.0099) |
| AGE | 0.0193*** (0.0065) | 0.9337*** (0.0904) | -0.0004*** (0.0001) | 0.0193*** (0.0007) |
| CABINET | | | -0.0318** (0.0130) | |
| PAPPOINT | | | -0.0477*** (0.0062) | |
| AGENCY | | | -0.0730** (0.0300) | |
| DEF | -0.1664 (0.1360) | -1.5730 (2.4011) | -0.0049 (0.0159) | -0.1664** (0.0800) |
| WEL | 0.0024 (0.1388) | 1.0575 (2.4934) | 0.0999*** (0.0156) | 0.0024 (0.0472) |
| LAW | 0.0154 (0.0765) | 0.2651 (0.8627) | 0.0311* (0.0166) | 0.0154 (0.0611) |
| MGT | 0.0288 (0.0588) | 0.8241 (0.9681) | 0.0113 (0.0141) | 0.0288 (0.0291) |
| REG | | | 0.0271 (0.0176) | |
| ADMIN | 0.3625*** (0.0528) | 13.157*** (0.7970) | 0.1980*** (0.0034) | 0.3625*** (0.0047) |
| SENATE | -2.1686*** (0.2292) | -82.126*** (4.1466) | -0.9433*** (0.0274) | -2.1686*** (0.0143) |
| HOUSE | 0.7397*** (0.1960) | 18.756*** (3.6623) | 0.0951*** (0.0181) | 0.7397*** (0.0197) |
| CONFIRM (H1) | 0.0403+ (0.0253) | 0.0336 (0.3332) | 0.0701*** (0.0072) | 0.0403** (0.0172) |
| DIVIDED (H2) | -0.0647*** (0.0093) | -2.5084*** (0.1379) | -0.0418*** (0.0003) | -0.0647*** (0.0010) |
| IDEO | | | 0.0315*** (0.0021) | |
| $IDEO^2$ (H3) | | | -0.0331*** (0.0077) | |
| Controls | Year | Year | Year | Year |
| *F* | 22.76*** | 114.64*** | 18884.00*** | $4.475\times10^{5}$*** |
| $R^2$ | 0.2094 | 0.4562 | 0.2056 | 0.2094 |

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$ in two-tail tests; +$p < 0.1$ in one-tail tests; $N$ = 1,596, # of Groups = 135
Robust standard errors are in parentheses; Year dummies are omitted.

**Table B3. Robustness Checks with Alternative Explanatory Variables**

| **Dep. Var.** | **DME_INV (The Proportion of DME to Total IT Investments)** | | |
|---|---|---|---|
| **Method** | Panel-Data GEE | Random Effects | Panel-Data GEE |
| | Alternative to CONFIRM | Alternative to DEVIDED | Alternative to IDEO |
| | (1) | (2) | (3) |
| CONFIRM | | 0.0497** (0.0221) | 0.3365** (0.1416) |
| DIVIDED | -0.6193***(0.0988) | | -0.6173***(0.0994) |
| IDEO | 0.0053 (0.1308) | 0.0256 (0.0175) | |
| $IDEO^2$ | -0.2293** (0.0935) | -0.0318** (0.0131) | |
| CONFIRM_2YR | 0.2475* (0.1282) | | |
| SENATE_DIVIDED | | -0.1887* (0.1040) | |
| HOUSE_DIVIDED | | 0.1010 (0.1033) | |
| LIBR | | | -0.3994* (0.2054) |
| CONS | | | -0.3920** (0.1805) |
| ITINV | 0.1412** (0.0631) | 0.0213** (0.0095) | 0.1434** (0.0635) |
| BUDGET | -0.0074 (0.0406) | 0.0042 (0.0055) | -0.0092 (0.0410) |
| INCREASE | 0.0787 (0.0759) | 0.0133 (0.0145) | 0.0795 (0.0757) |
| DIVERSE | 0.1922 (0.2637) | 0.0440 (0.0414) | 0.1997 (0.2586) |
| EMP | -0.052 (0.0532) | -0.0130 (0.0094) | -0.0547 (0.0535) |
| AGE | -0.0022* (0.0012) | -0.0004** (0.0002) | -0.0023** (0.0012) |
| CABINET | 0.0301 (0.3554) | -0.0347 (0.0348) | 0.0512 (0.3617) |
| PAPPOINT | -0.1958 (0.1793) | -0.0356 (0.0289) | -0.2716 (0.1882) |
| AGENCY | -0.6708***(0.1938) | -0.0839***(0.0293) | -0.6945***(0.1874) |
| DEF | -0.7113* (0.3826) | -0.0757 (0.0615) | -0.6894* (0.3739) |
| WEL | 0.3054 (0.2744) | 0.0877** (0.0434) | 0.3138 (0.2622) |
| LAW | 0.1776 (0.1705) | 0.0277 (0.0247) | 0.2272 (0.1705) |
| MGT | -0.0246 (0.3408) | 0.0039 (0.0414) | 0.0134 (0.3371) |
| REG | 0.1220 (0.1354) | 0.0242 (0.0222) | 0.1058 (0.1358) |
| ADMIN | 2.6774***(0.3719) | 0.2982***(0.0750) | 2.6812***(0.3744) |
| SENATE | -10.547***(2.4580) | -3.7841** (1.9038) | -10.745***(2.4680) |
| HOUSE | -6.2944***(2.1815) | 2.4695 (1.6141) | -6.1767***(2.1880) |
| Controls | Year | Year | Year |
| Wald Stat | 342.22*** | 523.02*** | 264.82*** |
| $R^2$ | | 0.1992 | |

