

“E-government and public investment management under fiscal consolidation”

AUTHORS	Mkhitar Aslanyan 
	
	Liudmyla Zakharkina 
	
	Rostyslav Shchokin 
	Tetiana Shabelnyk 
	Zaiga Oborenko 
ARTICLE INFO	Diana Zmicerevska 
	
	Zanna Klescevnikova 
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Mkhitar S. Aslanyan, Ph.D. in Economics, Associate Professor, Department of Finance, Faculty of Finance, Armenian State University of Economics, Armenia.

Liudmyla Zakharkina, Ph.D. in Economics, Associate Professor of the Department of Financial Technologies and Entrepreneurship, Sumy State University, Ukraine. (Corresponding author)

Rostyslav Shchokin, Doctor of Law, Professor, Professor of the Department of Administrative, Financial and Banking Law, Interregional Academy of Personnel Management, Ukraine.

Tetiana Shabelnyk, Doctor of Economics, Professor of the Intelligent Management Systems Department, Simon Kuznets Kharkiv National University of Economics, Ukraine.

Zaiga Oborenko, Ph.D. in Economics and Business, Professor, Department of Management, Riga Nordic University, Latvia.

Diana Zmicerevska, Mg. of Management, Department of Economics, Riga Nordic University, Latvia.

Zanna Klescevnikova, Mg. of Management, Department of Law, Riga Nordic University, Latvia.



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Mkhitar S. Aslanyan (Armenia), Liudmyla Zakharkina (Ukraine), Rostyslav Shchokin (Ukraine), Tetiana Shabelnyk (Ukraine), Zaiga Oborenko (Latvia), Diana Zmicerevska (Latvia), Zanna Klescevnikova (Latvia)

E-GOVERNMENT AND PUBLIC INVESTMENT MANAGEMENT UNDER FISCAL CONSOLIDATION

Abstract

The study tests whether e-government development is associated with the level of central-government investment and the size of the investment cut that accompanies fiscal consolidation. Two-way fixed-effects panel regressions are estimated for 134 economies across the twelve waves of the United Nations E-Government Survey between 2003 and 2024 (1,319 country-wave observations), with World Bank and International Monetary Fund (IMF) fiscal data. When the primary balance improves by at least one percentage point of GDP in a survey year, countries at the 25th percentile of the E-Government Development Index cut central-government investment by 0.94 percentage points of GDP, and those at the 75th by 0.20 (interaction $\beta = 2.15$ per index unit, $p = 0.009$). Above the upper quartile, the cut is indistinguishable from zero. Outside consolidation episodes, e-government development has no detectable association with investment levels, and the estimate rules out the negative cross-country gradient. The same pattern holds for the capital share of central-government spending and across alternative episode definitions, winsorized outcomes, leave-one-country-out, permutation, and placebo tests and two independent investment series; it is not separable from government effectiveness and weakens with country-specific trends and upper-tail trimming. Episodes achieved through revenue and current spending leave investment untouched at every level of the index; the attenuation reflects the composition of fiscal adjustment. The evidence casts e-government as a marker of the administrative capacity that keeps consolidation off the capital budget; if the association is causal, digital budget, procurement, and project-pipeline systems belong in place before adjustment begins.

Keywords

digital government, capital expenditure, austerity, GovTech, global panel, fixed effects, primary balance

JEL Classification

H54, H61, H11, O38

INTRODUCTION

About 30% of the value of public investment is lost to inefficiency, and stronger public investment management institutions could close up to two-thirds of that gap (IMF, 2015). Digital capacity has since spread quickly, and the number of UN member states in the top two groups of the E-Government Development Index grew from 87 of 193 in 2014 to 138 in 2024 (UN, 2024). Existing evidence concerns service delivery, transparency and corruption, not the two questions that matter for a finance ministry. Does a digitally capable government invest more, and does it cut investment less when the budget tightens?

The second question is no longer hypothetical. Global public debt is projected to reach 100% of GDP by 2029, and the IMF calls for credible, well-sequenced fiscal adjustment across country groups (IMF, 2026a). Previous adjustments fell on investment; in the European Union, gross public investment dropped by 0.8 percentage points of GDP in 2009–2013 while primary spending kept rising (Wolff & Darvas, 2022; Larch & van der Wielen, 2025). Investment is cut first because its ben-

efits arrive after the electoral cycle and postponing it seldom requires legislation. Digital budget, procurement, and project-pipeline systems make the pipeline visible, the commitments traceable, and the cost of interruption explicit. If that mechanism works, e-government should not raise investment in normal years but reduce the cut in consolidation years, and the balance improvement should come from revenue and current spending rather than the capital budget.

This paper tests both propositions on 134 economies across the twelve E-Government Survey waves of 2003–2024, with country and wave fixed effects, three independent measures of public investment, and placebo and permutation tests. The contribution is to join two literatures that have not met on a global within-country panel: the evidence on what digital government delivers and on how consolidation treats public investment. Moreover, the paper asks whether digital capacity shows in investment levels, in the size of the cut, or in the composition of the balance improvement.

1. LITERATURE REVIEW

Cross-country research on digital government measures service outcomes, not budgets. Global panels find that the E-Government Development Index raises quality of life (Vasylieva et al., 2026) and social progress (Kuzior et al., 2026); health system performance follows across 191 countries (Hrytsenko et al., 2026). The efficiency of digital public services ranks first among the correlates of material well-being (Yarovenko et al., 2025), as financial inclusion does in inclusive-growth research (Saher et al., 2024). Online services and infrastructure carry most of these associations; returns diminish above about 0.61 (Kuzior et al., 2026), the drivers of the index differ by income level (Samarkhanov et al., 2025), and maturity stays uneven even within the European Union (Valaskova et al., 2025). Thus, the index is a correlate of income and capacity, not a free-standing treatment. Reach depends on users, whose skills artificial intelligence is reshaping in education (Zimosz & Ober, 2025), and whose adoption turns on usefulness and trust (Thapaliya & Dongol, 2026; Van Vien et al., 2026). Whether e-government changes how governments spend is untested.

The mechanisms that could carry digital tools into the budget are documented at the transaction level and act on the quality and composition of spending, not its volume. E-procurement raised road quality and reduced delays without lowering prices (Lewis-Faupel et al., 2016), e-filing doubled tax payments among high-evasion firms (Okunogbe & Pouliquen, 2022), digital public infrastructure cut transfer leakages in India (Alonso et al., 2023), a pilot across 237 Chinese cities raised expendi-

ture efficiency (Tong et al., 2026), and image recognition extends oversight to construction sites (Zaryczańska & Karwot, 2025). E-government lowers corruption in early panels (Andersen, 2009), but innovation and regulatory quality explain most of the later variation (Yefimenko et al., 2025), and anti-money-laundering compliance combines technology with oversight (Kuzior et al., 2025). Transparency sustains the trust that data-driven governance needs (Eik et al., 2026), auditing bites only with enforcement (Bezverkhyi et al., 2024), accountability erosion and rent-seeking co-evolve (Ugulava, 2026), ethical leadership shapes what the tools achieve (Kyzenko et al., 2026), and policy signals can weaken compliance norms (Erina et al., 2026). Trust and government effectiveness fully mediate the effect of digital maturity on infrastructure recovery (Topazly et al., 2026), a sign that the digital variable may not be separable from the institutional one, while technical debt (Thibodeau, 2026) and legacy systems (Ndhlovu et al., 2026; Morshed & Khrais, 2025) keep the technical base fragile. None of this evidence reaches the capital budget.

