Chapter 11

Can Digital Government Improve Economic Resilience?

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1. Introduction

As the coronavirus disease (COVID-19) pandemic continues to tarnish the world economy, more than 3 years since its outbreak, it has become increasingly apparent that governments around the world have a crucial role to play – both to contain the spread of the virus and protect lives and to revitalise the economy. Indeed, as new variants continue to emerge, uncertainties remain as to when the pandemic will be brought under control. Meanwhile, internet-based contactless activities have flourished, on the one hand driven by sustained restrictions on people's movements and interactions to contain the spread of the virus, and on the other hand supported by the development of internet-related technologies. Many foresee significant changes taking place and gradually taking root in how societies will be organised and function in the future.

As societies change and adapt, an important question is how governments have and should respond to enhance and improve their performance, by taking advantage of the possibilities arising from the emergence and spread of many internet- and data-based contactless governance tools. In this chapter, we approach this question by examining whether and how digital government plays a role in two important aspects – protecting lives and enhancing growth.

On the other hand, as significant development gaps remain amongst countries, the degree of digitalisation and the adoption of internet-based technologies varies considerably, including by governments. In addition to addressing various challenges with the available technology and infrastructure, governments have tried to adjust the development of digital government to adapt to the impacts of the pandemic. This may further diverge the development of digital government and its contribution to economic growth amongst different countries in the future.

The objective of this study is to examine the role of digital government in the world's efforts to fight the global pandemic. Our main research questions are:

(i) What are the impacts of digital government on countries' overall economic performance before and during the pandemic?
(ii) What are the impacts of digital government development on governments' pandemic policies?
(iii) What are the impacts of the pandemic on the development of digital government?

2. Literature Review

2.1. The impacts of digital government on economic performance

Since the 1960s, governments in many countries have undertaken the computerisation and basic automation of government services (Dunleavy et. al., 2006), although the development of digital government varies significantly amongst nations (UN, 2012; Nograšek and Vintar, 2014). International organisations also call for more efforts on the implementation of digital-government. The United Nations (UN, 2012) defined digital government as the use of information and communication technologies (ICTs) to deliver government services more effectively and efficiently to citizens and businesses. The World Bank (2008) also considered digital government as the use of information technology (IT) to improve business processes and service delivery by government departments and other government entities. For the Organisation for Economic Co-operation and Development (OECD, 2003: 17), digital government is 'the use of ICTs, and particularly the internet, to achieve better government'.

However, earlier academic research about digital government focused on the technology side and its impacts on public services (Dunleavy et al., 2006). More attention has been paid to the economic impacts of digital government since the early 2010s. Some studies have shown a positive relationship between digital government and economic growth (Khan and Majeed, 2019; Castro and Lopes, 2022). Research has also investigated the impacts of digital government on different aspects of the economy, such as trade (Majeed and Malik, 2016), the digital economy (Ali, Hoque, and Alam, 2018), and foreign direct investment (Al-Sadiq, 2021). Zhao, Wallis, and Singh (2015) found that the relationships between digital government and the digital economy are reciprocal.

Based on annual data for 24 OECD member countries from 1998 to 2006, Corsi and D'Ippoliti (2013) showed that investment in digital government can significantly improve the productivity of public administrations, which can further contribute to economic growth.

Bélanger and Carter (2012) argued that by using ICT, digital government allows governments to provide better-quality and more effective and efficient public services for businesses, employees, residents, and other government entities, which can lubricant the growth of the economy. The adoption of digital government can also boost public services and communication (Krishnan, Teo, and Lim, 2013) as well as the information economy and other business opportunities, which are also growth drivers of the economy.

Ali (2021) showed that better digital government can help economies enhance foreign direct investment inflows through three channels: efficiency gains through cost and time reductions; reduced corruption, with more inclusive, effective, accountable, and transparent public services; and access to information and knowledge about investment opportunities.

Based on annual data for 15 countries in the Middle East and North Africa region between 2003 and 2018, Dhaoui (2022) showed that better digital government development significantly improves governance in terms of the control of corruption, government effectiveness, and regulatory quality. The study also found that good governance has a positive contribution to sustainable development, including gross domestic product (GDP) per capita. However, there is no significant evidence of digital government's positive impacts on any aspects of sustainable development they investigated.

On the other hand, evidence has shown that economic performance can also affect the development of digital government. For example, based on the annual data of the 534 largest cities in the world for 2003, 2009, and 2016, Ingrams et al. (2020) showed that population size, GDP, and regional competition have a positive impact on the development of digital government.

2.2. The role of digital government in the pandemic

As infectious cases began rising sharply in various countries in early 2020, governments took unprecedented steps to lock down social activities to contain the spread of the virus, which inadvertently disrupted the global economy. The negative impacts of the pandemic on the global economy have achieved widespread agreement amongst economists (Statista Research Department, 2023). A forecast by the World Bank indicated that the economic recession in 2020 would affect 90% of the world's economies and could become the deepest since World War II (World Bank, 2020). According to the International Monetary Fund (IMF, 2021), global economic growth fell to an annualised rate of around –3.2% in 2020. In addition, the impacts can be long-lasting. According to OECD (2020) calculations, output may remain around 5% below pre-crisis expectations in many countries in 2022. OECD (2020) also warned that the pandemic is fragmenting the global economy through a growing number of trade and investment restrictions and diverging policy approaches that are being implemented on a country-by-country basis, which can have very long impacts on the global economy.

Meanwhile, governments' economic policy responses to the pandemic were extraordinary in terms of the speed with which they took place, the broad scope of the fiscal and monetary policies they adopted, and the number of countries involved. Therefore, the implementation of these policies is crucial to their effectiveness.

Several studies have shown that digital government can play an important role in policy implementation during the pandemic. According to Knutt (2020), the Romanian Ministry of Labour used robotic process automation to distribute direct payments to self-employed workers impacted by COVID-19. Of the 285,000 claims processed, 96% were automated, with each claim taking 36 seconds as opposed to 20 minutes when processed manually. A Gartner report (Gartner, 2020) also showed that government organisations increased their IT spending on digital public services, public health, social services, education, and workforce reskilling in support of individuals, families, and businesses that were heavily impacted by the COVID-19 pandemic in 2020.

Sullivan et al. (2021) argued that digital government was no longer 'nice to have' for governments, but imperative. They found that, to meet the needs of the pandemic, governments all over the world accelerated their digital transformation through investment and human capital training, and 79% of government officials in their survey indicated that automation is making a significant positive impact on their business, so the adoption of automation is likely to continue. Based on a web survey amongst 404 residents during the Recovery Movement Control Order period in Malaysia in 2020, Dawi et al. (2021) showed that digital government significantly improved public engagement on protective behaviour. However, further quantitative analysis and studies on this topic are still needed.

Some governments have also adjusted the development of digital government to adapt to the impacts of the pandemic. Based on a survey of individuals, officials, and government agents in Latin America and the Caribbean, Roseth, Reyes, and Yee Amézaga (2021) found that the pandemic has led many countries to digitise a significant range of services. At the same time, the proportion of citizens using the internet to access government transactions rose from 21% before the pandemic to 39% during it. However, around 50% of citizens completed their last such transaction in person. Regarding teleworking in the public sector, almost half of all employees stated that they had been unable to perform critical tasks since the onset of the pandemic, many of which could have been resolved using digital governance tools. These findings point to the need to improve the availability and quality of digital services, as well as the feasibility of government telework.

