THE IMPACT OF DIGITAL GOVERNMENT ON LABOUR PRODUCTIVITY IN DEVELOPING COUNTRIES

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1. Introduction

1.1. A Background on Digital Government

Digital transformation is an integral tool of innovation that has in recent years prompted a paradigm shift amongst businesses and governments towards the use of more sophisticated technologies. Its role is regarded to be of considerable importance within the development of the public sector, notably through the development of digital government, or E-Government. Digital government has the ability to change the underlying processes, decision-making structures, and government procedures through the adoption of digital methods (Schuppan, 2009). The scope and sophistication of these advancements has created an environment for significant productivity gains to be realised in both developed and developing economies. An example of this can been seen in Estonia, where the near universal diffusion of electronic ID cards enables citizens to access over 1500 central and local government services online (Kattel et al, 2017). In developing economies, such technological advancements enable governments to increase the level of transparency between themselves and citizens in addition to promoting the use of digital technologies. Therefore, it has been argued that the returns to E-Government in developing economies are significant, and as such this study intends to focus on them as an area of considerable interest.

1.2. The Relationship Between Digital Government and Productivity

The appropriate application of E-Government can reduce the number of inefficiencies in government processes, leading to greater productivity growth (Ndou, 2004). The channels that facilitate this relationship can be separated into back office, front office, and investment effects. The back office consists of the internal operations and core processes of a government administration (Lau, 2005). According to McKinsey (2017), digitalizing back office processes offers the greatest potential for efficiency gains in the public sector, with significant resource and processing savings becoming possible. Undergoing structural changes, for example switching to paperless systems, or reducing the number of government service employees, frees up these resources for other purposes and can allow the government to increase its productive capacity (OECD, 2016).

The front office effect refers to the change in the relationship between government, citizens and businesses (Lau, 2005). Providing citizens and businesses with simplified and accessible methods of accessing public information services makes their communication with government more efficient and transparent (Bhatangar, 2003). The increased transparency of government can play a vital role in enhancing productivity, since citizens and businesses have greater access to the public information and services necessary for their operation.

The impact of public sector digitalization can also instigate economy-wide investment effects in digital technologies. Corsi (2010) stipulates that investment in public sector digitalization as a result of E-Government policy will stimulate the adoption of such technologies across

other sectors in the economy. This notion is furthered by Van Ark (2013), who states that the potential of IT and to accelerate productivity growth comes primarily from the use of these technologies by other industries in non-IT sectors, with the government acting as the driver of innovation. These developments can produce a positive feedback loop in the economy that can enable further reinvestments in technological capacity across a variety of sectors (Kattel et al, 2017).

1.3. The Relevance of Developing Economies

The efficiency gains and the spread of digital technologies associated with the development of a digital government framework are especially relevant in developing countries. Schuppan (2009) stipulates that E-Government can act as a catalyst for achieving essential development policy objectives, especially in countries where the public sector is characterized by inefficiency and limited capacity. This catalysing effect is particularly relevant in promoting transparency and digital diffusion, both of which can have significant positive impacts on productivity.

Transparency is key in promoting social and economic development. The increase in accessibility of information under a digital government framework makes the decision-making process of those in government more traceable (Bhatangar, 2003). This can provide a basis for stronger government accountability and public sector integrity (OECD, 2018b), and is incredibly relevant in developing countries where public administrations are often characterized by corruption and inefficiency. According to Lau (2005), E-Government can prevent corrupt practices by maintaining data on transactions, lessening individual discretion, and providing ways to trace corrupt acts. With regards to productivity, transparency can facilitate the better management of social and economic resources for development (Basu, 2004). This can ensure that public funds, for instance, are invested in public goods and services rather than being distributed amongst those in power, a behavioral change that is vital in promoting sustainable growth and development.

Digital government can also pose huge potential to the diffusion of technological innovation across developing economies. In order to facilitate growth and development, governments need to create an environment in which technologies and processes can be refined in the private sector and adapted to deliver better services (IoD, 2018). E-Government initiatives can actively achieve this. The OECD (2017) suggests that digital technologies should be embedded in public sector reform, since an absence of accessibility is likely to lead to uneven development and missed opportunities in the form of productivity gains, economic growth, and social inclusion. Moreover, Basu (2004) stipulates that developing economies can experience “leapfrogging” opportunities through the availability of digital technologies. He suggests that bypassing successive generations of technology provides developing countries with access to newer, more efficient, and often cheaper alternatives to traditional capital-intensive technologies. If adopted across a variety of sectors, leapfrogging technologies can completely reinvent the way an economy operates and provide developing countries with a platform upon which they can compete in the global market.

