COLLABORATIVE DIGITAL REGULATION: A MUCH – NEEDED APPROACH TO ACHIEVING GROWTH OF THE DIGITAL ECONOMY

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Abstract *– The International Telecommunication Union (ITU) has been advocating in recent years for the need to implement a new approach to Information and Communication Technology (ICT) regulation, labelled fifth generation collaborative digital regulation. To measure the levels of collaborative regulation, the ITU launched a pilot version of The Benchmark of Fifth Generation Collaborative Regulation in 2020. In this article, we examine the relevance of the updated version of the G5 Benchmark, based on a new metric structure, a larger number of indicators, and a wider range of data sources. We compare the G5 scores with those emerging from other established indexes measuring different aspects of the digital development in order to explore their correlation and the significance of the G5 Benchmark. In addition, our empirical analysis suggests that countries with a stronger collaborative regulation (as measured by the G5 Benchmark) are also the countries with more advanced digital development and with larger national economic output, although future research will be needed to establish firm conslusions over causality, when larger time-series become available. We conclude highlighting that the G5 Benchmark provides not only a tool to assess where a country stands in terms of the development of this critical capability but also a path on how to evolve and what are the areas that need to be emphasized.*

Keywords – Collaborative regulation, digital economy, information and communication technologies

1. INTRODUCTION

The International Telecommunication Union (ITU) has been advocating in recent years for the need to implement a new approach to Information and Communication Technology (ICT) regulation, labelled fifth generation collaborative digital regulation. Collaborative regulation or Fifth generation regulation (G5) is a broad notion that ITU has defined based on the concept of generations of regulation, evolving from the initial command and control approach that regulates public monopolies to collaboration across government institutions and public and private sector stakeholders to oversee the development of a competitive digital economy. The G5 benchmark measures the evolution of regulatory and policy frameworks and helps countries establish roadmaps towards the new paradigm.

ITU's efforts towards creating a framework to measure the levels of collaborative regulation materialized through the launch of a pilot version of *The Benchmark of Fifth Generation Collaborative Regulation* in 2020, and the release in 2021 of a refined G5 Benchmark, based on a new metric structure, a larger number of indicators, and a wider range of data sources. The G5 Benchmark provides governments with a set of guidelines of what needs to be achieved from an institutional framework to accelerate the growth of the digital economy, which is one of the critical levers to achieve economic recovery from COVID-19 [1].

The following paper starts with a brief explanation of the benchmark and details the position of countries around the world in terms of their score. On this basis, the analysis focuses on the economic and competitive benefits of countries engaged in improving their regulatory performance. After justifying the importance of collaborative regulation, some implications for countries are drawn to improve cross-institutional coordination and collaboration to build a single policy and regulatory focus on the digital economy domain.

2. WHAT IS COLLABORATIVE REGULATION

Collaborative regulation refers to inter-institutional coordination as a key requirement for policy and regulatory coherence to stimulate the development of the digital economy. The all-encompassing dimension of the digital economy addresses not only the development of a vibrant innovation eco-system but also the impact of digital

transformation across industries, from agriculture to manufacturing and services, and all public and private services. In this new context, silo-based regulation and isolated policy making cannot support the growth of the new paradigm: coordination across government agencies and ministries, coupled with collaboration between the public and private sectors becomes imperative.

The G5 Benchmark provides a path of what needs to be achieved in moving towards the new paradigm. It is predicated on four pillars:

- Collaborative governance, understood as the breadth and depth of cross-institutional collaboration between an ICT regulator and policy makers, and their peers from other sectors (for example, transportation, energy, science and technology, education, and the like).
- Policy design principles, focusing on the design of procedures to guide the development of policies and regulatory frameworks (such as public consultations, impact assessment methods, and transparency).
- Digital development encompasses the conditions needed to stimulate development of a sustainable digital economy. It considers emerging consumer needs, new business models and market dynamics within the digital ecosystem, as well as other enablers such as cybersecurity, and data protection.
- Digital Economic Policy Agenda represents the policies taken by a country to promote the growth of the digital economy. They range from an innovation framework (such as creation of digital skills and development of applications by sector) to digital transformation (such as Industry 4.0), sector taxation, and international/regional integration.

Each component is composed of multiple indicators. In total, the refined G5 Benchmark comprises 70 indicators, although some are aggregated within an interim subcomponent, becoming 54 indicators after grouping (see Table 1).

Table 1 – G5 Benchmark component structure

Pillars	Components	Sub-components	Indicators
Pillar I: National collaborative governance	Regulatory collaboration in digital core areas		Collaboration with (independent) Spectrum Authority
			Collaboration with (independent) Broadcasting (content) Authority
			Collaboration with cybersecurity agency
			Collaboration with CERT (Computer Emergency Response Team)
			Collaboration with (Independent) Data Protection Authority
			Collaboration between ICT ministry OR ICT regulator AND Digital (Transformation) Agency/National Agency in charge of (coordination of) the implementation of digital policies/strategies
	Cross-sector institutional cooperation		Collaboration between ICT policy body and (independent) Finance Regulator
			Collaboration between ICT policy body and energy regulatory authority
			Collaboration between ICT policy body and transport regulatory authority
			Collaboration between ICT policy body and (independent) competition authorities
			Collaboration between ICT policy body and postal regulatory authority
			Collaboration between ICT policy body and (independent) Consumer Protection Authority, Data Protection Authority
			Collaboration between ICT policy body and ministry responsible for health (e-health)
			Collaboration between ICT policy body and ministry responsible for education (e-education)
			Collaboration between ICT policy body and ministry responsible for the environment (e-waste)
			Collaboration between ICT policy body and ministry responsible for economic development OR similar focusing on a single or a subset of economic sector/s, e.g., industry, agriculture, fisheries)

Pillars	Components	Sub-components	Indicators
Pillar II: Policy Design Principles	Regulatory design procedures	Are public consultations designed as a tool to gather feedback from national stakeholders and guide regulatory decision-making?	
		Is there a formal requirement for Regulatory Impact Assessment (RIA) before regulatory decisions are made AND/OR ex-post or rolling reviews?	
		Are the decisions of the regulatory authority (entity in charge of regulation) subject to a general administrative procedures law?	
		Can affected parties request reconsideration or appeal adopted regulations to the relevant administrative agency (all sectors)?	
		Are national policy and regulatory frameworks technology and service-neutral?	
		Regulatory experimentation	Are there mechanisms for experimentation in ICT/digital regulation?
			Are there regulatory sandboxes for addressing digital financial services?
		Policy reviews	Do ministries/regulatory agencies conduct ex-post policy reviews?
			Do ministries/regulatory agencies conduct policy rolling reviews and commission monitoring reports?
	Transparency	Are the laws (all sectors) that are currently in effect available on a single website managed by the government?	
		Is public access to information ensured and fundamental freedoms protected, in accordance with national legislation and international agreements?	
		Are there rules on ethics in place that apply to staff, including Head/Chairperson and Members/Commissioners of a national regulatory agency?	
Pilar III: Digital Development Toolbox	Digital strategy for development	Strategy design and implementation	Is there an overarching digital strategy in place?
			Does the digital strategy have mechanisms for implementation/ operational objectives and targets?
		Is broadband considered as part of universal access/service definition?	
		Is there a digital identity framework in place?	
		Is there an e-gov/ digital first for government/ national e-government strategy or equivalent?	
		Has your country adopted e-waste regulations or e-waste management standards?	
		Does a regulatory framework exist for ICT accessibility for persons with disabilities?	
		Is there a legislation/regulation for child online protection?	
		Public services	Has your country adopted any policy/legislation/regulation related to smart cities?
			Has your country adopted any policy/legislation/regulation related to e-health or smart health?
			Has your country adopted any policy/legislation/regulation related to e-applications and/or m-applications on education and learning?
		Cybersecurity	Is there cybersecurity legislation or regulation?
			Has your country signed or ratified the Budapest convention on cybersecurity?
		Data protection	Are there formal data protection rules (e.g., law, regulations)?
			Has your country signed on international agreements determining jurisdiction and/or managing cross-border flows on data privacy?
		Emergency telecommunications	Has your country signed or ratified the Tampere Convention for communications in emergency situations?
			Does a national emergency (telecommunications) plan exist?
		Infrastructure sharing	Does an official register or a mapping exist in your country of all telecommunication/ICT infrastructure?
			Is there any cross-sector (ICT, energy, rail and other) infrastructure sharing or fibre co-deployment regulations/ agreements/promotion initiatives in your country?