A UN Department of Economic and Social Affairs policy brief showed that the percentage of government portals with COVID-19 information increased from 57 on 25 March 2020 to 86 on 8 April 2020. It argued that digitalisation can help governments and society respond to crises in the short term, resolve socio-economic repercussions in the midterm, and reinvent policies and tools in the long term (UN DESA, 2020).

Freeguard, Shepheard, and Davies (2020) argued that the pandemic has accelerated the digital transformation of public service delivery and government use of data in the United Kingdom. They showed that digitalisation has made public services more efficient in certain sectors, such as the Coronavirus Job Retention Scheme, the Self-Employment Income Support Scheme, the Vulnerable People Service, and Verify and Notify Citizens. However, they also noticed some high-profile failures, such as the roll-out of the contact tracing app, which caused more problems than it solved.

In summary, digital government has been considered an important contributor to many countries' economic growth and their efforts to combat the pandemic. Some countries have also accelerated the development of digital government during the pandemic. In the following sections, we will investigate how digital government has contributed to countries' efforts to combat the pandemic as well as its possible contribution to economic growth in the future.

3. Methodology

We follow the policy-oriented study of Bassanini and Scarpetta (2003) and use their policy-augmented growth equation derived from a neoclassical growth model based on constant-returns-to-scale technology (Barro, Mankiw, and Sala-I-Martin, 1995) as our benchmark equation:

$$g_{i,t} = \beta_0 + \beta_1 \, lny_{i,t-1} + \beta_2 \, lnI_{i,t} + \beta_3 \, h_{i,t} + \beta_4 \, \Delta lnpop_{i,t} + \sum_{i=5}^{m} \beta_j \, lnV_{i,t}^{j} + \varepsilon \qquad (1)$$

where g is the annualized growth rate of GDP per capita; y is GDP per capita; I is the investment; h is human capital; $\Delta lnpop$ is population growth; V_j is a vector of policy-related variables affecting economic efficiency; and ε is the usual error term. The policy-related variables include inflation, government size, financial development, and openness.

To investigate the impact of digital government on economic performance, we add digital government related variables into Equation (1). As suggested by the UN E-Government Survey, e-government can affect the economy from two aspects: the development status of e-government and public participation in e-governance. Since digital government shares many features with e-government, the economic impacts of digital government can be quite similar to those of e-government. Therefore, our analysis of the economic impacts of digital government also includes variables measuring the development status of e-government and public participation in e-governance.

According to the literature mentioned above, the COVID-19 pandemic impacted the economies mainly from three channels. First, the severe epidemic made people unable to carry out normal economic activities due to the fear of being infected. Second, the preventative measures implemented by governments to slow the spread of the virus also slowed down most economic activities. Third, governments' economic supporting policies may help reduce the economic damage caused by the epidemic and promote economic recovery. The first impact has negative impacts on almost all aspects of economic performance. Therefore, we add the pandemic-related variables to our estimated equations to investigate the impacts of pandemic severity, preventative measures, and economic support policies on economic performance.

The pandemic effects may also change the effectiveness of digital government. As many studies mentioned above have shown, during the pandemic, the development of digital government has been speeded up in many countries, including both infrastructure development and utilisation. At the same time, due to its contactless feature, digital government may also improve the effectiveness of governments' preventative measures and economic support policies. Therefore, the impacts of

digital government on economic performance may be strengthened during the pandemic. We add the interactive variables of digital government and pandemic-related variables into our estimated equations to test these possible impacts.

The data we used to measure the variables mentioned above are from three sources: the economic-related data are from CEIC Data's World Trend Plus Database (CEIC, 2022); the digital government related data are from the UN's E-Government Survey for 2014, 2016, 2018, and 2020 (UN, 2014, 2016, 2018, 2020); and the pandemic-related data are from the Oxford COVID-19 Government Response Tracker (OxCGRT) (Mathieu et al., 2020).

CEIC Data's World Trend Plus Database provides annual and seasonally adjusted quarterly time series data on key economic indicators such as nominal and real GDP and GDP growth, the Consumer Price Index (CPI), government consumption, exports, imports, capital formation, and population. CEIC calculates the seasonally adjusted series by X-12 ARIMA.[1]

The UN E-Government Survey is a biennial survey published by the Department of Economic and Social Affairs since 2001 (UN, 2001). It assesses the digital government development status (E-Government Development Index (EGDI)) and the effectiveness of the digital government (E-Participation Index (EPI)) of all 193 UN Member States. Neither the EGDI nor the EPI capture digital government development or inclusion in an absolute sense; rather, they give a performance rating of national governments relative to one another. The EGDI tries to incorporate countries' website development patterns and access characteristics, such as infrastructure and educational levels, to reflect how a country uses IT to promote access and inclusion. Therefore, the EGDI is a weighted average of three normalised scores on the three most important dimensions of e-government: (i) the scope and quality of online services (Online Service Index), (ii) the development status of telecommunication infrastructure (Telecommunication Infrastructure Index), and (iii) inherent human capital (Human Capital Index). These aspects are also the three most important factors for the development of digital government. Therefore, the EGDI can also reflect the development status of digital government.

The survey questions and the national scores of the EPI focus on how well a government relays information to its constituents (e-information sharing), how engaged citizens are in the design of policies (e-consultation), and how empowered citizens feel in the decision-making process (e-decision making). The EPI is normalised by taking the total score value for a given country, subtracting the lowest total score for any country in the same year survey, and dividing by the range of total score values for all countries.

The OxCGRT tracks the development of the COVID-19 pandemic and the policy measures that governments have taken to deal with COVID-19 since 1 January 2020. It provides systematic information covering more than 180 countries and codes the information into 23 indicators. In our study, we use the number of confirmed cases, the overall government response index, the stringency index, the economic support index, and the containment and health index.

A detailed description of the variables and data used in our empirical analysis is summarised in Table 11.1.

[1] X-12-ARIMA is a seasonal adjustment software package developed by the United States Census Bureau in 1998. It is based on the autoregressive integrated moving average (ARIMA) regression model.

