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Performance Paradox: Information Technology Investments and Administrative Performance in the Case of the 50 U.S. State Governments

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Abstract

This study introduces the terminology of performance paradox in the context of IT (information technology) investment and use. Although it is somewhat related to the concept of productivity paradox, in the case of performance paradox, the dependent variable (i.e., the measure of performance) is not productivity, but some other measure of performance.

This paper presents the results of a study that examined the relationship between IT investments by the 50 state governments of the United States and the administrative performance of these state governments. There are two parts to this study. In the first part, IT investments by state governments were related to multiple measures of state government performance, namely performance in financial management, human resource management, information technology management, capital management, and managing for results. In the second part of the study, IT investments by state governments were related to projected state government budget deficits. State budget deficits are used as a performance measure because they are an indicator of state government planning performance.

Structural equation modeling was performed to analyze the data. The results indicate incidence of performance paradox. It appears as though the more U.S. state governments invest in IT, the worse they perform. However, there are also indications that with the passage of time, the relationship between IT investment and performance shows improvement. Thus, over time, the performance paradox becomes less pronounced. In some cases, it appears that past investments in IT actually help future performance.

Keywords: Performance paradox, productivity paradox, public sector, e-government, structural equation modeling (SEM), IT investment, performance measurement, U.S. state governments

Introduction

The so-called productivity paradox has been a source of controversy and debate in the information systems (IS) research community for some time now (Brynjolfsson and Hitt 1998; Ives 1994; Roach 1989).

This present study introduces the terminology of performance paradox in the context of IT (information technology) investment and use. Although it is somewhat related to the concept of productivity paradox, in the case of performance paradox, the dependent variable (i.e., the measure of performance) is not productivity, but some other measure of performance. (Note: The phrase performance paradox has been used before [Meyer and Gupta 1994], albeit in a wholly different context.)

This paper presents the results of a study that examined the relationship between IT investments by the 50 state governments in the United States and the administrative performance of these state governments. There are two parts to this study. In the first
part, IT investments by state governments in 1999 were related to multiple measures of state government performance in 1999 and 2001. The performance measures that were used were state government performance in financial management, human resource management, information technology management, capital management, and managing for results. In the second part of the study, IT investments by state governments in 1999 and 2002 were related to projected state government budget deficits in 2003 and 2004. State budget deficits are used as a performance measure because they are an indicator of state government planning performance and ability (or lack thereof).

The results of the first part of the study indicate that IT investments in 1999 had a negative relationship with performance of the states in 1999 in each of the performance dimensions, i.e., financial management, human resource management, information technology management, capital management, and managing for results. This implies that state governments that invested more per capita in IT in 1999, also performed more poorly in 1999. In 2001, the relationships between 1999 IT investments and the five performance dimensions were still largely negative, but the effect sizes were much smaller, and almost negligible in some cases.

The results of the second part of the study indicate a positive relationship between IT investments and projected state budget deficits. This implies that state governments that invested more per capita in IT are projected to suffer larger per capita budget deficits in 2003 and 2004.

These results indicate incidence of performance paradox. It appears as though the more U.S. state governments invest in IT, the worse they perform. However, this is not the complete story. As detailed in the conclusions, there are also indications that with the passage of time, the relationship between IT investment and performance shows improvement. Thus, over time, the performance paradox becomes less pronounced. In some cases, it appears that past investments in IT actually help future performance. As discussed in the conclusions, this situation may be indicative of a learning-curve type phenomenon (Ives 1994).

This study arose out of a simple question: How is IT impacting the performance of governments? There are many possible, potential approaches and methodologies that can be used to go about answering this question. This study has attempted one such approach. It should be noted that this study has a number of limitations, described in the discussion and conclusions section. Given the study's limitations, it is not the intention of this paper to make conclusive claims regarding the existence of evidence in support of performance paradox. Instead, it should be understood that the contribution of this paper is that, within its limited research framework, it digs up some evidence of the existence of performance paradox and in doing so it intends to lay out important issues for future research; issues such as closer and more rigorous investigation of performance paradox and learning-curve phenomena in government use of IT. Additionally, there is a dearth of reliable data related to these issues, and many problems involved in obtaining such data, that make it very difficult to investigate these issues satisfactorily. By bringing such issues to the fore, this paper also intends to motivate future efforts toward the institution of stringent processes to collect reliable data related to the impact of IT on government performance.