Pillars	Components	Sub-components	Indicators
	Sustainable Development Goals (SDGs)	Is the digital strategy explicitly SDG-oriented OR does it have a specific mention of or reference to SDGs or other international development goals (e.g., MDGs, WSIS goals, EU strategic objectives)?	
		Are there policy instruments aimed at supporting the shift to sustainable consumption and production, or a coordination mechanism for sustainable consumption and production?	
		Is there a developed and operationalized global strategy for youth employment and to implement the Global Jobs Pact of the ILO?	
		Strategies for targeted groups	Broadband plan / initiative includes the promotion of the provision of broadband services to women and girls
			Broadband plan / initiative includes the promotion of the provision of broadband services to persons with disabilities
			Broadband plan / initiative includes the promotion of the provision of broadband services to youth people
Pillar IV: Digital Economy Policy Agenda	International collaboration and harmonization	Does your country belong to regional integration initiatives with ICT chapters?	
		Has your country made commitment to facilitate trade in telecommunication services?	
	Framework for innovation	Is there a holistic innovation policy/strategy or one tailored to the ICT/digital sector?	
		Is there a forward-looking competition policy, law or regulation applied to digital markets?	
	Framework for digital transformation	Has your country adopted a forward-looking or innovative national strategy, policy or initiative focusing on spectrum (e.g., IMT-2000, 5G, FWA, satellite, HAPS, 6 GHz)?	
		Are there policies and regulations for e-commerce/e-transactions?	
		Digital skills	Does universal service/access definition include connectivity for community telecentres or schools (primary, secondary post-secondary)?
			Has the Universal Service Fund (USF) financed projects for connecting schools (primary, secondary, post-secondary, universities, specialized training, institutions, etc.) or multi-purpose telecentres?
			Does the digital strategy include the educational sector?
		Policies for specific sectors Industry 4.0	Does the digital strategy include specific mentions of multiple sectors of the economy?
			Has your country adopted any policy/legislation/regulation related to e-apps and/or m-apps linked to agriculture/science/financial services?
			Does it include a strategy, policy or initiative focusing on the Internet of Things (IoT)? Or are any measures applied regarding spectrum management and availability for IoT?
			Has your country adopted a generic policy/legislation/regulation related to cloud and edge computing?
			Has your country adopted a national strategy, policy or initiative focusing on Industry 4.0 technologies related to artificial intelligence?
	Taxation framework	Are there specific taxes on the telecommunication/digital sector OR on Internet services/devices/SIM cards/airtime recharge?	
		Are there regulatory incentives targeted at network operators or other digital market players?	
	Code of conduct	Do codes of conduct exist (voluntary or enforceable/required by regulator)?	

Each pillar is composed of multiple sub-components, all of them focused on areas of policy and regulatory interventions shaping the digital economy (see Fig. 1).

As is the case in the development of any composite metric, the construction of the G5 Benchmark entailed addressing three main technical issues: scoring, weighting, and aggregation.

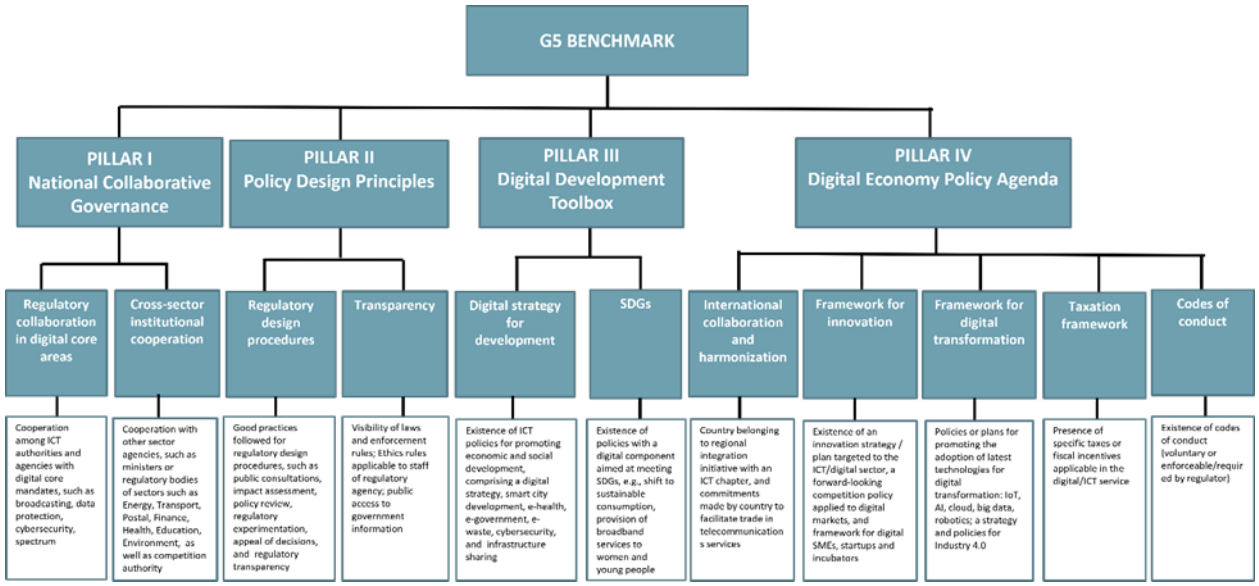

Fig. 1 – G5 Benchmark design

- Scoring relates to how regulatory and policy measures are transformed from qualitative to quantitative information.
- Weighting captures the relative importance of each indicator.
- The aggregation method determines how weights are applied to scores for calculating the index number.

In the case of scoring, each indicator was assigned a code between 0 and 2, where 2 is the best possible scenario based on internationally recognized best practices. Those were laid out in the 2019 Global Symposium of Regulators Best Practices Guidelines "Fast forward digital connectivity for all", as well as the series of GSR Best Practice Guidelines adopted by the global community of regulators since 2003.

The source of qualitative data used for scoring was self-reported information compiled from the answers to the ITU World Telecommunications Regulatory Survey[1], desktop research, World Bank sources, the United Nations sources (UNCTAD, UNTC), World Trade Organization (WTO), the Consultative Group to Assist the Poor (CGAP) and the Council of Europe, complemented with direct outreach to ICT regulatory authorities. In the case data is not available for a particular indicator in each country, the score is treated as zero. While this penalizes countries with omitted values, it also assumes that non-available data and no answer to a survey question indicates that the country has not adopted the given policy instrument.

The aggregation of the final score is calculated by summing up the scores of each pillar. Given that each pillar has a different composition in terms of indicators, implicitly their relative importance over the overall score is determined by the number of indicators within. The score is normalized to reach values between zero and 100, according to the following formula:

$$Overall\ Score = \left(\frac{\sum_{i=1}^{i=4} Score\ Pillar_i}{Max\ possible\ score}\right) * 100$$

Based on the scoring methodology, the maximum score attainable by a country is 100 and would be composed of the following pillar scores (see Table 2).

[1] The G5 Benchmark is based on self-reported information gathered via official ITU Surveys to Member States' Administrations, data sets compiled by international organizations as well as desktop research based on official government sources and direct outreach to national telecommunication/ICT regulatory authorities. Official data received from Member States' Administrations has been verified to an extent that is reasonably feasible.

Table 2 – Maximum pillar score

Pillars	Component	Maximum component score	Maximum pillar score	Maximum index score	Maximum index score (normalized)
Pillar I: National Collaborative Governance	Regulatory collaboration in digital core areas	12	32	108	100
	Cross-sector institutional cooperation	20			
Pillar II: Policy Design Principles	Regulatory design procedures	14	20		
	Transparency	6			
Pilar III: Digital Development Toolbox	Digital strategy for development	24	32		
	SDGs	8			
Pillar IV: Digital Economy Policy Agenda	International collaboration and harmonization	4	24		
	Framework for innovation	4			
	Framework for digital transformation	10			
	Taxation framework	4			
	Code of conduct	2			

Source: ITU

The benchmark was calculated for 193 countries for 2020 (full list in Table 9). Once calculated, the final G5 benchmark score was split into four stages of collaborative regulation. In addition to providing guidelines, the G5 benchmark measures where countries stand in the path to fulfilling the collaborative regulation requirements. Only a few nations have achieved a score higher than 80 (over a maximum of 100): Australia, Canada, Estonia, Finland, Germany, the Republic of Korea, Singapore and United Kingdom. Notably, low-scoring countries are mostly located in Africa, joined by some Asian and Latin American economies (see Fig. 2).

Table 3 provides a summary of the characteristics of each of the stages.