Table 11.1. Variable List

Variable	Description	Availability
	Economic variables	
growthi,t	Seasonally adjusted year-on-year growth of quarterly real GDP	Q1 2015–Q3 2021
Export	Seasonally adjusted year-on-year growth of quarterly exports in million US dollars	Q1 2014–Q3 2021
Import	Seasonally adjusted year-on-year growth of quarterly imports in million US dollars	Q1 2014–Q3 2021
lnCF	Logarithm of seasonally adjusted quarterly gross fixed capital formation in million US dollars	Q1 2014–Q3 2021
CPIYOY	Seasonally adjusted year-on-year change in quarterly Consumer Price Index	Q1 2014–Q3 2021
GDPPC	Real GDP per capita, annual data	2014–2020
lnH	Logarithm of the stock of human capital measured with the Human Capital Index from CEIC, which is calculated by the Groningen Growth and Development Centre and based on years of schooling and returns to education, annual data	2014–2020
lnPop	Logarithm of population in million persons, annual data	2014–2020
lnDeposit	Financial development measured by the logarithm of total deposits as a percentage of GDP, annual data	2014–2020
Open	Exposure of countries to foreign trade measured by the sum of exports and imports as a share of GDP, annual data	2014–2020
	Digital government variablesw	
EGOV	UN E-Government Index, biennial data	2016, 2018, 2020
EPart	UN E-Participation Index, biennial data	2016, 2018, 2020
EServ	Online Service Index, biennial data	2016, 2018, 2020
Tel	Telecommunication Infrastructure Index, biennial data	2016, 2018, 2020
	Pandemic-related variables	
Pandemic	A dummy variable valued at 1 for Q1 2020–Q3 2021, and 0 for Q1 2015–Q4 2019	Q1 2015–Q3 2021
lnConfirmed	Logarithm of the total number of confirmed cases. Equals 0 for periods before Q1 2020.	Q1 2015–Q3 2021
RConfirmed	Share of confirmed cases in population. Equals 0 for periods before Q1 2020.	Q1 2015–Q3 2021
GovResp	The OxCGRT overall government response index measures the overall strength of government responses based on all indicators in the database. A higher value indicates stronger government responses. Equals 0 for periods before Q1 2020.	Q1 2015–Q3 2021

Variable	Description	Availability
Stringency	The OxCGRT stringency index measures the strictness of 'lockdown style' policies that restrict people's behaviour and public information campaigns. A higher value indicates stricter policies. Equals 0 for periods before Q1 2020.	Q1 2015–Q3 2021
EconSupport	The OxCGRT economic support index measures the strength of economic policies such as income support and debt relief. A higher value indicates stronger economic support. Equals 0 for periods before Q1 2020.	Q1 2015–Q3 2021
Health	The OxCGRT containment and health index combines 'lockdown' restrictions and closures with health-related measures such as testing policy and contact tracing, short-term investment in healthcare, as well investments in vaccines.	Q1 2015–Q3 2021

GDP = gross domestic product, Q = quarter, UN = United Nations, US = United States.

Source: Authors' summary.

All policy-related variables have been introduced with a 1-year lag to reflect the lag of policy effectiveness. After combining data from all three data sources, we have 62 countries left in our estimations.

As our data mix up quarterly, annual, and biennial data, the number of observations for each regression is determined by the frequency of its dependent variable. If the data of the dependent variable are quarterly (e.g. the growth), the values of an independent variable with annual data will be the same for all quarters of the same year. If the dependent variable is a biennial digital government related variable, the values for the fourth quarter (Q4) of the previous year will be used for the independent economic variables. The values for different quarters of the same year will be used in separate regressions for the pandemic-related variables, so that the impacts of the pandemic at different periods can be investigated. A more detailed explanation is provided in the following section.

4. Statistic and Econometric Analysis Results

4.1. The impact of the pandemic and Chinese investment

To analyse the impacts of the pandemic on economies, we first compare the changes in economic performance in 2020 by region based on our data. The regional mean values[2] of year-on-year percentage changes in 2020 are calculated for the economic variables listed in Table 11.1 and reported in Table 11.2. Regions are listed in the order of their regional mean changes of real GDP, from lowest to highest. From Table 11.2, we have a preliminary finding: the pandemic did affect the economic performance of most economies in 2020. All regions recorded negative mean changes in real GDP and openness in 2020. All regions except South America increased government consumption expenditure in 2020.

To compare the development of digital government and the impact of the pandemic on digital government development for different regions, we calculated the regional mean values of digital government related variables as well as changes in these regional mean values for different regions in 2020. In Tables 11.3 and 11.4, regions are listed in the order of their regional mean e-government, index from highest to lowest. Table 11.3 reports the regional mean values of each index in 2020. Table 11.4 reports the differences between the regional mean of biennial index changes in 2020 and the regional mean of biennial index changes over 2016–2020. From Tables 11.3 and 11.4, we can see that the development of digital government in Oceania, East Asia, and Europe is better than in other regions. However, for all these top regions, the provision of online services is less developed than e-participation, human capital, and telecommunication infrastructure. The Arab Middle East is temporarily behind but developed rapidly during 2018–2020 (Table 11.4). All regions except South America have accelerated the development of telecommunication infrastructure in recent years, especially those left behind such as Sub-Aaharan Africa, the Arab Middle East, and West Asia (Table 11.4). On the other hand, the growth of online services provision and e-participation have been slowing significantly for most regions. This may be because the development of digital government has reached a more challenging stage compared with earlier stages for the whole world.

[2] We performed similar analysis based on median values, which produced similar findings.

Table 11.2. Year-on-Year Change in Economic Performance by Region, 2020
(%)

Region	Real GDP	Real GDP per capita	Openness	Government Consumption Expenditure	Total Deposit
North America	-10.36	1.19	-5.74	4.11	9.67
South America	-7.73	-8.30	-0.33	-6.79	14.40
Arab Middle East	-5.78	-6.17	-12.45	21.76	14.72
Sub-Saharan Africa	-4.37	-6.62	-6.14	4.31	22.91
Europe	-4.35	-4.10	-4.86	7.42	18.19
West Asia	-2.99	-3.83	-9.26	6.33	10.63
Southeast Asia	-2.75	-3.72	-1.39	4.23	9.68
Oceania	-1.79	-2.69	-5.72	7.25	18.36
East Asia	-1.72	-2.04	-5.19	8.23	17.12
Total	**-4.42**	**-4.91**	**-5.66**	**6.31**	**15.60**

GDP = gross domestic product.

Source: Authors' calculation based on data from CEIC (2022).

Table 11.3. Digital Government Development by Region, 2020

Region	E-Government Index	E-Participation Index	Online Service Index	Human Capital Index	Telecom-munication Infrastructure Index
Oceania	0.845	0.806	0.794	0.925	0.817
East Asia	0.835	0.865	0.812	0.858	0.835
Europe	0.826	0.813	0.786	0.878	0.816
South America	0.726	0.749	0.738	0.808	0.633
Southeast Asia	0.649	0.625	0.622	0.694	0.630
North America	0.642	0.610	0.607	0.730	0.591
West Asia	0.638	0.652	0.658	0.720	0.536
Arab Middle East	0.570	0.502	0.519	0.619	0.571
Sub-Saharan Africa	0.429	0.447	0.456	0.513	0.318
Total	**0.650**	**0.641**	**0.636**	**0.716**	**0.598**

Source: Authors' calculation based on data from UN (2014, 2016, 2018, 2020).

Table 11.4. Impacts of the Pandemic on Digital Government Development by Region

Region	E-Government Index	E-Participation Index	Online Service Index	Human Capital Index	Telecom-munication Infrastructure Index
Oceania	5.659	4.536	-3.959	-0.318	28.470
East Asia	-0.934	-17.621	-14.621	-0.872	15.768
Europe	-1.170	-17.481	-14.486	-3.571	12.828
South America	-5.692	-16.831	-18.683	-3.866	-8.407
Southeast Asia	1.695	-1.229	-19.867	-3.724	1.485
North America	-2.758	-30.663	-26.326	-0.542	11.256
West Asia	1.913	-33.191	-44.171	3.433	38.872
Arab Middle East	15.369	-0.804	13.636	5.227	40.409
Sub-Saharan Africa	9.277	0.901	-9.907	7.543	41.247
Total	**3.414**	**-12.488**	**-15.098**	**1.108**	**23.376**

Source: Authors' calculation based on data from the UN (2014, 2016, 2018, 2020).

