Rise of the central bank digital currencies: drivers, approaches, and technologies

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*The views are those of the authors and not necessarily the Bank for International Settlements

The rise of CBDC: drivers, approaches, and technologies

- Global interest in CBDCs is mounting

- But substantial heterogeneity across countries
  - some central banks are looking into CBDC development, others see no need
  - among those researching and developing CBDCs, both approaches and designs differ

- **In this paper, we:**
  - **construct a database of CBDC projects, speeches and search interest***
  - **discuss how and why central banks' approaches and technologies differ**
  - **assess the economic and institutional factors behind these differences**

*see https://www.bis.org/publ/work880.htm, updated as of April 2021.

Our findings in a nutshell

- Central banks' speech stance toward CBDCs has turned more positive in the past two years, ever more are embarking on projects and two central banks have issued live retail CBDCs
- CBDC projects are more likely:
  - in countries with higher mobile use and innovation capacity
  - (for retail CBDCs) where the informal economy is larger
- Heterogeneity in approaches and designs across countries (architecture, infrastructure, access, interlinkages of retail CBDC projects)
- Common elements: central banks generally see CBDCs as a complement to cash, and many are exploring designs where the private sector handles all customer-facing activity

I. A new database on CBDCs

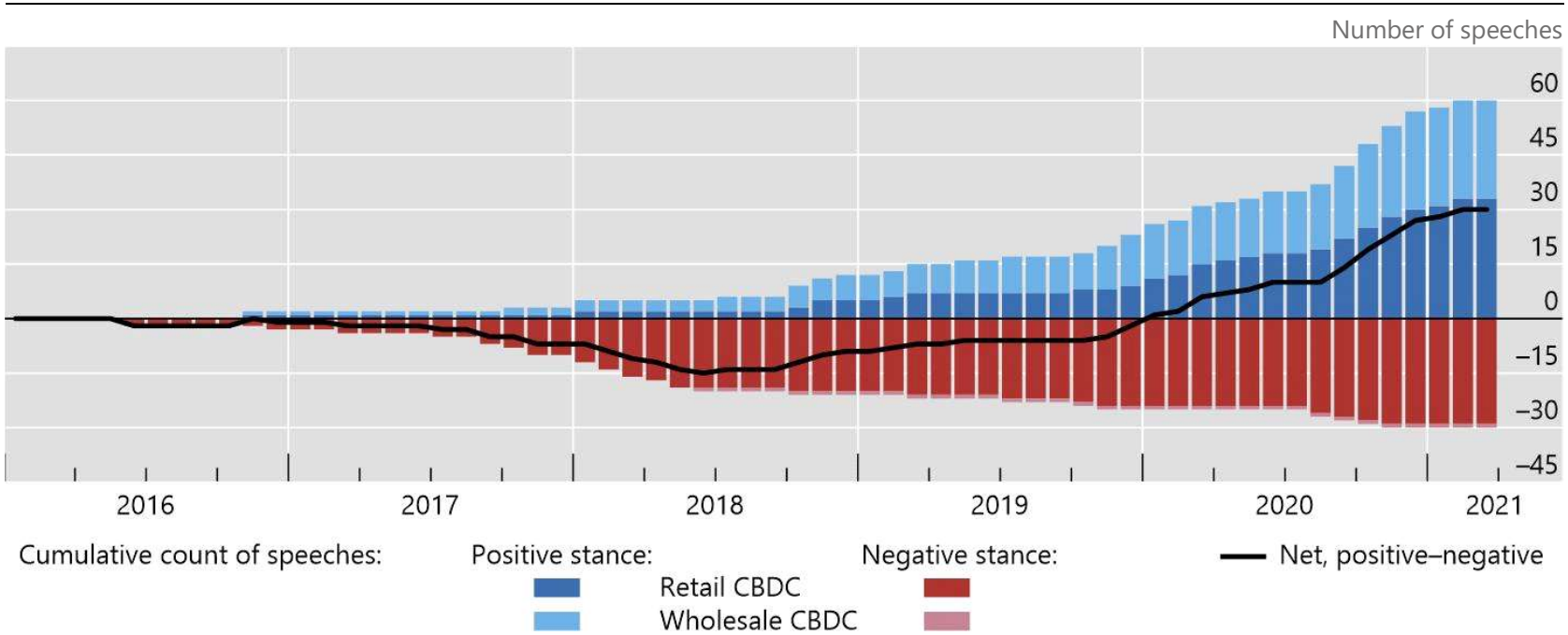
Three sources of information on CBDCs by country

