Digital Economy & Social Sustainability

DiGiX 2020 Update: A Multidimensional Index of Digitization[1]

Noelia Cámara

October, 2020

The 2020 DiGiX tracks digital performance and progress of the digitization levels of 99 selected economies:

- The top five countries are Denmark, Hong Kong, Singapore, United States and Netherlands.
- The most outstanding progress regarding 2019 is achieved by New Zealand that gains 31 positions in the ranking, Indonesia (+26), Armenia (+16), India (+13) and Macedonia (+12).
- Some countries have reached levels of digitization well above those expected at their income levels, such as Luxemburg, Singapore, Qatar and Ireland.
- Leaders within their respective regions include Denmark, the US, Hong Kong, Chile, United Arab Emirates, Mauritius and Azerbaijan.

About DiGiX:

- DiGiX aims to capture the digitization status over the world in order to compare digitization degrees across countries and identify areas requiring action.
- The 19 indicators included in the index are grouped in six dimensions that represent three broad pillars: supply conditions (infrastructure and costs), demand conditions (user, government and enterprise adoption), and institutional environment (regulation).
- Collaboration of governments, financial institutions, and regulatory bodies will be necessary to enhance digitization in order to serve society.

1: New versions of this document might be updated if errors in the data are detected due to posterior updates or imprecisions.
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Digitization and Economic Vulnerability

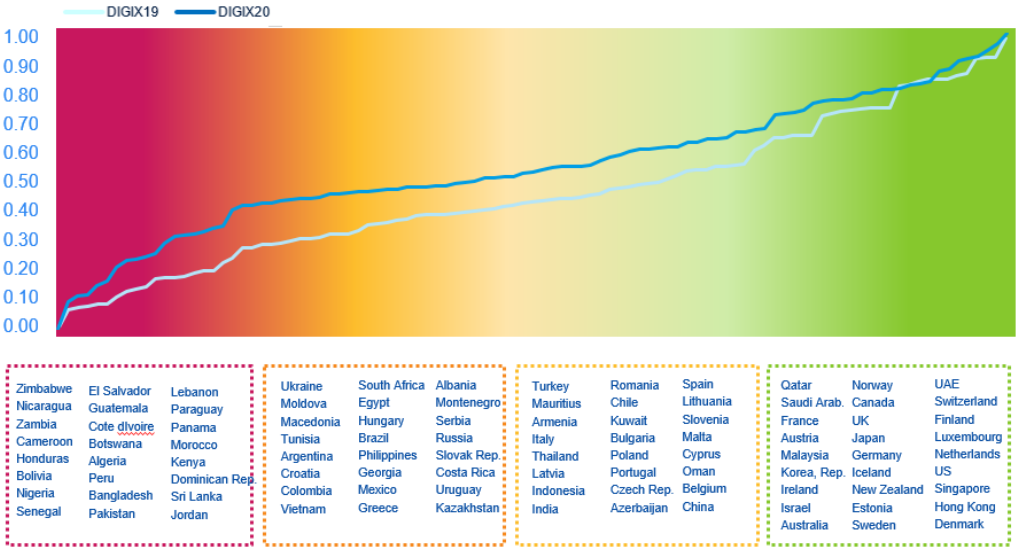
Advancing digitization is an essential goal for improving productivity and wellbeing. The COVID-19 pandemic has highlighted the importance of digitalization for economies to add value to society and to contribute to public health improvement, economic growth and environmental sustainability. The combination of digital assets and digital skills has played a critical role for economies in fighting the pandemic and building resilience for the subsequent economic collapse. Digital means have made it possible to track the spread of the virus, provide remote medical care to patients, and share knowledge to accelerate, more than ever, the search for cures and vaccines. On the socioeconomic side, countries with higher levels of digitization have been able to continue working while limiting the exposure of the workforce to the virus and its spread. E-commerce has rose dramatically, which has been essential for consumption in safe conditions. In addition, continuing education has been possible thanks to e-learning. Not least, digitalization has helped to connect people during lock-down periods avoiding physical contact. All these achievements that have boosted digitization will likely extend beyond the COVID-19 pandemic.