The rest of this paper is organized in the following way. First, a brief history of the productivity paradox is presented. Next, the data and methodology employed in the present research are described. The results of the research are then presented. Finally, the research results and conclusions are discussed and limitations of this study and suggestions for future research are outlined.

### A Brief History of the Productivity Paradox

This paper is concerned with performance paradox and not productivity paradox. However, the concept of performance paradox is related to and may be considered to have evolved out of the concept of productivity paradox. It has been suggested that traditional measures of productivity may not be appropriate to estimate the contribution of IT to organizational outcomes (Hitt and Brynjolfsson 1996) and researchers have called for alternative ways to measure such contributions of IT (Kohli and Sherer 2002). However, since existing research related to this subject is mostly concerned with productivity paradox, a brief history of this concept is provided.

While some have found no relationship between IT investments and productivity (e.g., Strassmann 1990), others have found the existence of a negative relationship between IT investments and productivity growth (e.g., Berndt and Morrison 1995). Among the possible reasons for productivity paradox that have been put forward are (1) unforeseen IT unreliability and incompatibility issues have harmed efficiencies; (2) IT has added jobs in terms of personnel required to support and maintain IT systems; (3) although work may have become more efficient through the use of IT, organizations may not have capitalized on the efficiency improvements by laying-off workers, and hence there is little measurable productivity gain (since productivity is defined as output per unit labor).

Several reasons have been proposed to account for the earlier findings of productivity paradox. Some of the reasons that have been put forward are IT investment evaluation is difficult to undertake because reliable estimates of IT costs and benefits are not always available or easy to obtain; it is difficult to isolate IT investments from other investments; it is not IT’s fault because IT was deployed without an effective strategy; past studies used anecdotal evidence based cross-sectional studies that failed to capture lag effects (since investments in IT take a while to start paying off) mid-20th century post-war high productivity was a fluke and cannot be replicated; service industry outputs are hard to quantify and have not been measured accurately; overall investments in IT were very low, only around 2 to 3 percent, and so it would be wrong to blame IT for the productivity losses; IT is an immature technology and provides significant benefits as it matures; IT workers were insufficiently trained to exploit the potential of IT (i.e., there is a learning-curve involved and as workers learn to use IT tools better, their productivity improves).

Indeed, some researchers have found that IT investments have made substantial and significant contributions to the output of firms (Brynjolfsson and Hitt 1993). Others have found that enabled by IT, white-collar workers are handling an increasing volume of business (McKeen and Smith 1993). Thus there is now a strong view that IT contributes significant intangible benefits that are usually not or cannot be measured. This unmeasured value contributed by IT results in significant improvements in quality, but not necessarily a dollar output increase. Thus, there are now better jobs, better products, and better services, but since they produce no dollars in becoming better, these improvements are ignored in measuring benefits from IT. For example, ATM machines provide banking customers with convenience, but the massive investments involved in setting up ATM networks do not necessarily result in increased dollar output per banking employee. Thus ATM machines do not necessarily increase productivity using the traditional definition of productivity as defined by the U.S. Bureau of Labor Statistics (i.e., productivity equals output per unit labor).

For these reasons, researchers are now calling for alternative ways to measure contributions from IT (Kohli and Sherrer 2002). For example, some researchers are proposing that service quality be used as a measure of IT performance (Kettinger and Lee 1997; Pitt et al. 1995, 1997). Further, it has been suggested that no single approach is suitable and that researchers should use multiple measures from multiple perspectives to obtain a superior estimate of the impact of IT investment on performance outcomes (Farbey et al. 1993).

The present research pays heed to such advice and employs multiple measures of performance using multiple perspectives.

**Research Data and Methodology**

This research investigated the relationship between IT investments made by the 50 U.S. state governments and the performance of these governments. Details of the data and methodology employed are presented here.