- Projects and design approaches (cross-section)
  - Reports by central banks on retail and wholesale CBDC research and pilots
  - Only official reports, not rumours
  - (For retail) technical characteristics: architecture, infrastructure, access, and interlinkages

- Central bank speeches (2013-2020)
  - Universe of BIS speeches
  - Search for keywords related to CBDCs / digital currencies
  - Measure stance – positive or negative

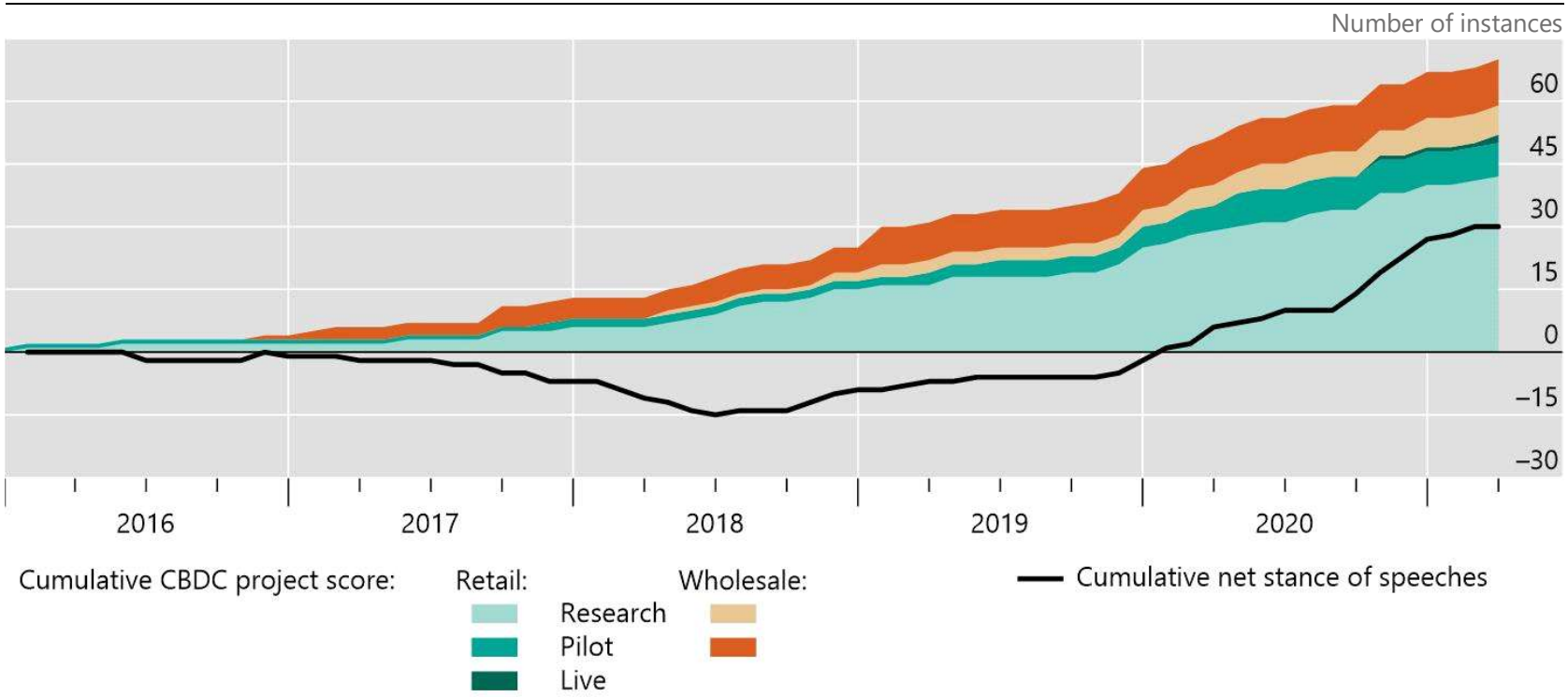
- General search interest, as measured by Google Trends and Baidu Trends (cross-section)