DiGiX aims to capture the digitization status over the world in order to compare the levels across countries and identify areas requiring action in six dimensions, infrastructure, affordability, users' adoption, enterprise adoption, government adoption and regulation. The results for 2020 show a global improvement in digital frontier, drawn by the degree of digitization in 99 countries, compared to 2019 (Figure 1). [2] There is an enormous potential for digitization and the frontier expansion depicts a convergence process of the word's digital capacity, with the part corresponding to top performers being almost unchanged. It might point out the limits of technology that generate a sort of steady state for the most digitally advanced countries. However, there is a wide digital divide across countries, especially between developed and emerging countries, as shown in Figure 2. It represents the relationship between DiGiX (scores in the vertical axis) and GDP per capita (in the horizontal axis).

Table A2 in the appendix presents the ranking and scores for the DiGiX 2020 update. By region, the most digitalized countries are in the regions of Western Europe, Northern America (developed) and South East Asia and Oceania. The region of Northern Africa and Western Asia presents the highest dispersion with the United Arab Emirates in the 9th position of the ranking and Lebanon in the 83th. Finally, Latin America and the Caribbean and Sub-Saharan Africa are in the second half of the ranking (50th to 99th), with Chile being the only exception (42th). Central and Southern Asia group is heterogeneous. In terms of progress between 2019 and 2020, the two countries that have advanced the most in the ranking, in comparison with the others, are New Zealand (+31) and Indonesia (+26). New Zealand started from a position around the middle of the ranking and Indonesia from position 71. Lebanon (-14), South Africa (-13) and Jordan (-12) are the countries that have worsened the most since 2019, losing 14, 13 and 12 positions respectively. Regional strategies to foster digitization might have a multiplying effect by allowing countries to benefit from bigger markets and scale economies to take advantage of new developments, more incentives for firms to innovate and more competitive prices.

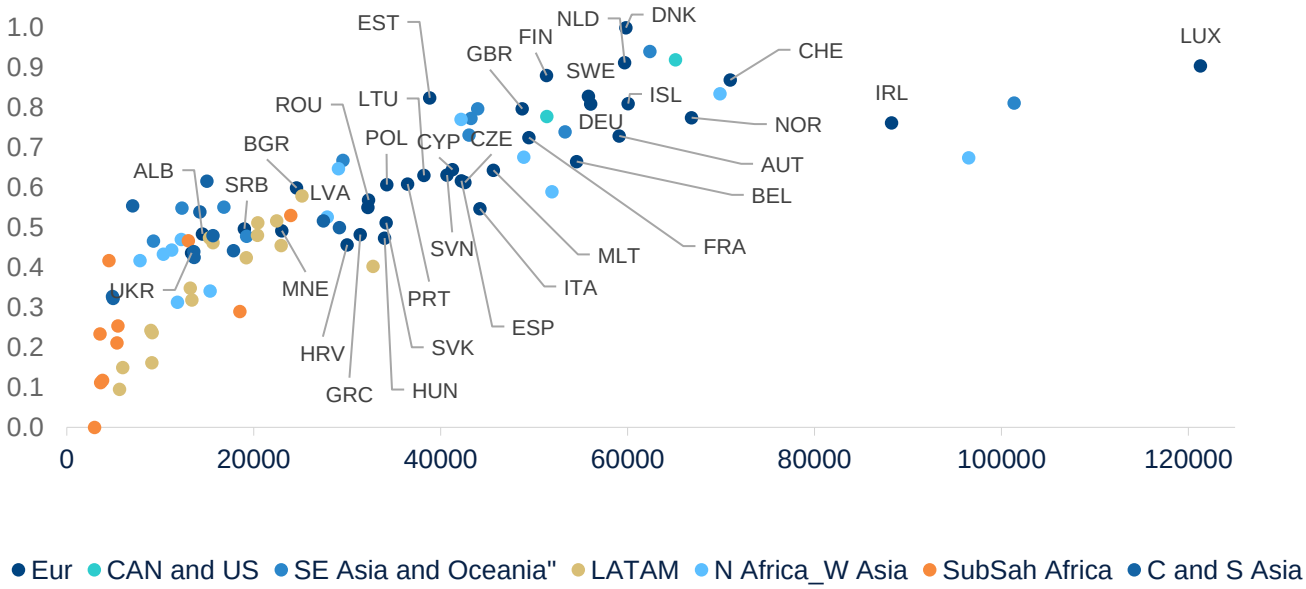
2: Technical details for data and calculations are included in the Appendix of this document.

