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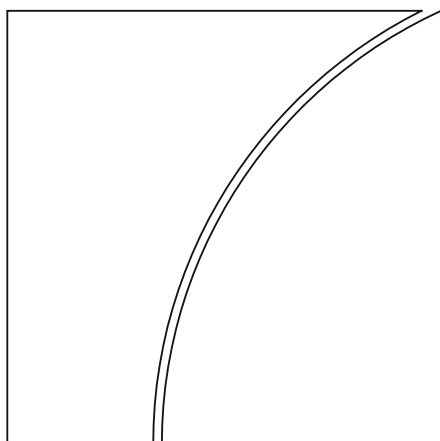
### Central bank digital currencies (CBDCs) in Latin America and the Caribbean

by Viviana Alfonso, Steven Kamin and  
Fabrizio Zampolli

BIS Representative Office for the Americas

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# Central bank digital currencies (CBDCs) in Latin America and the Caribbean<sup>1</sup>

Viviana Alfonso C, Steven Kamin and Fabrizio Zampolli

## Abstract

The pros and cons of CBDCs have been examined in numerous writings. However, much less research has focused on the benefits, costs and implementation issues of CBDCs in specific economies or regions. This paper attempts to fill that gap for the Latin American and Caribbean (LAC) economies. It first examines the views of central banks in the region toward CBDCs, drawing on their responses to a survey conducted by the BIS in late 2020 and early 2021. Second, it examines whether the engagement of LAC central banks with CBDCs can be explained by the structural characteristics of their economies. Third, it reviews the long list of potential benefits, costs and risks of CBDCs, focusing on their relevance to the LAC economies. Finally, the paper reviews the design choices that central banks face and the actual choices made by a number of central banks in the region.

Keywords: Central bank digital currency; CBDC; payment systems; central banking; digital currency.

JEL classification: E42, E51, F31, G21, G28, O32, O38.

<sup>1</sup> Viviana Alfonso is a senior economist at the Central Bank of Colombia and a former visiting economist at the BIS Representative Office for the Americas when the first draft of this paper was prepared. Steven Kamin is a senior fellow at the American Enterprise Institute. Fabrizio Zampolli is Head of Economics for Latin America and the Caribbean at the Bank for International Settlements. We thank Raphael Auer, Claudio Borio, Stijn Claessens, Jon Frost, Anneke Kosse, Eswar Prasad, Tara Rice, Hyun Song Shin, Alexandre Tombini and participants at the 2021 LACEA Conference for valuable comments. We also thank Cecilia Franco for her excellent research assistance. The views expressed in this document are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

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## Introduction and summary

Interest in central bank digital currencies, or CBDCs, is sweeping the financial sector, financial media and the central bank community. Most central banks are investigating design and implementation issues of CBDCs in their jurisdictions, and CBDCs are a major focus of the Innovation Hub Centres recently stood up by the Bank for International Settlements (BIS) around the world. However, many governments and central banks are still weighing the costs and benefits of CBDCs, and actual issuance of these digital currencies is not a foregone conclusion in most jurisdictions.

The pros and cons of CBDCs have been examined in numerous writings, including IMF (2020), Group of Central Banks (2020), BIS (2021), G7 (2021), CPMI, BISIH, IMF and WB (2021) and Prasad (2021). However, much less research has focused on the benefits, costs and implementation issues of CBDCs in particular economies or global regions. This paper attempts to fill that gap for the Latin American and Caribbean (LAC) economies. It first examines the views of central banks in the region toward CBDCs, drawing on their responses to a BIS survey conducted by the Committee on Payments and Market Infrastructures (CPMI) (Boar and Wehrli (2021)) and the authors of this paper.<sup>2</sup> It then examines whether the engagement of LAC central banks with CBDCs can be explained by structural characteristics of their economies, updating and refocusing analysis conducted by Auer et al (2020). Next, the paper reviews the long list of potential costs and benefits of CBDCs, focusing on their relevance to the LAC economies. The review concentrates on retail CBDCs, which attract the greatest interest from LAC central banks (see below) and which may represent a greater change in the payments system than wholesale CBDCs. It also addresses the challenges to central banks in the region posed by foreign CBDCs or private digital currencies, which may be especially salient for economies subject to significant currency substitution and volatility of capital flows. Finally, the paper reviews the design choices that central banks face and the actual choices made by LAC central banks that have already developed pilot projects or issued a retail CBDC.

The main findings of this research are as follows.

*Views of LAC central banks toward CBDCs.* LAC central banks are generally similar to other central banks in their interest in, and motivations for, CBDCs. 85% of LAC central banks are engaged in CBDC research, the same as for the BIS' global survey sample. Compared with the global sample, LAC central banks are more interested in retail CBDCs than in wholesale CBDCs. In terms of the motivations for their interest in CBDCs, LAC central banks, like other respondents, especially in emerging market and developing economies (EMDEs), place the greatest weight on financial inclusion, efficiency of the domestic payments system and safety of the payments system; despite the importance of remittances to the region, efficiency of cross-border payments is not a prominent motivation. Perhaps the most pronounced difference emerging from the study is the role of trends in cash usage: compared to central banks in other jurisdictions, LAC central banks report less decline in cash usage and, accordingly, that is less of a motivation for their interest in CBDCs.

<sup>2</sup> Specifically, 13 central banks in the LAC region answered the survey in 2020, which has been conducted annually by the CPMI since 2018 and was originally used as an input by Boar and Wehrli (2021) in December 2020. In the first half of 2021, 8 additional central banks were asked by us to respond to the same questionnaire, bringing the total number of LAC central banks surveyed for this report to 21.

*Drivers of LAC central bank interest in CBDCs.* Auer et al (2020) develop indices of engagement in CBDCs around the world, based on central bank work on CBDC projects, and show how those are related to a broad range of country characteristics (eg mobile phone usage, government effectiveness, financial development). Drawing on their work and updates of their data, we find that measures of engagement with CBDCs in the LAC region are lower than those in the advanced economies but broadly similar to those in other EMDEs. Applying probit analysis to the determinants of this engagement across the global sample, several explanatory variables are statistically significant, including the extent of innovation, the presence of fast payment systems, government effectiveness, the prevalence of financial account ownership, the extent of financial development more generally and the extent of the public's interest in CBDCs, as reflected in internet searches. Measures of these explanatory variables are generally lower in the LAC region than in the advanced economies, but broadly comparable to levels in other EMDEs. These findings do not necessarily bear on the question of whether CBDCs are appropriate or desirable in the LAC region, but they do suggest that the region's interest and engagement with CBDCs is in line with its economic, financial and technological attributes.

*Potential benefits of CBDCs for LAC economies.* We review the standard arguments for CBDCs and assess their applicability to the LAC region. A key motivation for CBDCs in advanced economies – to make up for dwindling cash usage – is less likely to apply to most LAC economies, as they continue to depend heavily on cash. However, the LAC economies may be well-positioned to benefit from CBDCs in other respects. Retail digital payments in many LAC economies are characterised by high cost and lack of access for a substantial swathe of the population. If CBDCs are supported by a digital platform that allows private payments providers to also participate, on an equal basis, with good data governance and interoperability between different payments arrangements, this could spur competition, improve convenience, reduce costs for users, and support further financial innovation (eg adoption of programmable contracts). They could therefore also prevent market dominance by large firms and support monetary sovereignty in the face of threats from private digital currencies (see below). The successful issuance of CBDCs could promote financial inclusion, a high priority in a region with many unbanked households, as well as reduce informality, which is prominent in many LAC economies.<sup>3</sup> Furthermore, having an additional means of payment such as a CBDC may help increase the resilience of payments in the face of natural disasters – for instance when the physical infrastructure for distributing cash (eg roads, bank premises) may take longer to repair than the digital infrastructure – and could also aid in the distribution of transfer payments, as during the recent Covid-19 pandemic. Finally, adoption of CBDCs could simplify and reduce the cost of cross-border payments, which is particularly relevant given the region's heavy dependence on remittances. Many of these benefits could also be achieved through a well-designed retail fast payment system, such as has been implemented in some LAC economies. However, because a CBDC constitutes the safest form of digital money, it allows for a more direct form of settlement, thereby eliminating the need for intermediary credit in payments and helping to reconfigure the payments system in a more parsimonious way.

<sup>3</sup> More widespread use of digital payments could reduce costs and encourage merchants and other economic actors in the region's large informal sector to accept such payments in addition to cash. Reducing informality would lead to higher tax revenues, greater social protection, better access to credit for small businesses and, ultimately faster economic development.

*Potential costs and risks of CBDCs for LAC economies.* CBDCs pose a number of costs and risks, but none of them appear insuperable, including for the LAC economies. CBDCs may be subject to cyber attacks and abuse for criminal purposes. Although private digital payments or other areas of finance could be exposed to the same risk, reputational costs for the central bank could be larger. The need to protect CBDCs against being used for illicit activities such as money laundering or terrorist financing could entail a politically sensitive expansion of the oversight power of the central bank; however, this concern could be substantially mitigated through adoption of a two-tiered CBDC architecture, as advocated by BIS (2021), in which consumer-facing operations are implemented by commercial banks and payment service providers (PSPs). CBDCs could lead to disintermediation and even exacerbate runs from private bank deposits, but these risks can be controlled by imposing limits on CBDC holdings, as with the Bahamas “Sand dollar”. Finally, by facilitating international payments, CBDCs, foreign and/or domestic, may lead to unwanted capital outflows and excessive volatility of exchange rates (CPMI, BISIH, IMF and WB (2021)). This concern may be especially salient for many LAC economies, but it could be adequately addressed through limits on the use of CBDCs, application of foreign exchange regulations and cooperation with relevant authorities in other jurisdictions.

*Challenges posed by private digital currencies and foreign CBDCs.* Risks may also arise from the issuance of digital currencies by private entities, such as stablecoins – cryptoassets that aim to maintain a stable value relative to specified assets (CPMI (2021)) – or by other central banks. Private digital currencies may provide greater convenience to users than cash or other domestic payments vehicles, but not necessarily reduce costs and improve access, especially if they take a dominant share of the market. Besides, the widespread use of private cryptoassets, especially stablecoins, could lead to new risks to financial stability, such as currency substitution and reduced effectiveness of domestic monetary policy, especially if they are denominated in foreign currency and domiciled outside the country. Similar risks could also arise from the adoption of CBDCs by a foreign issuer of a vehicle currency, such as the United States. As BIS (2021) recommends, cooperation among central banks can substantially limit opportunities for flight out of the domestic currency. Additionally, central banks may choose to counter the competition from other digital currencies by issuing their own CBDCs. However, this issuance will only succeed if the central bank is following sound policies and the primary motivation for people adopting other currencies is the ease, efficiency, and convenience of financial transactions, rather than high inflation and a volatile financial environment.

All told, the design of CBDCs must balance the many benefits of CBDCs with some of their attendant risks, which requires careful and unhurried attention to detail. These benefits are likely to be incremental rather than transformative. They include: greater efficiency, competition and resilience in domestic payments; lower costs of remittances and other cross-border payments; and greater financial inclusion and outreach to far-flung and disadvantaged communities. These benefits require appropriate design, implementation choices and complementary actions by other authorities, both domestic and international. Accordingly, and consistent with the predictions of the central banks surveyed by the BIS, most central banks do not see the actual issuance of CBDCs as urgent. In many cases, the preference is to prioritise the best and most robust design over speed of implementation. Yet the digital landscape is changing rapidly in LAC, and central banks need to be prepared to adjust their plans.



## Responses by Latin American and Caribbean central banks to BIS Survey on CBDCs

For several years, the BIS has surveyed a broad range of central banks around the world regarding their interest in and motivations for introducing a CBDC in their jurisdiction (Barontini and Holden (2019); Boar, Holden and Wadsworth (2020); and Boar and Wehrli (2021)). We contacted LAC respondents to the survey, along with several other central banks in the region that had not received or responded to the survey, to give their views on a confidential basis. This section compares their responses to the broader range of responses by advanced-economy (AE) and emerging market and developing economy (EMDE) central banks.

All told, there were 21 responses by LAC central banks, almost half the 44 responses by all EMDE central banks, and 21 responses by AE central banks described in Boar and Wehrli (2021). By and large, we found LAC central banks to be similar to other central banks in their interest in, and motivations for, CBDCs. Perhaps the most pronounced difference emerging from the study was the role of trends in cash usage: on average, fewer LAC central banks reported declines in cash usage compared to central banks in other jurisdictions. Accordingly, the need to provide an alternative central bank liability to compensate for declining cash use was less of a motivation for most of the respondents' interest in CBDCs. That said, there is considerable heterogeneity in cash use across the region and, moreover, LAC central banks certainly have other reasons to pursue CBDCs, as discussed below.