4.2. Estimation results

To further analyse the impacts of the pandemic and digital government on economies quantitatively, we performed some regressions and reported the estimations in Tables 11.5–11.13. Table 11.5 shows our estimations of the benchmark equation (the first column) and the overall impacts of the pandemic (columns 2–3) and digital government (columns 4–6) on economic growth, respectively. The dependent variables for all equations in this table are the year-on-year growth of seasonally adjusted quarterly GDP in real terms, and the results are based on random effect panel data regressions. Our benchmark equation is the estimation of Equation (1) based on pre-pandemic data (Q1 2015–Q4 2019). For the benchmark equation, the estimated convergent coefficients (the coefficient of GDPPC1, the GDP per capita lagged one period), the population, and inflation (*CPIYOY*) are significantly negative, while the estimated coefficients for capital formation, the growth of exports and imports, and financial development (*lnDeposit*) are significantly positive. These results are consistent with most literature. The estimated coefficients for human capital (*lnH1*) and Open are not significant but with expected signs. Column (2) also estimates the Equation (1) but is based on data during the pandemic (Q1 2020–Q3 2021). We can see that the estimated coefficients for *GDPPC1*, *lnPop*, and *CPIYOY* are no longer significant. The sign of the estimated coefficient for lnDeposit even changes from significantly positive

to significantly negative. This indicates that the pandemic has significant economic impacts. In column (3), we add a dummy variable *pandemic* to Equation (1) and include data both before and during the pandemic. The significance and signs of estimated coefficients in column (3) are similar to those in column (1), except that *lnDeposit* becomes insignificant. The estimated coefficient for *Pandemic* is significantly negative, which is consistent with our expectation of the pandemic's negative shock on economies.

We further investigate how the development of digital government has affected economic growth by adding digital government related variables to Equation (1) and estimate the equation with pre-pandemic data. As the digital government data are only available for two of the five pre-pandemic years (2016, 2018) covered by our study, our number of observations decreases from 1,298 in column (1) to 520 in columns (4)–(6) of Table 11.5. We can see that the estimated coefficients for EGOV are significantly positive in column (4). This indicates that the development of digital government promotes economic growth. We then decompose digital government into online service provision and telecommunication infrastructure. In column (5), the estimated coefficient is significantly positive for online service provision while insignificant for telecommunication infrastructure. This indicates that the expansion of available online services can significantly support economic growth, but the huge investment in telecommunication infrastructure has no clear impacts in the short run. When we add the E-Participation Index to the equation in column (6), its estimated coefficient is positive but not significant. But the estimated coefficient for the E-Government Index becomes insignificant with a much smaller value. This means that better public participation in digital government may play an important role in digital government's economic impacts. In unreported results, we also estimated Equation (4) with data during the pandemic. The estimated coefficient for digital government is still insignificant, but its sign becomes negative. This indicates that the impacts of digital government might be very different during the pandemic compared with pre-pandemic impacts.

To investigate the impacts of the pandemic on the development of digital government, we use the four digital government related variables mentioned above as dependent variables and regress them on the dummy variable *pandemic*, respectively, based on annual data for 2016, 2018, and 2020. To control for the various trending factors of the digital government development, we add the variable year into the estimations. Since the independent variable that we are interested in is *pandemic*, a dummy variable, the fixed effect panel data regression will drop it. Therefore, we use the random effect panel data regression. As shown in Table 11.6, based on our random effect panel data regressions, the estimated coefficients for *pandemic* are all statistically significant, which indicates that the development of digital government before and during the pandemic is significantly different. The signs of the estimated coefficients suggest that during the pandemic, the overall development of digital government and telecommunication connectivity is faster than before, while the improvement in public participation and the provision of online services is slower. This indicates that, although the overall online and digital transformation of public governance is accelerated during the pandemic, the involvement expansions of both citizens and public servants are slower than the development of facilities. This may because of the reduction in public governance activities during the pandemic.

Table 11.5. Overall Impacts of Digital Government and the Pandemic

Variable	(1) Benchmark	(2) In Pandemic	(3) Eq1	(4) Eq2	(5) Eq3	(6) Eq4
GDPPC1	-2.636 ***	0.644	-2.094 ***	-3.411 ***	-3.179 ***	-3.171 ***
lnCF	1.005 ***	2.656 ***	2.408 ***	1.429 ***	1.448 ***	1.415 ***
lnH1	-1.497	-1.182	-2.729	-1.264	-0.161	-0.900
lnPop	-1.972 ***	-0.931	-2.382 ***	-2.323 ***	-2.361 ***	-2.310 ***
Open	0.078	-1.565	0.234	0.274	0.272	0.279
Export	0.024 ***	0.169 ***	0.041 ***	0.019 ***	0.020 ***	0.019 ***
Import	0.027 ***	0.184 ***	0.063 ***	0.022 ***	0.022 ***	0.021 ***
CPIYOY	-0.153 ***	0.009	-0.095 ***	-0.128 ***	-0.124 ***	-0.123 ***
lnDeposit	0.793 ***	-1.615 *	-0.174	0.694 **	0.705 **	0.669 **
Pandemic			-6.136 ***			
EGOV				4.170 **		0.643
Eserv					1.782 *	
Tel					-0.488	
Epart						1.836
_cons	16.891 ***	-8.124	12.051 ***	19.210 ***	17.358 ***	17.940 ***
N	1298	228	1526	520	520	520
r2_o	0.206	0.551	0.508	0.293	0.287	0.295
r2_w	0.169	0.652	0.558	0.166	0.166	0.169
r2_b	0.304	0.388	0.371	0.422	0.413	0.425

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

Table 11.6. Impacts of the Pandemic on the Development of Digital Government (based on 2016, 2018, and 2020 annual data)

Variable	EGOV	Epart	Eserv	Tel
year	0.020 ***	0.046 ***	0.045 ***	0.013 ***
pandemic	0.019 ***	-0.093 ***	-0.096 ***	0.125 ***
_cons	-40.078 ***	-92.223 ***	-90.692 ***	-25.658 ***
N	596	596	596	596
r2_o	0.059	0.085	0.084	0.098

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

Table 11.7. Impacts of the Pandemic on the Development of Digital Government in Different Periods

Variable	EGOV	Epart	Eserv	Tel	EGOV	Epart	Eserv	Tel
				Q2 2020				
RConfirm	7.87E-06 *	7.58E-06	7.98E-06	1.18E-05 **				
lnConfirm					0.036 ***	0.05 ***	0.048 ***	0.035 ***
_cons	0.711 ***	0.711 ***	0.7 ***	0.657 ***	0.325 ***	0.195 ***	0.206 ***	0.285 ***
N	105	105	105	105	145	145	145	145
r2	0.054	0.029	0.04	0.075	0.18	0.252	0.266	0.115
				Q3 2020				
RConfirm	3.97E-06 ***	4.42E-06 **	4.53E-06 **	5.03E-06 ***				
lnConfirm					0.032 ***	0.045 ***	0.043 ***	0.029 ***
_cons	0.706 ***	0.702 ***	0.691 ***	0.655 ***	0.321 ***	0.188 ***	0.201 ***	0.296 ***
N	105	105	105	105	145	145	145	145
r2	0.051	0.037	0.048	0.051	0.128	0.179	0.187	0.074

Q = quarter.