Figure 1. **DIGITAL FRONTIER EXPANDS IN 2020**



Source: BBVA Research

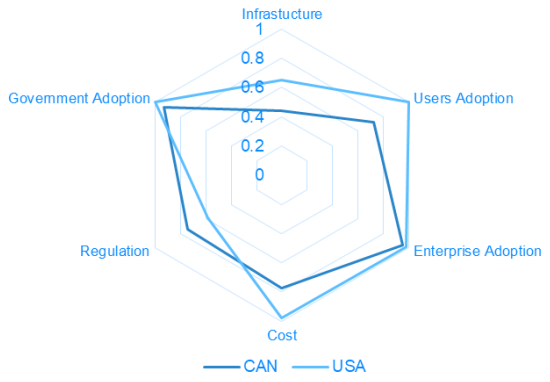
Figure 2. **DiGiX AND GDP PER CAPITA BY REGION**



Source: BBVA Research

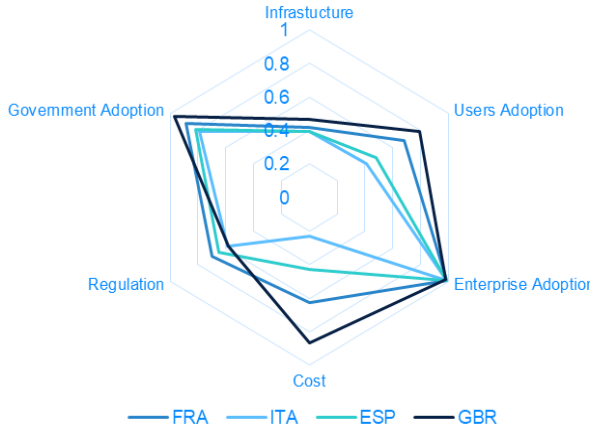
Figures 3 to 8 show the performance, by dimension, of selected countries in different regions. We observe some commonalities across dimensions and the selected countries in the same region. Infrastructure dimension has a relatively poor performance in most of the countries. Contrary, demand-side dimensions related to adoption by different agents show a good achievement. These results suggest that for digitization progress to occur the highest infrastructure levels are not a necessary condition but some levels above certain thresholds could generate a high adoption. High costs are often associated with poor infrastructure and a weak regulation is common in the countries with the worse overall performance in DiGiX. However, regionally, we observe a heterogeneous performance. North America (Figure 3), Europe (Figure 4) and Asia (Figure 5) exhibit similar shapes by dimension but different from Latin America (Figure 6), Africa (Figure 7) and Northern Africa and Western Asia (Figure 8). The figures suggest that uniform shapes (i.e. balanced dimensions) are associated with better digitization results. Collaboration of governments, financial institutions, and regulatory bodies, as well as regional strategies to foster digitization will be necessary to enhance digitization in order to serve society.

Figure 3. **DIGITIZATION PERFORMANCE: NORTHERN AMERICA** (Developed countries)



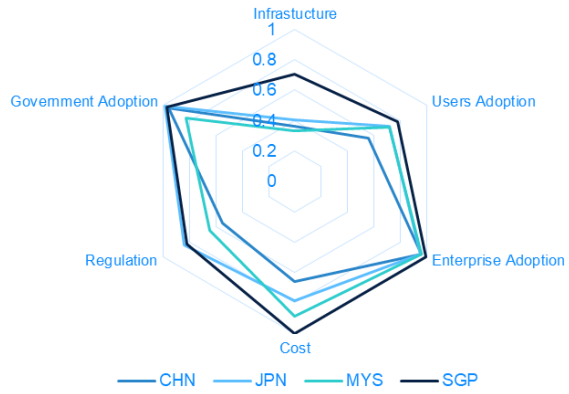
Source: BBVA Research

Figure 4. **DIGITIZATION PERFORMANCE: EUROPE** (Selected countries)



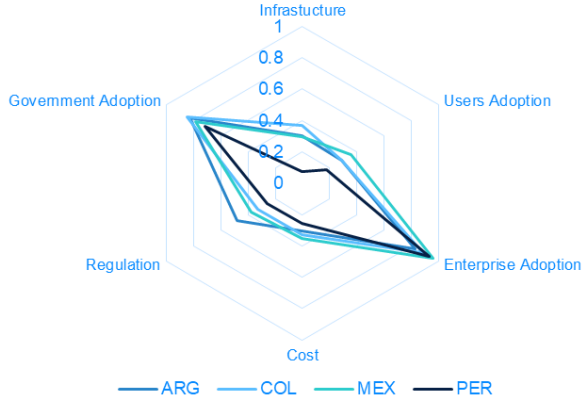
Source: BBVA Research

Figure 5. **DIGITIZATION PERFORMANCE: ASIA** (Selected countries)