### Interest in CBDC analysis

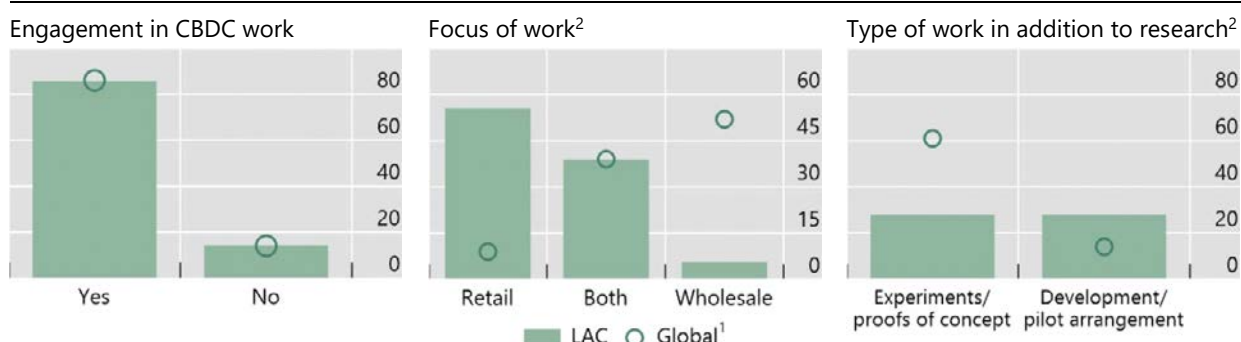
Graph 1 below compares the interest in CBDCs of LAC central banks with those of all the 65 central banks whose survey responses are reported by Boar and Wehrli (2021). As shown in the first panel, nearly identical shares – about 85% – of the LAC and global respondents reported they were engaged in CBDC work. Compared with other central banks, LAC central banks were a little more interested in retail CBDCs and a little less interested in wholesale CBDCs (second panel). For that matter, very few central banks in either the LAC or the global samples indicated an interest in wholesale CBDCs alone. One LAC respondent noted that it did not believe that CBDCs would improve on its real-time gross settlement (RTGS) system.

As indicated in the third panel, a smaller share of LAC central banks (34%) than global respondents (60%) are engaged in going beyond research to conduct experiments or proofs of concept. That said, about 24% of LAC central banks have moved forward to development and pilot arrangements, and this actually exceeds the global share.

## Central bank's work on CBDC advances further

Share of respondents

Graph 1



<sup>1</sup> Global results corresponds to the 65 countries, including the LAC countries, answering the survey in 2020 for Boar, C and Weherli, A, (2021): "Ready, Steady, Go", BIS Working paper N°114. <sup>2</sup> Share of respondents conducting work on CBDC.

Source: BIS central bank survey on CBDC.

## Motivations for interest in CBDCs

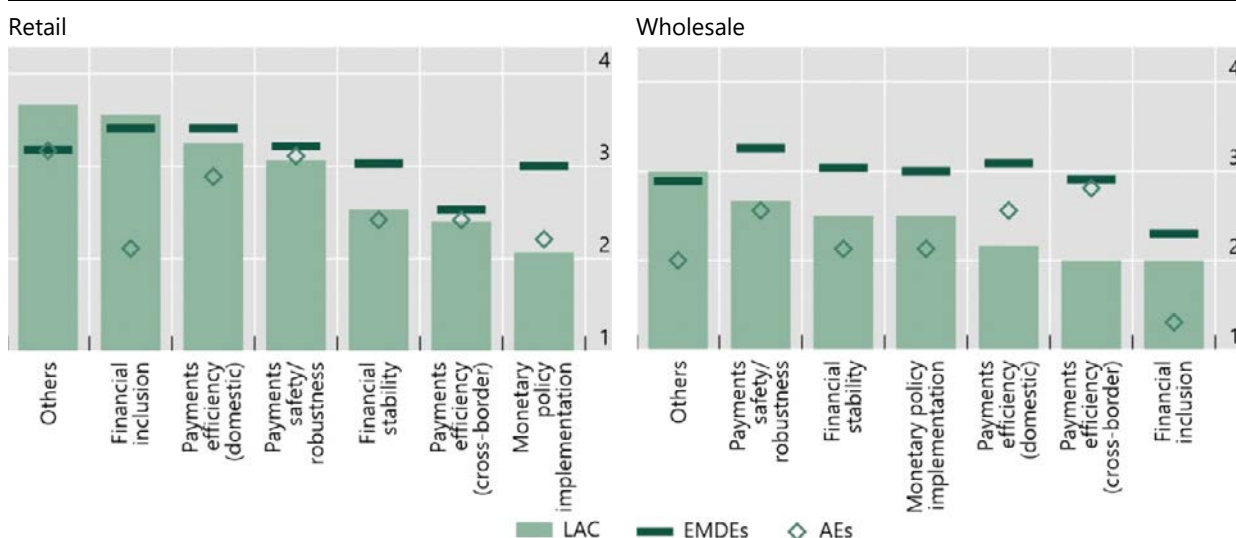
Central banks were asked to rate the importance they place on various motivations for issuing a CBDC, ranging from "not so important" to "very important". Graph 2, left-hand panel focuses on motivations for retail CBDCs, which, as noted above, are the primary interest of both LAC and global respondents. As in the case of their interest in CBDCs, the motivations for that interest by LAC central banks are generally similar to those of central banks in other regions.

Like other EMDE respondents, LAC central banks place the greatest weight on financial inclusion, efficiency of the domestic payments system and safety of the payments system. (Perhaps understandably, AE respondents put less weight on financial inclusion as a motivation than EMDE respondents.) In its comments, one central bank argues that financial inclusion could be achieved in other ways besides issuing a CBDC, and that its interest in CBDCs is mainly driven by a motivation to pursue innovations that could modernise the financial system. Another central bank notes that a CBDC could provide access to banking services in far-flung areas of its jurisdiction where such services were limited. A third central bank suggests that CBDCs could promote the use of electronic payments by the public. LAC central banks place low weights on financial stability and monetary policy implementation as motives for CBDCs. These are below the weights placed by other EMDEs but, interestingly, about the same as AE respondents. Surprisingly, given the importance of remittances to many emerging market economies, both LAC central banks and those of EMDEs more generally place low weight on payments efficiency for cross-border transactions.

## Motivations for issuing a CBDC

Average importance

Graph 2



(1) = "Not so important"; (2) = "Somewhat important"; (3) = "Important"; (4) = "Very important".

Source: BIS central bank survey on CBDC.

As noted above, LAC respondents appear to be more focused on general purpose or retail CBDCs than wholesale CBDCs. Indeed, a fair number of respondents did not answer the questions about motivations for interest in wholesale CBDCs. Among those that did answer those questions, like central banks in other regions, they place the greatest weight on payments safety and robustness, and the least weight on financial inclusion (Graph 2, right-hand panel). Curiously, LAC respondents place lower weight than their EMDE counterparts on payments efficiency, either for domestic or cross-border transactions. Finally, it bears noting that while financial stability and monetary policy implementation are not believed to be strong motivations for retail CBDCs, both LAC respondents and EMDE central banks more generally place high weight on these motivations for wholesale CBDCs.

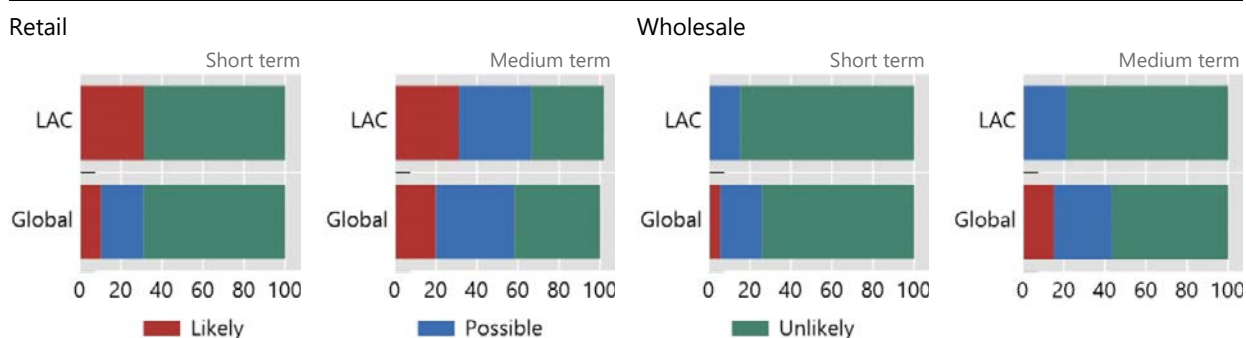
### Perceived likelihood of CBDC issuance

Most LAC central banks are not planning to issue CBDCs (whether retail or wholesale) very soon. Indeed, one central bank noted that CBDCs were currently viewed as unnecessary, since its jurisdiction already had a well-established, widely used, efficient, low-cost and reliable digital payments system, with an already high degree of financial inclusion. Graph 3 compares LAC respondents' views on the likelihood they would issue CBDCs with the views of global respondents more generally. Interestingly, 29% of LAC respondents, or 6 out of 21 respondents, reported they were likely to issue retail CBDCs within the next one to three years, a higher share than in the global sample. Within the medium term, the LAC responses are more similar to their global counterparts, with 33% reporting issuance of a retail CBDC to be likely, 38% possible, and 29% unlikely. Conversely, LAC central banks appear to be much less confident that they will issue wholesale CBDCs any time soon, consistent with smaller shares of LAC respondents than global respondents working on wholesale CBDCs, as shown in Graph 1.

## The likelihood of CBDC issuance

Graph 3

Share of respondents



Short term: 1–3 years; Medium term: 1–6 years. In all graphs “Likely” combines “very likely” and “somewhat likely”. “Unlikely” combines “very unlikely” and “somewhat unlikely”.

Source: BIS central bank survey on CBDC.

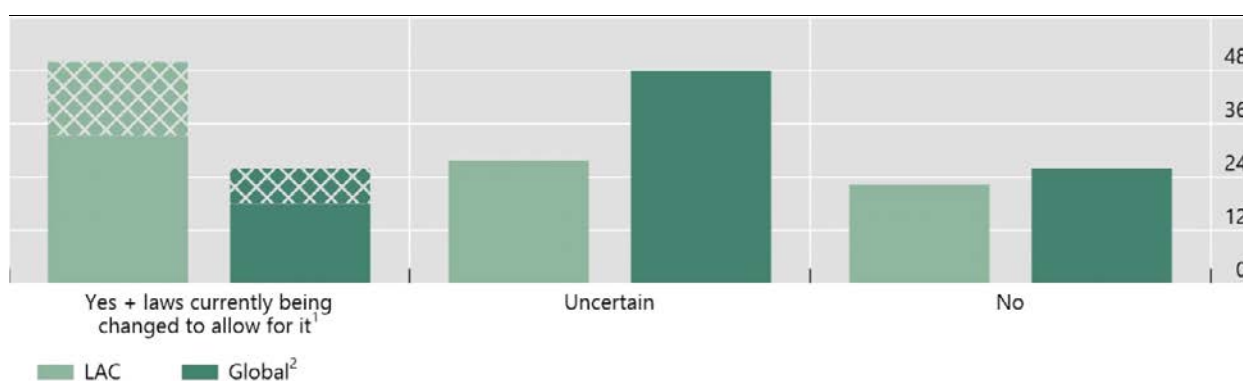
## Legal authority to issue CBDCs

Do central banks have the legal authority to issue CBDCs in their jurisdictions? Graph 4 indicates that LAC central banks are better positioned in this respect than many of their counterparts in other regions. Nearly half of LAC respondents either already have legal authority or are in the process of changing laws to allow for it. Additionally, a smaller share of LAC than global central banks are uncertain of their legal position in this respect.

## Legal authority of central banks to issue a CBDC

Share of respondents

Graph 4



<sup>1</sup> Diagonal cross patterns correspond to jurisdictions currently changing laws to allow issuing CBDC. <sup>2</sup> Global results correspond to the 65 countries answering the survey in 2020 for Boar, C and A Weherli (2021): “Ready, Steady, Go”, *BIS Working papers*, no 114.

Source: BIS central bank survey on CBDC.

## Trends in cash usage

An oft-cited motivation for CBDCs is the decline in the use of physical currency, or cash. Accordingly, the BIS survey asks respondents about trends in cash usage in their jurisdictions, and Graph 6 compares their responses to those of LAC central banks alone. Quite evidently, only a small fraction of LAC respondents, and much smaller than that of global respondents, report a decline or a prospective decline in the use of cash. This is particularly noteworthy in light of the social distancing encouraged by the Covid-19 pandemic, addressed below.

Of course, the lack of a decline in cash usage does not necessarily obviate an interest in CBDCs. In countries with high cash usage, CBDCs may be sought to reduce that usage, perhaps to build resilience in the payments system or to reduce informality. Alternatively, in some countries with relatively low cash usage CBDCs may be sought to provide backups or alternatives to other non-cash payments systems.

## Impact of Covid-19 pandemic on interest in CBDCs

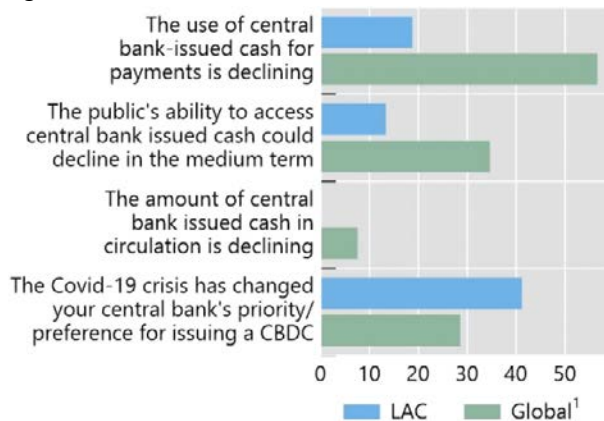
The social distancing requirements imposed by the Covid-19 pandemic, and the resultant heightened importance of digital transactions and communications, may have been expected to heighten central banks' interest in CBDCs. Indeed, as shown in Graph 5 below, 41% of LAC respondents report that the pandemic has changed their priorities on CBDCs, a slightly larger share than for global respondents to that question. Those respondents who report that their priorities have changed were then asked to identify one or more possible motivations for their heightened interest. LAC respondents place the greatest weight on enabling socially-distanced transactions, followed by channelling public funding. Consistent with these responses, one central bank notes that the Covid-19 pandemic has highlighted fragilities in the logistics of cash distribution, and that has heightened interest in exploring CBDCs.