Speeches on CBDCs have turned more positive since late 2018



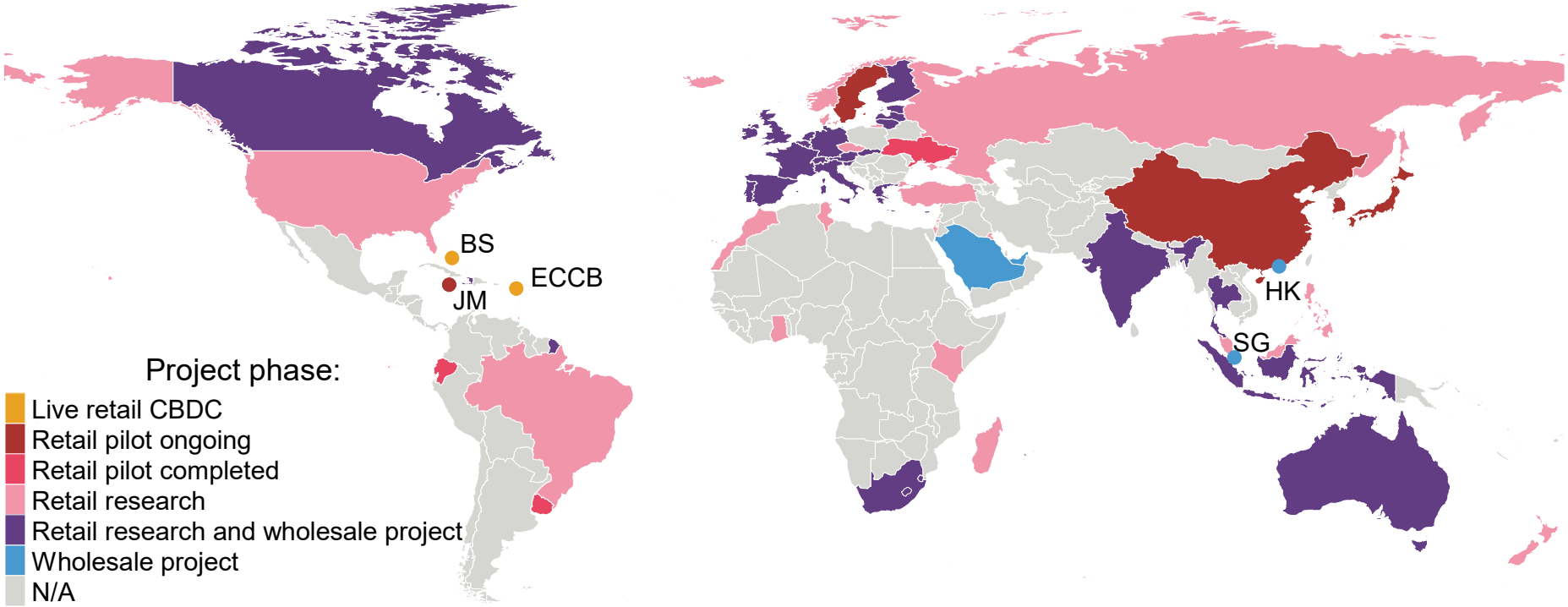
Source: R Auer, G Cornelli and J Frost (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS working papers*, No 880, August.

A growing number of retail and wholesale CBDC projects



Sources: R Auer, G Cornelli and J Frost (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS working papers*, No 880, August; central banks' websites.