*$p$ < 0.1, **$p$ < 0.05, ***$p$ < 0.01 in two-tail tests; $N$ = 1,596, # of Groups = 135
LIBR is equal to -1 × IDEO if IDEO < 0 (liberal agencies) and 0 otherwise.
CONS is equal to IDEO if IDEO > 0 (conservative agencies) and 0 otherwise.
Robust standard errors are in parentheses; Year dummies are omitted.

**Table B4. Estimation with Prior-Year DME Investments**

| **Dep. Var.** | **DME_INV (The Proportion of DME to Total IT Investments)** | | | |
|---|---|---|---|---|
| **Method** | Panel-Data GEE | | | |
| | (1) | (2) | (3) | (4) |
| ITINV | -0.0684 (0.0748) | -0.0952 (0.0828) | -0.0918 (0.0839) | -0.1221 (0.1005) |
| Log ($DME_{t-1}$) | 0.3678*** (0.0586) | 0.4113*** (0.0883) | 0.4218*** (0.0905) | 0.4629*** (0.0934) |
| Log ($DME_{t-2}$) | | -0.0354 (0.0593) | 0.0282 (0.0541) | 0.0068 (0.0520) |
| Log ($DME_{t-3}$) | | | -0.0962** (0.0374) | -0.1018** (0.0415) |
| Log ($DME_{t-4}$) | | | | -0.0201 (0.0435) |
| BUDGET | -0.0410 (0.0337) | -0.0438 (0.0354) | -0.0307 (0.0349) | -0.0120 (0.0403) |
| INCREASE | 0.1204 (0.0813) | 0.1051 (0.0882) | 0.1106 (0.0840) | 0.1262 (0.0919) |
| DIVERSE | 0.1471 (0.2539) | 0.2054 (0.2655) | 0.1486 (0.2603) | 0.0242 (0.2535) |
| EMP | -0.1159** (0.0493) | -0.1052** (0.0512) | -0.1151** (0.0477) | -0.1080** (0.0470) |
| AGE | -0.0012 (0.0010) | -0.0014 (0.0010) | -0.0014 (0.0009) | -0.0014 (0.0009) |
| CABINET | -0.0920 (0.2719) | -0.1399 (0.2528) | -0.1319 (0.2373) | -0.1081 (0.2318) |
| PAPPOINT | -0.1829 (0.1666) | -0.1664 (0.1692) | -0.1620 (0.1661) | -0.2249 (0.1799) |
| AGENCY | -0.7951*** (0.1554) | -0.8386*** (0.1670) | -0.7697*** (0.1652) | -0.6842*** (0.1606) |
| DEF | -0.8298** (0.3347) | -0.7262** (0.3568) | -0.5595 (0.3513) | -0.4191 (0.3290) |
| WEL | 0.2396 (0.2144) | 0.1883 (0.2146) | 0.2209 (0.2197) | 0.2369 (0.2210) |
| LAW | 0.0712 (0.1732) | -0.0449 (0.1825) | -0.0491 (0.1672) | -0.0520 (0.1720) |
| MGT | -0.0192 (0.2977) | -0.0168 (0.2954) | -0.0172 (0.3111) | 0.0565 (0.3355) |
| REG | 0.2207* (0.1206) | 0.2188* (0.1225) | 0.2144* (0.1162) | 0.1812 (0.1147) |
| ADMIN | 2.6925*** (0.4256) | 4.4405*** (1.0661) | 4.6001*** (1.0387) | 4.6773*** (1.0469) |
| SENATE | -9.3511*** (2.4229) | -37.186*** (6.3797) | -36.272*** (6.2782) | -35.272*** (6.3356) |
| HOUSE | -7.4238*** (2.2773) | 22.318*** (5.0201) | 23.042*** (4.8947) | 23.308*** (4.9159) |
| CONFIRM (H1) | 0.2772** (0.1258) | 0.2779** (0.1352) | 0.2465** (0.1207) | 0.3203** (0.1327) |
| DIVIDED (H2) | -0.6231*** (0.1161) | -1.1135* (0.6246) | -1.2117** (0.6131) | -1.3041** (0.6235) |
| IDEO | -0.0590 (0.1040) | -0.0632 (0.1060) | -0.0006 (0.1023) | 0.0300 (0.0985) |
| $IDEO^2$ (H3) | -0.2516*** (0.0826) | -0.2621*** (0.0936) | -0.2228*** (0.0859) | -0.1549** (0.0786) |
| Controls | Year | Year | Year | Year |
| *N* | 1,459 | 1,324 | 1,197 | 1,072 |
| # of Groups | 135 | 130 | 129 | 126 |
| Wald Stat | 399.02*** | 328.73*** | 523.02*** | 264.82*** |