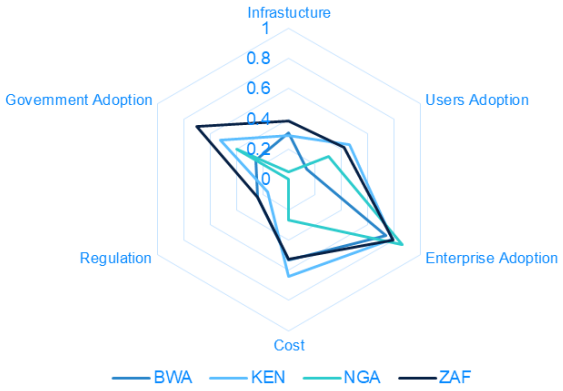
Source: BBVA Research

Figure 6. **DIGITIZATION PERFORMANCE: LATIN AMERICA** (Selected countries)



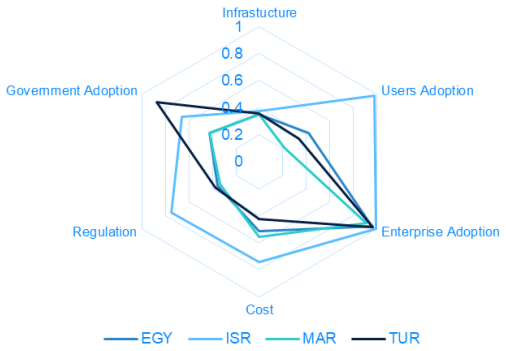
Source: BBVA Research

Figure 7. **DIGITIZATION PERFORMANCE: AFRICA** (Selected countries)



Source: BBVA Research

Figure 8. **DIGITIZATION PERFORMANCE: NORTHERN AFRICA AND WESTERN ASIA** (Selected countries)



Source: BBVA Research

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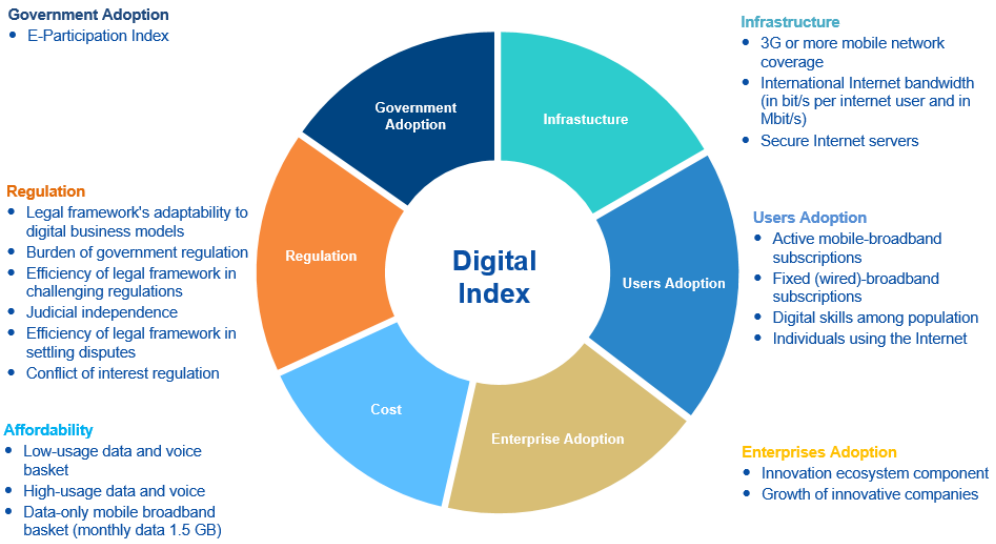
Appendix: Construction of DiGiX 2020

1. Variable Selection and Geographic Coverage

Figure A1 illustrates the structure of DiGiX 2020 – an index made of 19 indicators grouped in six distinct dimensions. These dimensions can be classified into three broad categories, supply conditions, demand conditions, and institutional environment.

