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A longitudinal study of e-government maturity

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ABSTRACT

We assembled a panel data set for the period 2002–2008 and fitted a mixed-effects regression model to study how the maturity of e-Government around the globe was influenced by changing levels of affluence, information communication technology (ICT) infrastructure, human capital, and governance. We found that e-Government matured faster with rising affluence (in terms of gross domestic product (GDP) per capita) and improvements in ICT infrastructure. Human capital and the quality of governance had no significant effect on e-Government maturity. The results suggest that a high level of e-Government maturity can be attained purely through investment in ICT infrastructure, without substantial changes to human capital or governance.

1. Introduction

Though information technology applications in government are decades old, e-Government is a comparatively new phenomenon [48]. Traditional IT in government is inward looking and addresses mainly applications internal to government agencies. Conversely, e-government is outward looking and connects government agencies to external stakeholders such as citizens, businesses, and other government agencies. If the World Wide Web (web servers and browser clients communicating over the HTTP protocol) is viewed as a general purpose technology with the characteristics of pervasiveness, progressive improvement in cost performance, and support for innovation [12]; e-Government can be conceptualized as the application of this general purpose technology to the specific domain of government. At its core, e-Government uses mostly the same building blocks as retail and business-to-business e-commerce, and faces many of the same technical challenges (e.g., availability, scalability, and security).

While the technology itself might be familiar, e-Government has proven hard to theorize [48]. Sitting at the cusp of public administration and information systems – two multidisciplinary fields in search of their own dominant paradigms – e-Government presents a challenge to native as well as imported theories [9]. Pre-2000 viewpoints of informatization and infocracy (transformation of government processes and structures through information technology) have been largely supplanted by more critical accounts of the reinforcement of existing power structures, over-government, and surveillance. Expectations of technology-led transformation persist, but are now tempered by organizational inertia and the recognition of diverging interests.

Against this backdrop, many past studies of e-Government can be categorized by their focus on the supply of and/or the demand for e-Government. Studies on the demand side investigate the uptake of e-Government services and the satisfaction of users – how e-Government affects citizens and firms [5,54]. Demand-side research on e-Government also examines the *impacts* of e-Government projects, such as the financial and nonfinancial outcomes. The results from these studies find e-Government to be positively associated with business competitiveness, national economic performance, and environmental protection [21,59–61], and negatively with corruption [40].

Studies on the supply side examine obstacles e-Government projects face in achieving their goals [62,25] and the demands they place on the back-office functions of government agencies [1]. They also include measures of "e-readiness" as an enabler of e-Government development, such measures often including technological infrastructure, citizens' skills, and political support. Large-scale empirical studies in this stream of research have explored how a variety of factors influences the adoption of

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e-Government around the globe. Factors found to have a significant effect include a country's income (gross domestic product (GDP)), the munificence of its macroeconomic environment, the quality of its information communication technology (ICT) infrastructure, the level of trust in the society, and the quality of its public institutions and civic life [4,20,58,59].

With the exception of Ifinedo (2011) [28], almost all the studies that have examined e-Government maturity so far use cross-sectional data [58,59] or within-country analyses [33,50]. These studies provide useful information comparing e-Government activity in different countries at particular points in time. However, e-Government evolves *over time*, and the factors influencing this evolution cannot be identified from cross-sectional studies. In particular, how does e-Government mature in a country as its affluence, ICT infrastructure, human capital, and governance evolve over time? Cross-sectional studies, which compare countries at one point in time, cannot answer this question.

Furthermore, the apparent relationship between the predictor and outcome variables estimated through cross-sectional analysis may not hold up in longitudinal analysis. A classic case, where the conclusion from cross-sectional analysis, is *reversed* by longitudinal examination, is described in Rosenthal and Rosnow (2013) [53] who cite [26] Hagenaars and Cobben's (1978) study on the rate of religious nonaffiliation among Dutch women over time. Cross-sectional analysis of this data set erroneously suggests that Dutch women became more religious as they got older, when longitudinal analysis uncovers just the opposite, the confusion being caused by differences in religiosity across successive cohorts (later cohorts starting out more religious than earlier cohorts).