CBDC research, pilots and live CBDCs around the globe



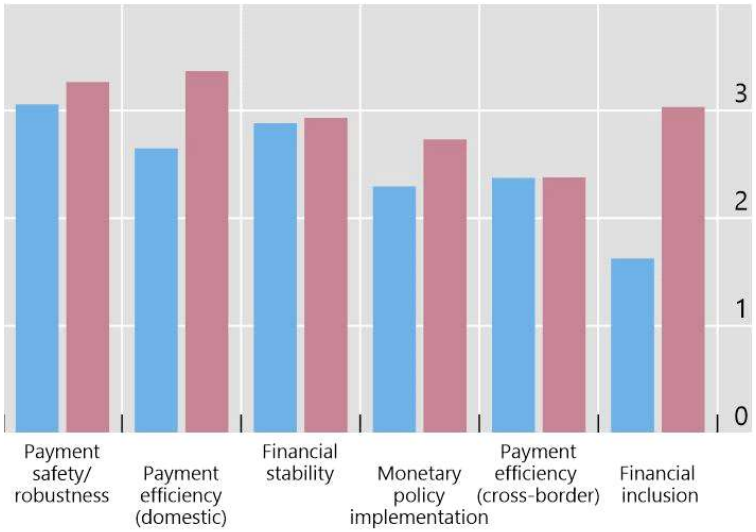
BS = The Bahamas; ECCB = Eastern Caribbean Central Bank; HK = Hong Kong SAR; JM = Jamaica; SG = Singapore. The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area.

Source: R Auer, G Cornelli and J Frost (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS working papers*, No 880, August.

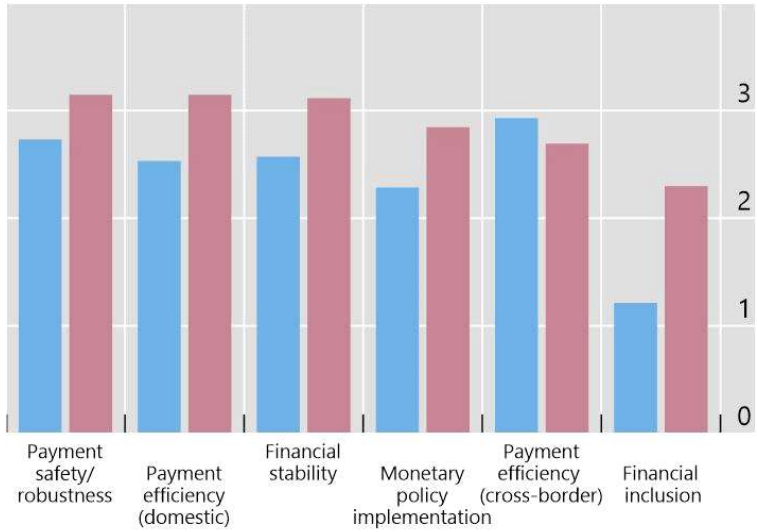
II. The drivers of CBDC projects

Motivations for issuing a CBDC

General purpose (retail) CBDC



Wholesale CBDC



Average importance: AEs EMEs

1 = not so important; 2 = somewhat important; 3 = important; and 4 = very important.

Source: CPMI survey of central banks; Boar et al (2020).

CBDC project index

- To gauge the status of CBDCs, we generate a CBDC project index

- Three breakdowns:
  - **Overall project index:** 0=no announced project, 1=research, 2=pilot, 3=live CBDC
  - **Retail project index:** 0=no announced retail project, 1=research on retail CBDC, 2=retail CBDC pilot, 3=live retail CBDC
  - **Wholesale project index:** 0=no announced retail project, 1=research on wholesale CBDC, 2=wholesale CBDC pilot, 3=live wholesale CBDC

- The overall project scores takes the maximum value of retail and wholesale CBDC projects

Which variables could explain CBDC research and development?

