Digital Economy & Social Sustainability

DiGiX 2022 Update: A Multidimensional Index of Digitization[1]

Noelia Cámara

June, 2022

DiGiX 2022 assesses digital performance and progress of 99 selected economies with latest data spanning over 2020 and 2021:

- The five top-ranking countries are Denmark, United States, Singapore, Netherlands and Finland.
- The five countries that rose the most in the ranking relative to DiGiX 2020 are Russia (+10), South Africa (+9), Senegal (+7), United Kingdom (+6) and Hungary (+6).
- The five countries that fell the most in the ranking are Luxembourg (-11), Philippines (-8), Georgia, Pakistan and Montenegro, each falling 5 positions compared to DiGiX 2020.
- "Regional leaders" remain unchanged: Denmark, the US, Hong Kong, Chile, United Arab Emirates, Mauritius and Azerbaijan.

About DiGiX:

- DiGiX aims to capture the global evolution of digitization by monitoring and ranking digitization across 99 countries.
- DiGiX combines 20 variables that 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).
- DiGiX sheds light on potential obstacles to any country´s digitization strategy - strategies that are key to reaching sustainable, greener and inclusive growth.

[1]: New versions of this document might be updated if errors in the data are detected due to posterior updates or imprecisions.
The messages in this document do not represent the view of the institution but only the personal view of the author. Any errors or omissions are author's responsibility.

Digitization for a more sustainable world

Ongoing digitization is essential to a country´ s resilience and long-term growth. In line with the urgent need to transform the world into a more sustainable place, digitization should be developed in a sustainable way, both environmental and social. Electric vehicles, cloud computing based companies or e-government development are good examples of how digital technologies contribute to this transformation in a long-lasting, green, and organic way. Gaining knowledge on the evolution of digitization can inform policy making about the best practices and areas of improvement.

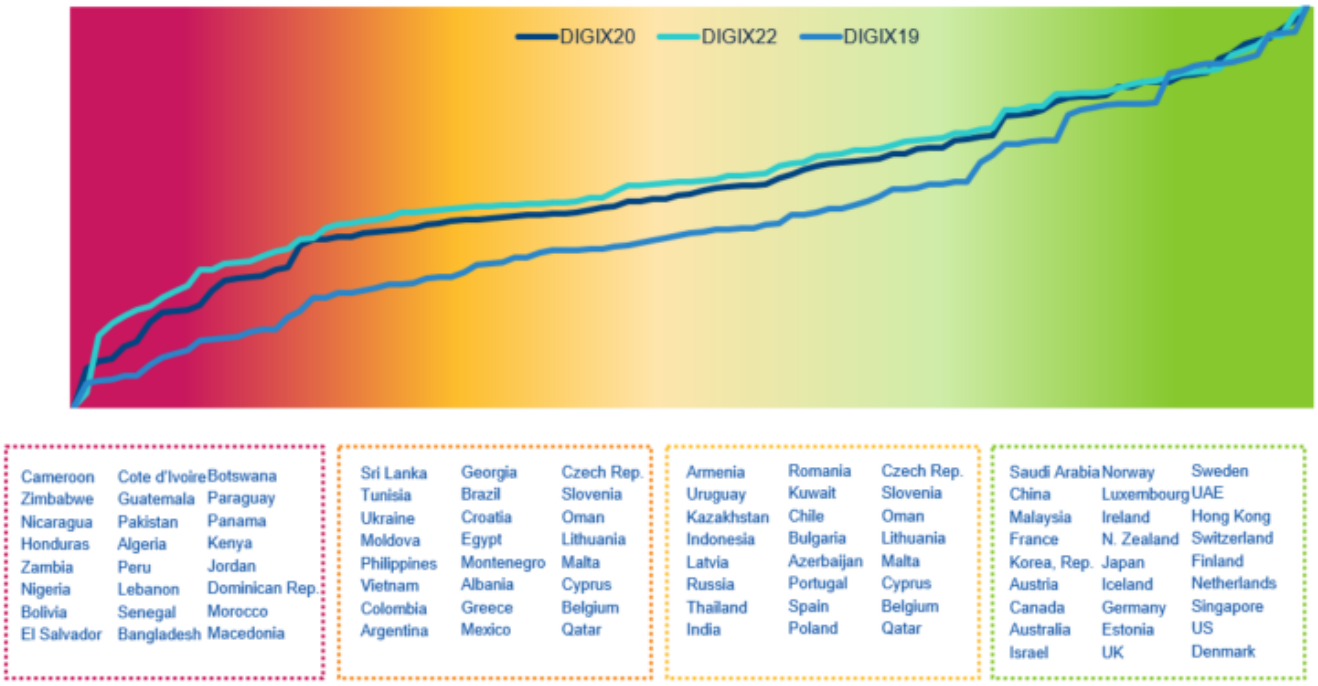
DiGiX aims to capture the digitization dynamics over the world in order to compare its evolution across countries and identify areas requiring action in six dimensions, infrastructure, affordability, users' adoption, enterprise adoption, government adoption and regulation. Figure 1 shows the digital frontiers depicted by DiGiX in the last three years. [2] The picture points to the existence of a saturation degree or steady state for the most digitally advanced countries in the sample, which can be determined by the current digital technologic capacity. Moreover, among the countries in the second half of the ranking (i.e. mostly developing countries), digital inequality has been reduced in the last three years. This can be considered a sort of convergence process. However, for developing countries, there is still an enormous potential for digitization and frontier expansion at the current technologic capacity.