The fiscal literature has established the investment cut and begun to map its moderators, all of them institutional or political. Public investment falls in downturns while current spending stays a cyclical, sharpest where horizons are short and institutions weak (Ardanaz & Izquierdo, 2022). A consolidation of at least 2% of GDP lowers public investment by about 10% under no rule or rigid rules but not under rules with escape clauses or investment exemptions (Ardanaz et al., 2021). Compliance with EU rules did not drive the post-crisis decline; non-compliant governments under general constraints

did (Larch & van der Wielen, 2025), so protection lies in the design of the constraint. A consolidation that penalizes investment relative to consumption reduces GDP by 0.7% after two years; one that protects it does not (Ardanaz et al., 2026). Fiscal rules raise expenditure efficiency (Apeti et al., 2025), efficiency feeds back into trust in the state (Afonso et al., 2024), and debt regimes and government effectiveness condition what spending and debt deliver (Gherghina et al., 2024; Cibulskienė et al., 2025). The pressure is current, with EU sustainability trajectories diverging (Tkacova et al., 2025), surveillance returning to debt vulnerability (Derradj & Toumache, 2025), expenditure tracking income and interest rates (Filipova et al., 2025), and non-productive spending feeding depreciation (Ahmed, 2025). Politics and war reshape composition, as the electricity price shock after Russia's invasion of Ukraine passed into European inflation (Vasylieva et al., 2025), guarantees spike in election years (Mačkić & Rusmir, 2024), wartime defense crowds out education (Yeremenko, 2026) while import surges weigh on growth (Tsymbal & Demediuk, 2025), and debt markets pause under uncertainty (Barros & Tessmann, 2026). Digital government has not been among the moderators tested.

Infrastructure and local finance show public investment as the budget line most exposed to institutional quality, the property any digital moderator must work through. Private participation in transport infrastructure rises where corruption is lower and regulation is sounder (Percoco, 2014); hybrid governance lets partnerships balance efficiency with public value (Oe et al., 2025); and well-structured partnerships widen fiscal space for digital urban infrastructure (Prokopenko et al., 2026a). Design decides outcomes, as renewables investment responds to feed-in tariffs and purchase agreements (Lyeonov et al., 2025), budgetary support sustains deployment (Fernandes et al., 2025) and technological readiness drives green finance (Patnaik & Hedau, 2026). Infrastructure stabilizes employment (Privara, 2025) and retains population in border regions (Vakhovych et al., 2026), while capacity varies, with municipal efficiency differing widely (Soares, 2024), own revenues covering little of rural budgets (Mohapatra, 2026) and governance quality closing health-spending gaps (Megbowon & Zerihun, 2025). Digital tools lower

the operating costs of municipal services (Kajda & Karwot, 2025, 2026), cut them further under coordinated smart-city management (Prokopenko et al., 2026b) and raise collections where technology reaches users (Mshana & Postrzednik-Lotko, 2026). Regulated balance sheets follow the same logic, as provisioning rules shift bank capital toward lower-risk assets (Shubita et al., 2025), governance raises bank returns (Altaee et al., 2024), and small firms stay under-insured against the shocks rules address (Daskalakis & Milienos, 2025). Whether digital capacity adds protection beyond institutional quality has not been asked.

Three gaps follow. First, the panel studies of e-government interpolate a biennial index into annual data (Hrytsenko et al., 2026; Vasylieva et al., 2026), so within-country identification rests partly on constructed observations, and none uses the GovTech Maturity Index empirically. Second, no study tests whether e-government changes the size of the investment cut during consolidation; the closest work moderates the cut by rule design (Ardanaz et al., 2021) or institutional quality (Percoco, 2014), and the closest digital studies stop at expenditure efficiency (Tong et al., 2026) or post-war recovery (Topazly et al., 2026). Third, e-government is seldom separated from government effectiveness or income when both enter as moderators; the one study that includes both finds telecommunication infrastructure significant and government effectiveness not, but for bank profitability (Ngoc, 2025). The present study addresses these gaps with country and wave effects on the survey grid, a consolidation indicator built from the primary balance, competing interactions, and three independent measures of public investment. Digital government has a documented association with service outcomes and transaction-level fiscal gains, and public investment has a documented vulnerability to consolidation that institutions attenuate; the two literatures have not been joined on a global within-country panel.

The aim of this study is to establish whether e-government development is associated with the level of central-government investment and with the size of the investment cut that accompanies fiscal consolidation, using two-way fixed-effects estimates for 134 economies across the twelve E-Government Survey waves of 2003–2024.

2. METHOD

2.1. Data and sample

The panel combines six sources on the survey grid of the United Nations E-Government Survey, which has scored every UN member state on the E-Government Development Index (EGDI) since 2003 (UN, 2024). The twelve waves (2003–2005, 2008, 2010 and every second year to 2024) define the time dimension, with annual covariates taken in wave years. Investment, expense, and five of the eight controls come from the World Development Indicators, government effectiveness from the Worldwide Governance Indicators (Kaufmann et al., 2011), and revenue, gross debt, and the primary balance from the IMF Fiscal Monitor, October 2025 vintage; the primary balance stays annual because the consolidation indicator compares the survey year with the preceding year. Two alternative investment measures serve as robustness checks: general-government gross fixed capital formation from the IMF Investment and Capital Stock Dataset (ICSD; latest release 2019; IMF, 2021) and general-government net acquisition of nonfinancial assets from the Government Finance Statistics (GFS). The Core Government Systems Index of the GovTech Maturity Index, a single 2025 cross-section, is used only to split the sample (World Bank, 2025).

Four samples are named throughout, and Appendix A, Table A1 traces every loss of observations between them. The full wave grid holds 2,604 country-waves for 217 economies; the 24 that are not UN member states carry no EGDI, so 193 enter the merge. The level sample for investment keeps country-waves with complete data on the outcome, EGDI, the Online Service Index (OSI), and the eight controls and drops countries observed in fewer than five waves, leaving 1,319 country-waves from 134 countries. The capital share is undefined for the 14 country-waves with negative net investment (Singapore in ten, India in two, Colombia and Namibia in one each; Appendix A, Table A3) and missing where expense is unreported. After the five-wave rule and the removal of the single remaining 2024 observation (Tanzania), a singleton within its wave effect, it covers 1,208 country-waves from 131 countries. The consolidation samples also require the primary balance in

the preceding year and hold 1,304 country-waves from 133 countries for investment and 1,205 from 131 for the capital share. Coverage rises from 87 countries in 2003 to 131 in 2014 and falls to 81 in 2024 because fiscal series lag the survey. Table 1 defines the variables, Table 2 describes the sample, and Appendix A, Table A2, lists the countries by income group.

Table 1. Variables and definitions

Variable (symbol)	Definition
Public investment, y (main)	Central-government net investment in nonfinancial assets, % of GDP
Capital share, S	$100 \times I / (I + G)$, I = net investment, G = expense, % of GDP
Public investment, ICSD (robustness)	General-government gross fixed capital formation, % of GDP
Public investment, GFS (robustness)	General-government net acquisition of nonfinancial assets, % of GDP
E-Government Development Index, E	Composite of online services, telecommunication infrastructure and human capital, 0–1
Online Service Index	Online-service component of EGDI, 0–1
Consolidation episode, C	1 if the primary balance improved by ≥ 1 percentage point of GDP on the preceding calendar year, Eq. (3)
Log GDP per capita	Natural log, constant 2015 USD
GDP growth	Annual real GDP growth, %
Revenue	General-government revenue, % of GDP
Debt	General-government gross debt, % of GDP
Government effectiveness	WGI estimate, about –2.5 to 2.5
Internet users	% of population
Urban population	% of total
Population growth	Annual, %

Note: The eight controls of vector X are log GDP per capita, GDP growth, revenue, debt, government effectiveness, internet users, urban population and population growth. Sources are given in subsection 2.1 and series codes in the Data Availability statement; WGI – Worldwide Governance Indicators.

2.2. Empirical strategy

The level models of Table 3 estimate

$$y_{it} = \alpha_i + \delta_t + \beta E_{it} + \gamma' X_{it} + \varepsilon_{it}, \quad (1)$$

where y_{it} is central-government investment (% of GDP) or the capital share of spending for country i in wave t , E_{it} is the E-Government Development Index (0–1) or, in alternative columns, the Online Service Index, X_{it} is the vector of eight controls listed in Table 1, γ' their transposed coefficient vector, α_i and δ_t are country and wave fixed effects, β the parameter of interest and ε_{it} the idiosyncratic

ic error. Equation (1) compares each country with itself across waves, net of shocks common to all countries in a wave, so β measures how within-country changes in e-government relate to within-country changes in investment. The capital share is defined as

$$S_{it} = 100 \cdot \frac{I_{it}}{I_{it} + G_{it}}, \quad (2)$$

where S_{it} is the capital share of spending, I_{it} net investment in nonfinancial assets and G_{it} expense, all for the central government in % of GDP; Eq. (2) is left undefined when $I_{it} < 0$. Equation (2) weighs investment against investment plus expense, so a cut concentrated on the capital budget lowers the share even when the total falls. Because 82% of the variance of E_{it} lies between countries, β in Eq. (1) draws on the 18% that moves within countries, and the text reports effects per within-country standard deviation (SD) of the index (0.093).