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

Table 11.8. Impacts of Pandemic Policies on the Development of Digital Government in Different Periods

Variable	Q2 2020				Q3 2020			
	EGOV	Epart	Eserv	Tel	EGOV	Epart	Eserv	Tel
Stringency	-0.014 ***	-0.015 ***	-0.013 ***	-0.017 ***	-0.009 ***	-0.010 ***	-0.008 ***	-0.013 ***
Health	0.016 ***	0.019 ***	0.016 ***	0.020 ***	0.012 ***	0.013 ***	0.011 ***	0.016 ***
EconSupport	0.003 ***	0.003 ***	0.003 ***	0.003 ***	0.003 ***	0.003 ***	0.003 ***	0.003 ***
_cons	0.410 ***	0.365 ***	0.368 ***	0.341 ***	0.347 ***	0.345 ***	0.347 ***	0.242 ***
N	145	145	145	145	145	145	145	145
r2	0.430	0.342	0.341	0.431	0.340	0.271	0.271	0.355

Q = quarter.

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

To study whether the impacts of the pandemic vary during different periods of the pandemic, or by the severity of the pandemic, we regress the digital government variables on the number of confirmed cases and the share of confirmed cases over the total population, respectively. As we have only 1 year (the 2020 UN E-Government Survey) of pandemic data for digital government, which reflect the digital government development status at the end of 2020, we use robust ordinary least squares (OLS) regressions based on the data for Q2 and Q3 2020. Our estimation results in Table 11.7 show that, for Q2 2020, the greater share of confirmed cases significantly accelerated the overall development of digital government and telecommunication connectivity, while the increase in the number of confirmed cases significantly increased the development of all aspects of digital government. For Q3 2020, a more severe pandemic, in terms of both the number and share of confirmed cases, accelerated all aspects of the digital government development.

We further investigate the impact of pandemic-related policies on the development of digital government with robust OLS regressions, based on data for Q2 and Q3 2020. As shown in Table 11.8, the stringency of virus containment measures significantly slowed the development of digital government in all aspects, while economic support and health policies (e.g. tracing and vaccination) significantly promoted the development of digital government.

As mentioned earlier, the development and availability of digital government may also help the global battle with the virus and economic performance. We investigate the impact of digital government on the government's response to the pandemic with random effect panel data regressions. To control for the impacts of the pandemic severity on governments' responses, we add the number or share of confirmed cases in the regressions, respectively. To solve the endogeneity problem, we use the 2018 digital government data, the latest before the pandemic. Our estimation results in Table 11.9 show that when we use the share of confirmed cases to reflect the severity of the pandemic, digital government significantly promotes governments' overall responses to the pandemic and the economic support policies. When we use the number of confirmed cases to reflect the impacts of pandemic severity, digital government significantly promotes all aspects of the government responses.

Table 11.9. Impacts of the Development of Digital Government on Government Responses to the Pandemic

Variable	Stringency	Health	EconSup-port	GovResp	Stringency	Health	EconSup-port	GovResp
RConfirm	0.000 ***	4.49E-06	-6.3E-05 **	-5.53E-06				
EGOV1	-1.849	8.37848	73.918 ***	16.693 **	23.737 ***	20.944 ***	67.758 ***	27.105 ***
lnConfirm					-2.059 ***	-0.029	0.572 **	0.016
_cons	65.332 ***	51.682 ***	0.471	45.178 ***	65.023 ***	44.401 ***	-3.094	38.509 ***
N	681	702	702	702	1010	1011	1011	1011
r2_o	0.033	0.007	0.123	0.021	0.019	0.078	0.249	0.151
r2_w	0.085	0.000	0.005	0.002	0.171	0.002	0.000	0.000
r2_b	0.001	0.012	0.211	0.034	0.045	0.149	0.417	0.264

Q = quarter.

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

Table 11.10. Impacts of Public Participation on Government Responses to the Pandemic, Q1 2020–Q3 2021

Variable	Stringency	Health	EconSup-port	GovResp	Stringency	Health	EconSup-port	GovResp
RConfirm	0 ***	7.32E-06	-6.00E-05 **	-2.45E-06				
EGOV1	-22.214 *	1.762	64.603 ***	9.221	6.588	22.1 ***	48.91 ***	25.799 ***
EPart1	17.69 *	5.78	8.139	6.56	16.031 *	-1.121	17.509	1.21
lnConfirm					-2.018 ***	-0.027	0.616 **	0.022
_cons	66.687 ***	52.11 ***	1.08	45.639 ***	65.125 ***	44.369 ***	-2.896	38.488 ***
N	681	702	702	702	1010	1011	1011	1011
r2_o	0.041	0.012	0.12	0.025	0.02	0.078	0.242	0.151
r2_w	0.088	0	0.007	0.001	0.174	0.002	0.002	0
r2_b	0.003	0.02	0.206	0.039	0.051	0.149	0.402	0.263

Q = quarter.

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

Table 11.11. Impacts of Digital Government Investment on Government Responses During the Pandemic, Q1 2020–Q3 2021

Variable	Stringency	Health	EconSup-port	GovResp	Stringency	Health	EconSup-port	GovResp
RConfirm	0.000 ***	1E-05	-5E-05	1.22E-06				
EGOV1	19.272 ***	10.668	42.604 ***	15.025 **	28.261 ***	10.138 **	45.510 ***	14.731 ***
EPart1	-20.132 ***	-1.444	19.016	0.851	-6.643	8.778 *	13.823	9.516 **
lnConfirm					-1.956 ***	-0.033	0.689 **	0.027
_cons	62.378 ***	50.738 ***	9.937	45.520 ***	64.581 ***	46.347 ***	1.811	40.856 ***
N	681	702	702	702	1010	1011	1011	1011
r2_o	0.055	0.024	0.105	0.037	0.026	0.074	0.221	0.143
r2_w	0.089	0.001	0.009	0.000	0.172	0.002	0.004	0.000
r2_b	0.029	0.043	0.178	0.059	0.035	0.142	0.365	0.250

Q = quarter.

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source:

Table 11.12. Impacts of the Pandemic on Economic Growth

Variable	(1)	(2)	(3)
GDPPC1	1.871 ***	1.274 *	-2.387 ***
lnCF	2.235 ***	2.333 ***	2.601 ***
lnH1	-10.562 ***	-9.245 ***	-2.608
lnP	-0.044	-0.424	-2.682 ***
Open	1.455 **	1.187 **	0.225
CPIYOY	-0.077 ***	-0.078 ***	-0.095 ***
Export	0.052 ***	0.052 ***	0.041 ***
Import	0.114 ***	0.111 ***	0.060 ***
lnDeposit	-2.398 ***	-2.118 ***	-0.081
Confirmed	-0.000 **		
RConfirmed		-0.000 ***	
Pandemic			-3.962 ***
Stringency			0.104 ***
Health			-0.116 ***
EconSupport			-0.030 ***
_cons	2.540	3.884	12.660 ***

Variable	(1)	(2)	(3)
N	1526	1526	1526
r2_o	0.233	0.263	0.518
r2_w	0.365	0.376	0.574
r2_b	0.109	0.140	0.362

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.