### Covid-19 and CBDC

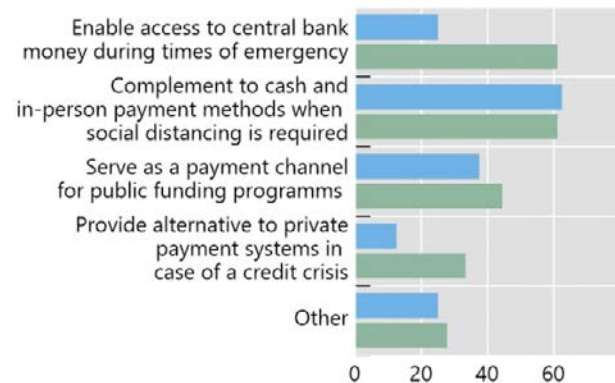
Share of respondents

Graph 5

Agreement to statements on cash use



Reasons for altered stance on CBDC due to Covid-19



Source: BIS central bank survey on CBDC.

## The drivers of central bank engagement in CBDCs

As discussed above, the interest and engagement by LAC central banks evidenced in the BIS survey appears broadly in line with that of central banks in other regions, and especially EMDE central banks. Does this similarity reflect the fact that the underlying drivers of central bank interest in CBDCs are similar in the LAC region and in the other regions of the world? Or is the interest in CBDCs by central banks in LAC and other regions driven more by global trends toward greater application of digital technology in finance rather than the specific structural characteristics of their own economies?

To address this question, we draw on analysis by Auer, Cornelli and Frost (2020), who develop indices of interest in CBDCs and show how those are related to a broad range of country characteristics (eg cell phone usage, government effectiveness and GDP per capita). We describe how Latin American economies fare both in terms of expressed interest in CBDCs and of the country characteristics that influence that interest.

We find that measures of interest and engagement in CBDCs in the LAC region are lower than those in AEs but broadly similar to those in other EMDEs. Consistent with this observation, we find that measures of country characteristics that might influence interest in CBDCs are, again, generally lower in the LAC region than in AEs, but broadly comparable to levels in other EMDEs. These findings do not necessarily bear on the question of whether CBDCs are appropriate or desirable in the LAC region. But they do suggest that the region's interest and engagement with CBDCs is in line with its economic, financial, and technological attributes.

Finally, we replicate the ordered probit analysis of Auer et al (2020) estimating the relationship between measures of CBDC interest and country characteristics that might be driving that interest. After controlling for the level of GDP per capita, which is positively associated with CBDC engagement, a number of other "drivers" of that interest remain statistically significant, including the extent of innovation, the presence of fast payment systems, government effectiveness, the prevalence of financial account ownership, the extent of financial development more generally, and the extent of the public's interest in CBDCs as reflected in internet searches.

Surprisingly, when this analysis is applied solely to LAC jurisdictions, only financial account ownership emerges as a significant explainer of CBDC engagement. Many other variables are significant when the analysis focuses on other regions. This would seem to suggest that differences among LAC central banks regarding their interest in CBDCs are not driven primarily by differences in their economic and financial situations, but perhaps by global technological and intellectual evolutions.

### Measures of interest in CBDCs

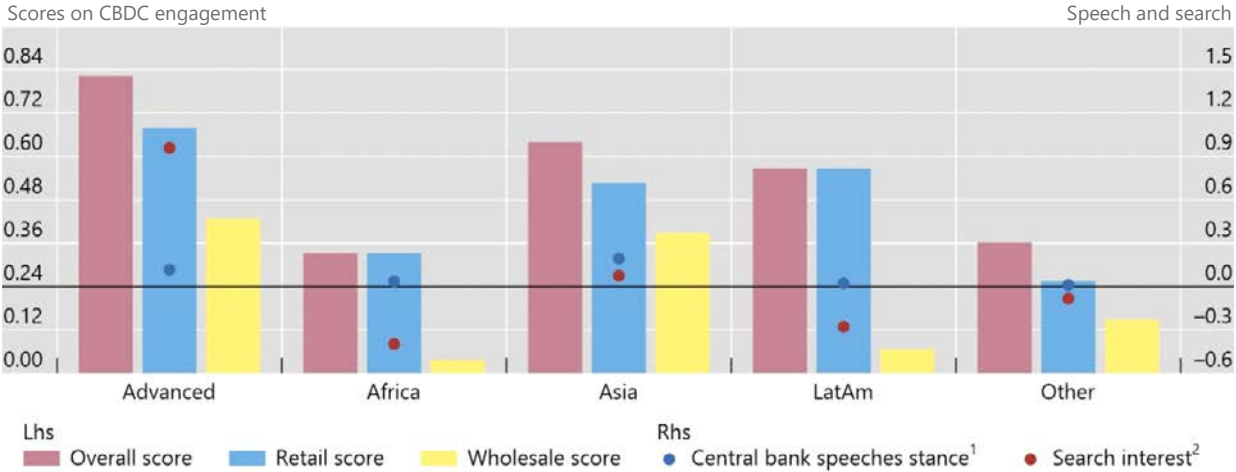
Auer et al (2020) compile three distinct measures of countries' interest in CBDCs. The first, labelled the CBDC project index, is based on central banks' announced work on CBDC projects. It is equal to 0 when no projects have been announced, 1 for public research studies, 2 for ongoing or completed pilots and 3 for a live CBDC. The authors computed sub-indices for retail and wholesale projects, as well as an overall index equal to the maximum of the two sub-indices.

The mean average values of these indices for different regions are shown in Graph 6 below. Clearly, AEs have made the most progress toward implementation of

CBDCs – though even for these countries, average scores are below 1, indicating that few economies have moved beyond the research phase. Turning to the EMDEs, LAC central banks are quite competitive with other regions, and lead other EMDE central banks in retail CBDC engagement. Their very low scores for wholesale CBDCs mirror the results of the BIS survey described above.

CBDCs scores and search interest

Graph 6



<sup>1</sup> Data have been normalised and windsorised at 5% <sup>2</sup> Data have been normalised

Source: Auer, R, G Cornelli and J Frost (2020): “The rise of central bank digital currencies: drivers, approaches and technologies”, *BIS Working Papers*, no 880, August 2020, updated as of October 2021.

Besides this measure of actual central bank work, Auer et al (2020) constructed two other measures. One, indicated by the red dots, is an index of internet searches for keywords related to CBDCs. Not surprisingly, average values for this index are well correlated with the measures of actual CBDC work shown by the blue bars: highest for AEs and lowest for Africa. The LAC countries represent an interesting exception, in that their internet search interest is well below what one would expect, based on their CBDC project score. This suggests that LAC central banks may be ahead of their populations in their interest in CBDCs and may have more work to do in popularising the project should they decide to move toward implementation.

The final index developed by Auer et al (2020), shown in blue, is a measure of the stance of central bank officials toward CBDCs, based on digital analysis of keywords in published speeches. It varies from -1 (negative stance) to 0 (neutral) to +1 (positive). Notably, average values of this measure are uncorrelated with CBDC project scores across regions and, with the exception of Asia, are generally close to 0, indicating a neutral stance on average. A number of factors may be at work here. First, the speech scores were based on speeches from 2013 to 2021, and the average reflects both earlier (often negative) speeches and later (often more positive) speeches on CBDCs by central banks. Second, the index merely measures the stance toward CBDCs – positive or negative – and not the intensity of the central banks’ interest. Finally, whether or not central banks are committed to issuing CBDCs at this time, they are pursuing research and even pilot projects in order to be prepared and get the design right should they choose to issue CBDCs at some future point.



## Drivers of interest in CBDCs

After defining and measuring the various indices of interest in CBDCs described above, Auer et al (2020) then examine the correlation of those indexes with a wide range of economic and financial indicators. These indicators, displayed in Table 1, include measures of a country's digital infrastructure (mobile phone usage, broadband subscriptions, fast payment networks), innovation capacity, economic and financial development, dependence on international trade and remittances, and measures of public and official interest in CBDCs.

### Descriptive statistics

Table 1

|  | Full sample | Advanced economies | Latin America and the Caribbean | Other EMDEs |
|--|-------------|--------------------|---------------------------------|-------------|
| Score index overall                                  | 0.53        | 0.82               | 0.57                            | 0.44        |
| Score index retail                                   | 0.45        | 0.67               | 0.57                            | 0.36        |
| Score index wholesale                                | 0.21        | 0.42               | 0.06                            | 0.20        |
| Central bank speech <sup>1</sup>                     | 0.07        | 0.11               | 0.02                            | 0.07        |
| Internet search interest <sup>2</sup>                | 0.04        | 0.95               | -0.28                           | -0.10       |
| Account ownership                                    | 60.56       | 94.09              | 51.22                           | 51.53       |
| Broadband subscriptions (fixed line, per 100 people) | 14.39       | 33.71              | 13.01                           | 9.68        |
| Government effectiveness                             | 0.07        | 1.35               | -0.06                           | -0.22       |
| Mobile cellular subscriptions (per 100 people)       | 109.12      | 122.80             | 110.82                          | 105.10      |
| Remittances to GDP                                   | 5.92        | 2.48               | 7.81                            | 6.87        |
| Innovation output score (WIPO)                       | 36.84       | 52.08              | 31.30                           | 33.04       |
| Trade openness                                       | 69.30       | 70.80              | 53.05                           | 72.89       |
| Shadow economy (% of GDP)                            | 25.91       | 13.60              | 34.27                           | 28.28       |
| Financial development index                          | 0.35        | 0.69               | 0.29                            | 0.28        |
| Fast payment systems                                 | 0.36        | 0.80               | 0.32                            | 0.25        |
| Ln (GDP per capita)                                  | 8.94        | 10.49              | 9.10                            | 8.49        |
| Central bank speech <sup>1</sup>                     | 0.07        | 0.11               | 0.02                            | 0.07        |

<sup>1</sup> Data have been normalised and winsorised at 5%. <sup>2</sup> Data have been normalised.

Source: Database used in R Auer, G Cornelli and J Frost (2020): "The rise of central bank digital currencies: drivers, approaches and technologies", *BIS Working Papers*, no 880, August 2020. Scores indices, central bank speech and internet search interest updated to October 2021. All other variables updated to 2020 values as available.

We can also compare mean values of these drivers of CBDC activity across the different global regions. In most cases, the values of these drivers in the LAC region are below those in AEs, consistent with their lower levels of CBDC project activity. (Table A1 in the annex assesses the statistical significance of differences in these indicators between the different global regions.) However, the value of the drivers in the LAC region is certainly broadly comparable with the values in other EMDE regions. This is again consistent with the fact that CBDC project indices in LAC are similar to that in other EMDEs.

Auer et al (2020) then estimate ordered probit regressions, relating the probability that the CBDC project index in a jurisdiction equals 0, 1, 2 or 3 to the value of a particular indicator. We re-estimate these regressions. First, we update their



database to include the latest available information – that is, updated (October 2021) values of the CBDC project index for the dependent variable, as well as observations up to 2020 when available for the explanatory variables. Second, we take into account the fact that many of the indicators that Auer et al (2020) featured as potential drivers of CBDC activity may be correlated with the level of income, which is itself positively correlated with CBDC activity. In order to control for this possible source of spurious correlation, we re-estimate the univariate regressions proposed by Auer et al (2020) adding the log of GDP per capita as a second explanatory variable.

The results are reported in the first column of Table 2. They show that after controlling for income, the correlations with CBDC activity of digital infrastructure, informality and remittances lose their significance (whether positive or negative). However, many potential drivers of CBDCs remain significant: innovation, fast payment systems, government effectiveness, financial account ownership, the level of financial development and internet search interest in CBDCs. Interestingly, although countries in LAC and other EMEs cite financial inclusion as one of the key motivations for researching or issuing a CBDC, the central banks' engagement is larger in countries where the population has, on average, more access to basic financial services, as shown by the significant coefficient of account ownership. Finally, we estimated the model separately for a number of sub-groups of countries: advanced economies, LAC economies, and other EMDEs.

Insofar as the statistically significant drivers of CBDC interest are ones in which LAC scores lower than AEs, the results suggest that progress by LAC central banks in exploring CBDCs is broadly in line with the structural characteristics of their economies. One result that gives us pause, however, is shown in the remaining columns of Table 2. When our probit regressions were estimated using data from LAC countries alone, only one of the drivers of CBDC interest proved statistically significant (financial account ownership). When the regressions were applied to data from the other global regions, the coefficients generally became larger and often statistically significant. This would seem to suggest that differences among LAC central banks regarding their interest in CBDCs are not being driven primarily by differences in economic and financial situation, but more research on this is needed.<sup>4</sup>

<sup>4</sup> An alternative specification, with interaction variables between the explanatory variables and a LAC regional dummy variable, confirms that the coefficients for LAC jurisdictions are generally much smaller than those for other regions. This does not reflect the paucity of observations: as indicated in Table 2, the number of LAC observations is comparable to that of the advanced economies; nor does it reflect an excessive similarity of explanatory variables across LAC jurisdictions, as they show considerable dispersion.