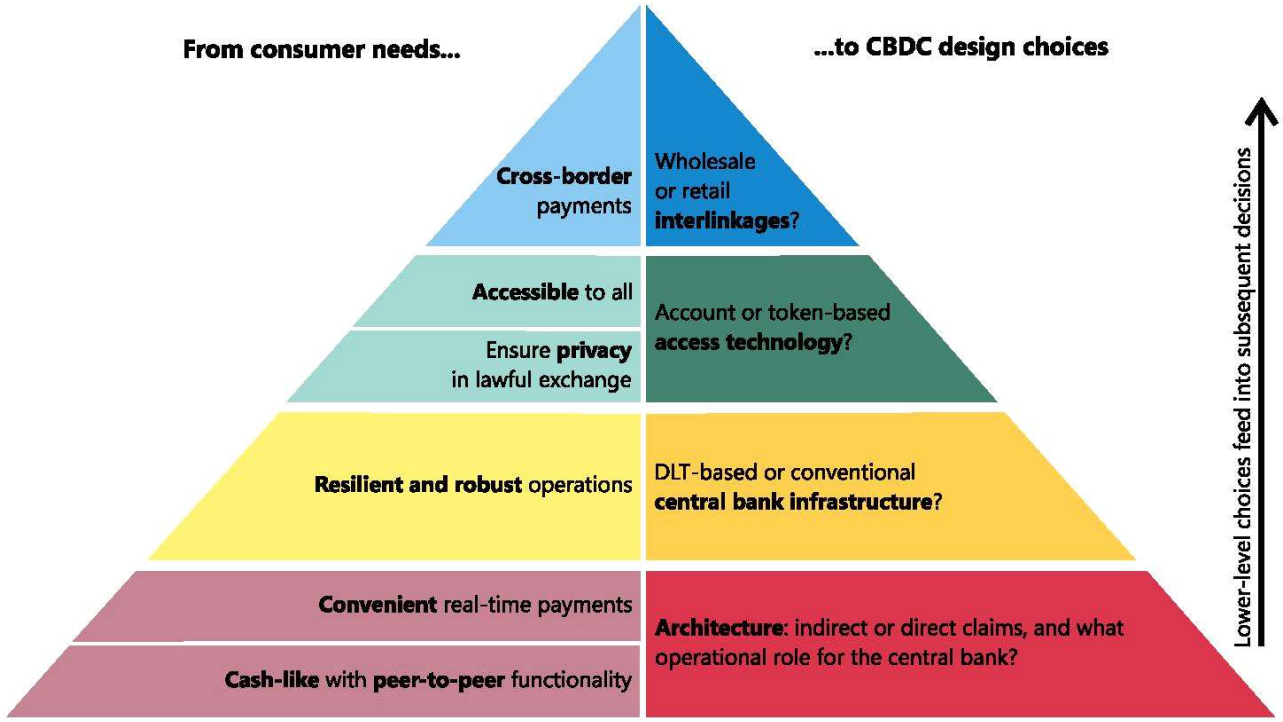
	Observations	Mean	Standard deviation	Min	Max
Dependent variables					
Overall CBDC project index	175	0.31	0.66	0	2
Retail CBDC project index	175	0.22	0.53	0	2
Wholesale CBDC project index	175	0.13	0.48	0	2
Independent variables					
Mobile cellular subscriptions (per 100 people)	169	109.24	39.54	12.60	320.55
Broadband subscriptions (fixed line, per 100 people)	167	13.60	13.38	0	47.16
Innovation output score (WIPO)	118	29.67	12.69	7.90	67.13
Fast payment system dummy	175	0.37	0.48	0	1
Government effectiveness	175	0.08	0.99	-2.24	2.19
Informal economy (% of GDP)	122	26.08	11.62	5.43	55.78
GDP per capita (USD)	168	16,652	21,423	301	110,344
Account ownership (% age 15+)	135	60.39	27.96	6.45	99.96
Financial development index[2]	158	0.36	0.22	0.06	0.93
Search interest index (Google/Baidu)[3]	175	0.11	1.13	–0.34	8.18
Remittances[4] to GDP	110	5.89	7.86	0.19	41.18
Trade openness[5]	134	80.05	48.87	0	345.69
Central bankers' speech stance index[7]	175	0.02	0.47	–0.13	1.68