2. Empirical Analysis

2.1. Data and Variables

This study proposes the two following hypotheses. Firstly, higher levels of E-Government development generate a positive impact on aggregate labour productivity. Secondly, the impact of E-Government on labour productivity is larger in developing economies relative to developed economies. The dataset I have used to conduct this investigation includes panel data on 178 countries for years 2003, 2004, 2005, 2008, 2010, 2012, 2014, and 2016. These are the years that have available data for our E-Government indicator. Although only spanning over a relatively short time period, this dataset still provides important insights into the development and impact of digital government programmes, especially considering that digital government development is still a fairly recent phenomenon. In order to capture the added value of E-Government development on developing countries, the data has been grouped into "developed" and "developing" countries.

We start by describing the key E-Government measurement variables, for which essential data was obtained from the United Nations (UN) E-Government Survey. Our primary indicator is the E-Government Development Index (EGDI), which incorporates access characteristics such as infrastructure, the diffusion of online services, and education, to reflect how a country is using information technologies to promote access and inclusion of citizens. The EGDI ranks countries from 0 to 1 based on the weighted average of three normalized scores on:

1. The scope and quality and online services, captured by the Online Service Index (OSI)
2. The development status of telecommunication infrastructure, captured by the Telecommunication Infrastructure Index (TII)
3. Inherent human capital, captured by the Human Capital Index (HCI)

The composition of EGDI from these three sub-indices is illustrated in Figure 1:

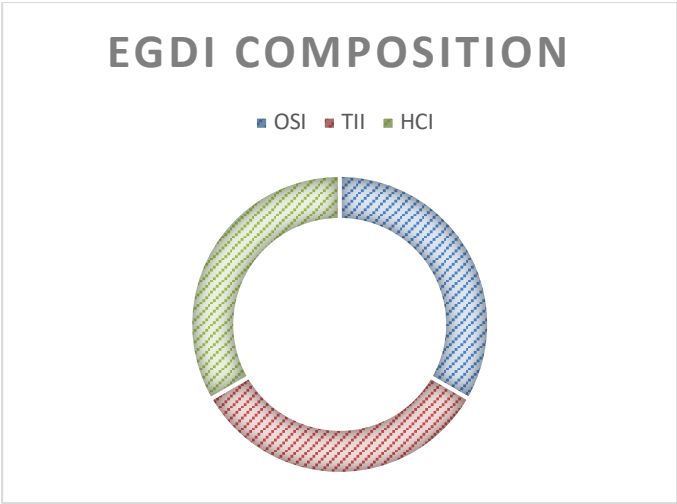

Figure 1: EGDI Composition
(Source: UN E-Government Survey)

It is worth noting that the EGDI is not designed to measure e-government development in an absolute sense; instead it aims to give a performance rating of national governments relative to each other. Therefore, an increase in the EGDI of a given country should be interpreted as an improvement of digital government relative to the scope of such services across other countries.