Ordered probit coefficients for central bank interest in CBDCs

Table 2

Log (per capita GDP) included as a covariate

|  | Full dataset        | Advanced economies (AE) | Latin America and the Caribbean (LAC) | Other EMDEs         |
|--|---------------------|-------------------------|---------------------------------------|---------------------|
| <b>Digital infrastructure</b>                            |                     |                         |                                       |                     |
| Mobile cellular subscriptions                            | 0.003<br>(0.003)    | -0.003<br>(0.016)       | -0.006<br>(0.008)                     | 0.006<br>(0.005)    |
| Broadband subscriptions                                  | 0.010<br>(0.012)    | 0.041<br>(0.048)        | -0.005<br>(0.040)                     | 0.022<br>(0.016)    |
| <b>Innovation capacity</b>                               |                     |                         |                                       |                     |
| Innovation output score (WIPO)                           | 0.044***<br>(0.018) | 0.102**<br>(0.044)      | -0.134<br>(0.568)                     | 0.094***<br>(0.024) |
| Fast payment system (FPS) dummy                          | 0.659***<br>(0.233) | 0.668<br>(0.544)        | -0.084<br>(0.444)                     | 1.103***<br>(0.295) |
| <b>Institutional characteristics</b>                     |                     |                         |                                       |                     |
| Government effectiveness                                 | 0.478**<br>(0.242)  | 1.623<br>(1.002)        | -0.309<br>(0.466)                     | 0.906***<br>(0.284) |
| Informal economy (% GDP)                                 | -0.012<br>(0.013)   | -0.092<br>(0.059)       | 0.052<br>(0.037)                      | 0.007<br>(0.016)    |
| <b>Development and financial inclusion</b>               |                     |                         |                                       |                     |
| Account ownership (% age 15+)                            | 0.011*<br>(0.006)   | 0.047<br>(0.057)        | 0.045**<br>(0.029)                    | 0.012*<br>(0.007)   |
| Financial development index                              | 3.434***<br>(0.813) | 3.313**<br>(1.504)      | 0.852<br>(1.747)                      | 9.059***<br>(1.367) |
| <b>Public interest in CBDCs and cryptoasset adoption</b> |                     |                         |                                       |                     |
| Search interest index (Google/Baidu)                     | 0.387***<br>(0.123) | 0.462**<br>(0.238)      | -0.381<br>(0.455)                     | 0.946***<br>(0.204) |
| <b>Cross-border transactions</b>                         |                     |                         |                                       |                     |
| Remittances to GDP                                       | -0.020<br>(0.021)   | -0.222<br>(0.180)       | 0.096<br>(0.069)                      | -0.083*<br>(0.042)  |
| Trade openness   | -0.005<br>(0.002)   | -0.012**<br>(0.005)     | -0.012<br>(0.009)                     | -0.004<br>(0.003)   |
| Maximum number of observations                           | 165                 | 28                      | 30                                    | 107                 |

Standard errors in parenthesis. \*, \*\* and \*\*\* represent significance at 1%, 5% and 10% respectively.

## Potential benefits of CBDCs

This section reviews the benefits of CBDCs that have been proposed. It makes a tentative assessment as to whether those benefits are likely to be more or less applicable to the LAC economies.

### Ensure continued access to central bank money if cash use is declining

In jurisdictions where cash use is declining, households and firms may lose access to risk-free central bank money. Accordingly, some observers and policymakers have suggested that it is desirable or even incumbent on central banks to provide digital currency instead (Group of Central Banks (2020), BIS (2021)). Declining cash use in Sweden, for example, has been a key motivation for the Riksbank to undertake the e-krona project (Riksbank (2019)).

For most LAC central banks, however, the responses to the BIS survey reviewed above make clear that cash usage has not trended downward and does not constitute a significant motivation for CBDCs. To be sure, since the eruption of the pandemic, consumers have reduced the use of physical cash to make payments in favour of digital and contactless payment instruments (eg Alfonso, Tombini and Zampolli (2020)). As many new users get accustomed to them and appreciate their convenience, the shift away from cash is unlikely to reverse entirely once the pandemic is over. Even so, the widespread use of cash in some LAC jurisdictions is unlikely to disappear any time soon. In fact, currency in circulation has actually increased in the last few years in most Latin American economies and reached a decade high during the Covid-19 pandemic in several jurisdictions (Red Book Statistics (2021)). However, larger demand was mostly for high-value banknotes, suggesting that cash was increasingly held as a store of value rather than for making payments.

### Reduce direct costs associated with physical cash

The cost of issuing and managing physical cash is estimated to range from as little as 0.2% of GDP (Norway) to 1% or higher (Albania, Guyana) (Kiff et al (2020)). Thus, in principle, replacing (some) physical currency with CBDCs could save costs, both for the central banks and for businesses.

However, there will be fixed costs to maintaining physical currency, so unless physical currency is eliminated entirely, which is unlikely, these fixed costs will remain. More generally, a CBDC infrastructure would likely exist in parallel to, rather than in substitution for, already existing payments systems in order to provide a backup to them in the event of extreme situations such as cyber attacks on private payments providers or natural disasters that could hinder the provision of financial and payment services.

Moreover, as discussed below, the potential savings that could be realised in terms of reduced cash use would have to be set against the costs of developing and issuing a CBDC. Thus, given the likelihood that physical cash will remain in use, and that the costs of installing a CBDC would be significant, it is unclear whether reduced currency costs are by themselves a strong rationale for CBDCs. However, this calculation may differ across jurisdictions.

## Reducing informality

Compared with AEs and even many EMDEs, LAC economies have very large informal sectors. The informal (or “shadow”) economy is generally made up of small firms and individual workers who generate a living outside formal institutional frameworks or reporting. While such activities are often an important part of families’ livelihoods, informality can constrain economic development and growth in many ways: it deprives governments of much-needed tax revenues, it reduces both the ability and the incentive for firms to finance long-term capital investments and, as a related point, it constrains the ability of firms to grow sufficiently to achieve economies of scale and innovation.

Informal sector activities generally rely on cash. Accordingly, if CBDCs were widely adopted by consumers, this could motivate informal retailers to accept them as payment. They could also reduce the fixed cost for informal firms and workers of accepting digital payments, which are currently very high in LAC. Depending on the design of CBDCs (see below), widespread use of CBDCs could help push some enterprises into the formal sector. The digital record of payments could help firms to access credit and to reduce costs of accounting and other requirements on formal sector firms. At the societal level, reduced informality could lead to a broader tax base, better social and regulatory protections and a business sector better positioned to invest and grow.

## Promoting financial inclusion

The flipside of informal sectors driven by cash is consumers for whom banknotes and coins are their only financial assets. Lack of access to the financial system remains a significant impediment to economic development and prosperity for large sub-groups of the population in many countries. CBDCs offered through mobile phones may help overcome such barriers. In LAC, mobile phone penetration is 69%, while mobile internet users represent 57% of the population. This compares to only 49% of the population, on average, having a transaction account. Moreover, CBDCs could be made available through other interfaces, such as cards or dedicated devices for offline payments. As such, provision of a digital currency may help further the cause of financial inclusion. The popularity of M-Pesa, Kenya’s private mobile banking and payments network, attests to the potential benefits of such a scheme.

A CBDC could help provide digital payments where private alternatives are lacking. For example, by targeting access by certain social groups, it could ensure that the least advantaged people are not left behind when private mobile banking providers start to serve wealthier segments of the population. Essentially, this would represent a socially beneficial subsidy of digital payments services for disadvantaged groups when such services are not cost-efficient for private operators to provide. A CBDC could also further financial inclusion by introducing more competition, lowering costs and increasing incentives for private financial institutions to expand their customer base. Finally, it should be noted that CBDCs may complement other initiatives to promote financial inclusion, such as subsidies for private bank outreach to the unbanked.

The LAC region may be especially well-positioned to benefit from CBDCs in this regard, given its especially limited extent of financial inclusion. As of 2017, only 49% of adults, on average, had access to transaction services, compared with 92% in AEs,

80% in emerging Asia and 70% in other EMEs (Alfonso, Tombini and Zampolli (2020)). As a result, financial inclusion was one of the most cited motivations for interest in CBDCs by respondents to the BIS survey.

That said, to promote financial inclusion in LAC through CBDCs, authorities will have to address several issues. First, not everyone has access to smartphones or computers, or stable internet connections. Data from the Global System for Mobile Communications Association (GSMA) indicate that, despite recent increases, in 2020 nearly 300 million people in the region were still unable to connect to the mobile internet. Moreover, 5G adoption (offering faster and more reliable access to Internet through smartphones) has just started and is expected to reach only 7% by 2025, which is quite low compared to the projected 50% in Asia, 48% in North America and 34% in Europe (GSMA (2020)). Accordingly, it may be desirable for a CBDC to have some offline payment options based on other interfaces than a smartphone such as smartcards or basic mobile phones.

Second, even if a CBDC provides a more convenient and cheaper means of payment, poor financial literacy, the difficulty in using or adopting a new method of payment by less “tech-savvy” citizens, or fear of cyber fraud may limit its adoption.

Finally, if know-your-customer (KYC) requirements are as stringent as for existing bank accounts, citizens without a proper identification or other required documentation could struggle to access the CBDC.

Summing up the pros and cons, financial inclusion would still appear to represent an apt motivation for issuance of CBDCs in the LAC region. However, in order to achieve that goal, great care must be taken in the design of the CBDC, in educating the public as to its use, and in ensuring its access by all sectors of society.

### Improve resilience and safety of payment systems by backing up other electronic payments mechanisms in case of failure

Khiaonarong and Humphrey (2019) point out that declines in the use of cash are not necessarily associated with greater demand for CBDCs, since in countries where cash usage has declined, households and businesses have most likely already adopted cash substitutes such as credit/debit cards or mobile phone payments. For example, in Brazil, provision of the PIX retail fast payments system has replaced some use of physical cash. However, there may still be an interest in a secure publicly provided back-up system in case private electronic payments systems fail. Failure could reflect power outages, natural disasters, management failures or other events – some of which admittedly could affect CBDCs as well. Moreover, if trust in private payments providers is lacking, there may be demand for a government-backed alternative that minimises risks associated with fraud, financial failure, cyber attacks and other forms of counterparty risk (Prasad, 2021).

At present, this consideration is probably less relevant for LAC than for other regions, as the use of cashless payments in most LAC jurisdictions remains limited, although it stepped up during the pandemic (Alfonso, Tombini, and Zampolli (2020)). However, as private electronic payments systems come to play a larger role, having a backup payments system such as a CBDC could become more attractive.

## Provide mechanism for distributing funds to hard-to-reach individuals or locations

Emergencies such as natural disasters, bank closures, difficulties restocking ATMs and transportation disruptions could lead to shortages of cash and liquidity for many households and businesses. This occurred in Puerto Rico after Hurricane Maria in 2017, when many roads became impassable. Widespread provision and use of CBDCs might have helped facilitate payments, at least once sufficient electricity was restored to power phones and computers. Indeed, the plethora of far-flung island communities with limited financial services was a salient motivation for the Central Bank of The Bahamas to issue its “Sand Dollar”.

Another, related use of CBDCs could be to provide efficient means of disseminating fiscal transfers to households and businesses. Since the start of the Covid-19 pandemic, governments have struggled to distribute relief payments in a timely and efficient manner. A CBDC, combined with a comprehensive social registry or even digital ID, would be able to disseminate payments more quickly and efficiently.

The relevance of these motivations for LAC countries is mixed. Large countries with dispersed and hard-to-reach rural communities could benefit from a CBDC network in times of natural disaster, or when rapid and widespread disbursement of fiscal transfers is desired. For instance, following a natural disaster, a CBDC with offline functionalities – that is, the ability to make payments without connecting to the internet, at least temporarily – could prove particularly useful. Moreover, in some situations, it may take much longer to restore the infrastructure needed to distribute physical cash (bank premises, ATM, deposits, roads, etc) than the network underpinning mobile phone and internet communication. For example, following Hurricane Dorian in 2019, the strongest to ever hit The Bahamas, it took several months to restore much of the physical infrastructure, but much less time to restore electrical power and the internet.

That said, CBDCs would still require a robust mobile and internet structure, as well as reliable electricity generation, and those might be lacking in some countries. Indeed, it took many months for electricity service in Puerto Rico to be fully restored after Hurricane Maria. Additionally, CBDCs, by themselves, would not suffice to facilitate fiscal transfers: as noted above, they would have to be combined with an extensive social registry or digital ID, which might have to be developed in some countries. Finally, during the Covid-19 pandemic, some LAC countries, such as Brazil, were able to quickly get funds to people even without CBDCs. All told, CBDCs may be helpful at the margin to distribute emergency funds but would require complementary reforms in other areas of government.

## Promoting openness and competition between private payments providers

Payment systems are subject to network effects and other economies of scale, giving rise to concentration, a lack of competition, and associated higher mark-ups and diminished service.

Big tech firms, in particular, have the potential to disrupt incumbent banks and other payment services providers. They can use the data they collect to offer a range

of services that exploit network effects, generating further user activity, which leads to the collection of even more data and so forth – what the BIS called the “data-network-activities” (DNA) loop (BIS (2019)). This loop could help big techs gain a dominant position. In China, for instance, two big techs have managed to conquer jointly 94% of the mobile payments market (Frost et al (2019))

Users may initially benefit from the greater convenience offered by big techs’ services. However, users may be worse off in the longer run as the emergence of one or few dominant players might limit competition and stifle innovation.