Multivariate ordered probit regressions on CBDC project indices

	Overall CBDC project index		Retail CBDC project index		Wholesale CBDC project index	
Mobile cellular subscriptions	0.013**	0.015***		0.011**		0.022**
(per 100 people)	(0.005)	(0.006)		(0.005)		(0.010)
Innovation output score	0.045***		0.067***	0.082***		
(WIPO)	(0.010)		(0.017)	(0.019)		
Informal economy		0.027*	0.033*	0.042***		-0.009
(% of GDP)		(0.015)	(0.018)	(0.016)		(0.026)
Financial development		3.909***			3.303***	4.287***
Index[2]		(0.867)			(0.775)	(1.299)
Trade openness[3]		-0.003		-0.016**	0.004*	-0.001
		(0.004)		(0.007)	(0.003)	(0.004)
Number of observations	118	105	110	100	132	105
Pseudo R^2	0.167	0.241	0.144	0.244	0.263	0.352

III. Comparing technical designs

The CBDC pyramid

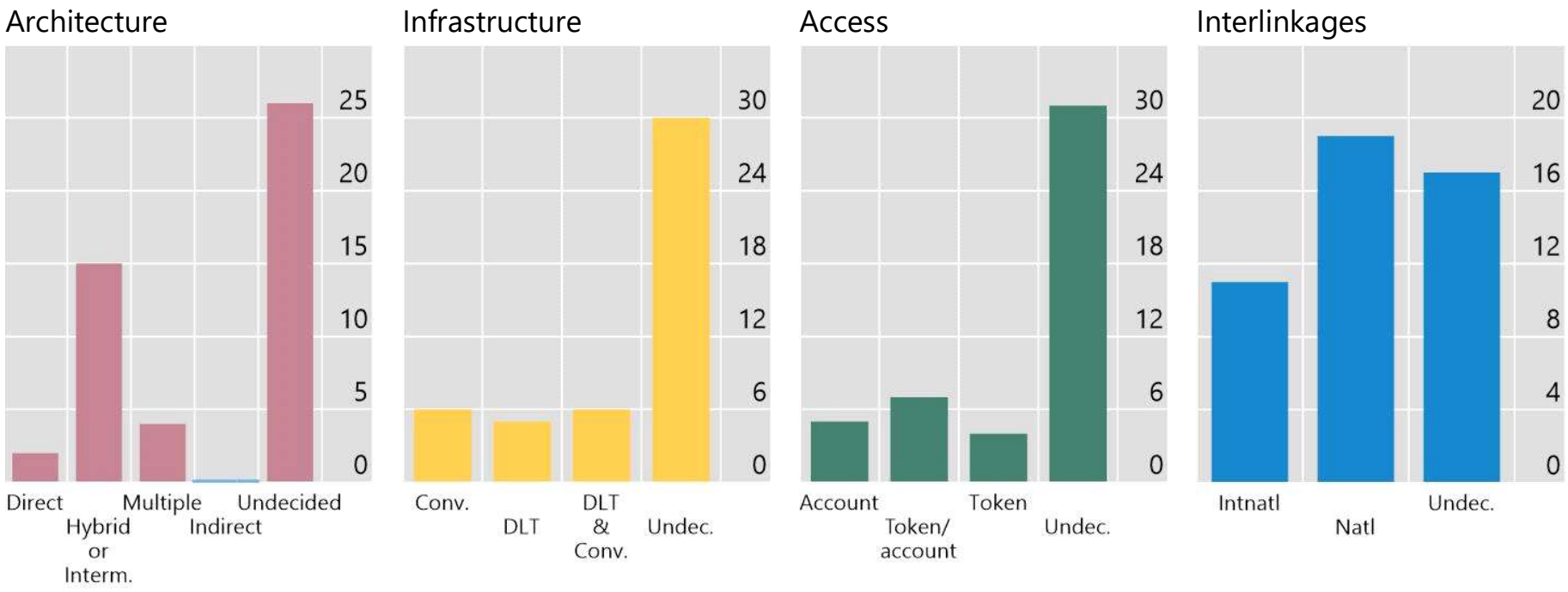


The CBDC pyramid maps consumer needs onto the associated design choices for the central bank. The left-hand side of the CBDC pyramid sets out such consumer needs and associated features that would make a CBDC useful. The pyramid's right-hand side lays out the associated trade-off – forming a hierarchy in which the lower layers represent design choices that feed into subsequent, higher-level decisions.