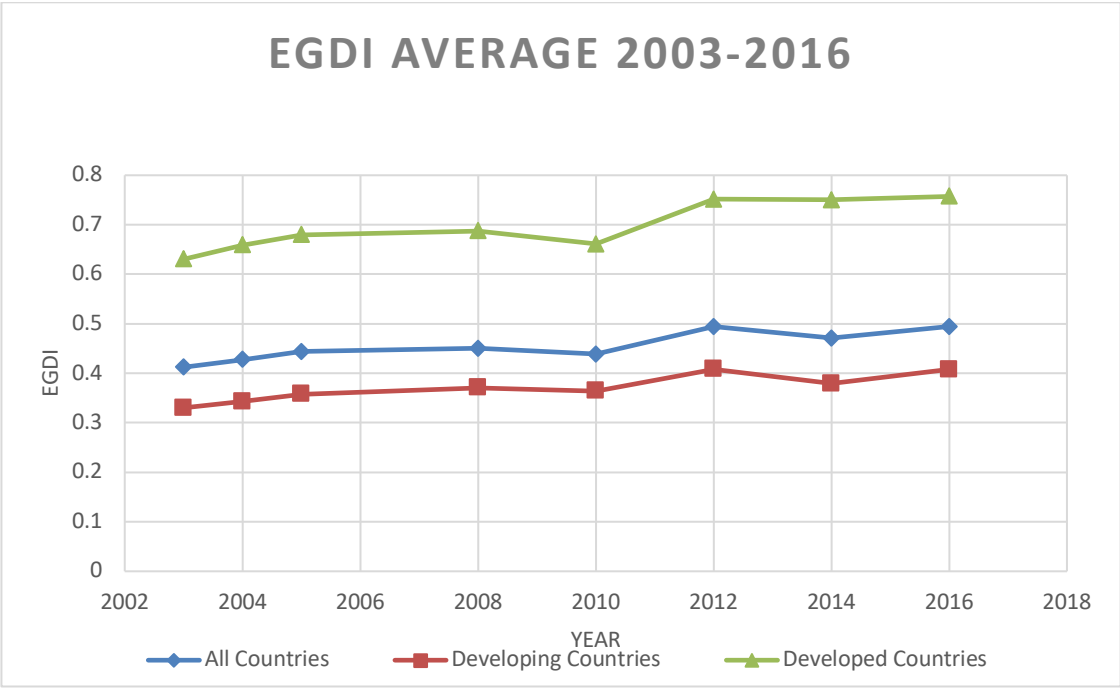

Figure 2: EGDI Average 2003-2016
(Source: UN E-Government Survey

The evolution of the EGDI is presented in Figure 2. The graph illustrates the gradual increasing trend in E-Government development across all countries over the period. This indicates that efforts in developing digital government increased over the 14-year period across both developed and developing samples. It is also worth noting that the pattern of E-Government development is also the same across the developed and developing country samples. This indicates that advances in the sophisticated digital government frameworks used in developed countries such as the UK, South Korea, and Denmark, who have consistently performed at the top of the EGDI index, can also permeate into the digital structures used by developing economies.

Labour productivity data was obtained from ILOSTAT, the public labour statistics database curated by the International Labour Organisation (ILO). Labour productivity is measured as gross domestic product (GDP) for the aggregate economy per the number of persons employed. This is expressed in purchasing power parities (PPP) to account for price differences in countries. Given that this is measured in absolute terms, in the regression we take the natural logarithm of the values in order to calculate the percentage change in labour productivity resulting from an increase in the EGDI (Wooldridge, 2012).

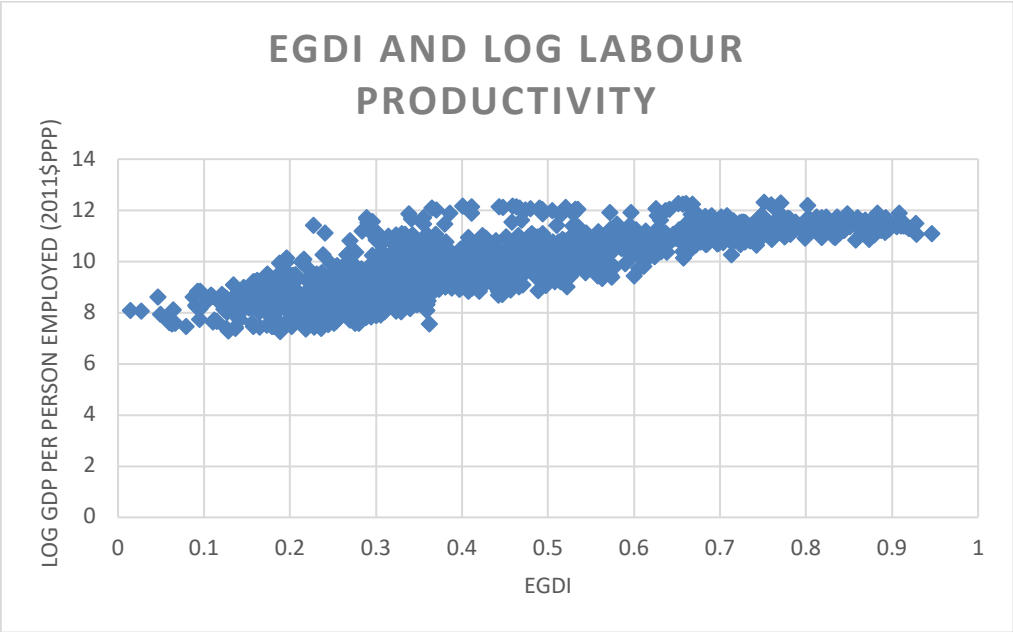

Figure 3: EGDI and Log Output per Worker
(Source: UN E-Government Survey, ILOSTAT)