**Data on IT Investments by U.S. State Governments**

Data on IT investments by U.S. state governments in 1999 and 2002 were obtained from the Center for Digital Government (www.centerdigitalgov.com), which describes itself as “a national research and advisory institute providing industry, government, and education leaders with decision support, research and services and an array of projects and publications covering the critical policy, executive leadership and technology applications surrounding electronic government” (from the Center’s Website). The reason for using data from the aforementioned years was due to availability of such data. The IT investment data comprised
estimates of investments and costs incurred by the 50 U.S. state governments in IT hardware, IT software, IT training, IT staffing, and IT services.

Different U.S. state governments have markedly different IT investment budgets and in order to standardize this quantity to make it comparable across states, the IT investment by each state government (in a particular year) was divided by the state’s population in order to obtain per capita IT investments by state government. The models in the methodology subsection and the analyses in the research results section use this per capita measure of IT investment by state governments.

Data on Performance Metrics of U.S. State Governments

To measure the performance of the state governments, two separate sets of performance metrics were used. These are described below.

Government Performance Project (GPP) Performance Metrics

The first set of performance metrics was obtained from the 1999 and 2001 Government Performance Project (GPP) reports produced by the Maxwell School of Citizenship and Public Affairs at Syracuse University and funded by the well-respected Pew Charitable Trusts (http://www.maxwell.syr.edu/gpp/). In 1999 and 2001, the project rated the administrative performance of each of the 50 U.S. state governments on an 11-point scale along each of five dimensions. These five dimensions are financial management (FM), human resource management (HRM), information technology management (IT), capital management (CM), and managing for results (MFR). Only two such reports have been produced so far. Sample data from the 2001 report are presented in Table 1.

<table>
<thead>
<tr>
<th>STATE</th>
<th>FM</th>
<th>HRM</th>
<th>IT</th>
<th>CM</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nebraska</td>
<td>B+</td>
<td>B-</td>
<td>C+</td>
<td>A-</td>
<td>B-</td>
</tr>
<tr>
<td>Nevada</td>
<td>B</td>
<td>D</td>
<td>C</td>
<td>B+</td>
<td>C</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>B-</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>D+</td>
</tr>
<tr>
<td>New Jersey</td>
<td>B-</td>
<td>C-</td>
<td>B-</td>
<td>B+</td>
<td>B-</td>
</tr>
</tbody>
</table>

The letter grade scores ranged from A to D– and for the purposes of numerical analyses, these scores were converted to numerical scores on an 11-point scale.

According to the GPP report, for the five dimensions, state government performance was evaluated on the following criteria.

• FM (financial management) scores were evaluated on the basis of performance in budget planning, fiscal stability and health, disclosure of financial information, and control over financial operations.

• HRM (human resource management) scores were evaluated on the basis of performance in strategic workforce planning, professional development, and reward, evaluation, and disciplinary schemes.

• IT (information technology management) scores were evaluated on the basis of quality of IT systems, information technology architecture, IT procurement efficiency, and use of IT to communicate with and provide services to citizens.

• CM (capital management) scores were evaluated on the basis of performance in capital planning, project management, and asset maintenance.

• MFR (managing for results) scores were evaluated on the basis of performance in strategic planning and decision making. Components of MFR include performance in organizational reform, customer service, organizational learning, and process reengineering.
State Budget Deficits as Performance Metrics

The second set of performance metrics that was used was the projected budget deficit of each of the state governments for the years 2003 and 2004. The projected budget deficit data were obtained from various reports published by the American Legislative Exchange Council (ALEC, www.alec.org), which describes itself as a bipartisan membership association for state lawmakers and a think tank that produces reports on issues of public policy. ALEC boasts of 12 sitting U.S. state governors and several former state governors among its members. ALEC also claims that over 80 members of the current U.S. Congress are among its members, including House Speaker J. Dennis Hastert and House Majority Whip Tom Delay.