A fiscal consolidation episode is defined on the annual change in the primary balance as

$$C_{it} = 1 \left[b_{it} - b_{i,t-1} \geq 1 \right], \quad (3)$$

where C_{it} is the consolidation indicator, b_{it} the general-government primary balance (% of GDP) in the survey year of wave t , $b_{i,t-1}$ its value in the preceding calendar year and $1[\cdot]$ the indicator function; Eq. (3) flags waves whose survey year saw the primary balance improve by at least one percentage point of GDP, a threshold in the range used for large fiscal adjustments (Alesina & Ardagna, 2010). Because survey waves are one to three years apart, a change between consecutive waves would apply the same threshold to spans of different length; that wave-to-wave version is kept as a robustness check. The two definitions agree in 81% of country-waves (Cohen's $k = 0.57$). Recession episodes replace the condition in Eq. (3) with negative real GDP growth in the survey year. The interaction model of Tables 4 to 7 reads

$$y_{it} = \alpha_i + \delta_t + \beta_1 \tilde{E}_{it} + \beta_2 C_{it} + \beta_3 (\tilde{E}_{it} \cdot C_{it}) + \gamma' X_{it} + \varepsilon_{it}, \quad (4)$$

where $\tilde{E}_{it} = E_{it} - \bar{E}$ is the index centred at the estimation-sample mean $\bar{E}$, β_1 its level coefficient, β_2

the association of a consolidation episode with the outcome at mean e-government development, and β_3 , the parameter that answers the research question, the change in that association per unit of the index. Equation (4) asks whether consolidation comes with a smaller cut where the e-government score is higher, net of country and wave effects (Brambor et al., 2006). The marginal effect $ME(e)$ of consolidation at index value e and its variance follow from Eq. (4) as

$$\begin{aligned} ME(e) &= \beta_2 + \beta_3 (e - \bar{E}), \\ Var[ME(e)] &= V_{22} + (e - \bar{E})^2 V_{33} \\ &\quad + 2(e - \bar{E})V_{23}, \end{aligned} \quad (5)$$

where V_{22} , V_{33} and V_{23} are the elements of the clustered covariance matrix of β_2 and β_3 ; Eq. (5), evaluated at the 25th and 75th percentiles of the index, gives the consolidation effects of Table 4; its 95% interval traces Figure 1 and the Johnson-Neyman threshold, the lowest e at which it includes zero (Bauer & Curran, 2005). To separate e-government from correlated country characteristics, Eq. (4) is extended in Table 6 to

$$\begin{aligned} y_{it} &= \alpha_i + \delta_t + \beta_1 \tilde{E}_{it} + \beta_2 C_{it} + \beta_3 (\tilde{E}_{it} \cdot C_{it}) \\ &\quad + \sum_{k=1}^K \theta_k (\tilde{Z}_{k,it} \cdot C_{it}) + \gamma' X_{it} + \varepsilon_{it}, \end{aligned} \quad (6)$$

where $\tilde{Z}_{k,it}$, $k = 1, \dots, K$, are the centered competing characteristics, log GDP per capita, government effectiveness, internet use, revenue and debt ($K = 5$), and θ_k are their interaction coefficients; Eq. (6) tests whether β_3 survives these competing interactions. Because the index and government effectiveness are strongly correlated, Table 6 also enters government effectiveness as the only moderator, replaces the index with its component orthogonal to government effectiveness and tests the two interactions jointly (Panel B and note to Table 6).

Net investment is a component of the primary balance, so a cut in investment contributes to the improvement that Eq. (3) flags. To separate the two, the balance is recomputed net of the outcome as

$$C_{it}^x = 1 \left[(b_{it} + I_{it}) - (b_{i,t-1} + I_{i,t-1}) \geq 1 \right], \quad (7)$$

where C_{it}^x is the consolidation indicator net of investment and I_{it} and $I_{i,t-1}$ are central-government net investment (% of GDP) in the survey year and the preceding year; $b + I$ is the primary balance before investment, so Eq. (7) flags improvements achieved through revenue and current spending alone. An episode of Eq. (3) is current-driven when it also satisfies Eq. (7) and investment-driven otherwise. Table 5 re-estimates Eq. (4) with C^x in place of C , dropping investment-driven episodes, and with the alternative episode definitions listed in its note, and reports the composition of episodes by quartile of the index.

All equations are estimated by ordinary least squares (OLS) with country and wave effects absorbed (Wooldridge, 2010) and standard errors (SE) clustered by country (Cameron & Miller, 2015); tables report coefficients, SE, observations (N), countries and the within R^2 , and p -values below 0.001 are reported as $p < 0.001$. The paper also estimates Eq. (1) by pooled OLS and random effects and applies the Hausman (1978) and Breusch and Pagan (1979) tests. Robustness checks re-estimate Eqs. (1) and (4) across the specifications listed in Appendix C, Tables C2 to C4, and Figure 2 summarizes the interaction estimates as a specification curve (Simonsohn et al., 2020). Two placebo tests use the episode of the following wave and random reassignment of episodes within countries, holding their number per country constant (Fisher, 1935); the permutation test draws $B = 4,999$ reassignments and reports $p = (1 + k) / (B + 1)$, k being the number of permuted estimates at least as large as the observed one (Phipson & Smyth, 2010). Estimation uses Python 3.12 with pyfixest, linear-models, and statsmodels.

2.3. Limitations

Five limitations bound the inference. First, the design is observational. β and β_3 are associations, and the episode indicator is defined on the realized change in the primary balance, to which the outcome itself contributes; the indicator net of investment in Eq. (7) and the placebo and permutation tests address this construction. Narrative measures (Devries et al., 2011) cover 17 economies through 2009, too few for this design, and the cyclically adjusted balance covers 71 of the 133 countries. Second, EGDI moves slowly within coun-

tries, so β_3 is identified from cross-country differences in the index combined with within-country timing of episodes, a characteristic-by-shock design (Rajan & Zingales, 1998); the placebo and permutation tests address timing, not an omitted slow-moving trait such as government effectiveness. Third, the main investment measure covers the central government only, and the two general-government series used as checks cover fewer countries and years. Fourth, central-government investment is heavily right-skewed, with volatile values in resource-dependent economies, so tail treatments and leave-one-country-out re-estimation accompany the interaction estimates. Fifth, the survey methodology changed between releases, which the fixed effects and the percentile-rank specification absorb only in part, and the 2024 wave is thin because fiscal statistics lag the survey.

3. RESULTS

The level sample holds 1,319 country-waves from 134 countries across twelve waves, with a median of 11 waves per country (Table 2). Central-government investment is heavily right-skewed (skewness 4.42, kurtosis 30.6), with a maximum of 47.3% of GDP (Timor-Leste in 2012) and 14 negative observations in four countries. Only 18% of the variance of EGDI lies within countries (within-country SD 0.093). Correlations and variance inflation factors are in Appendix B, Table B1; the largest VIF, 7.57 for log GDP per capita, stays below 10.

A one within-country SD increase in EGDI is associated with a change in investment of -0.04 percentage points of GDP, with a 95% confidence interval (CI) from -0.34 to $+0.26$ ($p = 0.78$; Table 3, column 1). OSI (0.21 , $p = 0.72$) and the stepwise addition of controls (Appendix C, Table C1) leave the estimate unchanged. For the capital share, the same change corresponds to $+0.50$ percentage points with a CI from -0.66 to $+1.65$ ($p = 0.40$; column 2). Among the controls, only revenue is positively associated with both outcomes; the coefficient on government effectiveness, with 4% of its variance within countries, is not interpreted.