Figure 3 presents a scatter plot of the log of output per worker, measured as the log of GDP per person employed, against the EGDI index. It includes a total of 178 countries over 8 individual years of measurement, with the EGDI ranging from 0.01387 to 0.94623. It is clear from the figure that there is a positive correlation between EGDI and output per worker. This strength of this correlation was calculated to be 0.8035. This suggests that, as anticipated,

there is a strong and positive relationship between E-Government development and labour productivity.

2.2. Identification Strategy and Reduced Form Estimation

It is worth noting that measures of E-Government have not been defined in absolute terms. As a result, the analysis proposed in this study is not seeking to define how an increase in E-Government investment, for instance, will impact labour productivity. Rather, the aim is to clarify the relationship between these two variables in order to motivate the development of a structural model. To conduct this analysis, I will run the following specifications for developed and developing country samples:

<u>Specification 1</u>

$$\log Y_{it} = \alpha + \beta_1 EGDI_{it} + \beta_2 \log(capital)_{it} + \beta_3 \log(rural)_{it} + \beta_4 \log(adr)_{it} + \beta_5 \log(mort)_{it} + \theta T_t + \varepsilon_{it}$$

<u>Specification 2</u>

$$\log Y_{it} = \alpha + \delta_1 OSI_{it} + \delta_2 HCI_{it} + \delta_3 TII_{it} + \delta_4 \log(capital)_{it} + \delta_5 \log(rural)_{it} + \delta_6 \log(adr)_{it} + \delta_7 \log(mort)_{it} + \theta T_t + \varepsilon_{it}$$

In both specifications, $i = 1, \dots, 178; t = 1, \dots, 8$

Where Y_{it} is nominal GDP per person employed measured in 2011 $PPP, $EGDI_{it}$ is the E-Government Development Index, $capital_{it}$ is gross capital formulation in current $USD, $rural_{it}$ is the rural population, adr_{it} is the age dependency ratio, $mort_{it}$ is the mortality rate, and T_t is a vector of time dummy variables that represent time specific effects. All data for control variables was obtained from the World Bank. In accordance with the results of the Hausman test, these regressions will by estimated using a fixed effects model.

3. Results

Table 1 reports the fixed effects estimates obtained for Specification 1. Table 5 includes analogous results for Specification 2. These estimates are split into our full sample of 178 countries (1) in the first column, and then separated to provide estimates for our developing sample (2) and our developed sample (3). Specification 1 aims to capture the effect of a unit change in the EGDI, as a composite index, on labour productivity. In our sample of all countries the EDGI has a positive and statistically significant impact on GDP per person employed, with a 0.01 increase in the EGDI increasing GDP per person employed by

0.137%. When decomposed into the separate developing and developed samples, it is clear that is effect is more salient in developing economies, with the coefficient on EGDI in (2) being larger and more statistically significant than those in (1) and (3). This coefficient suggests that in developing economies, a 0.01 unit increase in the EGDI is synonymous with an increase of 0.469% increase in GDP per person employed. It is worth noting that in Specification 1, the coefficient for developed countries (3) is not statistically significant. The insignificance of this results could be due to the relatively small sample size of 44 countries included in the developed sample, in addition to the lack of variation within across developed countries with regards to their EGDI values (refer to Table 1 for summary statistics).