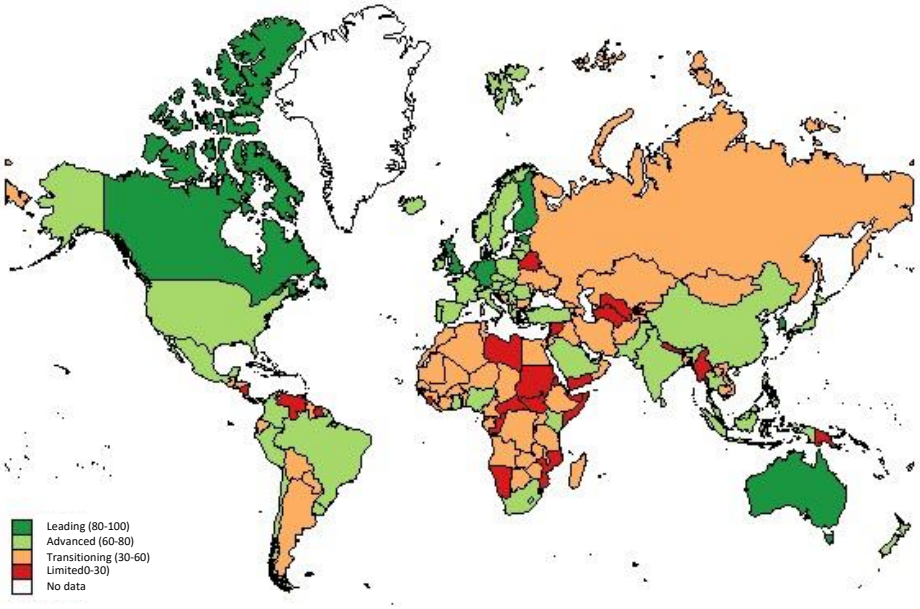

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Fig. 2 – Policy readiness for digital transformation according to the G5 benchmark score

Table 3 – Fulfilment of G5 Benchmark thresholds (by pillar) corresponding to the level of readiness for digital transformation

Readiness level	Pillar I: National collaborative governance	Pillar II: Policy design principles	Pillar III: Digital development toolbox	Pillar IV: Digital economy policy agenda	Maximum score	Minimum score
Limited	• No collaboration • No entity in charge	• Public consultations are not undertaken or required by law • No formal requirement for a regulatory impact assessment • The decisions of the regulatory authority are not subject to a general administrative procedures law • Affected parties may not request reconsideration or appeal of regulations adopted by the administrative agency • Authorization/operating licences or spectrum, are not technology and service neutral • No mechanisms for regulatory experimentation or sandboxes exist • No ex-post regulatory policy reviews	• No overarching digital strategy in place • No digital identity framework • No e-government strategy in place • No existence of policy/legislation/regulation for smart cities, e-health, and applications for education and learning • No cybersecurity/cybercrime legislation and/or regulation in existence • There is neither a data protection law nor a data protection agency • No national emergency telecommunications plan	• No holistic innovation strategy tailored to the ICT sector • No forward -looking competition policy, law or regulation applied to digital markets • No policies and regulations for e-commerce transactions in place • No strategy, policy or initiative focusing on IoT • Taxes on the telecommunications and digital sector exist	30	0
Transitioning	• Activities carried under the same ministry	• Public consultations exist but there is no requirement/it is unclear what the timeline and process is and whether the regulator incorporates results in their decision-making/ there is no obligation to consider/respond to all comments	• Overarching digital strategy expired, or being planned, is part of a broader development strategy, only covering specific plans or not clearly implemented	• Forward looking competition policy, law or regulation applied to digital markets, or spectrum management processes in the process of definition	60	30

Readiness level	Pillar I: National collaborative governance	Pillar II: Policy design principles	Pillar III: Digital development toolbox	Pillar IV: Digital economy policy agenda	Maximum score	Minimum score
Advanced	Formal collaboration (Joint Program of Committee)	• Public consultations designed as a tool to gather feedback from national stakeholders and guide most regulatory decision-making • Regulatory impact assessment is required for some decisions • The decisions of the regulatory authority are subject to a general administrative procedures law • Affected parties may request reconsideration or appeal of regulations adopted by the administrative agency to the judiciary • Authorization, operating licences, and spectrum are technology and service neutral • Frequent ex-post policy reviews • Laws that are currently in effect available on multiple websites managed by the government	• Existing of current digital strategy in place • Digital identity framework in place • Existence of a national e-government strategy or equivalent • Existence of policy/legislation/regulation for some areas of digital economy • Full cybersecurity and cybercrime legislation and regulatory framework • Existence of a law and data protection agency • Existence of a National Emergency Telecommunications Plan • Mention of SDG or other international development goals mentioned in the digital strategy	• Holistic but general innovation strategy • Competition policy, law or regulation applied to digital markets or spectrum management processes • Regulations for e-commerce transactions in place • Strategy, and initiative focusing on IoT • Selective tax exemptions for the telecommunications and digital sectors	80	60

Readiness level	Pillar I: National collaborative governance	Pillar II: Policy design principles	Pillar III: Digital development toolbox	Pillar IV: Digital economy policy agenda	Maximum score	Minimum score
Leading	Formal collaboration (Joint Program of Committee) with regular meetings and high level participation	• Public consultations designed as a tool to gather feedback from national stakeholders and guide all regulatory decision-making • Regulatory impact assessment is required for all major decisions • The decisions of the regulatory authority are subject to a general administrative procedures law • Affected parties may request reconsideration or appeal of regulations adopted by the administrative agency to an independent body or the judiciary • Authorization, operating licences, and spectrum are technology and service neutral • Mechanisms for regulatory experimentation or sandboxes exist • Systematic ex-post policy reviews • Laws that are currently in effect available on a single website managed by the government	• Existing of current and updated digital strategy in place • Digital identity framework in place • Existence of a national e-government strategy or equivalent • Existence of policy/legislation/regulation for smart cities, e-Health, and applications for education and learning • Full cybersecurity and cybercrime legislation and regulatory framework • Existence of a law and data protection agency • Existence of a national emergency telecommunications plan • Mention of SDG or other international development goals mentioned in the digital strategy	• Holistic innovation strategy tailored to the ICT sector • Forward looking competition policy, law or regulation applied to digital markets or spectrum management processes • Policies and regulations for e-commerce transactions in place • Strategy, policy, or initiative focusing on IoT • Overarching tax exemptions for the telecommunications and digital sectors	100	80

3. THE BENEFITS OF COLLABORATIVE REGULATION

There is emerging evidence that the adoption of principles and practices underlining the concept of collaborative regulation entails social and economic benefits. To begin with, the G5 Benchmark is correlated with macroeconomic outcomes (see Fig. 3).

Why is this the case? A stronger collaborative regulation context (as measured by the G5 benchmark score in the horizontal axis) is associated with faster growth of the digital sector, which is expected to translate into spillover gains for the overall economy (measure by GDP per capita in the vertical axis). Furthermore, the exponential nature of the relationship between both variables might indicate a potential return to scale: in other words, once countries reach a G5 score of approximately 60, economic growth triggered by the development of the digital economy begins to increase at a faster pace. While the correlations shown in this descriptive analysis seem to be strong enough, it is still necessary to find out if they are robust within econometric models.

Due to the lack of extended data series, the following econometric analysis presents some limitations. As the G5 Benchmark has only been developed for 2020, it is not possible to estimate a panel-data model, having instead to rely on a cross-section specification for a single year. This is an important limitation, as in the absence of a panel, it is not possible to control for unobservable country-level effects affecting the variance in the scores of the different indices.

The link between G5 and economic output (measured by GDP) was analyzed through a Cobb-Douglas production function after log-linearization:

$$log(GDP) = \alpha + \beta\, log(G5) + \gamma\, log(K) + \delta\, log(L) + \theta_r + \varepsilon$$

As can be seen, GDP is expected to depend on the G5 score, and we add as further controls measures for physical capital stock (K) and Labour (L), as well as regional dummies (θ_r). Results are presented in Table 4, with the estimation performed through the Ordinary Least Squares (OLS) approach with robust standard errors.

Table 4 – Regression analysis

Dep. var	**Log (GDP)**
Log (G5 score)	0.471***
	[0.129]
Log (Capital)	0.626***
	[0.047]
Log (Labour)	0.344***
	[0.054]
Region dummies	YES
R-squared	0.98
Observations	104

*Note: ***p<1%. Models estimated with constant term. Robust standard errors in brackets.*

The results point at a positive link between G5 score and national economy.

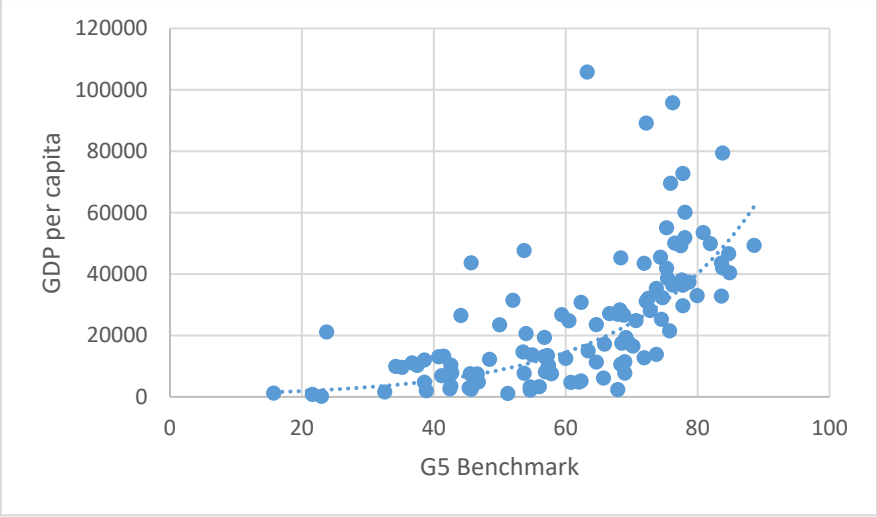

Fig. 3 – GDP per capita and G5 Benchmark

Table 5 – Selected global indices

Indicator	Geographical scope	Year of last edition	Source
E-Government Development Index	World	2020	United Nations
E-Participation Index	World	2020	United Nations
Doing Business	World	2020	World Bank
Digital Maturity Index	World	2020	Telecom Advisory Services
Global Competitiveness Index 4.0	37 countries	2020	World Bank
5G Readiness Index	Europe	2019	Incities
Global Innovation Index	World	2020	WIPO
Network Readiness Index	World	2020	Portulans Institute
B2C Ecommerce Index	World	2020	UNCTAD
Global Cybersecurity Index	World	2020	ITU

When analyzing the link of the G5 score with national economic output, with controls for capital and labour, it is determined that the coefficient associated to the G5 score is positive and statistically significant. This provides further evidence suggesting that countries with a stronger collaborative regulation are also the countries with better macroeconomic outcomes, although future research will be needed to establish firm conclusions over causality, when larger time-series become available.