The null survives 30 robustness specifications (Appendix C, Table C2), reaching $p < 0.05$ only for the GFS measure on 85 countries ($\beta = -6.18$, $p = 0.006$), while the ICSD measure on 162 coun-

Table 2. Descriptive statistics, level sample for investment, 134 countries, 2003–2024

Variable	Mean	SD	Min	Max
Public investment, central government (% of GDP)	3.583	4.025	–3.364	47.344
Capital share of central-government spending (%)	13.088	12.002	0.039	81.965
E-Government Development Index (0-1)	0.566	0.218	0.000	0.985
Log GDP per capita (constant 2015 USD)	8.865	1.407	5.493	11.609
GDP growth (%)	3.035	4.542	–32.909	31.726
General government revenue (% of GDP)	30.620	13.684	4.944	136.204
General government gross debt (% of GDP)	54.605	32.912	0.000	209.927
Government effectiveness (WGI estimate)	0.246	0.971	–2.156	2.318
Internet users (% of population)	48.282	31.861	0.024	100.000
Urban population (% of total)	60.317	21.433	10.984	100.000
Population growth (%)	1.079	1.373	–7.619	9.992

Note: N = 1,319 country-waves from 134 countries for every row except the capital share, computed on its estimation sample (1,208 country-waves, 131 countries; Table 3, column 2).

Table 3. E-government and public investment levels, two-way fixed effects, 2003–2024

Dependent variable	(1)	(2)
	Investment	Capital share
EGDI	–0.463 (1.647)	5.361 (6.373)
Log GDP per capita	2.776* (1.459)	4.883 (5.717)
GDP growth	–0.032 (0.047)	0.132 (0.081)
Revenue	0.145*** (0.052)	0.194** (0.076)
Debt	–0.003 (0.006)	–0.008 (0.027)
Government effectiveness	–0.994** (0.396)	–2.808** (1.304)
Internet users	–0.008 (0.012)	–0.021 (0.037)
Urban population	–0.010 (0.042)	–0.116 (0.163)
Population growth	0.114 (0.102)	0.222 (0.270)
N	1,319	1,208
Countries	134	131
R ² within	0.093	0.059

Note: Both columns include country and wave fixed effects; standard errors clustered by country in parentheses. Within-country SD of EGDI = 0.093, of OSI = 0.147. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Bivariate, OSI, stepwise and winsorized specifications are in Appendix C, Table C1.

tries carries the opposite sign ($\beta = 2.49$, $p = 0.18$). Dropping each of the 134 countries in turn keeps the coefficient between –1.66 and 0.26 with p between 0.18 and 0.94 (Appendix C, Table C4).

The negative cross-country association disappears once country fixed effects absorb permanent differences. Pooled OLS with wave effects yields $\beta = -6.83$ (SE 1.84, $p < 0.001$) for investment, –0.64 percentage points per within-country SD and out-

side the CI of the fixed-effects estimate. Random effects reduce the coefficient to –1.70 ($p = 0.23$) and country fixed effects to –0.46 ($p = 0.78$), and the capital share moves from –27.3 ($p < 0.001$) to –0.58 ($p = 0.91$) and 5.36 ($p = 0.40$). Hausman tests reject random effects for both outcomes ($\chi^2(20) = 56.6$ and $\chi^2(19) = 84.6$, $p < 0.001$), and Breusch–Pagan statistics of 165.9 and 169.0 ($p < 0.001$) motivate the country-clustered standard errors used throughout.

Consolidation episodes defined by Eq. (3) make up 31% of country-waves (680 of 2,185 with an observed annual change). At mean EGDI, an episode is associated with 0.59 percentage points of GDP less investment (Table 4, column 1) and 1.39 points less capital share (column 2). The cut shrinks with e-government development, by 0.21 points of GDP per 0.1 of EGDI for investment (interaction $p = 0.009$) and by 0.44 points for the capital share ($p = 0.015$). Figure 1 traces the marginal effect across the EGDI distribution, from -1.21 points at the 10th percentile to $+0.03$ at the 90th for investment and from -2.66 to -0.11 for the capital share; the cut is no longer distinguishable from zero above EGDI = 0.745 (25.3% of observations) and 0.725 (25.6%), respectively.

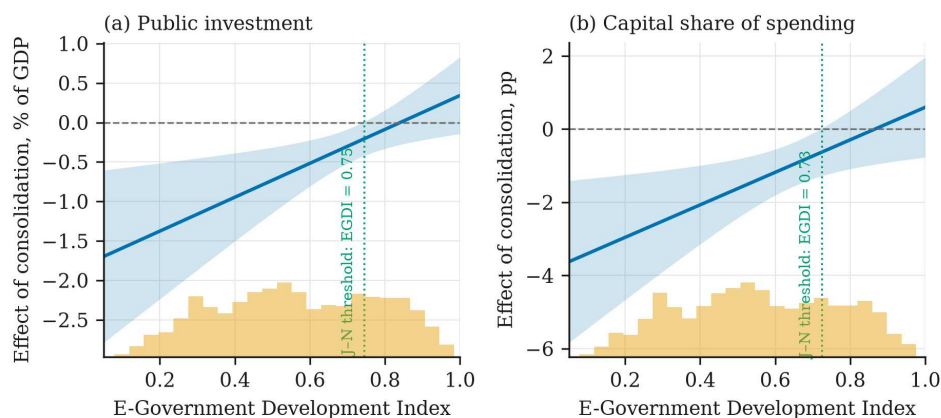
Recession episodes show no cut at the mean EGDI ($\beta = -0.358$, $p = 0.33$, for investment; 0.004 , $p = 0.995$, for the capital share) and a positive interaction (2.225 , $p = 0.018$; 5.489 , $p = 0.012$) that rests on the upper tail of the distribution. Trimming the top 1% lowers the investment interaction to 0.99 ($p = 0.18$), and the top 5% to 0.00 ($p = 1.00$), and the ICSD measure does not reproduce it ($\beta = 1.34$, $p = 0.19$), so the recession interaction plays no further role.

The attenuation appears under every definition of the episode that captures a current improvement in the balance, with precision falling as episodes become fewer (Table 5, Panel A). Interactions range from 1.392 to 5.938 across definitions, larg-

Table 4. Public investment under fiscal consolidation, two-way fixed effects, 2003–2024

Dependent variable	(1) Investment	(2) Capital share
Consolidation episode (at mean EGDI)	-0.594*** (0.170)	-1.394*** (0.356)
EGDI (centered) $\times$ consolidation	2.147*** (0.810)	4.444** (1.806)
Consolidation effect at 25th percentile of EGDI	-0.941	-2.117
Consolidation effect at 75th percentile of EGDI	-0.200	-0.613
N	1,304	1,205
Countries	133	131
Consolidation episodes in sample	385	356
R ² within	0.117	0.079

Note: Consolidation-improvement in the general-government primary balance of at least 1 percentage point of GDP on the preceding calendar year, Eq. (3). Both columns include the controls of Table 3 and country and wave fixed effects; EGDI is centered at the sample mean (0.564 and 0.552), so the consolidation coefficient is the effect at mean EGDI. Standard errors clustered by country in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Alternative definitions of the episode are in Table 5.



Note: Solid line – consolidation coefficient at each EGDI value from Table 4; shaded band – 95% confidence interval; dotted vertical line – Johnson-Neyman threshold (0.745 in panel a, 0.725 in panel b); histogram – distribution of EGDI in the estimation sample.

Figure 1. Marginal effect of a consolidation episode on (a) central-government investment and (b) the capital share across the E-Government Development Index

est under the wave-to-wave definition and weakest under diluted ones. The cyclically adjusted balance restricts the sample to 71 economies where consolidation carries no cut at mean EGDI (-0.102 , $p = 0.294$), so the interaction there is unidentified rather than rejected. Episodes defined on revenue alone (0.825 , $p = 0.385$; 0.653 , $p = 0.777$) and episodes of the preceding year (0.313 , $p = 0.656$; -0.087 , $p = 0.970$) carry no interaction.