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$ in two-tail tests;
Robust standard errors are in parentheses; Year dummies are omitted.

**Online Appendix C. The Estimation with the Overall Amount of IT Expenditures**

| Dep. Var. | Log (Total IT Expenditures) | Log (DME Expenditures) | Log (O&M Expenditures) |
|---|---|---|---|
| **Method** | **Random-Effects** | | |
| | (1) | (2) | (3) |
| BUDGET | 0.2738*** (0.0722) | 0.2441*** (0.0502) | 0.2466*** (0.0654) |
| INCREASE | -0.0134 (0.0839) | -0.0181 (0.0854) | -0.0792 (0.0722) |
| DIVERSE | -0.1287 (0.2620) | -0.1458 (0.2618) | -0.2077 (0.2112) |
| EMP | 0.2993*** (0.0964) | 0.3271*** (0.0545) | 0.3316*** (0.1074) |
| AGE | 0.0026 (0.0021) | -0.0020 (0.0018) | 0.0029 (0.0021) |
| CABINET | 0.7007 (0.4866) | 0.4364 (0.3558) | 0.7380 (0.4913) |
| PAPPOINT | -0.0394 (0.3056) | -0.1931 (0.2378) | 0.0210 (0.3062) |
| AGENCY | 1.7442*** (0.3614) | 1.1464*** (0.2751) | 1.8140*** (0.3626) |
| DEF | 0.8482 (0.7976) | -0.6610 (0.6998) | 0.7814 (0.7254) |
| WEL | 0.6528 (0.6432) | 0.5402 (0.5015) | 0.5376 (0.5446) |
| LAW | -0.4282 (0.7090) | 0.0250 (0.3609) | -0.5254 (0.6632) |
| MGT | 0.8655* (0.5093) | 0.2656 (0.2656) | 0.8203 (0.5201) |
| REG | 0.0881 (0.2803) | -0.1714 (0.2006) | 0.0010 (0.2846) |
| ADMIN | -0.4942*** (0.0932) | 1.4148*** (0.1233) | -0.7468*** (0.0913) |
| SENATE | 5.6390*** (1.7044) | -3.3487* (1.7092) | 5.7222*** (1.5287) |
| HOUSE | -4.4715** (1.7359) | -7.4041*** (1.5791) | -3.7102** (1.6171) |
| CONFIRM | 0.0781 (0.1357) | 0.1610 (0.1707) | 0.0015 (0.1465) |
| DIVIDED | -0.0166 (0.0422) | -0.4494*** (0.0347) | 0.0479 (0.0429) |
| IDEO | 0.5148* (0.2656) | 0.3400* (0.1815) | 0.4574* (0.2348) |
| $IDEO^2$ | -0.0946 (0.1718) | -0.1190 (0.1354) | -0.0661 (0.1569) |
| Controls | Year | Year | Year |
| Wald Stat | 329.27*** | 764.95*** | 514.74*** |
| $R^2$ | 0.5793 | 0.5700 | 0.5861 |

*$p$ < 0.1, **$p$ < 0.05, ***$p$ < 0.01 in two-tail tests; $N$ = 1,596, # of Groups = 135
Robust standard errors are in parentheses; Year dummies are omitted.