The benefits of collaborative regulation also extend to other domains. In general, the development of collaborative regulation is associated with ten well-accepted global indices, which address a wide range of metrics, all of them with a different focus and scope, but mostly linked to the development of digital economy frameworks (see Table 5).

Fig. 4 presents the scatter plots linking each selected indicator with the G5 benchmark score.

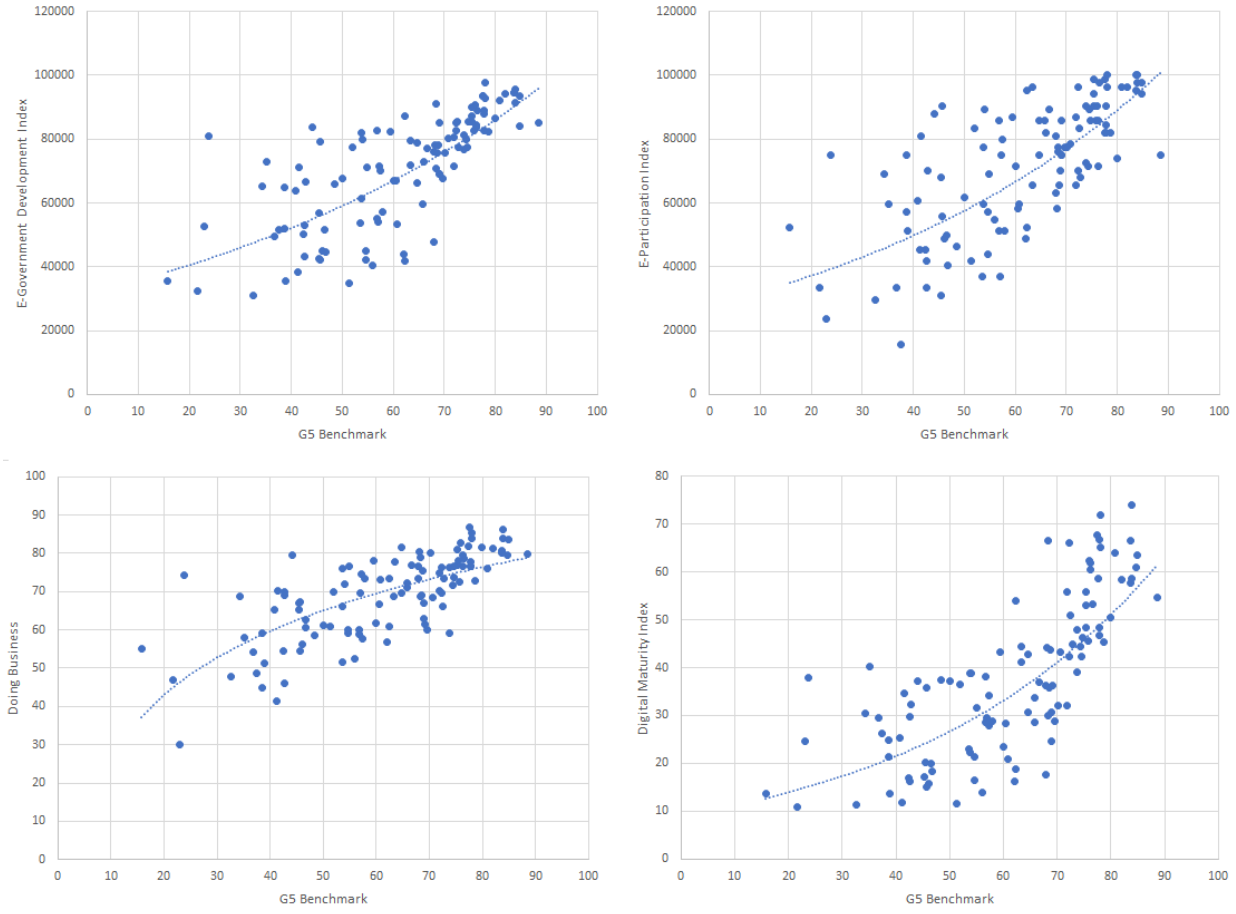

Fig. 4 – Scattergram of selected indices and G5 Benchmark

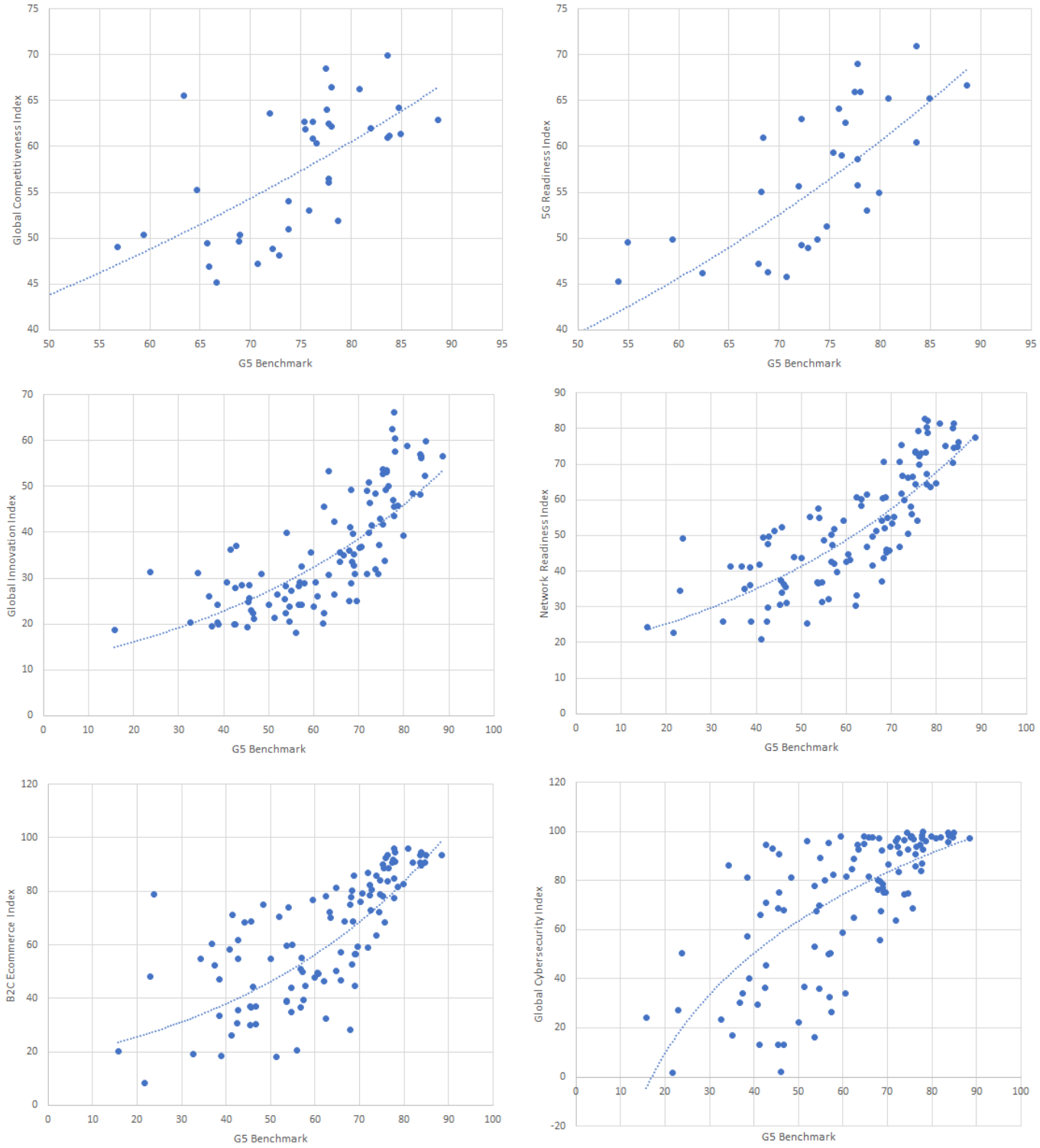

Fig. 4 (continued) – Scattergram of selected indices and G5 Benchmark

The plots in Fig. 4 indicate some minor differences that are worth observing. For instance, while in some cases the link is best expressed through a straight line (such as the Global Competitiveness Index[2], or the 5G Readiness Index[3]), in other cases the better fit comes from a logarithmic

[2] The Global Competitiveness Index, developed by the World Bank, assesses the microeconomic and macroeconomic foundations of national competitiveness, which is defined as the set of institutions, policies, and factors that determine the level of productivity of a country.