The composition of the episodes explains why (Table 5). On the indicator net of investment, Eq. (7), consolidation leaves investment untouched at every level of the index ($p = 0.470$ and 0.418), and dropping the investment-driven episodes sharpens the null ($p = 0.882$, with a consolidation effect at mean EGDI of $+0.05$; $p = 0.831$). Of the 370 annual episodes with an observed change in investment, the share achieved without a cut rises from 70% in the bottom quartile of EGDI to 94% in the top, the cuts within investment-driven episodes shrink from -3.05 points to -0.38 , and balance improvements are of comparable size throughout. Where e-government development is higher, consolidations of the same size are achieved through other budget items, as the interaction in Table 4 summarizes.

Entering one at a time next to the EGDI interaction, the interactions with internet use, revenue, and debt leave it between 2.13 and 4.43 for investment and between 4.50 and 8.86 for the capital share (all $p \leq 0.050$), the income interaction widens the intervals, and government effectiveness absorbs it (Table 6, Panel A). With all five entered jointly the EGDI interaction is 3.37 ($p = 0.061$) and 6.31 ($p = 0.151$), next to a government-effectiveness interaction of 0.83 ($p = 0.027$) and 1.73 ($p = 0.067$).

The index and government effectiveness measure one administrative capacity that the data do not separate (Table 6, Panel B). Government effectiveness alone carries the interaction (0.59 , $p = 0.003$, for investment; 1.21 , $p = 0.007$, for the capital share), the component of EGDI orthogonal to it carries none (0.63 , $p = 0.702$, and 0.71 , $p = 0.827$), and the two interactions are jointly significant in every variant (Wald $p = 0.010$ and 0.022). Under the wave-to-wave definition, OSI carries an interaction of its own next to government effectiveness (1.34 , $p = 0.014$); under the annual definition, it does not. The attenuation is a property of administratively capable governments, which e-government development measures but does not isolate.

Table 5. The consolidation episode: Alternative definitions and the composition of adjustment, 2003–2024

Panel A. The EGDI $\times$ consolidation interaction across definitions of the episode, two-way fixed effects								
Episode definition	Inv.: β	SE	p	Episodes	Cap. share: β	SE	p	Episodes
Annual change ≥ 0.5 pp	1.884	0.766	0.015	530	4.271	1.604	0.009	488
Annual change ≥ 2 pp	2.170	1.440	0.134	204	5.938	3.013	0.051	190
Wave-to-wave change ≥ 1 pp	2.414	0.741	0.001	420	5.412	2.126	0.012	381
Wave-to-wave change per year ≥ 1 pp	2.057	0.955	0.033	306	4.646	2.659	0.083	279
Any annual episode since the previous wave	1.392	0.729	0.058	601	3.067	2.067	0.140	553
Cyclically adjusted primary balance ≥ 1 pp	1.397	1.144	0.226	173	2.975	2.910	0.310	155
Net of investment, Eq. (7)	-0.883	1.219	0.470	350	-2.174	2.673	0.418	322
Eq. (7), investment-driven episodes dropped	-0.133	0.893	0.882	343	-0.522	2.447	0.831	316
Panel B. Composition of the annual consolidation episodes by quartile of EGDI								
EGDI quartile	Episodes	Share without an investment cut	Mean Δi , investment-driven	Mean Δb				
Q1 (lowest)	92	70%	-3.05	3.82				
Q2	84	70%	-1.79	2.64				
Q3	87	79%	-1.42	2.55				
Q4 (highest)	107	94%	-0.38	2.73				

Note: The baseline (annual change ≥ 1 pp) is Table 4; annual and wave-to-wave definitions agree in 81% of country-waves (Cohen's $\kappa = 0.57$), and the share of episodes under the wave-to-wave definition is 36%, 35% and 33% for one-, two- and three-year intervals between waves, against 36%, 31% and 18% for the annual definition. The cyclically adjusted primary balance follows Alesina and Ardagna (2010). Panel B classifies the 370 episodes of Eq. (3) with an observed change in investment (sample of Table 4, column 1) as current-driven when they also satisfy Eq. (7) and investment-driven otherwise; Δi and Δb are the changes in net investment and the primary balance, in percentage points of GDP. Standard errors clustered by country.

Table 6. EGDI × consolidation against competing interactions, two-way fixed effects, 2003–2024

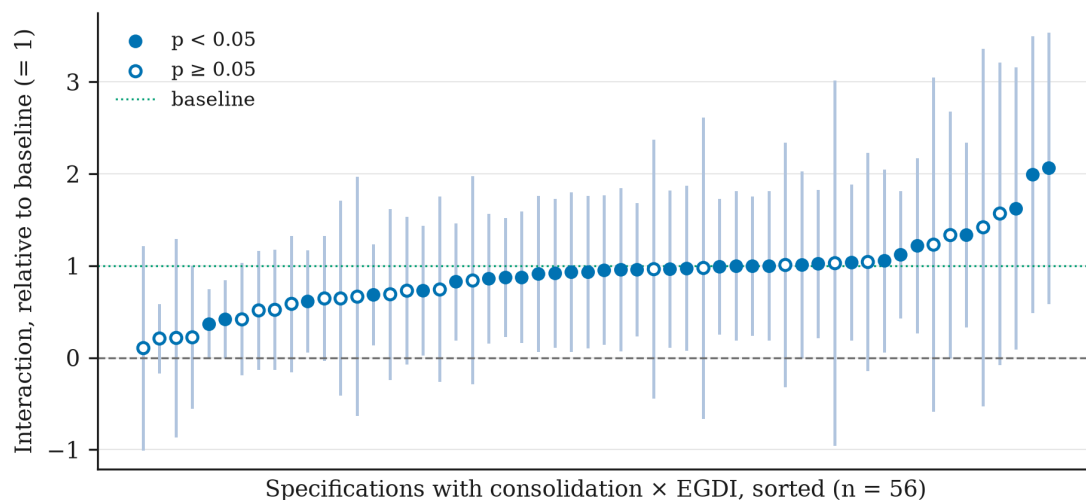
Panel A. Competing interactions entered alongside EGDI × consolidation						
Competing interaction added	Investment: EGDI × cons.	SE	p	Capital share: EGDI × cons.	SE	p
Log GDP per capita × cons.	2.075	1.525	0.176	4.340	3.687	0.241
Government effectiveness × cons.	0.466	1.164	0.690	0.470	2.483	0.850
Internet users × cons.	4.431	1.601	0.006	8.855	3.379	0.010
Revenue × cons.	2.876	1.084	0.009	4.504	2.273	0.050
Debt × cons.	2.130	0.793	0.008	4.606	1.891	0.016
All five jointly	3.371	1.786	0.061	6.313	4.375	0.151

Panel B. EGDI and government effectiveness as moderators							
Dependent	Moderators	EGDI component × cons.	p	Gov. effectiveness × cons.	p	Joint Wald $\chi^2(2)$	p
Investment	EGDI + GE	0.466	0.690	0.508	0.075	9.27	0.010
Investment	EGDI ⊥ GE + GE	0.668	0.683	0.594	0.003	9.19	0.010
Capital share	EGDI + GE	0.470	0.850	1.137	0.073	7.65	0.022
Capital share	EGDI ⊥ GE + GE	0.583	0.855	1.223	0.007	7.72	0.021

Note: Panel A adds the listed interaction (centered variable × consolidation) to the specification of Table 4 (N = 1,304 and 1,205); in the joint model, the government-effectiveness interaction is 0.828 ($p = 0.027$) and 1.728 ($p = 0.067$). In Panel B, government effectiveness (GE) enters as the centered WGI estimate, and EGDI ⊥ GE is the residual from a regression of EGDI on that estimate with wave effects; the joint Wald test is $\chi^2(2)$ on the two interaction coefficients; $\text{corr}(\text{EGDI}, \text{GE}) = 0.78$ and 0.80. Standard errors clustered by country.