Fragmentation, as opposed to concentration, could also be an issue. If a large number of payments providers manage to enter the market, they may end up offering payment services that are not inter-operable. This means that it would be difficult for participants in different payments systems to conduct, clear and settle payments or financial transactions across those systems. This would then lead to higher costs and reduced efficiency.

A CBDC could help ameliorate both problems (Group of Seven (2020), BIS (2021)). Specifically, a CBDC can be designed to offer a common and neutral means to transfer funds – that is, open to every payment service provider and supervised to ensure fair competition. This would ensure that payment solutions developed by private firms are interoperable. Furthermore, a CBDC could be designed to ensure good data governance, as access to it may be subordinated to common rules on how private data are managed.

This motivation could be especially germane for LAC jurisdictions. Relative to other regions, retail payment services in LAC involve high costs for end users and subpar efficiency, partly reflecting low competition among financial institutions. As a related matter, relative to other regions, these retail services also suffer from low interoperability, further eroding efficiency and boosting costs. Private sector participants might not have sufficient incentives to undertake costly investment to improve interoperability, not least because this might also erode their margins (Alfonso, Tombini and Zampolli (2020)).

It must be noted that to improve competition and interoperability, other avenues than the issuance of a CBDC are available. For example, a few countries have already developed retail fast payment systems (FPS) – PIX in Brazil and CoDi in Mexico – that offer instant payments at lower cost to a wide range of users. Launched in November 2020, PIX has already come to dominate small-value transactions in Brazil (with over 70% of the total number of digital transactions, well ahead of traditional bank transfers, and 15% in terms of value). Other countries have issued regulations – eg Transferencia 3.0 in Argentina – to make instant payments more widespread and affordable.

Retail FPS can be built with the same functionalities that a retail CBDCs could be designed to possess. When combined with technical standards such as application programming interfaces (APIs) that enable secure sharing of data (CGIDE (2020; 2021)), FPS can promote effective competition through interoperability of payment platforms. That said, a CBDC offers additional advantages, to which the paper turns below.

## Further simplifying the financial system and fostering innovation

A CBDC constitutes the safest form of digital money and ensures ultimate finality of payments. This allows for a more direct form of settlement, eliminating the need for intermediary credit in payments. This means that adoption of CBDCs, including the installation of a well-designed digital platform to support them, can help reconfigure the payments system in a more parsimonious way. One area in which the simplification of the monetary architecture could yield large benefits is cross-border payments (see below).<sup>5</sup>

Besides helping to simplify payments transactions, the provision of CBDCs, by guaranteeing finality of payments and by providing a safe, open, and competitive digital platform, may also help to foster financial innovation. One notable example is represented by programmable contracts (also known as “smart contracts”). These contracts are pieces of software that execute certain actions if certain conditions occur. They can therefore automate all or part of the most common transactions (eg the purchase of goods or assets, the granting of credit, or the purchase of insurance) and ensure that once the parties have signed the contract there will be no breach. Thus, by speeding up execution, reducing costly reconciliation and human intervention, programmable contracts can make transaction faster and cheaper. Another advantage of programmable contracts is that they could in principle be designed to overcome some of the inefficiencies that prevent many users from accessing credit or insurance, thus improving financial inclusion. They can also be offered to users who do not have a transaction account at a bank but only a digital wallet on a smartphone. The safety and stability in value of a CBDC may contribute significantly to the acceptance of programmable contracts as users will not have to worry about fluctuations in the value of money held in escrow.

## Support monetary sovereignty and financial stability

The safety and trust enjoyed by a CBDC (which needs to be supported by strong institutions and good policy) is a clear advantage over private digital money. This is clear in comparison with private sector stablecoins – as maturity and liquidity mismatches in the assets backing stablecoins could make them subject to runs.

A CBDC could provide the public with an alternative to private or foreign-issued digital currencies, thereby reducing the risks that their widespread adoption could limit domestic monetary policy control or obstruct financial supervision and regulation (Kiff et al (2020)).

Preventing an outflow of wealth or payments into private digital currencies, foreign digital currencies (private or CBDCs), or dollars is a very relevant consideration for Latin American central banks. These issues are discussed more thoroughly below, in “Challenges posed by foreign CBDCs and other digital currencies.”

<sup>5</sup> Another example has to do with retail FPS themselves. In a retail FPS, the underlying wholesale settlement between PSPs may occur with some delay, for example at the end of the day. This delay implies a loan between PSPs and hence credit risk. With a CBDC, there is no such risk because transactions are settled directly on the central bank’s balance sheet.



## Improve efficiency and lower the cost of cross-border payments

An important area where CBDC hold the promise of significantly simplifying the financial architecture is in the context of international payments. A key focus of concern in the international monetary system is the high cost, low speed, limited access and lack of transparency of cross-border payments (FSB (2020)). Along with financial inclusion, improvement of cross-border payments is among the motivations for CBDCs most frequently cited in public commentary. CBDCs in different countries could be designed to interact with one another, or with private payments systems. They could form an alternative to long chains of corresponding banking relationships, which tend to make cross-border payments expensive and slow. As described in Auer et al (2021a) and BIS (2021), the design of CBDCs with cross-border interoperability has been an important focus of recent central bank design research. Indeed, the BIS Innovation Hub has been active in exploring “multiple CBDC” (mCBDC) arrangements that permit the exchange of CBDCs of different jurisdictions. This includes the “mCBDC Bridge” pilot experiment with Hong Kong, Thailand, China, and the United Arab Emirates (Auer and Holden (2021); CPMI, BISIH, IMF and WB (2021)).

Like financial inclusion, cross-border payments could be a significant motivation for many LAC economies, given the importance of remittances and the social benefits that would flow from cheaper remittance costs. However, even by comparison with the already-challenging prospect of designing and implementing a domestic CBDC, the technical challenges of creating a CBDC with cross-border interoperability would be substantial. Moreover, there are other non-technical barriers to cross-border payments, including legal and regulatory hurdles that would not be addressed by CBDCs (Group of Seven (2020)). Accordingly, CBDCs should not be adopted in the hopes of getting a quick payoff in terms of improved cross-border payments. Additionally, given the need to ensure compliance with relevant laws and regulations, including with respect to KYC and capital flow issues, it seems likely that, at least initially, only wholesale CBDCs will be used in cross-border payments, while retail CBDCs will be intended for domestic use (including by non-residents such as tourists and business travellers).

Interestingly, cross-border payments are not emphasised by LAC respondents to the BIS survey as an especially important motivation for exploring CBDCs. Moreover, in the analysis of the drivers of interest in CBDCs described above (Table 2), remittances are not positively correlated with interest in CBDCs. Even so, the development of efficient means of using CBDCs in cross-border payments might well benefit LAC economies in the future.

## Augmenting the channels of monetary policy transmission

A CBDC could allow the central bank to transmit monetary policy actions more directly to the economy. Mancini-Griffoli et al (2018) argue that if the CBDC helps increase financial inclusion and more households are exposed to interest rate-sensitive instruments, the transmission of monetary policy could be strengthened. Proponents have also suggested that, whereas holders of cash can evade negative interest rates, such rates could be imposed on CBDC accounts, either explicitly or by reducing the quantity of the CBDC in people’s accounts. By the same token, central banks could pursue expansionary “helicopter drops” by increasing the value of CBDC accounts (Kiff et al (2020)). Finally, “smart contracts” could be embedded in CBDCs to incentivise spending or saving, or to distinguish between different classes of CBDCs

holders. Fiscal authorities may find these functions attractive. However, central banks would need to be careful not to intrude too far into areas of microeconomic decision-making or policies better left for other areas of government.

Many of these motivations for CBDCs are probably less relevant for most LAC jurisdictions than for other, primarily advanced, economies. The scope to impose negative interest rates is most useful for economies whose inflation is low enough that it may be necessary at times to push interest rates below zero, an atypical (albeit not unprecedented) situation for most LAC economies. Additionally, while LAC economies have begun to use asset purchases since the outbreak of the pandemic, it has been mainly to support functioning in financial markets. LAC central banks may not yet have the need or scope to pursue massive monetary expansion via household accounts. More generally, a CBDC may alter the transmission mechanism of monetary policy in ways that are difficult to anticipate, such as changing the demand for base money and how it responds to movements in interest rates (Carstens (2019)).

## Costs and risk of CBDCs

When designing a CBDC, central banks must clearly identify and assess the costs and possible undesirable consequences and risks that its issuance might have. These may be relevant for the banking sector, capital markets, the transmission of monetary policy and financial stability, among other issues.

### Costs of implementing a CBDC

Depending on its design, a CBDC would most likely entail considerable fixed costs associated with the construction of an adequate infrastructure. On top of that, Kiff et al (2020) identify significant labour, software, cyber security and support costs associated with the operation of a CBDC. Staff will need to be trained and then paid to operate the system. Licences and service fees will be paid to external providers. Resources will need to be devoted to cyber security protections and to guarantee its availability 24/7. Finally, a substantial public education and support programme will be necessary for the successful launching and operation of the digital currency.

For the private sector, the cost of CBDC comprises the costs to businesses of accepting CBDC (which could be lower or higher than the current cost of other electronic payments), any potential fees charged to consumers, and the costs paid by payment service providers to the central bank for using the CBDC infrastructure. The scale of such costs is uncertain (Maniff and Wong (2020)).

All told, these costs are unlikely to be so high as to reverse the net benefits of CBDCs outlined above. However, they are probably sufficient to materially reduce the cost savings, also described above, of reducing the use of physical cash.

### Risk of cyber attacks and criminal activity

As a digital currency, a CBDC could be vulnerable to the same cyber risks that threaten other digital or electronic payment means. For example, if the CBDC is account-based and authentication is weak, a cyber attack could be perpetrated to obtain profit from fraud. Similarly, if the CBDC does not have sufficient controls, eg to separate identity

and transaction information, a data leakage could occur, and sensitive and personal data be revealed to criminals or non-authorised third parties. In both cases, the central bank might be accountable for malfunctioning, fraud or theft. This could imply reputational risks to the central bank that could hinder the adoption of the CBDC.

Likewise, a CBDC could be vulnerable to use for money laundering, terrorist financing, and other illegal activities, as has occurred with physical cash and other digital payment systems in the region.<sup>6</sup>

Cyber risks are highly relevant in LAC countries. Cyber attacks in the region have been increasing, targeting mainly financial institutions. The region has also become a focus for account creation fraud, as described in a recent Inter-American Development Bank report (IDB (2020)). Moreover, although LAC countries have enhanced their cyber security protections in recent years, they remain in the early stages of development (IDB (2020)).<sup>7</sup> People in some LAC jurisdictions also perceive a high risk of digital theft or mistakes by service providers, contributing to a stronger preference for physical cash than in other countries in the region.

To mitigate cyber risk, the central bank must include resilience and safety as one of the guiding principles in the design of a CBDC. This should be applied throughout all the components of the ecosystem and requires that the central bank review and strengthen its IT operational capabilities. It should also demand the highest security standards of potential third parties involved in the implementation of the CBDC.

To mitigate the risk of being used for illicit activities, the CBDC should be subject to the same regulations concerning KYC as those applying to other digital payments. This would imply that the CBDC should be account-based rather than an anonymous token. This introduces a trade-off between the privacy of users and the oversight power of the central bank. However, this trade-off could be substantially mitigated through adoption of a two-tiered CBDC structure, as advocated by the BIS (2021), in which the central bank issues the CBDC, but consumer-facing operations, including KYC measures, are implemented by commercial banks and other PSPs. Moreover, even in the account-based model, it may be possible to provide some degree of anonymity for accounts of limited size.

These measures to control cyber and criminal risks associated with CBDCs will require thoughtful and energetic implementation, but they are well within the capabilities of LAC jurisdictions. Indeed, such mitigants are already in place in fast payments systems such as the PIX in Brazil and the lessons of this experience can be transferred to future CBDC arrangements as well.

<sup>6</sup> In Brazil, express kidnapping increased in the Brazilian state of São Paulo after the introduction of the instant payment system PIX, as the latter is believed to facilitate the payment of ransoms. To counteract this, at the end of August 2021 the central bank has introduced a transaction limit for transfers executed at night. However, PIX users can ask their financial institutions to raise such limit.

<sup>7</sup> According to the Cybersecurity Capacity Maturity Model for Nations (CMM), which measures the development of the capacities of countries to defend against the threats of cyberspace, the average maturity level of the region is still between 1 and 2, in which 1 stands for “startup” and 5 stands for “advanced” (Global Cyber Security Capacity Centre (2021)). Most countries in LAC have started formulating some cyber security initiatives, but they are being implemented in an ad-hoc manner, lacking coordination among key stakeholders.

## Undesirable implications for financial stability

### Effects on the banking sector

The issuance of a CBDC could negatively affect the banking sector. If the CBDC is an interest-bearing instrument, it could compete with bank deposits, challenging bank's intermediation capacity and potentially affecting credit and financial markets.

First, banks might need to substitute deposit funding either with more expensive market-based funding or with central bank borrowing. If they rely on the former option, lending could be more expensive and the supply of credit to the economy might contract or become more volatile. If they rely on the latter option, they would need to provide adequate collateral to the central bank, which would increase the demand for safe assets and affect their market rates.

Second, and relatedly, banks could try to stabilise deposits by increasing their remuneration or offering ancillary services. Unless banks become more efficient, this could compromise their profitability and, as above, reduce the supply of credit.