[3] The 5G Readiness Index, developed by Incities, measures the developments of European countries in the 5G race. The score comprises 6 factor categories with 35 criteria in total within those categories.

(Doing Business [4]) or an exponential tendency (case of E-Government Development Index [5], E-participation Index[6], or Digital Maturity Index[7]). The logarithmic correlation could indicate that once the G5 Benchmark reaches a certain threshold (for example, the value of 50 in the Doing Business index), the increase would undergo a gradual saturation (or diminishing returns). On the other hand, for the correlations that indicate an exponential tendency, when the G5 score reaches a certain threshold, the corresponding index might indicate a return to scale (this threshold is approximately 50 for the E-Government Development, the E-Participation indices, while it seems to be close to 60 in the case of the Global Innovation[8] and the Digital Maturity Index).

This analysis provided evidence of a strong link between the novel G5 Benchmark with several indicators of reference: Network Readiness Index[9], E-Government Development Index, E-Participation Index, Global Cybersecurity Index[10], Doing Business, Global Innovation Index, B2C Ecommerce Index[11], Maturity Index, Global Competitiveness Index 4.0, and 5G Readiness Index. Overall, there is a strong correlation between the G5 Benchmark and each of these indices. This supports the postulate that collaborative regulation is associated with positive outcomes across areas with impact on the digital economy, with consequent development outcomes. Conversely, the lack of cross-institutional coordination can be identified as a critical barrier for the development of policy coherence and regulatory consistency.

In addition to the correlational analysis, the different development indices were regressed against the G5 score by specifying the following equation:

$$\log(Index) = \alpha + \beta \log(G5) + \gamma \log(FBB)$$

$$+\delta \log(MBB) + \lambda \log(GDPpc) + \theta_r + \varepsilon$$

Each index was introduced as dependent variable, and on the right-hand side the G5 benchmark score was added as an explanatory regressor, plus other controls (fixed and mobile broadband penetration, GDP per capita, and regional dummies (θ_r) to capture region-level unobservable factors). Results are reported in Table 6, with all estimates performed through the OLS approach with robust standard errors.

In general, these results confirm those represented in the descriptive analysis in Fig. 4. The coefficient associated with the G5 regressor is in all cases positive and statistically significant, which suggest that a stronger collaborative regulation and digital prone environment (as measured by the G5 Benchmark) is associated with positive frameworks for competitiveness, innovation, cybersecurity, and the like.

Beyond that, there are some differences among the equations that are worth observing. In the first place, the maximum effect appears to exist in the relationship with the Global Cybersecurity Index regression: an increase of 10% in the G5 score seems to be associated with an increase of 12.6% in the Cybersecurity index. This is not a surprise: cybersecurity is an enabler affecting all segments of the economy and society (energy, financial services, consumer trust, etc.). Its development is higher with higher levels of collaborative regulation.

4 The Doing Business index, developed by the World Bank, provides a measure of business regulations for local firms in 190 countries. Even if the Doing Business is not particularly focused on the digital economy, the more digitized the environment becomes, the easier should be the business procedures with the administrative bodies, largely because of the development of e-government.

5 The E-Government Development Index, developed by the United Nations (UN), was designed to present a country-level state of e-gov by assessing the website development patterns in each economy as well as infrastructure and educational levels.

6 The E-Participation Index, also developed by the UN, focuses on the use of online services to facilitate the provision of information by governments to citizens, interaction with stakeholders, and engagement in decision-making processes.

7 The Digital Maturity Index, developed by Telecom Advisory Services for CAF Development Bank for Latin America, is based on five pillars: Digital Foundations, Digital Talent, Digital Innovation, Adoption and Localization.

8 The Global Innovation Index, developed by the World Intellectual Property Organization, sheds light on the state of innovation financing. While this index is focused on innovation, we can expect a more digitized environment to be positively linked to it.

9 The Network Readiness Index measures the degree of digital transformation of the economy. This index, originally developed by INSEAD and later by Cornell University, is based on four fundamental dimensions: Technology, People, Governance, and Impact.

10 The Global Cybersecurity Index, developed by the ITU, is usually considered a reference that measures the commitment of countries to cybersecurity.

11 The B2C Ecommerce Index, developed by UNCTAD, assesses a country's developments in the space.

Table 6 – Regression analysis

Dep. var:	Log(NRI)	Log(E-gov)	Log(E-part)	Log(Cyber)	Log(DB)	Log(GII)	Log(E-com)	Log(DMI)
Log(G5)	0.243***	0.122***	0.163*	1.264***	0.196***	0.224***	0.241**	0.153**
	[0.037]	[0.040]	[0.046]	[0.316]	[0.035]	[0.061]	[0.107]	[0.070]
Log (FBB)	0.026	0.025**	–0.001	0.028	–0.008	0.021	0.033	0.047***
	[0.011]	[0.013]	[0.029]	[0.071]	[0.017]	[0.016]	[0.057]	[0.017]
Log (MBB)	0.277***	0.318***	–0.012	0.597*	0.027	0.348***	0.632***	0.521***
	[0.081]	[0.066]	[0.161]	[0.338]	[0.090]	[0.104]	[0.140]	[0.115]
Log (GDPpc)	0.065*	0.061**	0.163***	–0.117	0.072**	0.062*	0.029	0.098*
	[0.037]	[0.024]	[0.046]	[0.097]	[0.025]	[0.037]	[0.048]	[0.053]
Region dummies	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.91	0.92	0.62	0.58	0.71	0.86	0.88	0.91
Obs.	108	109	109	109	109	105	108	109

*Note: ***p<1%, **p<5%, *p10%. Models estimated with constant term. Robust standard errors in brackets.*

Collaborative regulation is also associated, albeit at a lower level, with digital transformation (as measured by the Network Readiness Index), innovation (measured by the Global Innovation Index), and e-commerce (measured by the B2C e-commerce index). Again, this is not surprising, since all three indices are cross-sectoral and measure trends that are highly dependent on policies and regulations being implemented across domains. For example, a highly developed e-commerce eco-system depends on policies and regulations in such diverse areas as transportation, consumer protection, connectivity, digital literacy, and financial inclusion.

As a final remark, it is important to reiterate that the econometric analysis conducted had an important limitation related to data availability. Due to having a value for the G5 Benchmark for a single year (2020), it was not possible to perform panel estimates, which allow control for unobservable factors. In addition, due to the absence of data prior to 2020, it was not possible to test the lagged effects of the G5 scores on the other variables. Therefore, any causality conclusion should be addressed with caution, and further research will be necessary when more complete data sets become available.

4. IMPLICATIONS FOR COUNTRIES

The G5 Benchmark provides not only a tool to assess where a country stands in terms of the development of this critical capability but also a path on how to evolve and what are the areas that need to be emphasized. Considering the challenges posed by COVID-19, the need for cross-institutional coordination and collaboration highlights the need to build a single policy and regulatory focus in the digital economy domain.

How can this be achieved?

Countries should migrate away from a restricted view of telecommunications, and even ICT regulation and policy to an expanded scope of the digital economy, which incorporates innovation, science and technology, telecommunications infrastructure, among key areas of interest. This new view requires the development of observatories that monitor indicators across development of the digital sector and the digital transformation of the economy.

Additionally, regulators and policy makers should incorporate as a conventional course of action the implementation of regulatory impact tools that capture all digital economy dimensions in a systematic fashion. The development of enhanced tools for conducting regulatory impact assessment should be supported by a recognition that the development of the digital economy is based on multiple interrelationships between digital infrastructure (networks, data centres, and the like), connectivity (access devices), household digitization (which comprises issues such as affordability and digital literacy), digitization of production (including mature and advanced technologies, such as artificial intelligence and Internet of Things), digital talent and general skills of the labor force, and the development of digital industries and platforms. All these components are highly synergistic, which means that policy development becomes more complex requiring

not only better analytical tools but also improved technical and social science capabilities among policy makers.

From an institutional standpoint, countries at the leading edge of constructing collaborative regulation frameworks have implemented high level national coordination bodies which comprise not only representatives of the different agencies and ministries, including sub-sovereign parties, but also private sector participants.

While inter-institutional coordination is a key requirement for policy and regulatory collaboration, policy coherence is not only fulfilled by cross-institutional coordination but also through a proactive action of the executive branch at its highest level. In some countries, the President, the Prime Minister, or a collegial body reporting to the maximum level of government proactively pulls the different agencies together through agenda setting, goal formulation, and implementation monitoring processes. This political commitment at the highest level [2] brings all agencies and institutions together in fulfilling collaboration.

Collaborative regulation needs to be underlined by holistic economic policy considerations. As a common example, a reduction in taxation of digital goods and services has a positive impact on affordability and, consequently, adoption of ICT and positive spillovers. However, it can also imply a revenue shortfall in the short term for the national treasury. Under the proposed cross-institutional framework, countries should have the capability to assess trade-offs, and make policy decisions by examining the multiple economic dimensions while keeping the development of the digital economy as their north star.