Figure 2 collects 56 estimates of the interaction from the robustness battery. All are positive, 32 reach $p \leq 0.05$ and 37 reach $p < 0.10$, and relative to the baseline they range from 0.11 to 2.06; for investment 20 of 29 specifications reach $p \leq 0.05$, including alternative index measures, winsorized outcomes and sample windows (Appendix C, Table C3). The exceptions are country-specific trends, trimming the top 5% of the outcome, which re-

moves most of the cuts, and the 2-point threshold; the continuous balance change, outside the curve because its scale differs, gives 0.331 per percentage point ($p = 0.054$). Dropping each of the 133 countries in turn keeps the interaction between 1.760 and 2.432 (p from 0.002 to 0.018), the lower end produced by removing the Republic of the Congo or Angola, both oil exporters (Appendix C, Table C4). The ICSD series on 161 countries reproduces



Note: Each point is one estimate of the interaction divided by the baseline of the same dependent variable (Table 4), with 95% confidence intervals; filled markers $p < 0.05$, open markers $p \geq 0.05$; dotted line – baseline (1.0), dashed line – zero. The 56 specifications are blocks A to D of Appendix C, Table C3, except the wave-to-wave winsorized rows, together with the definitions of Table 5, Panel A, the competing interactions of Table 6, Panel A, and the split of Table 7.

Figure 2. Specification curve of the EGDI × consolidation interaction, 56 specifications, relative to the baseline estimate

Table 7. EGDI × consolidation by core government systems, two-way fixed effects, 2003–2024

Subsample	Dependent	EGDI × cons.	SE	p	Cons. at mean EGDI	N	Countries
CGSI above median	Investment	2.004	0.932	0.034	–0.247	887	85
CGSI below median	Investment	2.651	1.974	0.186	–1.131	405	47
CGSI above median	Capital share	3.749	2.529	0.142	–0.569	807	83
CGSI below median	Capital share	4.587	4.469	0.310	–2.855	387	47

Note: CGSI – Core Government Systems Index (GovTech Maturity Index, 2025 release), split at its median (0.660) across 194 economies; specification of Table 4. Interaction EGDI × CGSI-above-median in the pooled level model: 2.956 ($p = 0.179$) for investment, 8.177 ($p = 0.151$) for the capital share. Standard errors clustered by country.

the interaction ($p = 0.049$) and the GFS series on 84 countries does too ($p = 0.039$). For the capital share 12 of 27 specifications reach $p \leq 0.05$; OSI, upper-tail trimming, country trends, and the 2008–2024 window fall short.

Two placebo tests address timing. Interacting EGDI with the consolidation episode of the following wave yields -0.60 ($p = 0.454$) for investment and -1.36 ($p = 0.406$) for the capital share. Reassigning episodes at random within each country 4,999 times, holding their number per country fixed, produces permuted estimates with mean -0.14 and SD 0.84 for investment (95th percentile 1.22, maximum 3.02) and mean -0.76 and SD 2.19 for the capital share (95th percentile 2.90, maximum 6.81). Eleven permuted estimates reach the observed 2.147 and 47 reach 4.444, so $p = (1 + k) / (B + 1) = 0.0024$ and 0.0096 (Phipson & Smyth, 2010).

The level association remains undetectable within every income group, at -1.16 ($p = 0.25$) in the 49 high-income, -0.49 ($p = 0.82$) in the 42 upper-middle-income, and -2.87 ($p = 0.28$) in the 43 lower-middle- and low-income countries. On either side of the median (0.660) of the 2025 Core Government Systems Index (CGSI), it is -1.18 ($p = 0.26$) in the 86 countries with stronger core systems and -0.61 ($p = 0.87$) in the 47 with weaker ones. Nor does the split distinguish the groups in the interaction, whose confidence intervals overlap throughout (Table 7). What differs is the cut itself: 0.25 percentage points of GDP at mean EGDI where core systems are stronger and 1.13 points where they are weaker.

4. DISCUSSION

The within-country null for investment levels matches the between-country anatomy of most documented e-government effects. Vasylieva et al.

(2026) find that the quality-of-life association of EGDI rests mainly on its between-country component, and the estimator comparison shows the same anatomy, with the pooled coefficient dissolving under country fixed effects. Transaction-level evidence concurs, as e-procurement improved quality without lowering prices (Lewis-Faupel et al., 2016) and Chinese pilots raised spending efficiency, not volume (Tong et al., 2026). If digital tools act on the quality, timing, and composition of spending, a level effect was not to be expected, and the Table 3 null is the benchmark for the consolidation result.

The smaller cut at higher e-government development is consistent with the two anchors of the fiscal literature, adjustment falling on investment where horizons are short and institutions weak (Ardanaz & Izquierdo, 2022) and the cut disappearing under rules with escape clauses or exemptions (Ardanaz et al., 2021). The estimates add a moderator of the same sign, and the composition in Table 5 names the margin, since where capacity is higher, balance improvements of comparable size, 3.8 points of GDP in the bottom quartile against 2.7 in the top, come from revenue and current spending. The shared mechanism is plausibly visibility, a flexible rule making the exemption explicit and digital systems making the cost of interruption explicit. The one discrepancy is the recession interaction, which does not survive upper-tail trimming, whereas Ardanaz and Izquierdo (2022) identify the downturn asymmetry robustly; the gap is plausibly measurement, since the central-government series is thin where recessions are deepest and its upper tail belongs to Timor-Leste in 2012. All comparisons rest on associations; none establishes that digitalization causes the smaller cut.

The inability to separate the index from government effectiveness is the main theoretical implication. The interaction is carried by the compo-

nent of EGDI shared with government effectiveness; the orthogonal component carries nothing, and the two are jointly significant (Table 6, Panel B). Read through measurement, the index is not a distinct technological input but one indicator of a broader administrative capacity, as GovTech research does when it models digital government as a technological, institutional, and human system (Kuzior et al., 2026) and as mediation evidence does when trust and government effectiveness absorb the effect of digital maturity (Topazly et al., 2026). Through this mechanism, the complementarity has a direction. Digital budget, procure-

ment, and pipeline systems make the investment portfolio visible, but visibility protects investment only where an administration can act on it, which is what the composition of adjustment describes. For theory, the protective effect of technology alone cannot be tested with composite indices; it requires variation in specific systems, financial management platforms or e-procurement, with adoption dates, in an event-study design. For policy, the finding reframes rather than weakens the case for digitalization, because the systems are part of the capacity the association rewards, not a substitute for it.

CONCLUSION

The paper has tested whether digitally developed governments invest more and whether they cut investment less when they consolidate. The evidence covers 134 economies across twelve UN E-Government Survey waves, 2003–2024, with country and wave fixed effects and three measures of public investment. On the first question, e-government development shows no detectable within-country association with investment levels, and the estimates rule out the negative gradient that holds across countries. On the second, the investment cut that accompanies consolidation shrinks from 0.94 percentage points of GDP at the 25th percentile of the index to 0.20 at the 75th, with a qualification that defines its meaning: the attenuation is not separable from government effectiveness, and episodes achieved through revenue and current spending leave investment untouched.

The contribution is a within-country test of e-government against fiscal outcomes on a global panel, and its product is a change of interpretation, the index entering as a marker of the administrative capacity that decides how a balance improvement is composed rather than as a lever that raises investment. Digital government does not buy more public investment in normal times. Its fiscal value appears when adjustment comes, as a consolidation achieved through revenue and current spending rather than the capital budget, and it matters most for governments that expect consolidation under debt rules (the EU fiscal framework in Latvia), program conditionality (the IMF arrangements for Armenia and Ukraine), or post-crisis stabilization.

The capital share of spending is a cheap early indicator of whether an adjustment falls on investment, and consolidation programs in countries below the upper range of the index can set explicit floors for capital spending. Because the data do not separate e-government from the capacity it is embedded in, digital budget, procurement, and project-pipeline systems are best treated as part of public financial management capacity, and the direct test of their protective role is an event study on the adoption dates of such systems.

AUTHOR CONTRIBUTIONS

Conceptualization: Mkhitar S. Aslanyan, Liudmyla Zakharkina, Rostyslav Shchokin, Tetiana Shabelnyk, Zaiga Oborenko, Diana Zmicerevska, Zanna Klescevnikova.

Data curation: Zaiga Oborenko, Diana Zmicerevska, Zanna Klescevnikova.