An additional concern with cross-sectional studies is the bias in coefficient estimates introduced by the misspecification of models, particularly the omission of potentially relevant predictors. Data permitting, one way to guard against omitted-variable bias is panel data analysis, where we regress period-to-period *changes* in the dependent variable on the *changes* in the independent variables. If the omitted variable (e.g., geography or culture) is time *invariant* for each country, its effect is captured in the intercepts of the regression model. The effect of omitted variables that change at the *same* rate for all countries is picked up by the slope on the time variable. Panel data analysis can thus be restricted to variables that change at different rates for different countries (GDP, ICT infrastructure, human capital, governance, etc.). Limiting the proliferation of independent variables addresses the width (number of countries) versus depth (number of variables) trade-off [18] faced by most longitudinal studies; here we are able to retain 191 countries in our models, reducing the chances of sampling bias.

Driven by these twin concerns, stronger causal inference [17] and robustness to errors arising from model misspecification, we develop and use panel data to examine the drivers of e-Government maturity. Our research question is: how does the maturity of a country's e-Government services change *over time* as it improves its income level, its ICT infrastructure, its human capital, and its governance institutions and processes? Our focus is not so much on comparing the *state* of e-Government maturity in different countries at a point time as on understanding why e-Government matures at different *rates* over time in different countries. Our mixed-effects statistical models allow countries to start at different levels of e-Government maturity at the start of the study window, and then experience different rates of growth over time (random components in intercept as well as slope estimates).

The next section presents in brief the conceptual arguments supporting our choice of variables that bear on e-Government maturity. Next, we describe our methodology and data, before presenting our results. We conclude with a short discussion of our findings, possible limitations, and avenues for future research.

2. Conceptual model and hypotheses development

2.1. e-Government Maturity

e-Government maturity may be defined as the extent to which a government has established an online presence [81]. The online presence of governments is realized through the features implemented in e-Government web sites such as free access to online publications, access to databases, and a variety of online services (free and paid). Well-developed e-Government sites use multimedia to supplement text in multiple languages, and allow access from a wide range of computing devices (such as tablets and smartphones). e-Government web sites must make it easy for users to voice their concerns and provide feedback, with special attention to disability access [31]. Finally, e-Government web sites must safeguard privacy and security even more closely than their commercial counterparts, and present their policies in these matters clearly for all users.

The demanding requirements laid out above for e-Government web sites cannot be met overnight, and e-Government maturity usually represents a continuum of developmental stages, from publishing information to supporting online transactions, with some having progressed further than others [83]. Previous research on e-Government has thus conceptualized maturity using an evolutionary approach [43,2]. In this view, e-government is seen to progress through a series of *stages* as a function of integration and complexity, or as a function of increasing levels of online activity and customer centricity. Such maturity models are useful because they guide practitioners, help the citizenry understand the trajectory of e-Government, and can be used as a communication tool to explain e-Government to third parties [36].

In this study, we seek to measure and explain e-Government maturity as *demonstrated behavior*, in contrast to other measures that assess the *potential* of a country to enact e-Government. A well-known example of the latter is the United Nation's (UN's) e-Government Readiness Index, which includes, among other components, the state of a nation's telecommunication infrastructure and its level of human capital [72–76]. Other measures of e-Government potential include the World Economic Forum's Networked Readiness Index [87–93], which covers about half to two-thirds of all countries in the world.

The UN and World Economic Forum indices indicate the capacity of a country to engage in e-Government programs, but do not explicitly address its current success in implementing them. Hence, we rely on the evaluation of e-Government web sites by West and his associates at the Inside Politics research center at Brown University. West and his associates examined >1500 government web sites from >190 nations in the summer of each year from 2002 to 2008 [78–84]. Details of the data collected by West are provided in a later section. With respect to stage theories of e-Government evolution, some of West's criteria – databases, security features, and support for digital signatures and credit card payments – bear directly on the capability to deliver service transactions. As a result, our conceptualization of e-Government maturity is focused more on the provision of services than on political activity [36]. Given the wide variation among countries, transaction capability appears to be, in the time frame of the study, a common denominator on which e-Government can be compared across countries.

2.2. Determinants of e-Government maturity

The determinants of e-Government maturity examined in this study are national affluence (in terms of a country's GDP per capita, adjusted for purchasing power parity), ICT infrastructure, human

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