As a final comment, we believe it is important to reiterate some of the limitations faced in the research process. First, we were constrained by the availability of information in the ITU surveys conducted to the national regulatory agencies, something that prevented us from incorporating further metrics specifically suited for our purpose. For example, we could not consider the possibility of countries opting for different but equally effective governance models. This may generate an unintended effect, of triggering convergence towards a specific governance model, instead of welcoming a variety of approaches and focusing rather on outcome and impact indicators. To overcome this limitation, we suggest using the information provided by the G5 Benchmark in combination with data on performance, such as the level of e-skills development, digital infrastructure deployments, penetration of latest technologies such as IoT and AI. Second, our econometric models were limited to the lack of panel-data availability for the G5 Benchmark indicator, thus we could only talk about an association, not causality, between this index and the outcome variables, at most. Therefore, future editions of the G5 Benchmark will have to address these limitations in order to add robustness to the indicator.

5. APPENDIX: TEST OF BENCHMARK ROBUSTNESS

In this section, the G5 Benchmark is analysed from a statistical viewpoint to assess the theoretical coherence of the conceptual framework and the impact of its key assumptions on the final country scores and rankings. The procedures to be followed in this section are based on the analysis carried out by research documents adressing other indices [3], [4]. The results presented herein suggest that the benchmark is sound, coherent, and robust, from a conceptual and statistical position.

5.1 Benchmark framework

The G5 Benchmark is composed of 54 indicators (some of them being an aggregation of multiple indicators in a composite one), grouped into four pillars: i) National collaborative governance, ii) Policy design principles, iii) Digital development, and iv) Digital economy policy agenda. The distribution of indicators and maximum scores by pillars is presented in Table 7. The overall score is the sum of the four pillar scores. Every pillar contributes to the score proportionally to the number of indicators it contains. The sum of the maximum pillar scores equals 100 (after normalization), which is the maximum theoretical score any country can achieve.

Table 7 – Distribution of indicators by pillar and maximum scores

Pillar	Name	Number of indicators	Max score	Max score (over 100)
I	National collaborative governance	16	32	29.63
II	Policy design principles	10	20	18.52
III	Digital development	16	32	29.63
IV	Digital economy policy agenda	12	24	22.22
G5 Benchmark		54	108	100

5.2 Data availability and missing values

To deal with missing values, the criteria followed was to implicitly treat cells with missing values as if a zero value had been imputed. Given that most information comes from country surveys and desktop research, the control procedure is two-fold:

- On the one hand, a no answer from a country questionnaire can be reasonably interpreted as a 'no'. As pointed out in [3] for the case of the Regulatory Tracker, it is probably correct to assume that missing values are equal to zero, since for example some survey respondents may prefer leaving blanks rather than stating that their country has not adopted a given policy instrument and implicitly, does not comply with international best practices.
- On the other hand, if no further evidence can be found in the additional desktop research, then it seems appropriate to consider that the respective condition stipulated in the indicator is not verified for that country.

To check an alternative procedure, the benchmark score was calculated by relying only in the available information. The score was computed assuming that the maximum value (100) can be attributed to a certain country if it reaches the maximum score on each of the non-blank responses (normalization by the number of non-blank observations). However, when comparing this result with that of the original procedure (Fig. 5), important distortions are produced. Several points lie outside the diagonal line, which suggest that the results will change considerably. This provides support to considering missing information as zero.

As shown in Table 8, most of the missing values in the data set are concentrated in indicators I06, I16, II06b, II07a, II07b, III03, III08c, III15, III16a, III16c, IV07a, IV07c and IV8b, where missing values account for over 20 per cent. This compilation of missing observations will allow us to focus on data collection and reporting efforts in future versions of the benchmark.

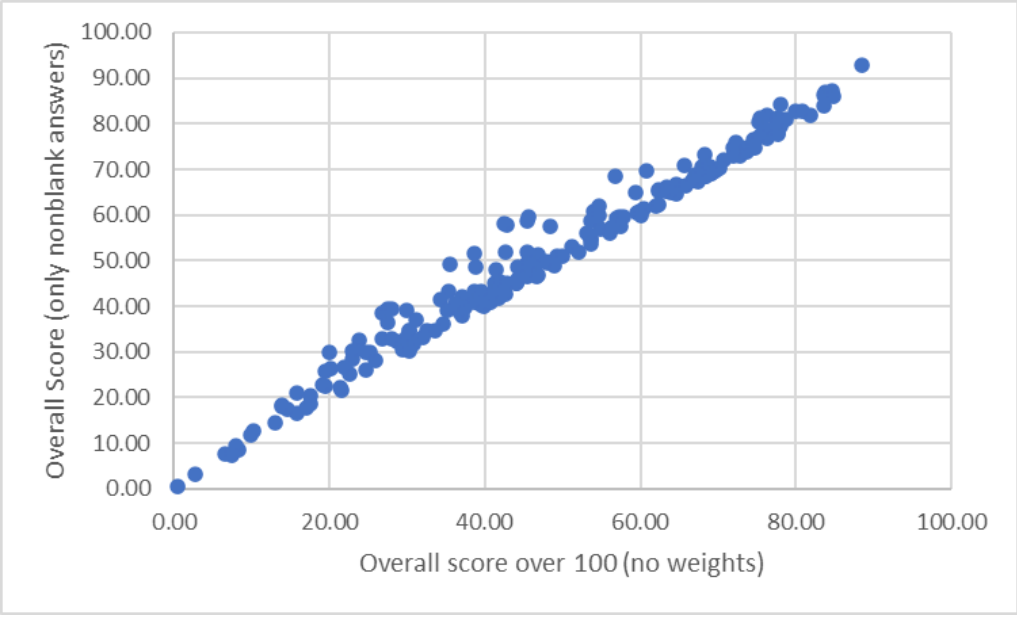

Fig. 5 – Comparison of score assuming missing data as zero and score calculated only with non-blank observations.

Table 8 – Missing observations by indicator

Pillar I: National collaborative governance			Pillar II: Policy design principles			Pillar III: Digital development toolbox			Pillar IV: Digital economy policy agenda		
Indicator	**Number missing**	**% Missing**	**Indicator**	**Number missing**	**% Missing**	**Indicator**	**Number missing**	**% Missing**	**Indicator**	**Number missing**	**% Missing**
I01	5	2.59%	II01	4	2.07%	III01a	22	11.40%	IV01	0	0.00%
I02	4	2.07%	II02	0	0.00%	III01b	37	19.17%	IV02	0	0.00%
I03	16	8.29%	II03	22	11.40%	III02	24	12.44%	IV03	20	10.36%
I04	33	17.10%	II04	15	7.77%	III03	47	24.35%	IV04	18	9.33%
I05	1	0.52%	II05	10	5.18%	III04	1	0.52%	IV05	12	6.22%
I06	41	21.24%	II06a	14	7.25%	III05	11	5.70%	IV06	14	7.25%
I07	0	0.00%	II06b	115	59.59%	III06	5	2.59%	IV07a	61	31.61%
I08	1	0.52%	II07a	49	25.39%	III07	26	13.47%	IV07b	14	7.25%
I09	27	13.99%	II07b	49	25.39%	III08a	12	6.22%	IV07c	70	36.27%
I10	1	0.52%	II08	5	2.59%	III08b	14	7.25%	IV08a	26	13.47%
I11	11	5.70%	II09	0	0.00%	III08c	46	23.83%	IV08b	47	24.35%
I12	5	2.59%	II10	31	16.06%	III09a	3	1.55%	IV09a	11	5.70%
I13	24	12.44%				III09b	0	0.00%	IV09b	10	5.18%
I14	28	14.51%				III10a	16	8.29%	IV09c	10	5.18%
I15	2	1.04%				III10b	0	0.00%	IV10	12	6.22%
I16	48	24.87%				III11a	0	0.00%	IV11	3	1.55%
						III11b	21	10.88%	IV12	24	12.44%
						III12a	3	1.55%			
						III12b	26	13.47%			
						III13	29	15.03%			
						III14	0	0.00%			
						III15	75	38.86%			
						III16a	71	36.79%			
						III16b	35	18.13%			
						III16c	72	37.31%			

Country inclusion is decided based on the available data while providing a reasonable depiction of the situation. Following a criterion similar to that of the ICT Regulatory Tracker, countries are included if the available data covers at least 50 per cent of data required for each of the four pillars.

Following the experience of ITU in the Regulatory Tracker, the use of thresholds provides for a robust metric of the benchmark. Considering this criteria, 193 countries were included in the sample, as detailed in Table 9.