	All Countries (1)	Developing Countries (2)	Developed Countries (3)
EGDI	0.137* (0.07)	0.469*** (0.08)	0.148 (0.09)
log(capital)	0.173*** (0.01)	0.172*** (0.01)	0.077*** (0.01)
log(mort)	0.048 (0.05)	0.054 (0.05)	0.026 (0.10)
log(rural)	-0.348*** (0.04)	-.0265*** (0.05)	-0.202*** (0.05)
log(ADR)	0.363*** (0.06)	-0.043 (0.08)	0.700*** (0.08)
year==2003	0.000 (.)	0.000 (.)	0.000 (.)
year==2004	0.01 (0.004)	-0.007 (0.01)	0.014 (0.01)
year==2005	0.004 (0.01)	-0.011 (0.01)	0.014 (0.01)
year==2008	0.004 (0.02)	-0.019 (0.02)	0.032 (0.02)
year==2010	0.038* (0.02)	0.006 (0.02)	0.052* (0.02)
year==2012	0.043* (0.02)	-0.001 (0.02)	0.035 (0.03)
year==2014	0.068*** (0.02)	0.035 (0.03)	0.027 (0.03)
year==2016	0.120*** (0.02)	0.069** (0.03)	0.023 (0.04)
constant	9.410*** (0.82)	9.471*** (0.93)	9.247*** (1.29)
R^2	0.546	0.644	0.522

* p<0.05, ** p<0.01, *** p<0.001

Table 1: Fixed Effects Regression of GDP per person Employed on EGDI (Specification 1)

	All Countries (4)	Developing Countries (5)	Developed Countries (6)
OSI	0.051 (0.03)	0.167*** (0.03)	-0.002 (0.04)
TII	0.072 (0.06)	0.221** (0.07)	0.183** (0.07)
HCI	0.039 (0.05)	0.107* (0.05)	-0.072 (0.18)
log(capital)	0.172*** (0.01)	0.171*** (0.02)	0.078*** (0.02)
log(mort)	0.044 (0.05)	0.051 (0.05)	0.027 (0.10)
log(rural)	-0.331*** (0.04)	-0.222*** (0.06)	-0.207*** (0.05)
log(ADR)	0.360*** (0.06)	-0.058 (0.08)	0.686*** (0.08)
year==2003	0.000 (.)	0.000 (.)	0.000 (.)
year==2004	0.004 (0.01)	-0.004 (0.01)	0.028 (0.02)
year==2005	0.006 (0.01)	-0.004 (0.01)	0.020 (0.01)
year==2008	0.000 (0.02)	-0.027 (0.02)	0.036 (0.02)
year==2010	0.034* (0.02)	-0.002 (0.02)	0.051* (0.02)
year==2012	0.037 (0.02)	-0.018 (0.02)	0.022 (0.03)
year==2014	0.059* (0.02)	0.010 (0.03)	0.001 (0.04)
year==2016	0.109*** (0.02)	0.040 (0.03)	-0.005 (0.04)
constant	9.190*** (0.83)	8.946*** (1.29)	9.415*** (1.29)
R^2	0.541	0.636	0.532

* p<0.05, ** p<0.01, *** p<0.001

Table 2: Fixed Effects Regression of GDP per person Employed on OSI, TII, and HCI (Specification 2)

In Table 2, it is possible to determine the impacts of the individual indices comprised to form the EGDI. As shown in column (5), in developing countries the OSI, TII and HCI are all statistically significant. In this case the TII has the most significant impact on labour productivity, with a 0.01 increase in the TII resulting in a 0.221% increase in GDP per person employed. Furthermore, column (6) shows that in our developed sample the TII is the only statistically significant EGDI variable, with a 0.01 increase in the TII yielding a 0.183%

increase in GDP per person employed. In contrast to the impact of the HCI and the OSI, the coefficients on TII are not largely different between developed and developing samples. This indicates that the development and maintenance of infrastructure is somewhat more important in determining labour productivity than human capital and the availability of online services. In practice this is very intuitive, since without foundations in digital infrastructure (i.e. telephone and internet cables, reliable access to electricity), access and use of digital government would be significantly impeded regardless of the sophistication of the online platforms or the digital literacy of the population.

4. Conclusion

To conclude, the relationship between digital government development and labour productivity is significant, with developing economies experiencing the largest impact. This result confirms both of the hypotheses considered in this study. However, given the lack of a structural model that can describe the direct relationship between digital government and output per worker, it is not possible from this study alone to determine a causal relationship between these two variables. Furthermore, given that EGDI is a relative rather than absolute measure of digital government development, the interpretation of our results cannot be done in absolute terms. However, the significance of this study is in its role as a benchmark for future research in analysing the economic effects of digital government. In order to clarify a causal relationship, future groundwork must be done on the development of a structural model and the analysis of the inputs and outputs involved in digital government development. These avenues of research are paramount in our understanding of the scope and sophistication of digital government and the positive socioeconomic impact it can have on both developed and developing economies.

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