There is a wide digital divide between developed and emerging countries, as shown in Figure 2. By region, the most digitized countries are in the regions of Western Europe, Northern America (developed) and SouthEast Asia and Oceania. The region of Northern Africa and Western Asia presents the highest dispersion with the United Arab Emirates in the 8th position of the ranking and Lebanon in the 86th. 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 (41th). The Central and Southern Asia group is heterogeneous and countries are spread in high and low positions of the ranking. The new trends in the economic world that points to a new order based on regional trade blocs, created important incentives to close the digital gap, at least within regions, to benefit from equal playing fields that reduce transaction costs. This might help in fostering digitization with a multiplying effect.

In terms of progress between 2020 and 2021, the two countries that have advanced the most in the ranking, in comparison with the others, are Russia (+10) and South Africa (+9). Luxemburg (-11), Philippines (-8) are the countries that have worsened the most. Table A2 in the appendix presents the ranking and scores for the DiGiX 2022 by country.

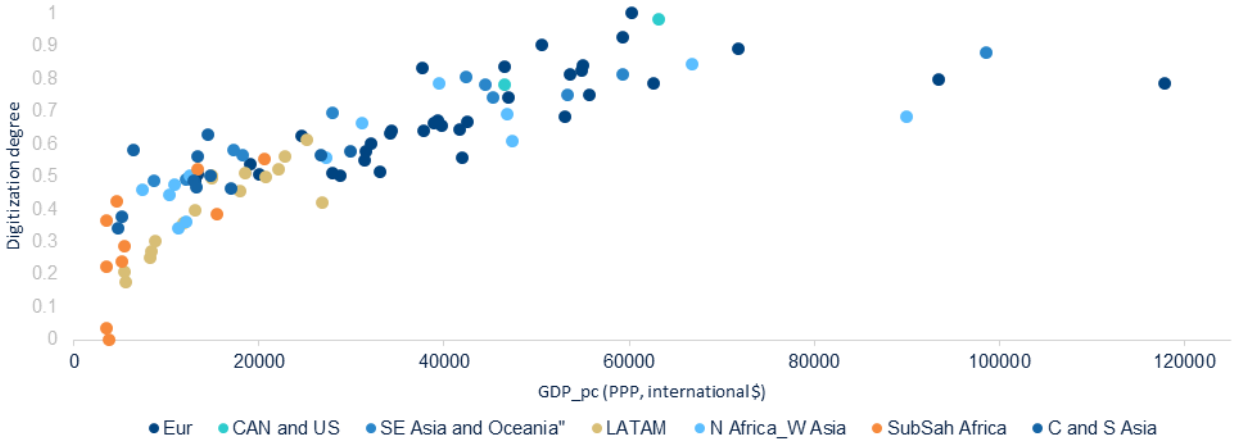
[2]: Technical details for data and calculations are included in the Appendix of this document.