Third, banks might end up taking greater risks. They could try to earn higher returns to offset the reduction in deposits by accepting riskier assets in their balance sheets. With fewer depositors and less information about them, their risk assessment capacity could be harmed (ECB (2020)).

Fourth, in times of financial stress, depositors may have an incentive to run into CBDCs. As a direct claim on the central bank, the CBDC would offer a liquid alternative to deposits that could be perceived as safer. The risk of a bank run is not evident in all types of stressful events. In a currency or sovereign crisis, depositors and investors would normally run from all local assets, including a CBDC. Conversely, in a bank crisis, a run into the CBDC could be more likely.

None of these concerns is insuperable. Central banks could mitigate the potential negative effects on bank intermediation through various means. One is to impose limits on the holdings of CBDCs. To ensure users could accept payments even after the limit is reached, they could designate a private "waterfall" account to which all holdings surpassing the limit would be automatically transferred. Such an approach is currently followed by the Central Bank of The Bahamas.<sup>8</sup> A second option is through a tiered remuneration scheme under which less attractive interest rates or service fees are applied when individual holdings exceed the established threshold. Or, like cash, the CBDC might offer no remuneration at all.

To further mitigate the risk of runs to the CBDC, bank deposits should be covered by a solvent deposit insurance scheme. Additionally, the central banks could limit the commercial banks' ability to provide on-demand convertibility of deposits into CBDCs (although this could backfire by incentivising depositors to run even earlier). Finally, even if a run were to occur, it would likely be less damaging than what is currently possible through online transfers of funds to other banks or foreign assets,

<sup>8</sup> In The Bahamas, the mobile wallet that holds the Sand Dollar (the name given to the CBDC) has to be linked to deposit accounts at domestic financial institutions into which any excess holdings of the currency would have to be deposited. Similarly, and without exception, all wallets held by businesses have to be linked to established bank accounts. Because the ultimate goal of Project Sand Dollar is financial inclusion, individuals are still able to have mobile wallets without the need for a bank account, but with fewer functional capabilities.

since central banks could channel the liquidity from CBDC inflows back to commercial banks.

### Effects on capital flows

Depending on design, CBDCs could facilitate or accelerate capital movements from one country to the other in response to adverse shocks. If several central banks issue their own digital currency and allow them to be used in different jurisdictions, citizens could more easily shift their domestic currency denominated assets into the CBDC of a different country. This could put additional pressures on funding and solvency risk in dollarised economies.

As with the domestic financial stability risks discussed above, these risks can be mitigated. Central banks could limit the use of their CBDC only to residents and visitors to their jurisdiction, or limit the scope for converting domestic CBDCs into foreign CBDCs. Similarly, public authorities should adapt their regulations regarding investments in foreign assets to include CBDCs. Finally, cooperation among central banks in different jurisdictions could be used to limit capital flight and prevent runs into foreign CBDCs. These issues are addressed in BIS (2021) and discussed further below.

### Risk of overlaps between monetary and fiscal policy

The use of a CBDC to rapidly disburse funds to hard-to-reach individuals or locations could also become a potential risk if not properly managed. In particular, the divide between monetary and fiscal policy could become less clear-cut. Hence, it would have to be made explicit when the central bank is acting as an agent for the fiscal authority (eg fiscal transfers) and when it is acting on its own account (eg “helicopter money” infusions or applying different interest rates to different subjects).

## Challenges posed by foreign CBDCs and other digital currencies

In our discussion above, we have focused primarily on the benefits and costs of a central bank issuing its own CBDC. But, as noted above, central banks may also face challenges posed by the issuance of CBDCs by foreign central banks or by the issuance of private digital currencies (either by domestic or foreign parties). In this section, we flesh out some of the challenges briefly identified in the “Support monetary sovereignty” section above and discuss possible policy responses.

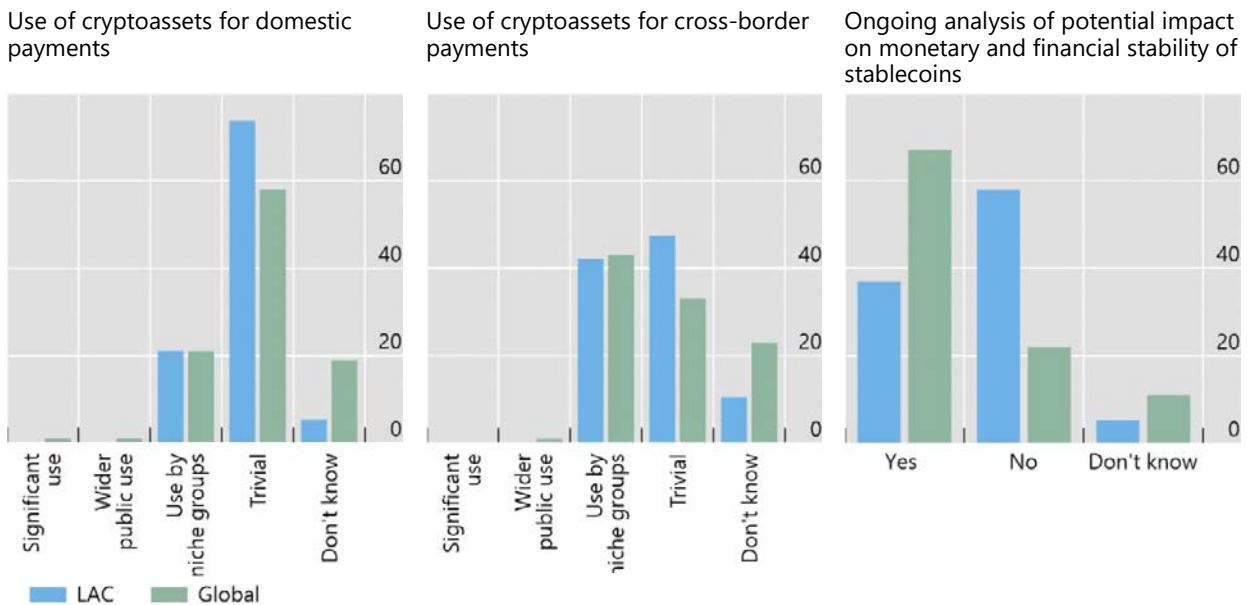
Before doing so, we revert back to the BIS survey on central bank interest in CBDCs and compare the responses of LAC central banks to those of central banks more generally to the final questions in the survey, regarding the use of private cryptoassets in their jurisdictions. On the first two questions, the use of cryptoassets for domestic and cross-border payments, the responses of LAC central banks were similar to those of the global sample: for both types of payments, cryptoassets were viewed as mainly used by niche groups, with little take-up by the general public (Graph 7, left-hand and centre panels). On the third question, LAC central banks appear to be devoting less effort to analysing the impact of stablecoins than central banks elsewhere (right-hand panel). However, this is not universally the case, as some

central banks in the region have indicated their interest in developing CBDCs to provide an alternative to the use of stablecoins in their jurisdiction. Moreover, competition from digital currencies, whether foreign CBDCs or private currencies, might emerge in other jurisdictions in the future.

## Private digital tokens<sup>1</sup>

Share of respondents

Graph 7



<sup>1</sup> Global results corresponds to the 65 countries answering the survey in 2020 for Boar, C and A Wehrli (2021): "Ready, Steady, Go", *BIS Working papers*, no 114.

Source: BIS central bank survey on CBDC.

## Risks from competing digital currencies

As identified in IMF (2020), BIS (2021), He (2021) and CPMI, BSIH, IMF and WB (2021), foreign CBDCs and private digital currencies may pose two related challenges to many central banks. The first is accelerating currency substitution – that is, the substitution of the foreign or digital currency for domestic currency. The second is reinforcing the volatility of capital flows – that is, capital flows may become more sensitive to economic and financial conditions, both at home and abroad. Both challenges might emerge because CBDCs and private digital currencies, depending on their configuration, may allow for greater accessibility and lower transaction costs, and may also flatten the multi-layered structure currently required for cross-border transactions. In turn, this would make it easier for users to switch out of domestic currency, to transact and hold saving in non-domestic currencies, and to transfer wealth abroad.

The difficulties posed by heightened currency substitution and capital flow volatility are well known: among other things, they interfere with the process of monetary transmission, making it more difficult for the central bank to control domestic financial and macroeconomic conditions. They may exacerbate financial instability, both by raising the likelihood of runs on the domestic banking system and by moving financial transactions out of the regulated sphere. And by reducing

demand for domestic currency, they reduce seigniorage. Also, the adoption of a foreign CBDC, combined with poor cooperation among tax authorities across jurisdictions, could expand the scope for tax evasion as it could allow individuals to quickly move their resources abroad.

The likelihood of these developments arising depends both on domestic considerations and on how the foreign CBDCs or private digital currencies are configured. On the domestic side, the most prominent factor will be the stability of the macroeconomic and financial environment. Countries with higher inflation, more volatile currencies, and more fragile financial systems may already experience some degree of currency substitution and capital flow volatility. The scope to move funds easily into digital currencies, foreign and/or private, could reinforce those tendencies. Similarly, countries with less secure bank deposits and more costly payments systems would seem more vulnerable to encroachment by non-domestic currencies.

But much depends as well on the configuration of the competing digital currencies. If the Federal Reserve, for example, were to issue CBDC accounts solely to residents of the United States, this might offer little incentive to substitute out of domestic currencies in LAC. Conversely, a token-based system of dollar CBDCs, readily stored and transacted around the world using smartphones, might offer large advantages over paper dollar currency and substantially accelerate the process of currency substitution in higher-inflation or unstable economies.<sup>9</sup>

The vulnerability of domestic economies to private digital currencies will also depend on their design, configuration and applicable regulation. Cryptoassets such as Bitcoin, which fluctuate widely in value and are inefficient for transactions, are unlikely to substantially replace domestic currencies for transactions and saving purposes. However, private stablecoins, if credibly pegged to safe assets and buttressed by a secure network of distribution and redemption, would be more likely to replace domestic currencies and/or make capital flows more sensitive to financial conditions. This would be the case as the stablecoins might be able to exploit the network externalities of the large customer base of the big tech companies, allowing a quick and widespread adoption that can reach global scale.

## Potential policy responses to competition from digital currencies

How should governments respond to competition from foreign CBDCs or private digital currencies? As noted above (Kiff et al (2020)), one response to such competition may be to issue one's own CBDC. Indeed, the heightened interest in CBDCs following Facebook's announcement in 2019 of its Libra (Diem) stablecoin speaks to such a motive.

Issuance of CBDCs may effectively counter the competition from other digital currencies if the primary motivation for adopting these other currencies is the ease, efficiency and convenience of financial transactions, and if the issuing central bank and government are believed to be pursuing credible macroeconomic and financial

<sup>9</sup> That said, the distinction between account-based and token-based CBDCs should not be exaggerated. There is not yet a universally accepted distinction between a token-based and account-based approach. "Tokens" in the computer science literature can also refer to an object that is transferred from one network node to another, so that tokens could be held in a wallet whose use requires some form of ID. In any case, for the end-user the difference between using an account-based CBDC and using a token-based one may not be noticeable. See eg Shah et al (2020).



policies. Given the mounting popularity of stablecoins and other cryptoassets, and well as the increasing demand for cashless payments in general, this could be a significant rationale for CBDCs in many jurisdictions.

For some economies, however, neither of these conditions hold. When inflation is high and macroeconomic conditions are uncertain, the motive for adoption of non-domestic digital currencies is likely to be currency substitution or capital flight. In these circumstances, if the central bank is not perceived as credible, its CBDC will not be considered sufficiently secure and desirable to dominate foreign CBDCs or private digital currencies, and hence will not suffice to protect the country's monetary sovereignty.

These considerations suggest that the first-best response to the threat of currency substitution from digital currencies is to implement or strengthen policy reforms that support monetary and financial stability. But that is a difficult and slow-acting process, and in any event, there would be many reasons for governments and central banks to pursue such reforms besides the threat from digital currencies.

To garner more immediate results, governments might consider regulatory action to limit or ban the encroachment of foreign CBDCs or private digital currencies. In fact, a recent survey to 50 central banks shows that although most jurisdictions currently have no restrictions on the use of foreign currency for domestic transactions, almost a third of responding central banks may reconsider their FX restrictions if there were widespread use of a foreign CBDC in their jurisdiction (Auer et al (2021a)).

Additionally, cooperation among central banks could prove critical to limiting flows of domestic assets into foreign CBDCs or private digital currencies. No central bank wants to undermine the monetary sovereignty of others. There is scope for central banks to jointly monitor flows into digital currencies and to work together on policy actions when that is necessary from the perspective of either the issuing or receiving economy.

How effective such actions might be will again depend on the design of these currencies and the ability of authorities to enforce limitations. For example, if foreign CBDCs are account-based, as is recommended by BIS (2021), cooperation with the foreign central bank may be used to exclude domestic residents from holding such accounts. Conversely, it may be more difficult to prevent the circulation of token-based foreign CBDCs and especially private stablecoins.

## CBDC work and currency substitution

Are central banks in jurisdictions with greater potential for currency substitution and capital flight more interested in CBDCs? To address this question, we re-estimated the ordered probit regressions described above, using as explanatory variables (in addition to per capita income) the rate of inflation, the rate of currency substitution, and a measure of holdings and use of cryptoassets.