The logic for using state budget deficits as performance metrics is quite simple. Computers and IT are supposed to improve information access and information processing and thus they are expected to augment managerial planning capabilities. Budgeting is nothing but a planning process. Thus budget accuracy is a measure of planning performance. It has been reported that the projected budget deficits for U.S. states in 2003 and 2004 are the largest ever in the country’s history (NASBO 2003). Budget deficits, in this case, are a good proxy for measuring the relative planning performance (or lack thereof) of different state governments.

Different U.S. state governments have markedly different budget deficits. In order to standardize this quantity to make it comparable across states, the budget deficit of each state was divided by the state’s population in order to obtain per capita budget deficits of state governments. The model for analyzing the state budget deficits and the analyses presented in the research results use this per capita measure of state government budget deficits.

Methodology

To analyze the data, structural equation modeling (SEM) was performed using the Amos software package (version 5 beta). There are several advantages of using the SEM technique. SEM is an excellent method to assess stability and/or change in longitudinal data. SEM allows for the testing of directed relationships (i.e., implied causation) in models even in non-experimental designs (e.g., correlational studies) where the time-ordered sequence of the involved variables approximates causal modeling. SEM allows the assessment of change and/or stability while controlling for measurement errors. SEM performs simultaneous estimation of equations, estimates both direct and indirect relationships and provides indices of global model fit (Kline 1998).

In this study, structural equation models were created using the maximum likelihood method. However, since in the models, the data did not meet the multivariate normality assumption required for the maximum likelihood method, all the analyses were performed using the bootstrapping technique, which is considered an appropriate and sufficient corrective technique when there is lack of multivariate normality (Babakus et al. 1987; Curran et al. 1996; Fan et al. 1999; Olsson et al. 2000). Additionally, there was a small amount of missing data. However, since SEM is capable of compensating for small amounts of missing data (Arbuckle 1996), built-in capabilities of Amos were used to compensate for the missing data.

As explained earlier, different U.S. state governments have markedly different IT investment budgets and budget deficits. In order to standardize these quantities to make them comparable across states, IT investments and budget deficits of each state were divided by the state’s population in order to obtain per capita IT investments and per capita budget deficits of state governments. The models presented here and the analyses in the research results use these per capita measures of IT investment and state budget deficits.

Theoretical Model with GPP Performance Metrics

The theoretical model for analyzing the GPP performance data is presented in Figure 1.

This model posits that IT investments by state governments in 1999 have an impact on state government performance measured along the Y dimension in 1999 and 2001. SEM is capable of isolating such impacts from specific independent variables, and all other determinants of the dependent variables are contained within the error terms. The Y term is simply a placeholder for the performance dimensions FM, HRM, IT, CM, and MFR and thus this analysis will be repeated five times, once for each of these performance dimensions. R1, R2, and R3 in the model are regression weights and the arrows show directionality from the independent variable to the dependent variables. This analysis is primarily interested in R1 and R2. What this research is interested in knowing is, if Y is replaced any of the five performance dimensions (i.e., FM, HRM, IT, CM, or MFR), what will be the values (i.e., regression weights) of R1 and R2, and will these values be positive or negative?
Theoretical Model with State Budget Deficits as Performance Metrics

The theoretical model for analyzing the state budget deficits performance data is presented in Figure 2. This model posits that IT investments by state governments in 1999 and 2002 have an impact on state budget deficits in 2003 and 2004. The logic of this model is simple. Computers and IT are supposed to improve information access and information processing and thus they are expected to augment managerial planning capabilities. Budgeting is nothing but a planning process. Thus budget accuracy is a measure of planning performance. It has been reported that the projected budget deficits for U.S. states in 2003 and 2004 are the largest ever in the country's history (NASBO 2003). It would be interesting to find out if these state budget deficits are related in any way to IT investments by these states in the past. R1, R2, R3, R4, and R5 in the model presented in Figure 2 are regression weights and the arrows show directionality from the independent variable to the dependent variables. SEM is capable of isolating such impacts from specific independent variables, and all other determinants of the dependent variables are contained within the error terms. The two variables for per capita IT investments are connected by a curvy arrow to indicate that they are correlated. This analysis is primarily interested in knowing the values of R1, R2, R3, and R4 and whether these values are positive or negative.