Formal analysis: Mkhitar S. Aslanyan, Rostyslav Shchokin, Tetiana Shabelnyk, Zaiga Oborenko, Zanna Klescevnikova.

Investigation: Liudmyla Zakharkina.

Methodology: Liudmyla Zakharkina.

Project administration: Liudmyla Zakharkina.

Resources: Mkhitar S. Aslanyan, Zaiga Oborenko, Diana Zmicerevska.

Software: Mkhitar S. Aslanyan, Rostyslav Shchokin, Tetiana Shabelnyk, Zaiga Oborenko, Diana Zmicerevska, Zanna Klescevnikova.

Supervision: Liudmyla Zakharkina.

Validation: Liudmyla Zakharkina, Rostyslav Shchokin, Tetiana Shabelnyk, Diana Zmicerevska, Zanna Klescevnikova.

Visualization: Mkhitar S. Aslanyan, Rostyslav Shchokin, Tetiana Shabelnyk, Zaiga Oborenko, Diana Zmicerevska, Zanna Klescevnikova.

Writing – original draft: Mkhitar S. Aslanyan, Liudmyla Zakharkina, Rostyslav Shchokin, Tetiana Shabelnyk, Zaiga Oborenko, Diana Zmicerevska, Zanna Klescevnikova.

Writing – review & editing: Mkhitar S. Aslanyan, Liudmyla Zakharkina, Rostyslav Shchokin, Tetiana Shabelnyk.

DATA AVAILABILITY

The study uses publicly available secondary data, all accessed in September 2026. Central-government net investment in nonfinancial assets and expense, GDP per capita, GDP growth, internet users, urban population and population growth come from the World Development Indicators (World Bank, 2026a); government effectiveness from the Worldwide Governance Indicators (World Bank, 2026b); general-government revenue, gross debt and primary balance from the Fiscal Monitor database, October 2025 vintage (IMF, 2025); the E-Government Development Index and Online Service Index from the United Nations E-Government Survey, 2003–2024 editions (United Nations, 2024); the Core Government Systems Index from the GovTech Maturity Index 2025 (World Bank, 2025); general-government investment and capital stock from the Investment and Capital Stock Dataset, 2021 vintage (IMF, 2021); and general-government net acquisition of nonfinancial assets from the Government Finance Statistics, Statement of Operations (IMF, 2026b). Series codes in the source databases are GC.NFN.TOTL.GD.ZS and GC.XPN.TOTL.GD.ZS for central-government net investment and expense; NY.GDP.PCAP.KD, NY.GDP.MKTP.KD.ZG, IT.NET.USER.ZS, SP.URB.TOTL.IN.ZS and SP.POP.GROW for the WDI co-variables; GE.EST for government effectiveness; G1_S13_POGDP_PT, G63G_S13_POGDP_PT, GPB_S13_POGDP_PT and CAPB_S13_POPGDP_PT for the Fiscal Monitor series; P51G_S13_Q_POGDP_PT for the ICSD measure; and G31 (S13, POGDP_PT) for the GFS measure.

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APPENDIX A. Sample construction and country coverage

Table A1. Sample construction: From the full wave grid to the estimation samples

Step	N	Countries	Obs. lost	Countries lost	From step
1. Full wave grid: World Bank universe x 12 EGDI survey waves	2,604	217	–	–	–
2. EGDI observed in the wave	2,316	193	288	24	1
3. + Online Service Index observed	2,316	193	0	0	2
4. + central-government net investment observed (WDI GC.NFN.TOTL.GD.ZS)	1,416	153	900	40	3
5. + eight controls complete	1,373	151	43	2	4
6. Countries in ≥ 5 waves → level sample, investment (Table 3, columns 1–3)	1,319	134	54	17	5
7a. Of step 6: capital share defined (expense observed, net investment ≥ 0)	1,219	134	100	0	6
7b. ≥ 5 waves re-applied, wave singleton dropped → capital-share sample (Tables 2–4; Table 3, columns 4–6)	1,208	131	11	3	7a
8a. Of step 6: annual primary-balance change observed	1,304	133	15	1	6
8b. ≥ 5 waves re-applied → consolidation sample, investment (Table 5, column 1)	1,304	133	0	0	8a
9a. Of step 7b: annual primary-balance change observed	1,205	131	3	0	7b
9b. ≥ 5 waves re-applied → consolidation sample, capital share (Table 5, column 3)	1,205	131	0	0	9a

Note: The 24 economies without EGDI are World Bank economies that are not UN member states. Step 7b drops Panama, Singapore, and Uganda and the single remaining 2024 observation (Tanzania), a singleton within its wave effect. Singapore, with no primary-balance series in the Fiscal Monitor, leaves the investment consolidation sample at step 8a.

Table A2. Countries in the level sample by income group, with waves observed and consolidation episodes, 2003–2024

Income group (countries; median waves; consolidation episodes)	Countries (ISO3)
High income (49; 12; 166)	ARE†, AUS†, AUT†, BEL†, BGR†, BHR†, BHS, BRB, CAN†, CHE†, CHL†, CRI, CYP†, CZE†, DEU†, DNK†, ESP†, EST†, FIN†, FRA†, GBR†, GRC†, HRV†, HUN†, IRL†, ISL†, ISR, ITA†, KNA, KOR†, LTU†, LUX†, LVA†, MLT†, NLD†, NOR†, NZL†, PAN†, POL†, PRT†, ROU†, RUS†, SAU†, SGP†, SVK†, SVN†, SWE†, TTO, USA†
Upper-middle income (42; 9.5; 117)	ALB†, ARG†, ARM†, AZE†, BIH, BLR†, BLZ*, BRA†, BWA, COL†, CPV†, DOM†, ECU†, FJI, FSM, GEO†, GNQ, GTM, JAM, JOR†, KAZ†, LCA*, LKA†, MDA†, MDV, MEX†, MHL*, MKD†, MNG†, MUST†, MYST†, PER†, PHL†, PRY†, SLV†, SRB†, THA†, TON*, TUR†, UKR†, VCT*, ZAF†
Lower-middle income (31; 8; 75)	AGO†, BGD†, BTN†, CIV, CMR*, COG, EGY†, GHA†, HND, IND†, KEN†, KGZ*, KHM†, KIR*, LAO, LBN, LSO, MAR, MMR*, NAM, NIC, NPL*, PNG*, SLB*, SWZ, TGO, TLS*, TUN†, TZA†, UZB†, ZMB†
Low income (12; 7.5; 27)	AFG*, BDI*, BFA, CAF*, COD, ETH, MDG, MLI, MOZ*, MWI, RWA†, UGA†

Note: † = Core Government Systems Index (2025) above the sample median of 0.660; * = fewer than eight EGDI waves in the sample; consolidation episodes counted in the estimation sample of Table 4, column 1 (annual definition, Eq. 3); Singapore, without a primary-balance series in the Fiscal Monitor, contributes none.

Table A3. Country-waves with negative central-government net investment in nonfinancial assets, excluded from the capital share

Country	Survey years with negative net investment (value, % of GDP)
Colombia	2012 (–2.107)
India	2003 (–0.217), 2018 (–0.157)
Namibia	2008 (–1.876)
Singapore	2005 (–0.787), 2008 (–1.721), 2010 (–3.098), 2012 (–3.364), 2014 (–2.232), 2016 (–1.010), 2018 (–1.276), 2020 (–0.305), 2022 (–0.445), 2024 (–1.002)

Note: Negative values arise when disposals of nonfinancial assets exceed acquisitions; these 14 observations remain in the level models.