Figure 1. **DIGITAL FRONTIER SHOWS INCREASING CONVERGENCE IN THE RACE OF DIGITIZATION**



Source: BBVA Research

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



Source: BBVA Research

References

- Cámara, N., and Tuesta, D. (2017). DiGiX: The Digitization Index (No. 17/03)
- Chakravorti, B., and Chaturvedi, R. S. (2017). Digital planet 2017: How competitiveness and trust in digital economies vary across the world. The Fletcher School, Tufts University.
- DESI, The Digital Economy and Society Index, 2021. The European Commission
- ITU. Measuring the Information Society Report 2021. International Telecommunication Union.
- MĂRGINEAN, S., and Orăștean, R. (2017). Measuring the digital economy: European Union countries in global rankings. Rev. Econ, 69(5).
- OECD (2010), Revision of the methodology for constructing telecommunication price baskets, Working Party on Communication Infrastructure and Services Policy, March 2010.
- Sussan, F., Autio, E., and Kosturik, J. (2016). Leveraging ICTs for Better Lives: The Introduction of an Index on Digital Life.
- UN E-Government Survey 2020. United Nations

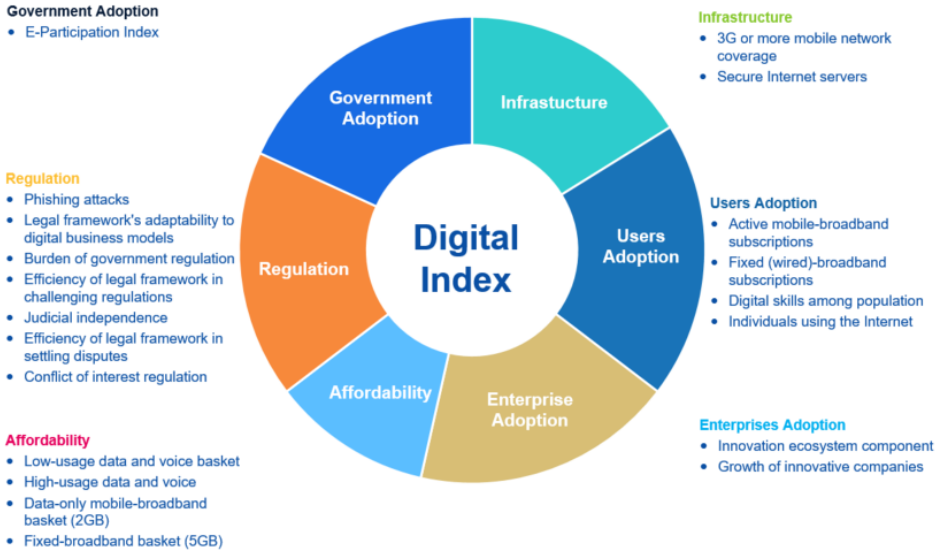
Appendix: Construction of DiGiX 2022

1. Variable Selection and Geographic Coverage

Figure A1 illustrates the structure of DiGiX 2022 – an index made of 20 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 2022 consist of three actions:

Figure A1. **DIGITAL INDEX 2022: COMPOSITION AND STRUCTURE**



Source: BBVA Research

1. Eliminating the variable international internet bandwidth per Internet user, without any replacement due to lack of data. This variable is no longer available for most of the countries in our sample (60 out pf 99). The ITU does not report updated information on this variable. Thus, the infrastructure dimension contains two variables (i.e. population covered by at least a 3G mobile network and secure Internet servers) rather than the three of the previous versions.
2. Adding new variables. Firstly, the “affordability” dimension, which is based on the cost of internet access, now includes information on the prices for the fixed-broadband basket and updates the basket for the data-only mobile broadband basket to 2GB instead of 1.5 GB. Secondly, the regulation dimension includes information on cybercrime through the ratio of sites currently being used for cybercrime (i.e. phishing attacks)/ Active Sites.
3. The World Economic Forum has not released the following information: indicators 2 to 7 included in the regulation dimension, the two indicators in the enterprise adoption and digital skills among population in the user adoption dimension. We have maintained the values for 2019 for these affected variables (see Table A3).

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 to minor changes in variable composition.

In terms of geographical coverage, our sample includes 99 developed and developing countries.[3] This is the same sample of countries as in previous waves (i.e. 2019 and 2018). The requirement for a country to be included in our sample 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.

[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.

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 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 to 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 2022 RANKING**