Research Results

The results from structural equation modeling on the data are presented below. The relevant regression weights are indicated directly in the models themselves, next to the appropriate arrows. (Note: All regression weights are standardized.) In order to reduce clutter and preserve clarity, results and information not relevant to this analysis have not been presented in the figures. Model fit indices have been provided below each model result diagram along with a summary description of the fit. The following abbreviations for model fit indices have been used: DF = degrees of freedom, CFI = comparative fit index, IFI = incremental fit index, NFI = normed fit index.
**Results Using First Set of Performance Metrics (GPP Data)**

The first set of performance metrics used GPP data on state governments’ performance in financial management (FM), human resource management (HRM), information technology management (IT), capital management (CM), and managing for results (MFR). The model results are presented in Figures 3 through 7.

![Diagram](image_url)

Model Fit Indices: \( \chi^2 = 0.00, \text{ DF} = 0, \text{ CFI} = 1, \text{ IFI} = 1, \text{ NFI} = 1. \) (Model fits very well.)

**Figure 3. Results of the Model that Used Performance in Financial Management (FM)**

![Diagram](image_url)

Model Fit Indices: \( \chi^2 = 0.00, \text{ DF} = 0, \text{ CFI} = 1, \text{ IFI} = 1, \text{ NFI} = 1. \) (Model fits very well.)

**Figure 4. Results of the Model that Used Performance in Human Resource Management (HRM)**

![Diagram](image_url)

Model Fit Indices: \( \chi^2 = 0.00, \text{ DF} = 0, \text{ CFI} = 1, \text{ IFI} = 1, \text{ NFI} = 1. \) (Model fits very well.)

**Figure 5. Results of the Model that Used Performance in Information Technology Management (IT)**
Results Using Second Set of Performance Metrics (State Budget Deficits)

The second set of performance metrics used state budgets deficits as measures of state government performance. The model result is presented in Figure 8.

Model Fit Indices: $\chi^2 = 0.00$, $DF = 0$, $CFI = 1$, $IFI = 1$, $NFI = 1$. (Model fits very well.)

Figure 8. Results of the Model that Used State Deficits as Performance Metrics
Discussion of the Research Results and Conclusions

The results in Figures 3 through 7 indicate that IT investments in 1999 had a negative relationship with performance of the states in 1999 in each of the performance dimensions, i.e., financial management, human resource management, information technology management, capital management, and managing for results. The standardized regression weights in these cases range from -0.36 to -0.15. This implies that state governments that invested more per capita in IT in 1999 also performed more poorly in 1999.

In 2001, the relationships between 1999 IT investments and the five performance dimensions are quite different than was the case in 1999. The effect sizes in the case of financial management, human resource management, and managing for results, although still negative, are only -0.07, -0.06, and -0.04 respectively, much smaller than the effect sizes in 1999. Interestingly, in 2001, the effect size for capital management is positive and large (0.27). The effect size for information technology management is still negative but not as large as earlier (-0.11).

An overall assessment of the results in Figures 3 through 7 data suggests that, as time progresses, the relationship between IT investment and state government performance undergoes a change. Specifically, it appears that the relationship becomes more positive with time. Thus it appears that performance may be improving due to past investments in IT. The case of capital management performance is especially interesting because the relationship changed from the most negative to a positive one in two years. As such it will be instructive to investigate more closely whether and how capital management in 2001 benefitted from IT investments in 1999.

The results in Figure 8 indicate a positive relationship between IT investments and projected state budget deficits. The standardized regression weights of 1999 IT investments on projected budget deficits in 2003 and 2004 are 0.30 and 0.23 respectively. The standardized regression weights of 2002 IT investments on projected budget deficits in 2003 and 2004 are 0.25 and -0.01 respectively. This implies that state governments that invested more per capita in IT in 1999 are projected to suffer larger per capita budget deficits in 2003 and 2004. This also implies that state governments that invested more per capita in IT in 2002 are projected to suffer larger per capita budget deficits in 2003. However, this also implies that state governments that invested more per capita in IT in 2002 are projected to suffer slightly lower per capita budget deficits in 2004 (regression weight is -0.01); thus indicating that in this case there may a negligibly positive impact on performance due to past IT investment.