Our theoretical framework to define digitization has not changed, so the broad structure of six dimensions remains unaltered. The changes in this version of DiGiX for 2020 consist of three actions:

Figure A1. **DIGITAL INDEX 2018: COMPOSITION AND STRUCTURE**



Source: BBVA Research

1. Replacing a variable, which is no longer available, with new data. More specifically, the “affordability” dimension is now constructed from three rather than one indicator. Mobile broadband Internet monthly subscription has been replace for low-usage data and voice basket, High-usage data and voice and Data-only mobile broadband basket (monthly data 1.5 GB). This change responds to new the methodology followed by the ITU for informing mobile broadband prices.
2. The measure of unlicensed software installation (belonging to the regulation dimension) has been eliminated without any replacement due to lack of data. For the robustness check and sensitivity analysis, we tested the effect of discarding a variable, as well as the effect of using different normalization strategies and the effect of varying weightings of variables. In general, we observe that the top ranking and bottom ranking countries were the least sensitive to changes in the Index composition with middle ranking countries being more sensitive. This analysis shows that the ranking is relatively stable, even to major changes in variable composition.
3. Replacing E-Government Index indicator with E-Participation Index. Both indicators are highly correlated. However, E-Participation Index incorporates a demand approach that is more in line with the users and enterprises adoption. Such indicator is fully informed by the UN since 2020.

In terms of geographical coverage, our sample includes 99 developed and developing countries.[3] This is the same sample of countries as in 2019 and 2018, and one less that in the previous periods since Bahrain has been dropped from our data base due to the lack of reliable data since 2018. The requirement to be included is having complete information in all the indicators in order to minimize data imputation.

2. Data checking and structure

We collect annual information from different official public data sources.[4] We check different aspects that are relevant for composite index constructions. Firstly, in terms of information, standard correlation structure is explored to examine similarities in information across variables belonging to the same dimension and across dimensions. Since our sample of variables represent the same underlying structure (i.e. digitization), we expect to have acceptable levels of correlation, both within dimensions and between dimensions.[5] Although colinearity is not a concern since our aggregation method of Two Stage Principal Components Analysis (2PCA) is robust to redundant information, we avoid using highly correlated variables in order to keep our indicator as simple as possible. We also check the correlation between the per capita GDP and our sample of variables in order to take decisions to simplify our index. The strategy is to exclude those variables that are highly correlated with GDP since they do not add different information from income conditions.

Secondly, the discriminatory power of the variables across countries is another relevant issue. As any phenomenon advances, it is more likely that countries reach their saturation level for the different indicators involved (i.e. percentage of population covered by at least 3G). Since saturation levels for different variables might coincide at least within the group of developed countries and, at a different level, within developing countries, some indicators might tend to discriminate less and less. They might just reflect the economic development status and do not add any extra information. This feature is tested through standard deviations of the variables.

Thirdly, the imputation strategy for missing values takes into account the convergence process of each variable. Growth rates adjusted by the distance to maximum values for each variable are used for the computation.

Finally, the treatment for outliers has been done in a conservative manner. We consider a variable with an outlier as those having distributions with a kurtosis greater than 3.5 and an absolute skewness greater than 2. For variables with upper-end outliers, the largest value was transformed to have the same value as the second largest value and for those with lower-end outliers, the smallest value was transformed to have the same value as the second smallest value. This process was iterated until the variable's skewness and kurtosis fell within the commonly acceptable limits.

3. Aggregation Strategy and Results

The methodology used to compute DiGiX, as well as dimensions, is two-stage Principal Component Analysis, which is consistent for every period.

This section briefly describes the methodology applied for the aggregation strategy and the weighting scheme, and focuses on the results in terms of the ranking and discussion.

When constructing a composite index, it is important to carefully assess the suitability of the data by studying the overall structure of the indicators and correlation between them. 2PCA is used to explore the underlying structure

3: Table A2 in the Appendix presents the list of countries.
4: See Table A1 in the Appendix for a detailed explanation of the variables and data sources.
5: Results are available upon request.

of the data and then construct our composite index using the weights obtained from the 2PCA. First, PCA is applied to the indicators belonging to each dimension in order to get the six different dimensions. Then, we apply PCA to our dimensions to compute the overall index. Only the first component is retained in each iteration. However, if we were to apply just PCA to the three first components it would have been necessary to retain similar cumulative variation. By doing it in two stages, we end up with a composite indicator that has desirable properties and helps us in ranking countries according their degree of digitization. The size of colored areas in Figure A1 represent the weights of dimensions and shows that all dimensions are nearly equally weighted. Our index and dimensions are not biased toward any particular indicator, which is a desirable condition for indices.