Rank	Country	Score	Rank	Country	Score
1	Denmark	1.00	51	Armenia	0.56
2	United States	0.98	52	Italy	0.56
3	Singapore	0.93	53	Turkey	0.56
4	Netherlands	0.93	54	Mauritius	0.55
5	Finland	0.90	55	Slovak Republic	0.55
6	Switzerland	0.89	56	Serbia	0.54
7	Hong Kong	0.88	57	Costa Rica	0.52
8	United Arab Emirates	0.84	58	South Africa	0.52
9	Sweden	0.84	59	Hungary	0.51
10	United Kingdom	0.83	60	Mexico	0.51
11	Estonia	0.83	61	Greece	0.51
12	Germany	0.82	62	Albania	0.51
13	Iceland	0.81	63	Montenegro	0.51
14	Japan	0.81	64	Egypt	0.50
15	New Zealand	0.80	65	Croatia	0.50
16	Ireland	0.80	66	Brazil	0.50
17	Luxembourg	0.79	67	Georgia	0.50
18	Norway	0.78	68	Argentina	0.50
19	Israel	0.78	69	Colombia	0.50
20	Australia	0.78	70	Vietnam	0.49
21	Canada	0.78	71	Philippines	0.49
22	Austria	0.75	72	Moldova	0.48
23	Korea, Rep.	0.75	73	Ukraine	0.48
24	France	0.74	74	Tunisia	0.47
25	Malaysia	0.74	75	Sri Lanka	0.47
26	China	0.69	76	Macedonia, FYR	0.46
27	Saudi Arabia	0.69	77	Morocco	0.46
28	Qatar	0.68	78	Dominican Republic	0.45
29	Belgium	0.68	79	Jordan	0.44
30	Cyprus	0.67	80	Kenya	0.42
31	Malta	0.67	81	Panama	0.42
32	Lithuania	0.66	82	Paraguay	0.39
33	Oman	0.66	83	Botswana	0.39
34	Slovenia	0.65	84	Bangladesh	0.38
35	Czech Republic	0.64	85	Senegal	0.36
36	Poland	0.64	86	Lebanon	0.36
37	Spain	0.64	87	Peru	0.36
38	Portugal	0.63	88	Algeria	0.34
39	Azerbaijan	0.63	89	Pakistan	0.34
40	Bulgaria	0.62	90	Guatemala	0.30
41	Chile	0.61	91	Cote dIvoire	0.29
42	Kuwait	0.61	92	El Salvador	0.27
43	Romania	0.60	93	Bolivia	0.25
44	India	0.58	94	Nigeria	0.24
45	Thailand	0.58	95	Zambia	0.23
46	Russian Federation	0.58	96	Honduras	0.21

47	Latvia	0.58	97	Nicaragua	0.18
48	Indonesia	0.57	98	Zimbabwe	0.03
49	Kazakhstan	0.56	99	Cameroon	0.00
50	Uruguay	0.56			

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 (2022)	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.
i3_secservers	Secure Internet servers (per 1 million people)	Netcraft and World Bank (2022)	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 (2022)	Active mobile-broadband subscriptions per 100 inhabitants
au2_fbroadband	Fixed broadband subscriptions per 100 inhabitants	ITU (2022)	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 (2022)	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]

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

Short name	long name	Source	Definitions
Costs			
c1_low	Low-usage data and voice basket	ITU (2022)	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 (2022)	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 (2GB)	ITU (2022)	Data-only mobile broadband basket with a monthly data allowance of 2 GB. (% of GNI p.c.)
c4_datafixed	Fixed-broadband basket (5GB)		Fixed-broadband basket 5GB. (% of GNI p.c.)
Regulation			
r1_cybercrime	Sites Currently Being Used for Cybercrime / Active Sites (phishing attacks)	Netcraft (2022)	Sites Currently Being Used for Cybercrime / Active Sites
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"

Source: BBVA Research

DISCLAIMER

This document has been prepared by BBVA Research Department. It is provided for information purposes only and expresses data, opinions or estimations regarding the date of issue of the report, prepared by BBVA or obtained from or based on sources we consider to be reliable, and have not been independently verified by BBVA. Therefore, BBVA offers no warranty, either express or implicit, regarding its accuracy, integrity or correctness.

Any estimations this document may contain have been undertaken according to generally accepted methodologies and should be considered as forecasts or projections. Results obtained in the past, either positive or negative, are no guarantee of future performance.

This document and its contents are subject to changes without prior notice depending on variables such as the economic context or market fluctuations. BBVA is not responsible for updating these contents or for giving notice of such changes.

BBVA accepts no liability for any loss, direct or indirect, that may result from the use of this document or its contents.

This document and its contents do not constitute an offer, invitation or solicitation to purchase, divest or enter into any interest in financial assets or instruments. Neither shall this document nor its contents form the basis of any contract, commitment or decision of any kind.

With regard to investment in financial assets related to economic variables this document may cover, readers should be aware that under no circumstances should they base their investment decisions on the information contained in this document. Those persons or entities offering investment products to these potential investors are legally required to provide the information needed for them to take an appropriate investment decision.

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