The grand implication of the results in Figures 3 through 8 is that state governments seem to experience some kind of performance paradox when they invest in IT. It appears as though the more U.S. state governments invest in IT, the worse they perform, at least initially. However, over time, this performance paradox becomes less pronounced. In some cases, it appears that past investments in IT actually aid future administrative performance.

This situation may be indicative of a learning-curve type phenomenon (Ives 1994). In the productivity paradox literature, it has been suggested that some of the paradoxical performance outcomes of IT use may be occurring due to the fact that there is a learning-curve involved in learning how to use IT effectively. Not only do people need formal training in using IT effectively and efficiently, they also need considerable experience with IT tools before they can learn how to utilize these tools in an optimal way. Therefore, as time progresses, past investments in IT begin to have a positive impact on performance. Another way in which the learning-curve manifests itself is in the alignment between organizational structure and technology. An infusion of IT may not be good enough unless an organization restructures itself in some way to accommodate the IT; and over time, organizations may learn how to better accommodate past infusions of IT.

These results need to be confirmed using other studies that use different methodologies and contexts. However, if true, these results have several important implications regarding investments in IT. First, these results suggest that state governments, when evaluating IT investments, should keep a long time-horizon in mind, as such investments may take a long time to pay off. Second, these results suggest that it may be worthwhile to investigate the mechanisms behind the learning curve phenomenon. It would be useful to find out if the learning-curve can be controlled and harnessed in any way, or if there are intervening mechanisms that catalyze or inhibit learning. Third, it appears that the impact of IT on different aspects of performance may vary with time. For example, in Figures 3 through 7, compared to other performance dimensions, performance in capital management appeared to improve the most due to past investments in IT. Research is needed in order to investigate how different performance capabilities may be impacted by past IT investments and how the passage of time moderates these relationships.

This study has several limitations and future research studies should attempt to address and remedy them. First, this study has not considered the effect of potential moderating or mediating variables (e.g., investments in the reorganization of administrative procedures). This is partly due to research design limitations imposed by the small sample size. There are only 50 states in the
United States, providing a sample size of 50. In structural equation modeling, a small sample size such as this necessitates the creation of extremely simple models. Therefore, under the circumstances, it was not considered appropriate to include additional variables in the models. Second, data were chosen on the basis of availability and not on the basis of design. For example, IT investment data used were from 1999 and 2002, GPP state performance data were from 1999 and 2001, etc. Therefore, the particular years from which data have been taken are somewhat arbitrary. This may cause problems of comparability. Future research should aim for greater control by filling in the gaps in the years and thus building more comprehensive models that use data from several years together, without missing years in between. Third, it should be noted that government budgeting is not always a rational activity (Bartle 2001). Therefore, the use of state budget deficits as indicators of state government planning ability may not be completely appropriate. In fact, some would argue that using budget deficits as a measure of performance is quite questionable and that there need be no cause-effect relationship between IT investments and budget deficits at all. Fourth, the data used were derived from three independent institutions. This may have lent itself to problematic issues with respect to definitions, assumptions, and comparability that may have biased the data in some unknown way. Additionally, the author cannot vouch for the accuracy of the performance and investment data as these data have been produced by other independent entities. A fifth limitation is that IT investment is an extremely difficult quantity to measure. There are many hidden costs of IT and also many costs that cannot be isolated. Therefore, estimates of IT investments are often faulty and incomplete. This is always going to be a challenge for researchers of concepts such as the performance paradox.

Conventional wisdom suggests that organizations and governments invest in IT because such investments enhance their performance in various ways. However, there remain some questions about nature of the impacts of IT on organizational and governmental performance. This research suggests that, in the context of U.S. state governments, IT investments initially lead to reduced performance, but over time these investments may lead to more positive outcomes. This is suggestive of two phenomena, namely performance paradox and the learning curve. It is imperative that future research be done, perhaps in different contexts and using alternative approaches, to see if these phenomena can be identified and to assess the generalizability of these findings.

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Pew Center for the States Takes Over Responsibility For The Government Performance Project
Final Report from the Maxwell School Available On-line

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