Table 3 below shows how these data are distributed across the various global regions. As expected, inflation is lower in AEs, suggesting it will probably not be a good explanation for CBDC work. Also as expected, currency substitution, as measured by the share of deposits in foreign currency, is lowest in AEs and highest in LAC. Finally, a measure of cryptoasset use drawn from Chain Analysis Market Intelligence shows slightly higher values for AEs than for EMDEs.



## Descriptive statistics

Table 3

|  | Full sample | Advanced economies | Latin America and the Caribbean | Other EMEs (Other) |
|--|-------------|--------------------|---------------------------------|--------------------|
| Inflation <sup>1</sup>                             | 2.31        | 0.98               | 3.38                            | 2.76               |
| Share of deposits in foreign currency <sup>2</sup> | 31.00       | 17.00              | 40.95                           | 30.55              |
| Cryptoassets adoption <sup>3</sup>                 | 0.12        | 0.13               | 0.11                            | 0.12               |

<sup>1</sup> Median value. Data run from 2013 to 2020 <sup>2</sup> Ratio of foreign currency deposits to total deposits from E Levy Yeyati (2021). <sup>3</sup> Data for 2020. The Global Crypto Adoption Index is made up of three metrics: on-chain cryptocurrency value received, weighted by purchasing power parity (PPP) per capita; on-chain retail value received, weighted by PPP per capita; and peer-to-peer (P2P) exchange trade volume, weighted by PPP per capita and the number of internet users.

The probit results are shown in Table 4 below. As expected, despite the greater likelihood of currency substitution and capital flight in high-inflation economies, there is little evidence of a link between inflation and central bank work on CBDCs. The correlation between currency substitution itself and CBDC interest is also statistically insignificant. Finally, the regressions do indicate a significant correlation between cryptoasset adoption and central bank interest in CBDCs. However, it is unclear whether this correlation reflects that central banks are trying to thwart the competitive challenge of cryptoassets, or whether countries with greater interest in private digital currencies are naturally more interested in CBDCs as well.

## Ordered probits for central bank interest in CBDCs

Table 4

Log (per capita GDP) included as a covariate.

|                                       | Full dataset        | Advanced economies (AE) | Latin America and the Caribbean (LAC) | Other EMDEs         |
|---------------------------------------|---------------------|-------------------------|---------------------------------------|---------------------|
| Inflation                             | -0.000<br>(0.006)   | 0.282<br>(0.357)        | 0.007<br>(0.005)                      | -0.000**<br>(0.001) |
| Share of deposits in foreign currency | 0.150<br>(0.461)    | 0.660<br>(1.786)        | 0.228<br>(0.844)                      | 0.008<br>(0.607)    |
| Cryptoasset adoption                  | 2.836***<br>(0.587) | 2.01<br>(1.641)         | 1.271<br>(1.033)                      | 3.782***<br>(1.170) |

Standard errors in parenthesis. \*, \*\* and \*\*\* represent significance at 1%, 5% and 10% respectively.

## Design choices for CBDCs in LAC






As described above in the review of survey results, an unusual number of LAC central banks – five, or nearly a quarter of surveyed respondents – have developed pilot or more permanent CBDC arrangements. Ecuador introduced a CBDC in 2014, but it abandoned the experiment several years later as concerns about government policies and the safety of the new currency limited take-up by the public (Arauz et al (2021)). Uruguay introduced a pilot project in 2018 that was deemed a technical success, although there are no immediate plans to follow up with a more permanent

arrangement (Sarmiento (2021)). More recently, three Caribbean central banks have implemented standing CBDC arrangements (Bahamas, Eastern Caribbean) or pilot arrangements (Jamaica).<sup>10</sup>

It would be premature at this point to evaluate the central banks' experiences with CBDCs, especially those of the Caribbean jurisdictions. However, it may be useful to discuss the choices made by these central banks in the design of their CBDCs. In designing a CBDC, a central bank has important choices to make, reflecting not only its primary motivations for creating the CBDC but also the specific characteristics of its financial system (Auer and Boehme (2020)). These choices often involve trade-offs that are not always clear and may therefore benefit from the experience of earlier adopters. Table 5 below describes the main design choices that LAC central banks have made.

Features of major CBDC projects in Latin America and the Caribbean

Table 5

|                      | Ecuador<br> | Uruguay<br> | The Bahamas<br> | East Caribbean<br> | Jamaica<br> |
|----------------------|--|--|--|--|--|
| Architecture         | Direct <sup>1</sup>  | Hybrid   | Hybrid <sup>2</sup>  | Hybrid <sup>3</sup>  | Hybrid <sup>4</sup>  |
| Infrastructure       | Centralised  | Centralised  | DLT and Centralised  | DLT  | Centralised  |
| Cross-border use     | National use only  | National use only  | National use only  | Use by EC residents only   | National use only  |
| Offline use          | Available  | Available  | Possible <sup>5</sup>  | Possible <sup>6</sup>  | Possible   |
| Users' personal data | Held on the central bank platform  | Anonymous but traceable  | Can be accessed only by user's wallet provider   | Can be accessed only by user's financial institution   | Can be accessed only by user's wallet provider   |
| Transaction registry | Held on the central bank platform  | Managed by a private company   | Central bank keeps the ledger of all individual transactions and holdings                        | Held on the blockchain   | Central bank can access retail ledger but not the user's identity                              |
| Current status       | Operated between 2014 and 2018   | Pilot concluded in April 2018  | Live CBDC  | Live CBDC  | Pilot concluded in December 2021. Rollout planned for 2022                                     |

<sup>1</sup> Central bank handles the retail payments and digital wallets. <sup>2</sup> Central bank maintains the ledger of all individual holdings of the digital currency; private providers of digital wallets onboard clients and perform KYC procedures. <sup>3</sup> The CBDC is issued to financial institutions, and they distribute it to their customers on demand. <sup>4</sup> The Bank of Jamaica will issue to commercial banks as well as authorised deposit-taking institutions, building societies, merchant banks and payment service providers (PSPs). These entities will distribute CBDCs to the retail market. The central bank will only have the wholesale ledger of transactions. <sup>5</sup> Users can make pre-set payments when the network in the island is down and wallets update against the network once communications are re-established. <sup>6</sup> The party initiating the payment must have an internet connection. If the receiver is offline, the payment will be still processed and the balances would be updated as soon as they are back online.

Sources: Central banks; A Arauz, R Garatt and D Ramos, "Dinero Electrónico: The rise and fall of Ecuador's central bank digital currency", *Latin American Journal of Central Banking*, vol 2, issue 2, June 2021; R Auer, G Cornelli and J Frost, "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS Working Papers*, no 880, August 2020, as updated in October 2021.

A first choice concerns the architecture – that is, the nature of the claims and the respective operational roles of central banks and private institutions in handling transactions (eg payment initiation, record-keeping, onboarding, KYC procedures,

<sup>10</sup> See Prasad (2021) for a more detailed discussion of the CBDC initiatives in Ecuador, Uruguay, and The Bahamas.

customer services). All central banks but one that have issued a CBDC in the region have focused on some form of hybrid approach (Table 5). In the case of The Bahamas' Sand Dollar, commercial banks and other PSPs provide and manage mobile wallets, while the central bank provides the infrastructure and the regulatory framework. Similarly, in the case of Eastern Caribbean's DCash, financial institutions perform onboarding and KYC procedures for most clients. Furthermore, citizens without a traditional bank account can open a basic digital wallet using only their national ID and an email address. Such basic accounts have less stringent KYC requirements but also stricter holding limits (see below). In the case of Ecuador's now defunct CBDC, the currency was offered directly by the central bank with the explicit goal of promoting financial inclusion.

A second choice is about the features a CBDC should have to minimise the potential adverse impact on bank intermediation (cost, quantity and volatility of funding) and financial stability (potential for exacerbating runs) discussed above. To limit competition with bank deposits, The Bahamas and the Eastern Caribbean Central Bank have issued non-interest bearing currencies and established both transaction and holding limits to CBDC accounts. In The Bahamas, these limits depend on whether the account holder is a business or an individual and whether the individual is banked or not.<sup>11</sup> In the Eastern Caribbean, transaction and holding limits vary according to the KYC profile of each client as well as anti-money laundering (AML) and combating the financing of terrorism (CFT) regulations.<sup>12</sup>

A third choice is about how users access the CBDC. A first option is to tie ownership of the CBDC to an identity scheme ("account based"). A second option is to permit access when the CBDC user demonstrates knowledge of an encrypted value ("token based"). Regardless of the approach chosen, central banks also need to decide the degree of data privacy and anonymity offered to users. As noted above, this issue is especially thorny in LAC, as informality rates and the use of physical cash are generally higher than in other EMEs. In addition, the fraction of consumers willing to share their data with financial institutions, fintechs or non-financial services companies is below the global average. To protect consumers' data and privacy against improper use by the central banks, in the CBDC arrangements adopted by The Bahamas, Jamaica and the Eastern Caribbean, the central bank holds the ledger of transactions, but only the financial institution that verifies the client's identity has access to the client's personal data.<sup>13</sup>

A fourth choice is about the infrastructure – in particular, whether the CBDC should be implemented using a conventional centrally controlled database or distributed ledger technology (DLT). In principle, by its distributed nature, the latter

<sup>11</sup> In The Bahamas, businesses can hold total balances up to the greater of \$8,000 or 5% of their annual sales receipts, subject to a maximum ceiling of \$1 million, with unlimited annual transactions. Individuals can access two types of wallets. One is available for the unbanked population and is not tied to any bank account. It is capped at \$500, with a \$1,500 monthly transaction limit. The other is linked to a bank account to which any excess CBDC is automatically transferred (a "waterfall" account). It is capped at \$8,000, with a \$10,000 monthly transaction limit.

<sup>12</sup> Merchants can have three types of wallets based on their financial size. Class A wallets have a 300,000 Dcash limit; Class B wallets 150,000; and Class C wallets 25,000.

<sup>13</sup> The Bank of Jamaica has recently clarified that wallet providers cannot share users' identity and personal information with the Bank of Jamaica or any other authority due to customers' confidentiality and data protection. This information can only be shared under a court order. However, the Bank of Jamaica can track individual flows (without knowing the user identity).

could offer greater resilience. It can also provide greater interoperability with private sector solutions based on similar technologies. However, many DLT solutions have limited scalability due to the time needed to validate a transaction. This is particularly severe for permissionless DLT, of the type used by Bitcoin, which to date can only process a few tens of thousands of transactions per minute.<sup>14</sup> No central bank is known to be considering permissionless DLT for a CBDC. Instead, they are looking at permissioned DLT, where transactions can only be validated by trusted parties.<sup>15</sup> Moreover, there may be means to combine decentralisation and trusted parties. For example, in The Bahamas, the Sand Dollar uses a DLT layer, where all transactions are recorded, and a centralised infrastructure where the settlement occurs. Other central banks are using conventional centralised infrastructures, which can be designed to offer many of the same functions (programmability, instant settlement, resilience) but based on a trusted central party. Regardless of the specific choice, central banks need to have the necessary know-how, for both implementation and daily operations, and resources, to limit any diversion from other valuable activities.

A fifth choice is whether the CBDC should be made available – now or in the future – to non-residents. As noted above, allowing non-residents to access CBDCs could reduce the cost and complexity of cross-border payments. However, a possible downside is that they may make it easier for users to switch out of the domestic currency, hold savings in non-domestic currencies, and transfer wealth abroad, which may also expand the scope for tax evasion. Central banks could reduce these risks by requiring identification of users as well as imposing restrictions on access to non-residents. But for the time being, all countries in the region have opted for the more cautious approach of limiting CBDC holdings to residents alone.

Once design choices are made, an important issue is to ensure that the public be fully informed about the CBDC through public campaigns, especially in countries where the public has a low level of trust in their institutions. One of the main reasons why the Central Bank of Ecuador ultimately discontinued Dinero Electrónico (DE) was the population's deep-seated distrust about the true reasons for its creation. Some feared that the digital currency would evolve into a new sovereign currency, leading to de-dollarisation and monetary instability, while others argued that DE would become a government surveillance mechanism (Arauz et al, 2021).

<sup>14</sup> Distributed ledger technology (DLT) allows the same information or ledger to be recorded at multiple locations or institutions, also called nodes. Unlike with a centralised database, there is no central administrator or single trusted party. Instead, the same copy of the ledger can be accessed and modified by each node. To ensure that different copies of the ledger record each transaction in a truthful and accurate manner, DLT relies on a set of rules or protocol stating how transactions are verified and written and what to do when copies of the ledger are not consistent with each other. Given the lack of a central authority, a consensus needs to be reached among various nodes for a new transaction to be considered valid. Furthermore, the rules need to be specified in a way that it is in the interest of the nodes to follow them. This generally means that each node receives a reward for participating in the validation process and doing so honestly.

<sup>15</sup> Auer et al (2021b) analyse the conditions under which decentralised designs are preferable to a centralised one.