Source: Authors.

Table 11.13. Interactive Impacts of Digital Government and the Pandemic

Variable	(1)	(2)	(3)	(4)
GDPPC1	-1.814 **	2.332 ***	-1.887 **	-2.009 ***
lnCF	2.259 ***	1.977 ***	2.554 ***	2.521 ***
lnH1	0.923	5.757 **	1.409	1.454
lnP	-2.275 ***	-1.272 *	-2.681 ***	-2.738 ***
Open	-0.219	-0.138	-0.206	-0.224
CPIYOY	-0.045	0.001	-0.039	-0.038
Export	0.066 ***	0.082 ***	0.069 ***	0.069 ***
Import	0.097 ***	0.133 ***	0.088 ***	0.090 ***
lnDeposit	-0.143	-0.862 **	-0.059	0.061
Pandemic	-12.476 ***			
RConfirmed		0.001		
Stringency			-0.142	-0.053
Health			-0.098	-0.169
EconSupport			0.009	0.028
EGOV	-5.445	-42.763 ***	-10.038 **	
Epart	0.844	12.211 ***	2.508	
*EGOV*Pandemic*	7.297 **			
*EPart*Pandemic*	1.831			
*EGOV*RConfirmed*		-0.001		
*EPart*RConfirmed*		0.000		
*EGOV*Stringency*			0.858 **	
*EGOV*Health*			-0.768	
*EGOV*EconSupport*			0.040	
*Epart*Stringency*			-0.486 *	

Variable	(1)	(2)	(3)	(4)
*Epart*Health*			0.637 *	
*Epart*EconSupport*			-0.100	
EServ				-0.923
Tel				-5.140 **
*EServ*Stringency*				-0.227
*EServ*Health*				0.444
*EServ*EconSupport*				-0.142 **
*Tel*Stringency*				0.502 **
*Tel*Health*				-0.491 *
*Tel*EconSupport*				0.058
_cons	9.006 **	-11.357 ***	8.425 **	6.996 *
N	744	744	744	744
r2_o	0.614	0.490	0.634	0.636
r2_w	0.656	0.624	0.684	0.683
r2_b	0.428	0.216	0.412	0.427

Notes: *** = significant at the 1% level; ** = significant at the 5% level; * = significant at the 10% level.
Source: Authors.

The estimation results in Table 11.10 show that the improvement in e-participation significantly increases the stringency of virus containment measures. This indicates that, with better prepared digital government, governments tend to be stricter in terms of controlling the virus spread. The reason can be that it is easier for governments to implement the stringency policies with the help of digital government. In the estimations shown in Table 11.11, we decompose digital government into telecommunication connectivity and online service provision. We can see that better online service provision significantly promotes governments' responses to the pandemic in all aspects. However, the development of telecommunication connectivity has a significantly negative impact on stringency policies. This may because governments can trace people's activity better with well-developed telecommunication connectivity, so there is no need to implement very stringent policies.

Finally, to study the interactive impacts of digital government development and the pandemic on economic growth, we add both the digital government and pandemic-related variables as well as their interactive variables to Equation (1). Tables 11.12 and 11.13 show our random effect panel data estimation results. As shown in Table 11.12, we found that the impact of the share of confirmed cases (column (2)) on the growth is more significant than that of the number of confirmed cases (column (1)).

This is different from the impact of the pandemic severity on governments' responses, as shown in Tables 11.9–11.11, where the number of confirmed cases tends to have more significant impacts. This may because governments target the number of confirmed cases when they respond to the pandemic.

Secondly, still shown in Table 11.12, when we decompose governments' responses, we find that the stringency policies have significantly positive impacts on economic growth (column (3)). This indicates that the stringency policy may effectively control the spread of the virus and alleviate the negative shock of the pandemic. On the other hand, the estimated coefficients for the containment and health index are significantly negative (*Contain* in column (3)). This index includes information on both activity restrictions and health-related measures, such as the testing policy, contact tracing, short-term investment in healthcare, and investments in vaccines. As the impacts of activity restrictions have been controlled by the stringency index, the estimated coefficients of *contain* should mainly reflect the impacts of health-related measures. Therefore, our estimation indicates that the health-related policies have negative impacts on economic growth. This may be because governments spent significant resources and money to implement the health policies, which decreases the resources for economic growth. The estimated coefficient for the economic policy index in column (3) of Table 11.12 is also significantly negative. The reason may be similar to that of the health policies. As governments spent substantial resources and money to help and subsidise business and people during the pandemic, less resources and money than usual are available to support economic growth. Therefore, the economic support policies during the pandemic have negative impacts on economic growth.

Columns (1)–(4) of Table 11.13 add both digital government and pandemic-related variables to Equation (1). For column (1), we can see that the estimated coefficient is still significantly negative for *pandemic* while insignificant for *EGOV* and *Epart*. However, the sign of the estimated coefficient for *EGOV* becomes negative. The estimated coefficients are even significantly negative for *EGOV* in column (2) and (3) while significantly positive for *Epart* in column (2). This may be because the development of digital government consumes significant resources which could otherwise be used for economic growth. This negative impact can be more critical for economic growth during a pandemic. We can also see that the estimated coefficients for telecommunication infrastructure in column (4) are also significantly negative. This may also be because the investment in telecommunication infrastructure has become a crucial burden in the pandemic. At the same time, the increase in public participation can help enhance the growth impacts of digital government. However, when we add the interactive variables to the equation, we can see that the estimated coefficients for *pandemic* doubled (comparing column (1) of Table 11.13 with column 3 of Table 11.5). The goodness of fit (measured by *r2_o* and *r2_w*) for the estimations also doubled. Therefore, digital government has impacts on the economic effects of the pandemic. The estimated coefficient of *EGOV*Pandemic* in column (1) of Table 11.13 shows that digital government significantly decreases the pandemic's negative impacts on economic growth. The estimated coefficients for interactive variables in column (3) of Table 11.13 show that

digital government can help enhance the positive impact of stringency policies on economic growth (*EGOV*Stringency*) while public participation weakens it (*Epart*Stringency*). Public participation can also weaken the impacts of health policies (*Epart*Health*). As we discussed in Tables 11.9–11.11, countries with better digital government development tend to have stricter policies. Therefore, digital government may help the implementation of stringency policies to be more efficient in terms of controlling the spread of the virus. This can further help economic growth. On the other hand, with better public participation, the split in public opinion may make it more difficult to implement the stringency policies.

In column (4) of Table 11.13, we investigate the impacts of the two components of the E-Government Index: telecommunication infrastructure and online service provision. The estimation results show that the provision of online services increases the negative impact of economic support policies on economic growth. On the other hand, better telecommunication infrastructure strengthens both the stringency and the health policies' impacts.