4. Results and Ranking

Table A2. **DiGiX 2020 RANKING**

Rank	Country	Score	Rank	Country	Score
1	Denmark	1.00	51	Turkey	0.53
2	Hong Kong	0.97	52	Kazakhstan	0.52
3	Singapore	0.94	53	Uruguay	0.52
4	United States	0.92	54	Costa Rica	0.51
5	Netherlands	0.91	55	Slovak Republic	0.51
6	Luxembourg	0.90	56	Russian Federation	0.50
7	Finland	0.88	57	Serbia	0.50
8	Switzerland	0.87	58	Montenegro	0.49
9	United Arab Emirates	0.84	59	Albania	0.48
10	Sweden	0.83	60	Greece	0.48
11	Estonia	0.82	61	Mexico	0.48
12	New Zealand	0.81	62	Georgia	0.48
13	Iceland	0.81	63	Philippines	0.48
14	Germany	0.81	64	Brazil	0.47
15	Japan	0.80	65	Hungary	0.47
16	United Kingdom	0.80	66	Egypt	0.47
17	Canada	0.78	67	South Africa	0.47
18	Norway	0.77	68	Vietnam	0.47
19	Australia	0.77	69	Colombia	0.46
20	Israel	0.77	70	Croatia	0.46
21	Ireland	0.76	71	Argentina	0.46
22	Korea, Rep.	0.74	72	Tunisia	0.44
23	Malaysia	0.73	73	Macedonia, FYR	0.44
24	Austria	0.73	74	Moldova	0.44
25	France	0.73	75	Ukraine	0.44
26	Saudi Arabia	0.68	76	Jordan	0.43
27	Qatar	0.67	77	Sri Lanka	0.43
28	China	0.67	78	Dominican Republic	0.43
29	Belgium	0.67	79	Kenya	0.42
30	Oman	0.65	80	Morocco	0.42
31	Cyprus	0.64	81	Panama	0.40
32	Malta	0.64	82	Paraguay	0.35
33	Slovenia	0.63	83	Lebanon	0.34
34	Lithuania	0.63	84	Pakistan	0.33
35	Spain	0.62	85	Bangladesh	0.32
36	Azerbaijan	0.62	86	Peru	0.32
37	Czech Republic	0.61	87	Algeria	0.31
38	Portugal	0.61	88	Botswana	0.29
39	Poland	0.61	89	Cote dIvoire	0.25
40	Bulgaria	0.60	90	Guatemala	0.24
41	Kuwait	0.59	91	El Salvador	0.24
42	Chile	0.58	92	Senegal	0.23
43	Romania	0.57	93	Nigeria	0.21
44	India	0.55	94	Bolivia	0.16
45	Indonesia	0.55	95	Honduras	0.15
46	Latvia	0.55	96	Cameroon	0.12
47	Thailand	0.55	97	Zambia	0.11
48	Italy	0.55	98	Nicaragua	0.10
49	Armenia	0.54	99	Zimbabwe	0.00
50	Mauritius	0.53			