Table 9 – Countries included in the G5 Benchmark

Afghanistan	Chad	Ghana	Liberia	Norway	South Sudan
Albania	Chile	Greece	Libya	Oman	Spain
Algeria	China	Grenada	Liechtenstein	Pakistan	Sri Lanka
Andorra	Colombia	Guatemala	Lithuania	Palestine*	Sudan
Angola	Comoros	Guinea	Luxembourg	Panama	Suriname
Antigua and Barbuda	Congo (Rep. of the)	Guinea-Bissau	Madagascar	Papua New Guinea	Sweden
Argentina	Costa Rica	Guyana	Malawi	Paraguay	Switzerland
Armenia	Côte d'Ivoire	Haiti	Malaysia	Peru	Syrian Arab Republic
Australia	Croatia	Honduras	Maldives	Philippines	Tajikistan
Austria	Cuba	Hong Kong, China	Mali	Poland	Tanzania
Azerbaijan	Cyprus	Hungary	Malta	Portugal	Thailand
Bahamas	Czech Republic	Iceland	Marshall Islands	Qatar	Timor-Leste
Bahrain	Dem. Rep. of the Congo	India	Mauritania	Romania	Togo
Bangladesh	Denmark	Indonesia	Mauritius	Russian Federation	Tonga
Barbados	Djibouti	Iran (Islamic Republic of)	Mexico	Rwanda	Trinidad and Tobago
Belarus	Dominica	Iraq	Micronesia	Saint Kitts and Nevis	Tunisia
Belgium	Dominican Rep.	Ireland	Moldova	Saint Lucia	Turkey
Belize	Ecuador	Israel	Monaco	Saint Vincent and the Grenadines	Turkmenistan
Benin	Egypt	Italy	Mongolia	Samoa	Tuvalu
Bhutan	El Salvador	Jamaica	Montenegro	San Marino	Uganda
Bolivia	Equatorial Guinea	Japan	Morocco	Sao Tome and Principe	Ukraine
Bosnia and Herzegovina	Eritrea	Jordan	Mozambique	Saudi Arabia	United Arab Emirates
Botswana	Estonia	Kazakhstan	Myanmar	Senegal	United Kingdom
Brazil	Eswatini	Kenya	Namibia	Serbia	United States of America
Brunei Darussalam	Ethiopia	Kiribati	Nauru	Seychelles	Uruguay
Bulgaria	Fiji	Korea (Rep. of)	Nepal (Republic of)	Sierra Leone	Uzbekistan
Burkina Faso	Finland	Kuwait	Netherlands	Singapore	Vanuatu
Burundi	France	Kyrgyzstan	New Zealand	Slovakia	Venezuela
Cabo Verde	Gabon	Lao P.D.R.	Nicaragua	Slovenia	Viet Nam
Cambodia	Gambia	Latvia	Niger	Solomon Islands	Yemen
Cameroon	Georgia	Lebanon	Nigeria	Somalia	Zambia
Canada	Germany	Lesotho	North Macedonia	South Africa	Zimbabwe
Central African Rep.					

Note: The status of the State of Palestine in ITU is governed by Resolution 99 (Rev. Dubai, 2018) of the ITU Plenipotentiary Conference.

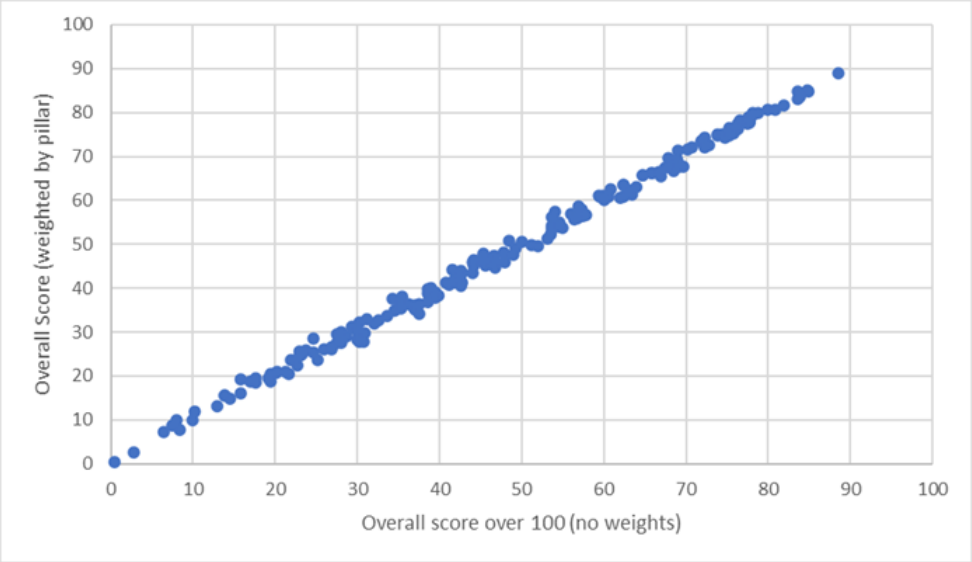

Fig. 6 – Comparison of score without weights and score with equally weighted pillars

To check the robustness of the results, each of the four pillar scores could be normalized according to the min-max formula. Thus, the raw pillar score for any given country, can be scaled into a normalized pillar score by subtracting from the raw pillar the theoretical minimum score for that pillar (zero) and dividing by the difference between the theoretical maximum and the theoretical minimum value for the pillar. By following this procedure, each of the four pillars would now have a minimum of zero, and a maximum of 100, and then calculate the overall score as the weighted average of those normalized pillar scores.

The original score can then be compared with a normalized and weighted score, to assess if substantial changes occur. The weights to be used for this calculation can be, for instance, equal to each pillar: 25 per cent each. This marks a departure from the original scoring procedure without weights, as each pillar had a relative importance according to the number of indicators included within each one. As shown in Fig. 6, the overall scores following this approach are very close to the original scores.

5.3 Statistical coherence

To check the statistical coherence of the results, a correlation analysis was carried out to evaluate whether the indicators fit statistically in their respective pillar. As expected, results in Table 10 confirm that the grouping of indicators into pillars is statistically coherent, since individual indicators tend to be more correlated to their own pillar than to any other.

Table 10 – Correlation matrix among indicators and pillars

Indicators	Pillar I	Pillar II	Pillar III	Pillar IV
I01	0.50	0.28	0.28	0.24
I02	0.48	0.43	0.34	0.35
I03	0.35	0.18	0.18	0.12
I04	0.66	0.54	0.57	0.62
I05	0.59	0.47	0.46	0.53
I06	0.52	0.26	0.26	0.25
I07	0.20	0.13	0.10	0.12
I08	0.52	0.32	0.41	0.37
I09	0.50	0.34	0.41	0.41
I10	0.55	0.52	0.49	0.44
I11	0.48	0.31	0.42	0.39
I12	0.54	0.38	0.40	0.40
I13	0.72	0.34	0.44	0.42
I14	0.73	0.36	0.47	0.47
I15	0.65	0.28	0.39	0.39
I16	0.54	0.20	0.18	0.23
II01	0.39	0.60	0.41	0.42
II02	0.29	0.61	0.32	0.31
II03	0.36	0.57	0.37	0.33
II04	0.08	0.42	0.21	0.26
II05	0.59	0.61	0.56	0.49
II06a	0.22	0.47	0.43	0.50
II06b	0.72	0.76	0.79	0.80
II07a	0.37	0.50	0.41	0.53
II07b	0.24	0.32	0.26	0.29
II08	0.28	0.63	0.43	0.44
II09	0.29	0.60	0.43	0.41
II10	0.50	0.55	0.44	0.42
III01a	0.37	0.30	0.50	0.46
III01b	0.29	0.32	0.42	0.36
III02	0.34	0.25	0.52	0.38
III03	0.20	0.20	0.36	0.27
III04	0.47	0.65	0.72	0.76
III05	0.51	0.59	0.67	0.63
III06	0.33	0.48	0.66	0.55
III07	0.35	0.27	0.58	0.39
III08a	0.25	0.37	0.52	0.46
III08b	0.26	0.28	0.43	0.35
III08c	0.17	0.25	0.42	0.30
III09a	0.33	0.35	0.53	0.49
III09b	0.45	0.54	0.58	0.56
III10a	0.25	0.42	0.51	0.43
III10b	0.29	0.37	0.34	0.38
III11a	0.17	0.24	0.35	0.26
III11b	0.26	0.28	0.36	0.33
III12a	0.31	0.48	0.52	0.50
III12b	0.28	0.44	0.52	0.47
III13	0.36	0.32	0.50	0.40
III14	0.33	0.40	0.54	0.48
III15	0.53	0.56	0.66	0.59
III16a	0.00	0.00	0.13	-0.03
III16b	0.16	0.14	0.42	0.26
III16c	0.02	0.02	0.22	0.02
IV01	0.36	0.37	0.41	0.49
IV02	0.42	0.49	0.51	0.65
IV03	0.49	0.56	0.69	0.76
IV04	0.38	0.57	0.58	0.65
IV05	0.37	0.60	0.68	0.73

Indicators	Pillar I	Pillar II	Pillar III	Pillar IV
IV06	0.08	0.31	0.31	0.32
IV07a	–0.17	–0.15	–0.17	–0.13
IV07b	–0.12	–0.02	–0.02	–0.10
IV07c	0.12	0.18	0.10	0.15
IV08a	0.55	0.36	0.55	0.58
IV08b	0.09	0.23	0.36	0.24
IV09a	0.27	0.45	0.62	0.60
IV09b	0.16	0.24	0.32	0.32
IV09c	0.25	0.40	0.53	0.49
IV10	0.40	0.19	0.26	0.42
IV11	0.46	0.40	0.40	0.55
IV12	0.36	0.43	0.50	0.61

Source: ITU

The four pillars are also strongly correlated to each other and to the overall score, which suggests that the benchmark is well balanced in its four pillars (Table 11).