5. Conclusions and Discussion

5.1. Impacts of digital government on economic growth and policies during the pandemic

In this study, based on countries' economic, digital government, and pandemic-related data, we study the relationship between digital government and the pandemic as well as their impacts on economic growth. We have some interesting findings. First, the pandemic has significant impacts on economic growth. But the impacts are comprehensive, not straightforward. For governments' decision-making in response to the pandemic, the share of confirmed cases should be a more important factor to be considered than the number of cases because the former has more significant impacts on economic growth. In terms of government responses, the stringency policies have significant positive impacts on economic growth. On the other hand, pandemic-related health policies – such as testing policy and contact tracing, investment in vaccines, and economic support policies (e.g. income support and debt relief) – have significant negative impacts.

Second, before the pandemic, the development of digital government had significantly positive impacts on economic growth. However, the huge infrastructure investment in digital government development has become a crucial burden during the pandemic and has negatively affected economic growth. As public participation increases, the negative impacts of digital government on economic

growth can be partially alleviated. Therefore, in the long run, digital government should be beneficial for economic growth and welfare improvement. In the short run, for countries with well-developed digital government infrastructure, to make the development of digital government more beneficial for economic growth, more attention should be paid to the expansion of public participation in digital government activities.

Third, the pandemic accelerated the development of digital government overall. However, the expansion of public participation and online service provision has been slower since the beginning of the pandemic. This may be because of the reduction in normal public governance activities in the pandemic. At the same time, stringency policy has negative impacts on all aspects of digital government development, such as the telecommunication infrastructure, online services provision, and public participation. On the other hand, health policies and economic support policies promote the development of all aspects of digital government. Therefore, the acceleration of digital government development during the pandemic is primarily due to the demand induced by health policy implementation and economic support policies. The stringency policies hindered the development of digital government. The severity of the pandemic also slowed the expansion of digital government utilisation. After the pandemic, governments should try to promote the development and utilisation of digital government in areas not related to the pandemic.

Fourth, the development of digital government has significant impacts on governments' responses to the pandemic. For countries with better digital government development, governments tend to be more responsive, with stronger stringency, health, and economic support policies. The online service provision shows more significant impacts than other components of digital government. It promotes the implementation of governments' responses to all aspects of the pandemic. At the same time, better public participation increases the strength of stringency policies while better telecommunication infrastructure decreases the strength of stringency policies.

Finally, we also find significant evidence for the impacts of the development of digital government on the economic effects of the pandemic. The development of digital government helped enhance the positive impacts of stringency policies, but public participation weakened the impacts of some policies. This indicates the dilemma of digital government utilisation during the pandemic. Better development of digital government, including the provision of online service and better telecommunication infrastructure, can increase the efficiency of policy implementation, while better public participation may slow the decision-making process. Due to data limitations, we cannot find more evidence for the decomposed impacts of digital government development. This could be done in the future when more data are available.

5.2. Policy suggestions for the development of digital government

Our findings in this study support the view of Sullivan et al. (2021) that digitalisation is no longer 'nice to have' for governments, but an imperative. In addition, we find that better development of digital government is beneficial not only for economic growth, but also public health in the long run. We believe that many other aspects of society – such as education, care of older persons, and social security – can also benefit from the improvement in digital government development. Based on our findings in this study, we have the following policy suggestions for the development of digital government in the post-pandemic era.

First, the governments of all countries should pay more attention to the development of digital government, irrespective of the economic and digital government development status of the country. As we showed earlier, some countries have slowed the development of digital government for various reasons. However, as our findings have indicated, the development of digital government is good for economic growth in the long run. Therefore, all countries should try to improve their digital government development.

In addition, it can also stimulate economies and support the recovery of economic activities if governments increase their investment in digital government development. As government behaviour can reach all aspects of national economic activities, the development of digital government can also be related to all aspects of economic activities. Therefore, the increase in economic activities related to digital government development can have impacts on a relatively long and comprehensive supply chain. This indicates that the investment multiplier can be large for governments' investment in digital government development.

Second, after the pandemic, governments should try to promote the development and utilisation of digital government in areas not related to the pandemic. As we have mentioned, due to the virus containment policies and the weak economic performance, many activities have slowed or even stalled, including digital government activities unrelated to the pandemic. However, like all other ICT-based activities, economies of scale and scope can help accelerate the development of digital-government. Utilisation in a single area, such as public health, can only include limited users and applications. Therefore, it is important to expand and strengthen the utilisation of digital government in areas other than public health.

Third, for countries with better digital government development, more attention should be paid to the expansion of public participation and online service provision in digital government activities. Our findings indicate that public participation and online service provision are important for the implementation and effectiveness of policy. However, as we can see from Table 11.4, the expansion of online service provision and e-participation have slowed significantly for most regions. As leading countries in this area tend to have good human capital and infrastructure already, increasing the provision of online services and e-participation could be more efficient and easier to improve the utilisation of digital government in these leading countries.

Fourth, for countries with less developed digital government, accelerating the construction of telecommunication infrastructure is the most important factor for digital government development. As shown in Table 11.3, regions with a low E-Government Index all have an even lower score for their telecommunication infrastructure. Without the necessary infrastructure, it is even harder to expand e-participation and online services provision. The accumulation of human capital in related areas can also be very slow.

Fifth, it is important for all countries to strengthen cooperation in this field. As mentioned earlier, the development of digital government has reached a more challenging stage compared with earlier stages throughout the whole world. Therefore, even for the leading countries, the growth of online services provision and e-participation have slowed significantly in recent years. It now takes longer for leading countries to make progress in promoting digital government, even though they already have good infrastructure and human capital in this area. Therefore, for countries left behind with disadvantages in infrastructure and human capital, establishing more international cooperation and obtaining more international aid should be a more efficient means of digital government development.

On the other hand, as mentioned earlier, economies of scale and scope are crucial for rapid development of digital government. The involvement of more countries means more government users and developers, which imply more application scenarios and more powerful development capability. This will further accelerate global digital government development. In this context, increased international cooperation is crucial and beneficial for any country involved.

References

Al-Sadiq, A.J. (2021), 'The Role of E-Government in Promoting Foreign Direct Investment Inflows', *IMF Working Paper*, No. WP/21/8. Washington, DC: International Monetary Fund.

Ali, M.A., M.R. Hoque, and K. Alam (2018), 'An Empirical Investigation of the Relationship Between E-Government Development and the Digital Economy: The Case of ASIAN Countries', *Journal of Knowledge Management*, 22(5), pp.1176–200.

Barro, R.J., N.G. Mankiw, and X. Sala-i-Martin (1995), 'Capital Mobility in Neoclassical Models of Growth,' *American Economic Review*, 85(1), pp.103–15.

Bassanini, A. and S. Scarpetta (2003), 'The Driving Forces of Economic Growth: Panel Data Evidence for the OECD Countries', *OECD Economic Studies*, 2001/2, 33(2), pp.9–56.

Bélanger, F. and L. Carter (2012), 'Digitizing Government Interactions with Constituents: An Historical Review of E-Government Research in Information Systems', *Journal of the Association for Information Systems*, 13(5), pp.363–94.