Source: BBVA Research

Table A3. **VARIABLE SELECTION**

Short name	long name	Source	Definitions
Infrastructure			
i1_3gcoverage	Percentage of the population covered by at least a 3G mobile network	ITU (2020)	Percentage of the population covered by at least a 3G mobile network refers to the percentage of inhabitants that are within range of at least a 3G mobile-cellular signal; irrespective of whether or not they are subscribers. This is calculated by dividing the number of inhabitants that are covered by at least a 3G mobile-cellular signal by the total population and multiplying by 100.
i2_bandwidth	International Internet bandwidth per Internet user	ITU (2020)	International Internet bandwidth per Internet user (bit/s)
i3_secservers	Secure Internet servers (per 1 million people)	Netcraft and World Bank (2020)	The number of distinct, publicly-trusted TLS/SSL certificates found in the Netcraft Secure Server Survey.
Users Adoption			
au1_mbroadband	Active mobile-broadband subscriptions per 100 inhabitants	ITU (2020)	Active mobile-broadband subscriptions per 100 inhabitants
au2_fbroadband	Fixed broadband subscriptions per 100 inhabitants	ITU (2020)	Fixed broadband subscribers divided by population and multiplied by 100.
au3_digskills	Digital skills among population	WEF(2019)	Response to the survey question “In your country, to what extent does the active population possess sufficient digital skills (e.g. computer skills, basic coding, digital reading)?” [1 = not all; 7 = to a great extent] 1–7 (best)
au5_intpeople	Internet users (%)	ITU (2020)	This indicator can include both; estimates and survey data corresponding to the proportion of individuals using the Internet; based on results from national households surveys. The number should reflect the total population of the country; or at least individuals of 5 years and older. If this number is not available (i.e. target population reflects a more limited age group) an estimate for the entire population should be produced. If this is not possible at this stage; the age group reflected in the number (e.g. population aged 10+; population aged 15-74) should be indicated in a note. If no survey data are available at all; please provide an estimate specifying in detail the methodology that has been applied to calculate the estimate.
Firms Adoption			
ae1_innovation	Innovation ecosystem component	WEF(2019)	Composite index (1-100) that combines business dynamism and innovtion capability
ae2_innofirms	Growth of innovative companies	WEF(2019)	In your country, to what extent do new companies with innovative ideas grow rapidly? [1 = not at all; 7 = to a great extent]

Source: BBVA Research

Table A3. **VARIABLE SELECTION** (cont)

Short name	long name	Source	Definitions
Costs			
c1_low	Low-usage data and voice basket	ITU (2020)	Low-usage data and voice basket with a monthly allowance of 70 minutes, 20 SMS and 500 MB. (% of GNI p.c.)
c2_high	High-usage data and voice basket	ITU (2020)	Data refer to a high-usage data and voice basket with a monthly allowance of 140 minutes, 70 SMS and 1.5 GB. (% of GNI p.c.)
c3_data	Data-only mobile broadband basket	ITU (2020)	Data-only mobile broadband basket with a monthly data allowance of 1.5 GB. (% of GNI p.c.)
Regulation			
r2_efficiencyreg	Efficiency of legal framework in challenging regulations	WEF(2019)	Response to the survey question : In your country, how easy is it for private businesses to challenge government actions and/or regulations through the legal system? [1 = extremely difficult; 7 = extremely easy].
r3_independence	Judicial independence	WEF(2019)	Response to the survey question: In your country, to what extent is the judiciary independent from influences of members of government, citizens, or firms? [1 = heavily influenced; 7 = entirely independent].
r4_efficiencydisputes	Efficiency of legal framework in settling disputes	WEF(2019)	Response to the survey question : In your country, how efficient is the legal framework for private businesses in settling disputes? [1 = extremely inefficient; 7 = extremely efficient].
r5_governmentreg	Burden of government regulation	WEF(2019)	Response to the survey question : In your country, how burdensome is it for businesses to comply with governmental administrative requirements (e.g., permits, regulations, reporting)? [1 = extremely burdensome; 7 = not burdensome at all]
r6_digitalbusinessmodels	Legal framework's adaptability to digital business models	WEF(2019)	Response to the survey question "In your country, how fast is the legal framework of your country adapting to digital business models (e.g. e-commerce, sharing economy, fintech, etc.)?" [1 = Not fast at all; 7 = Very fast]
r7_conflictinterestreg	Conflict of interest regulation	WEF(2019)	The Extent of conflict of interest regulation index measures the protection of shareholders against directors' misuse of corporate assets for personal gain by distinguishing three dimensions of regulation that address conflicts of interest: transparency of related-party transactions, shareholders' ability to sue and hold directors liable for self-dealing, and access to evidence and allocation of legal expenses in shareholder litigation. The scale ranges from 0 to 10 [best].
Government Adoption			
co1_gov	E-Participation Index	ONU (2020)	0–1 (best). Government use of online services in providing information to its citizens or "e-information sharing", interacting with stakeholders or "e-consultation" and engaging in decision-making processes or "e-decision-making"

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ENQUIRIES TO:
BBVA Research: Azul Street. 4. La Vela Building – 4th and 5th floor. 28050 Madrid (Spain).
Tel. +34 91 374 60 00 y +34 91 537 70 00 / Fax (+34) 91 374 25
bbvaresearch@bbva.com www.bbvaresearch.com