Table 11 – Correlation matrix among pillars and overall score

	Pillar I	Pillar II	Pillar III	Pillar IV	Overall
Pillar I	1	0.58	0.67	0.69	0.85
Pillar II	0.58	1	0.73	0.74	0.83
Pillar III	0.67	0.73	1	0.87	0.93
Pillar IV	0.69	0.74	0.87	1	0.93
Overall	0.85	0.83	0.93	0.93	1

5.4 Impact of modelling assumptions

In this section, the extent to which the final ranks would be affected by changes in the weights assigned to each pillar has been assessed. Table 11 shows the different sources of uncertainty considered for the analysis. The 2000 simulated scenarios used in the analysis result from the randomly generated weights within an interval of +/–20 per cent of the reference values provided by the original scoring procedure.

Table 11 – Conditions for uncertainty analysis

Pillar	Indicators	Reference values (based on number of indicators per pillar)	Confidence interval	
			Min	Max
Pillar I	16	29.6%	23.7%	35.6%
Pillar II	10	18.5%	14.8%	22.2%
Pillar III	16	29.6%	23.7%	35.6%
Pillar IV	12	22.2%	17.8%	26.7%

Source: ITU

By comparing the overall score of each country for the baseline scenario and the median score of the 2000 simulated values, it seems clear in Fig. 7 that the results seem to be consistent, reaching almost identical scores.

Fig. 8 reflects the uncertainty analysis by including median ranks and 90 per cent confidence intervals computed across the simulated 2000 scenarios. With very few exceptions, the width of the confidence intervals is narrow enough. Only 12 per cent of the country's present confidence interval widths over 15 points in terms of the final score.

The robustness is even more clear when analysing the original ranking position in comparison with the ranks from the simulated median values (Fig. 9). Only 11 per cent of the sample changes more than four positions in the rank when the simulation is carried out.

This analysis confirms the robustness of the benchmark, as it is not influenced by the assumptions on importance of the pillars and by the aggregation procedure.

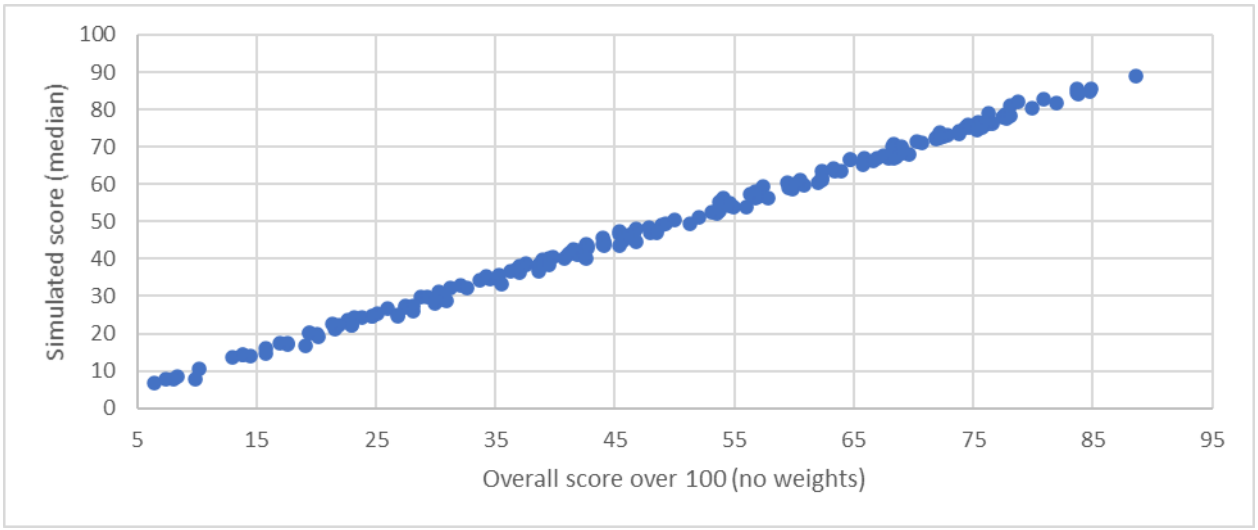

Fig. 7 – Comparison of score from the baseline procedure and median score from 2000 simulations

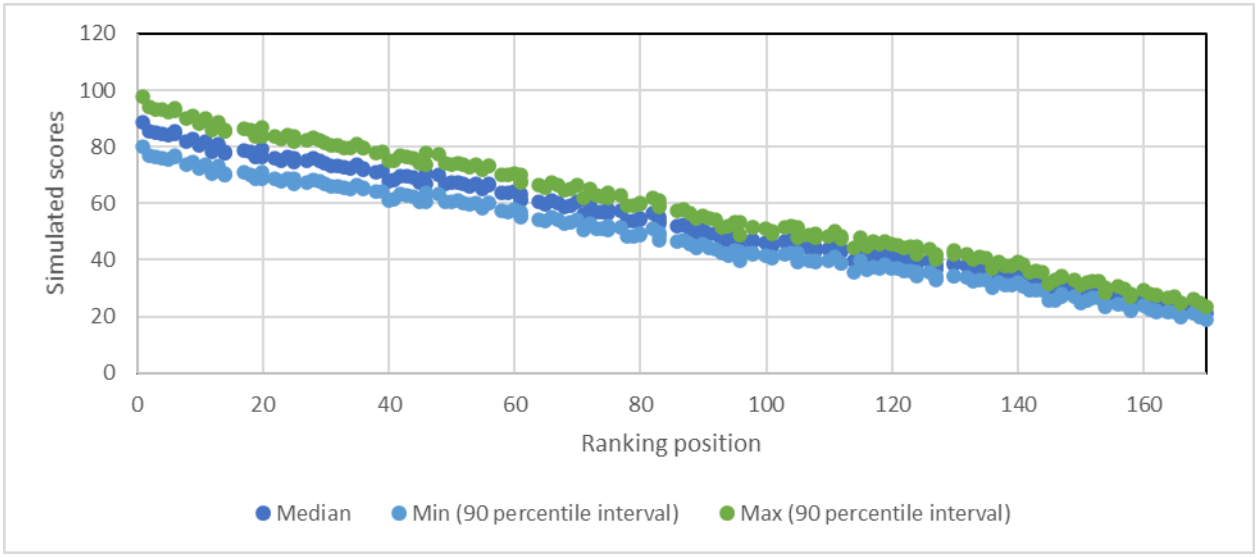

Fig. 8 – Median and 90 per cent confidence interval for scores from 2000 simulations

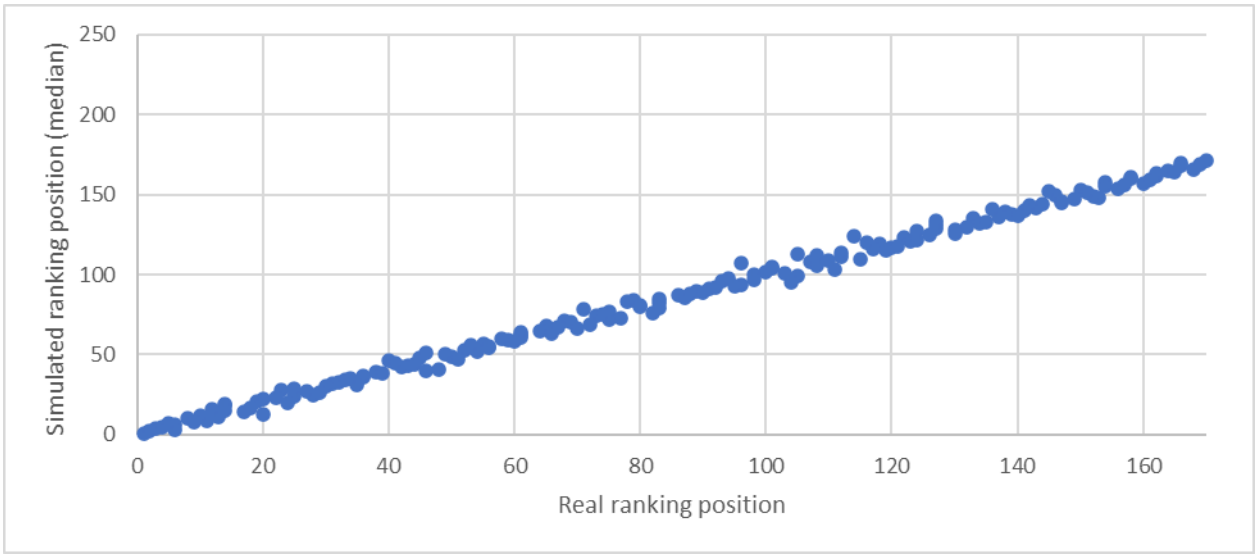

Fig. 9 – Comparison of rank position from the baseline procedure and median rank from 2000 simulations

5.5 Statistical robustness assessment

The statistical robustness assessment underscores the fact that the conceptual structure of the benchmark is supported by the results of the analysis. The grouping of indicators into pillars is statistically coherent, and the overall score appears to be a good and balanced summary measure of its four underlying pillars. Moreover, the robustness of the benchmark with respect to changes in the modelling assumptions is supported also by the results of the uncertainty and sensitivity analysis.

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