## References

- Alfonso, V, A Tombini and F Zampolli (2020): "Retail payments in Latin America and the Caribbean: present and future," *BIS Quarterly Review*, December.
- Arauz, A, R Garratt and D Ramos (2021): "Dinero Electrónico: The rise and fall of Ecuador's central bank digital currency", *Latin American Journal of Central Banking*, vol 2, issue 2, June.
- Auer, R, C Boar, G Cornelli, J Frost, H Holden and A Wehrli (2021): "CBDCs beyond borders: results from a survey of central banks", *BIS Papers*, no 116, June.
- Auer, R and R Boehme (2021): "Central bank digital currency: the quest for minimally invasive technology", *BIS Working Papers*, no 948, June.
- Auer, R, G Cornelli and J Frost (2020): "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS Working Papers*, no 880, August.
- Auer, R, P Haene and H Holden (2021a): "Multi-CBDC arrangements and the future of cross-border payments", *BIS Papers*, no 115.
- Auer, R, C Monnet and HS Shin (2021b): "Distributed ledgers and the governance of money", *BIS Working Papers*, no 924.
- Bank for International Settlements (2019), "Big tech in finance: opportunities and risks", *Annual Economic Report*, Chapter III, June.
- Bank for International Settlements (2021), "CBDCs: an opportunity for the monetary system", *Annual Economic Report*, Chapter III, June.
- Barontini, C and H Holden (2019): "Proceeding with caution - a survey on central bank digital currency", *BIS Papers*, no 101, February.
- Boar, C, H Holden and A Wadsworth (2020): "Impending arrival – a sequel to the survey on central bank digital currency", *BIS Papers*, no 107, January.
- Boar, C and A Wehrli (2021): "Ready, steady, go? – results of the third BIS survey on central bank digital currency", *BIS Papers*, no 114, January.
- Carstens, A (2019): "The future of money and payments", speech at the Central Bank of Ireland, Whitaker Lecture, Dublin, 22 March, <https://www.bis.org/speeches/sp190322.pdf>
- Chainalysis (2020): "The 2020 Geography of Cryptocurrency Report. Analysis of Geographic Trends in Cryptocurrency Adoption and Usage", September.
- Committee on Payments and Market Infrastructures (CPMI) (2021): "Application of the Principles for Financial Market Infrastructures to stablecoin arrangements", *CPMI Papers*, no 198, October.
- Committee on Payments and Market Infrastructures (CPMI) (2021): "Covid-19 accelerated the digitalisation of payments", *Red Book Statistics*, December
- Committee on Payments and Market Infrastructures (CPMI), BIS Innovation Hub (BSIH), International Monetary Fund (IMF) and the World Bank (WB) (2021): "Central bank digital currencies for cross-border payments", Report to the G20, July.
- Consultative Group on Innovation and the Digital Economy (CGIDE) (2020): "Enabling open finance through APIs", *BIS Other Publications*, 8 December.

Consultative Group on Innovation and the Digital Economy (CGIDE) (2021): "Enabling open finance through APIs: report on payment initiation", *BIS Other Publications*, 29 September.

European Central Bank (2020): *Report on a digital euro*, October.

Financial Stability Board (FSB) (2020): *Enhancing Cross-border Payments – Stage 1 assessment report to the G20*, April.

Frost, J, L Gambacorta, Y Huang, HS Shin and P Zbinden (2019): "BigTech and the changing structure of financial intermediation", *BIS Working Papers*, no 779, April.

Global Cyber Security Capacity Centre (2021): *Cybersecurity capacity maturity model for nations*, March, <https://gcsc.ox.ac.uk/the-cmm>

Global System for Mobile Communications Association (GSMA) (2020): "The Mobile Economy Latin America 2020".

Group of Central Banks (2020): "Central Bank Digital Currencies: Foundational Features and Core Features", *BIS Other Publications*, October.

Group of Seven (G7) (2021): "Public Policy Principles for Retail Central Bank Digital Currencies (CBDCs)", October.

He, D (2021): "Digitalization of cross-border payments," *China Economic Journal*, Vol 14, no 1, pp 26–38, January.

Inter-American Development Bank (2020): "Cybersecurity risks, progress, and the way forward in Latin America and the Caribbean", 2020 Cybersecurity Report.

International Monetary Fund (2020): "Digital money across borders: macro-financial implications," *IMF Policy Paper* no 2020/050, October.

Khiaonarong, T and D Humphrey (2019): "Cash use across countries and the demand for central bank digital currency", *IMF Working Paper* WP/19/46, March.

Kiff, J, J Alwazir, S Davidovic, A Farias, A Khan, T Khiaonarong, M Malaika, H Monroe, N Sugimoto, H Tourpe and P Zhou (2020): "A survey of research on retail central bank digital currency", *IMF Working Paper* no 20/104, June.

Levy-Yeyati, E (2021): "Financial dollarization and de-dollarization in the new millennium," *Latin America Reserve Fund Working Paper*.

Mancini-Griffoli, T, M S Martinez, I Agur, A Ari, J Kiff, A Popescu and C Rochon (2018): "Casting Light on Central Bank Digital Currency," *IMF Staff Discussion Note* SDN/18/08.

Maniff, J and P Wong (2020): "Comparing means of payment: what role for a central bank digital currency?", *Fed Notes*, 13 August.

Prasad, E (2021): *The future of money. How the digital revolution is transforming currencies and finance*. The Belknap Press of Harvard University Press.

Riksbank (2020): "E-krona", <https://www.riksbank.se/en-gb/payments--cash/e-krona/>

Sarmiento, A (2021): "Seven lessons from the e-Peso pilot plan: the possibility of a central bank digital currency", Presentation for CEMLA.

Shah, D, R Arora, H Du, S Darbha, J Miedema and C Minwalla (2020): "Technology approach for a CBDC", *Bank of Canada Staff Analytical Note* no 2020-6, February.

## Annex 1: Drivers of CBDC interest

### Differences in drivers

Table A1

|  | LAC (-) Advanced Economies | LAC (-) Other EMDEs |
|--|----------------------------|---------------------|
| Score index overall                                  | -0.25                      | 0.12                |
| Score index retail                                   | -0.11                      | 0.20                |
| Score index wholesale                                | -0.36**                    | -0.13               |
| Central bank speech <sup>1</sup>                     | -0.09                      | -0.05               |
| Search interest <sup>2</sup>                         | -1.23***                   | -0.17               |
| Account ownership                                    | -42.87***                  | -0.31               |
| Broadband subscriptions (fixed line, per 100 people) | -20.70***                  | 3.33                |
| Government effectiveness                             | -1.41***                   | 0.16                |
| Mobile cellular subscriptions (per 100 people)       | -11.97*                    | 5.72                |
| Remittances to GDP                                   | 5.32**                     | 0.94                |
| Innovation output score (WIPO)                       | -20.78***                  | -1.74               |
| Trade openness                                       | -17.84**                   | -19.85**            |
| Shadow economy (% of GDP)                            | 20.67***                   | 5.98**              |
| Financial development index                          | -0.40***                   | 0.00                |
| Fast payment systems                                 | -0.47***                   | 0.07                |
| Ln (GDP per capita)                                  | -1.38***                   | 0.61***             |

\*,\*\* and \*\*\* indicate significance at 10%, 5% and 1% respectively.

<sup>1</sup> Data have been normalised and winsorised at 5%. <sup>2</sup> Data have been normalised.

## Annex 2: Regression results with LAC interaction dummies

Table A2 reports the results of ordered probit regressions, similar to those shown in Table 2, relating the probability that the CBDC project index in a jurisdiction equals 0, 1, 2 or 3 to the value of a particular indicator. Each regression is estimated on the full dataset of jurisdictions, and includes the following explanatory variables: the log of GDP per capita, a specific explanatory variable (eg mobile cellular subscriptions), a dummy variable equal to 1 if the jurisdiction is in LAC and 0 otherwise, and an interaction term equal to the explanatory variable multiplied by the LAC dummy. For each regression, Table A2 shows the estimated coefficient for the explanatory variable, the dummy and the interaction term. The coefficient on the explanatory variable itself measures its effect on the CBDC project index in all jurisdictions outside of LAC. The coefficient on the interaction variable measures that additional effect (positive or negative) of the explanatory variable in LAC jurisdictions.

As may be seen, for the regions outside LAC (AE and other EMDEs) the coefficients are generally statistically significant (broadband subscriptions, innovation, fast payment systems, government effectiveness, financial account ownership, financial development, search interest, and remittances). However, as indicated by the coefficients on the interaction terms, these effects are in most cases considerably smaller in the LAC jurisdictions. This reinforces the idea that differences among LAC central banks regarding their interest in CBDCs might not be driven primarily by differences in economic and financial situation.



## Ordered probit coefficients for central bank interest in CBDCs

Table A2

| Digital infrastructure                     | Log (per capita GDP) included as covariate,<br>dummy for LAC and interactions terms | Sample size |
|--|---|-------------|
| <b>Digital infrastructure</b>              |   |             |
| Mobile cellular subscriptions              | 0.004   | 163         |
| Region= LAC                                | 1.578   |             |
| Interaction LAC                            | -0.013  |             |
| Broadband subscriptions                    | 0.014   | 162         |
| Region= LAC                                | 0.405   |             |
| Interaction LAC                            | -0.024  |             |
| <b>Innovation capacity</b>                 |   |             |
| Innovation output score (WIPO)             | 0.054***  | 133         |
| Region= LAC                                | 2.952   |             |
| Interaction LAC                            | -0.084  |             |
| Fast payments system                       | 0.906***  | 165         |
| Region= LAC                                | 0.55  |             |
| Interaction LAC                            | -1.079*   |             |
| <b>Institutional characteristics</b>       |   |             |
| Government effectiveness                   | 0.700***  | 165         |
| Region= LAC                                | 0.292   |             |
| Interaction LAC                            | -0.643  |             |
| Informal economy                           | 0.009   | 119         |
| Region= LAC                                | -0.976  |             |
| Interaction LAC                            | 0.025   |             |
| <b>Development and financial inclusion</b> |   |             |
| Account ownership                          | 0.012**   | 133         |
| Region= LAC                                | -0.417  |             |
| Interaction LAC                            | 0.012   |             |
| Financial development index                | 4.036***  | 151         |
| Region= LAC                                | 0.944   |             |
| Interaction LAC                            | -1.199  |             |
| <b>Public interest in CBDCs</b>            |   |             |
| Search interest index                      | 0.453***  | 165         |
| Region= LAC                                | 0.744   |             |
| Interaction LAC                            | -0.977  |             |
| <b>Cross-border transactions</b>           |   |             |
| Remittances to GDP                         | -0.086**  | 109         |
| Region= LAC                                | -0.625  |             |
| Interaction LAC                            | 0.119***  |             |
| Trade openness                             | -0.005  | 154         |
| Region= LAC                                | 0.543   |             |
| Interaction LAC                            | -0.008  |             |

\*, \*\* and \*\*\* indicate significance at 10%, 5% and 1% respectively.

## Annex 3: Countries included in the econometric exercises

### Advanced economies

- Australia
- Austria
- Belgium
- Canada
- Cyprus
- Denmark
- Estonia
- Euro Area
- Finland
- France
- Germany
- Greece
- Finland
- France
- Germany
- Greece
- Ireland
- Italy
- Japan
- Lithuania
- Luxembourg
- Malta
- Netherlands
- New Zealand
- Norway
- Portugal
- Slovenia
- Spain
- Sweden
- Switzerland
- United Kingdom
- United States

### Latin America and the Caribbean

- Argentina
- Aruba
- Bahamas
- Barbados
- Belize
- Bermuda
- Bolivia
- Brazil
- Cayman Islands
- Chile
- Colombia
- Costa Rica
- Cuba
- Dominican Republic
- Eastern Caribbean
- Ecuador
- El Salvador
- French Guiana
- Guatemala
- Guyana
- Haiti
- Honduras
- Jamaica
- Mexico
- Nicaragua
- Panama
- Paraguay
- Peru
- Suriname
- Trinidad and Tobago
- Uruguay
- Venezuela

### Other Emerging Market and Developing Economies

- Albania
- American Samoa
- Bahrain
- Belarus
- Bosnia and Herzegovina
- Brunei Darussalam
- Bulgaria
- Cabo Verde
- Croatia
- Czechia
- Djibouti
- Egypt
- Eritrea
- Fiji
- Gambia
- Greenland
- Hungary
- Iceland
- Iran

- Iraq
- Israel
- Kiribati
- North Korea
- Latvia
- Macao
- Macedonia
- Maldives
- Moldova (the Republic of)
- Nauru
- Niue
- Papua New Guinea
- Poland
- Réunion
- Romania
- Russian Federation
- Samoa
- Saudi Arabia
- Serbia
- Seychelles
- Slovakia
- Solomon Islands
- South Africa
- Swaziland
- Tonga
- Turkey
- Tuvalu
- Ukraine
- United Arab Emirates
- Vanuatu
- Algeria
- Botswana
- Comoros
- Economic Community of Central African States
- Ethiopia
- Ghana
- Guinea
- Kenya
- Lesotho
- Liberia
- Lybia
- Madagascar
- Malawi
- Mauritania
- Mauritius
- Morocco
- Mozambique
- Namibia
- Nigeria
- Sierra Leone
- Somalia
- South Sudan
- Sudan
- Tanzania
- Tunisia
- Uganda
- West African Economic and Monetary Union
- Zambia
- Zimbabwe
- Afghanistan
- Armenia
- Azerbaijan
- Bangladesh
- Bhutan
- Cambodia
- China
- Georgia
- Hong Kong
- India
- Indonesia
- Jordan
- Kazakhstan
- Korea
- Kuwait
- Kyrgyzstan
- Lao People's Democratic Republic
- Lebanon
- Malaysia
- Mongolia
- Myanmar
- Nepal
- Oman
- Pakistan
- Philippines (the)
- Qatar
- Singapore
- Sri Lanka
- Syrian Arab Republic
- Taiwan (Province of China)
- Tajikistan
- Thailand
- Turkmenistan
- Uzbekistan
- Viet Nam
- Yemen

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