Castro, C. and C. Lopes (2022), 'Digital Government and Sustainable Development', *Journal of the Knowledge Economy*, 13, pp.880–903.

CEIC Data (2022), *World Trend Plus Database*. https://info.ceicdata.com/en-products-world-trend-plus-database

Chinese Academy of International Trade and Economic Cooperation (2021), 'China's Trade and Investment Cooperation Under the Belt and Road Initiative'. https://www.caitec.org.cn/n5/sy_gzdt_xshd/json/5973.html

Corsi, M. and C. D'Ippoliti (2013), 'The Productivity of the Public Sector: A Classical View', *PSL Quarterly Review*, 66(267), pp.403–34.

Dawi, N.M., H. Namazi, H.A. Hwang, S. Ismail, P. Maresova, and O. Krejcar (2021), 'Attitude Toward Protective Behavior Engagement During COVID-19 Pandemic in Malaysia: The Role of E-Government and Social Media', *Frontiers in Public Health*, 9, 609716.

Deng, H., K. Karunasena, and W. Xu (2018), 'Evaluating the Performance of e-Government in Developing Countries: A Public Value Perspective', *Internet Research*, 28(1), pp.169–90.

Dhaoui, I. (2021), 'E-Government for Sustainable Development: Evidence from MENA Countries', *Journal of the Knowledge Economy*, 13, pp.2070–99.

Dunleavy, P., H. Margetts, S. Bastow, and J. Tinkler (2006), 'New Public Management Is Dead – Long Live Digital-Era Governance', *Journal of Public Administration Research and Theory*, 16(3), pp.467–94.

Elbahnasawy, N.G. (2021), 'Can e-Government Limit the Scope of the Informal Economy?', *World Development*, 139, 105341.

Freeguard, G., M. Shepheard, and O. Davies (2020), *Digital Government During the Coronavirus Crisis*. London: Institute for Government.

Gartner (2020), 'Forecast: Enterprise IT Spending for the Government and Education Markets, Worldwide, 2018–2024, 2Q20 Update', 8 July. https://www.gartner.com/en/documents/3987256

IMF (2021), *World Economic Outlook: Recovery During a Pandemic – Health Concerns, Supply Disruptions, Price Pressures*. Washington, DC: International Monetary Fund (October).

Ingrams, A., A. Manoharan, L. Schmidthuber, and M. Holzer (2020), 'Stages and Determinants of E-Government Development: A Twelve-Year Longitudinal Study of Global Cities', *International Public Management Journal*, 23(6), pp.731–69.

Khalil, O.E.M. (2011), 'E-Government Readiness: Does National Culture Matter?', *Government Information Quarterly*, 28(3), pp.388–99.

Khan, F.N. and M.T. Majeed (2019), 'ICT and E-government as the Sources of Economic Growth in Information Age: Empirical Evidence from South Asian Economies', *South Asian Studies – A Research Journal of South Asian Studies*, 34(1), pp.227–49.

Knutt, E. (2020), 'Take Out the Tedious: Robotic Automation in Government', Global Government Forum, 14 October.

Krishnan, S., T.S.H. Teo, and V.K.G. Lim (2013), 'Examining the Relationships Among E-Government Maturity, Corruption, Economic Prosperity and Environmental Degradation: A Cross-Country Analysis', *Information and Management*, 50(8), pp.638–49.

Lau, E. (2005), *E-Government and the Drive for Growth and Equity*. Cambridge, MA: Belfer Center for Science and International Affairs.

Majeed, M.T. and A. Malik (2016), 'E-government, Economic Growth and Trade: A Simultaneous Equation Approach', *The Pakistan Development Review*, 55(4), pp.499–519.

Mathieu, E. et al. (2020), Coronavirus Pandemic (COVID-19). https://ourworldindata.org/coronavirus (last accessed 9 May 2023).

Nograšek, J. and M. Vintar (2014), 'E-Government and Organisational Transformation of Government: Black Box Revisited?', *Government Information Quarterly*, 31(1), pp. 108-18.

Norazryana, N.D., H. Namazi, H.J. Hwang, S. Ismail, P. Maresova, and O. Krejcar (2021), 'Attitude Toward Protective Behavior Engagement During COVID-19 Pandemic in Malaysia: The Role of E-Government and Social Media', *Frontiers in Public Health*, 9: 609716.

OECD (2003), *The e-Government Imperative*, OECD e-Government Studies. Paris: Organisation for Economic Co-operation and Development.

OECD (2020), *OECD Economic Outlook, Interim Report 2020: September 2020*. Paris: Organisation for Economic Co-operation and Development.

Roseth, B., A. Reyes, and K. Yee Amézaga (2021), *Public Services and Digital Government During the Pandemic: Perspectives of Citizens, Civil Servants, and Government Institutions*. Washington, DC: Inter-American Development Bank.

Srivastava, S.K. and P.K. Panigrahi (2016), 'The Impact of E-Government and E-business on Economic Performance: A Comparative Study of Developing and Developed Countries', *Journal of Contemporary Issues in Business and Government*, 22(1), pp.36–50.

Statista Research Department (2023), 'Impact of the Coronavirus Pandemic on the Global Economy – Statistics & Facts', Statista. https://www.statista.com/topics/6139/covid-19-impact-on-the-global-economy/ (accessed 8 May 2023).

Sullivan, M., J. Bellman, J. Sawchuk, and J. Mariani (2021), 'Accelerated Digital Government: COVID-19 Brings the Next Generation of Digitization to Government', *Deloitte Insights*, 4 March. https://www2.deloitte.com/us/en/insights/industry/public-sector/government-trends/2021/digital-government-transformation-trends-covid-19.html/ - endnote-5

UN (2001), *Benchmarking E-government: A Global Perspective*. New York: United Nations.

UN (2012), *United Nations E-Government Survey 2012: E-Government for the People*. New York: United Nations.

UN (2014), *United Nations E-Government Survey 2014: E-Government for the Future We Want*. New York: United Nations.

UN (2016), *United Nations E-Government Survey 2016: E-Government in Support of Sustainable Development*. New York: United Nations.

UN (2018), *United Nations E-Government Survey 2018: Gearing E-Government to Support Transformation Towards Sustainable and Resilient Societies*. New York: United Nations.

UN (2020), *United Nations E-Government Survey 2020: Digital Government in the Decade of Action for Sustainable Development (With Addendum on COVID-19 Response)*. New York: United Nations.

UN DESA (2020), 'COVID-19: Embracing Digital Government During the Pandemic and Beyond', *UN DESA Policy Brief,* No. 61. New York: United Nations Department of Economic and Social Affairs.

World Bank (2008), 'Digital Government for Development', *Brief*. https://www.worldbank.org/en/topic/digitaldevelopment/brief/digital-government-for-development

World Bank (2020), *Global Economic Prospects*, June 2020. Washington, DC: World Bank.

Zhao, F., J. Wallis, and M. Singh (2015), 'E-Government Development and the Digital Economy: A Reciprocal Relationship', *Internet Research*, 25(5), pp.734–66.

Ziemba, E., T. Papaj, R. Zelazny, and M. Jadamus-Hacura (2016), 'Factors Influencing the Success of E-Government', *Journal of Computer Information Systems*, 56(2), pp.156–67.