APPENDIX B. Correlations and multicollinearity

Table B1. Pairwise correlations and variance inflation factors, level sample for investment, 134 countries, 2003–2024

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	VIF
(1)	1.000	0.750	−0.440	−0.390	0.120	0.090	−0.190	−0.370	−0.350	−0.410	0.270	
(2)	0.750	1.000	−0.630	−0.590	0.230	−0.300	−0.160	−0.530	−0.520	−0.550	0.430	
(3)	−0.440	−0.630	1.000	0.840	−0.280	0.400	0.180	0.790	0.890	0.720	−0.350	7.310
(4)	−0.390	−0.590	0.840	1.000	−0.230	0.450	0.160	0.880	0.770	0.760	−0.280	7.570
(5)	0.120	0.230	−0.280	−0.230	1.000	−0.180	−0.240	−0.180	−0.350	−0.200	0.220	1.220
(6)	0.090	−0.300	0.400	0.450	−0.180	1.000	0.030	0.420	0.400	0.320	−0.330	1.360
(7)	−0.190	−0.160	0.180	0.160	−0.240	0.030	1.000	0.170	0.180	0.150	−0.080	1.090
(8)	−0.370	−0.530	0.790	0.880	−0.180	0.420	0.170	1.000	0.700	0.620	−0.240	4.830
(9)	−0.350	−0.520	0.890	0.770	−0.350	0.400	0.180	0.700	1.000	0.660	−0.320	5.060
(10)	−0.410	−0.550	0.720	0.760	−0.200	0.320	0.150	0.620	0.660	1.000	−0.180	2.710
(11)	0.270	0.430	−0.350	−0.280	0.220	−0.330	−0.080	−0.240	−0.320	−0.180	1.000	1.250

Note: Pearson correlations on the estimation sample of Table 3, column 1; VIF from the regression of each regressor on the others; largest VIF 7.57. Variables: (1) Public investment; (2) Capital share; (3) EGD; (4) Log GDP per capita; (5) GDP growth; (6) Revenue; (7) Debt; (8) Government effectiveness; (9) Internet users; (10) Urban population; (11) Population growth.

APPENDIX C. Robustness of the level and interaction estimates

Table C1. E-government, public investment, and the capital share of spending: Stepwise controls and winsorized outcome, two-way fixed effects, 2003–2024

Variable	(1) EGD	(2) + macro	(3) full	(4) OSI, full	(5) full, winsorized
Central-government investment (% of GDP)					
EGD	0.100 (1.988)	−1.558 (1.440)	−0.463 (1.647)		−0.294 (1.326)
OSI				0.214 (0.590)	
N	1,319	1,319	1,319	1,319	1,319
R ² within	0.000	0.083	0.093	0.093	0.100
Capital share of central-government spending (%)					
EGD	4.293 (6.401)	2.627 (5.610)	5.361 (6.373)		2.146 (4.668)
OSI				1.608 (2.158)	
N	1,208	1,208	1,208	1,208	1,208
R ² within	0.002	0.045	0.059	0.058	0.041

Note: Standard errors clustered by country in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Column (2) adds the macro-economic controls, columns (3) to (5) the full control set of Table 3, and column (5) winsorizes the outcome at 1/99; 134 and 131 countries.

Table C2. Robustness of the level estimates of EGD, selected specifications, two-way fixed effects

Specification	β	SE	p	N	Countries
Excluding top 1% of the outcome	−0.641	1.055	0.544	1,298	131
Excluding top 5% of the outcome	−0.937	0.939	0.321	1,235	126
Outcome winsorized at 1/99	−0.294	1.326	0.825	1,319	134
ICSD general-government investment (2003–2018)	2.487	1.829	0.176	1,421	162
GFS general-government investment	−6.181	2.195	0.006	834	85
EGD lagged one wave	0.496	2.095	0.813	1,232	134
EGD led one wave	0.770	1.825	0.674	1,234	133
EGD within-wave percentile	−1.031	1.195	0.390	1,319	134
Excluding microstates (< 1 million)	−0.125	1.730	0.943	1,162	116
Excluding the 2024 wave	−0.613	1.795	0.733	1,234	133
2008–2024 window	0.256	2.087	0.902	1,033	131

Note: β and SE per unit of the index (per within-SD = $\beta \times 0.093$); standard errors clustered by country; baselines are Table 3. Thirty specifications were estimated; the table shows the tail, measurement, timing, and sample checks reported in the text.

Table C3. Robustness of the EGDI × consolidation interaction: Measurement, sample, placebo, and permutation tests

Specification	Investment: β	SE	P	N	Capital share: β	SE	p	N
Baseline (Table 4)	2.147	0.810	0.009	1,304	4.444	1.806	0.015	1,205
A. Measures of the index								
OSI instead of EGDI	1.324	0.593	0.027	1,304	2.329	1.440	0.108	1,205
EGDI within-wave percentile	1.855	0.754	0.015	1,304	3.893	1.432	0.007	1,205
EGDI lagged one wave	1.967	0.912	0.033	1,219	4.299	1.905	0.026	1,122
EGDI led one wave	1.982	0.870	0.024	1,220	4.543	1.791	0.012	1,205
B. Sample and trends								
Country-specific linear trends	1.258	0.796	0.116	1,304	3.255	1.784	0.070	1,205
Top 1% of the outcome excluded	1.474	0.586	0.013	1,282	2.296	1.428	0.111	1,179
Top 5% of the outcome excluded	0.452	0.396	0.256	1,220	0.992	1.728	0.567	1,114
Microstates excluded	2.005	0.894	0.027	1,147	4.333	1.996	0.032	1,053
2008–2024 window	2.269	1.073	0.036	1,024	3.314	2.250	0.143	927
2024 wave excluded	2.052	0.871	0.020	1,220	4.444	1.806	0.015	1,205
C. Winsorized outcome								
Winsorized at 1/99	1.778	0.679	0.010	1,304	3.266	1.564	0.039	1,205
Winsorized at 1/99 (wave-to-wave)	1.931	0.611	0.002	1,213	4.699	1.943	0.017	1,116
Winsorized at 5/95	0.902	0.451	0.048	1,304	1.879	1.345	0.165	1,205
Winsorized at 5/95 (wave-to-wave)	1.472	0.503	0.004	1,213	3.305	1.690	0.053	1,116
D. Independent general-government series								
ICSD investment (general government)	0.788	0.397	0.049	1,400	–	–	–	–
GFS investment (general government)	3.490	1.663	0.039	819	–	–	–	–
E. Net of investment, continuous change								
$\Delta b \geq 1$ and $\Delta(b + I) \geq 0.5$ only	1.424	0.966	0.143	1,183	3.696	2.550	0.150	1,082
EGDI × $\Delta(b + I)$, continuous	–0.241	0.264	0.363	1,239	–0.422	0.237	0.077	1,131
EGDI × Δb , continuous (same sample)	0.331	0.168	0.051	1,239	0.426	0.330	0.199	1,131
F. Placebo and permutation								
Placebo, next-wave consolidation	–0.596	0.794	0.454	1,222	–1.355	1.624	0.406	1,207
Placebo, next-wave recession	–1.164	0.978	0.236	1,234	–3.542	2.382	0.140	1,208
Permutation, 4,999 draws	2.147	0.838	0.002	1,304	4.444	2.190	0.010	1,205

Note: Consolidation specifications only; ICSD and GFS rows use general-government investment (161 and 84 countries); otherwise 133 and 131 countries unless the sample is restricted. Blocks A to D, except the wave-to-wave winsorized rows, are the points of Figure 2 together with the definitions of Table 5, Panel A, the competing interactions of Table 6, Panel A, and the split of Table 7; blocks E and F are outside the curve because the regressor or its scale differs. Permutation rows report the SD of the 4,999 permuted estimates as SE and $p = (1 + k) / (B + 1)$, $k = 11$ and 47. Standard errors clustered by country.

Table C4. Leave-one-country-out re-estimation: Level model and consolidation interaction

Model	Re-estimations	β min	β max	p min	p max	Share $p < 0.05$
Level model, investment (EGDI)	134	–1.662	0.263	0.184	0.938	0.000
Consolidation interaction, investment	133	1.760	2.432	0.002	0.018	1.000
Consolidation interaction, capital share	131	3.339	4.795	0.009	0.036	1.000

Note: Each row re-estimates the named model dropping one country at a time (Table 3, column 1; Table 4, columns 1 and 2). Largest shifts: level model, Equatorial Guinea (–1.199), Timor-Leste (+0.726); investment interaction, Congo, Rep. (–0.387), Angola (–0.338), Namibia (+0.285); capital-share interaction, Congo, Rep. (–1.105), Angola (–0.801), Equatorial Guinea (–0.622).