Source: R Auer and R Boehme (2020), "The technology of retail central bank digital currency", *BIS Quarterly Review*, March, p. 85-100.

Attributes of retail CBDC projects

Number of retail CBDC projects investigating each design option



Source: R Auer, G Cornelli and J Frost (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS working papers*, No 880, August.

IV. Conclusion

Conclusion

- Interest in CBDCs is rising, and issuance is imminent in some economies
- Novel CBDC project index and speech, search interest scores provided with the paper as a public good for researchers, policy makers and the general public
- CBDCs more likely in countries with higher mobile use and innovation capacity
- Retail CBDCs more likely where the informal economy is larger, ceteris paribus
- Heterogeneity in approaches and designs across countries (architecture, infrastructure, access, interlinkages)
- Many central banks are considering CBDCs as a direct cash-like claim on the central bank, but where the private sector handles all customer-facing activity

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Thank you!

Annex

Univariate ordered probit regressions on overall CBDC project index

Digital infrastructure							
Mobile cellular subscriptions		0.010***					
(per 100 people)		(0.004)					
Broadband subscriptions			0.042***				
(fixed line, per 100 people)			(0.008)				
Innovation capacity							
Innovation output score				0.047***			
(WIPO)				(0.009)			
Fast payment system (FPS)	dummy				0.882***		
					(0.221)		
Institutional characteristics							
Government effectiveness						0.674***	
						(0.118)	
Informal economy							–0.03***
(% of GDP)							(0.013)
Number of observations		169	167	118	175	175	122
Pseudo R^2		0.057	0.126	0.129	0.074	0.145	0.058

Univariate ordered probit regressions on overall CBDC project index (2)

Development and financial inclusion						
Ln(GDP per capita)	0.439***					
	(0.092)					
Account ownership		0.023***				
(% age 15+)		(0.005)				
Financial development			3.414***			
index[2]			(0.552)			
Public interest in CBDCs						
Search interest index				0.432***		
(Google/Baidu)[3]				(0.098)		
Cross-border transactions						
Remittances[4] to GDP					–0.157**	
					(0.068)	
Trade openness[5]						0.001
						(0.003)
Number of observations	168	135	158	175	110	134
Pseudo R^2	0.119	0.131	0.215	0.105	0.113	0.001

Univariate ordered probit regressions on retail CBDC project index

Digital infrastructure						
Mobile cellular subscriptions	0.005**					
(per 100 people)	(0.002)					
Broadband subscriptions		0.037***				
(fixed line, per 100 people)		(0.008)				
Innovation capacity						
Innovation output score			0.046***			
(WIPO)			(0.010)			
Fast payment system dummy				0.678***		
				(0.227)		
Institutional characteristics						
Government effectiveness					0.522***	
					(0.114)	
Informal economy						–0.027**
(% of GDP)						(0.013)
Number of observations	169	167	118	175	175	122
Pseudo R^2	0.016	0.108	0.135	0.047	0.10	0.038

Univariate ordered probit regressions on retail CBDC project index (2)

Development and financial inclusion						
Ln(GDP per capita)	0.352***					
	(0.09)					
Account ownership (% age 15+)		0.018***				
		(0.005)				
Financial development index[2]			2.616***			
			(0.519)			
Public interest in CBDCs						
Search interest index (Google/Baidu)[3]				0.258***		
				(0.067)		
Cross-border transactions						
Remittances[4] to GDP					–0.138**	
					(0.069)	
Trade openness[5]						–0.007**
						(0.004)
Number of observations	168	135	158	175	110	134
Pseudo R^2	0.086	0.09	0.149	0.052	0.101	0.031

Univariate ordered probit regressions on wholesale CBDC project index

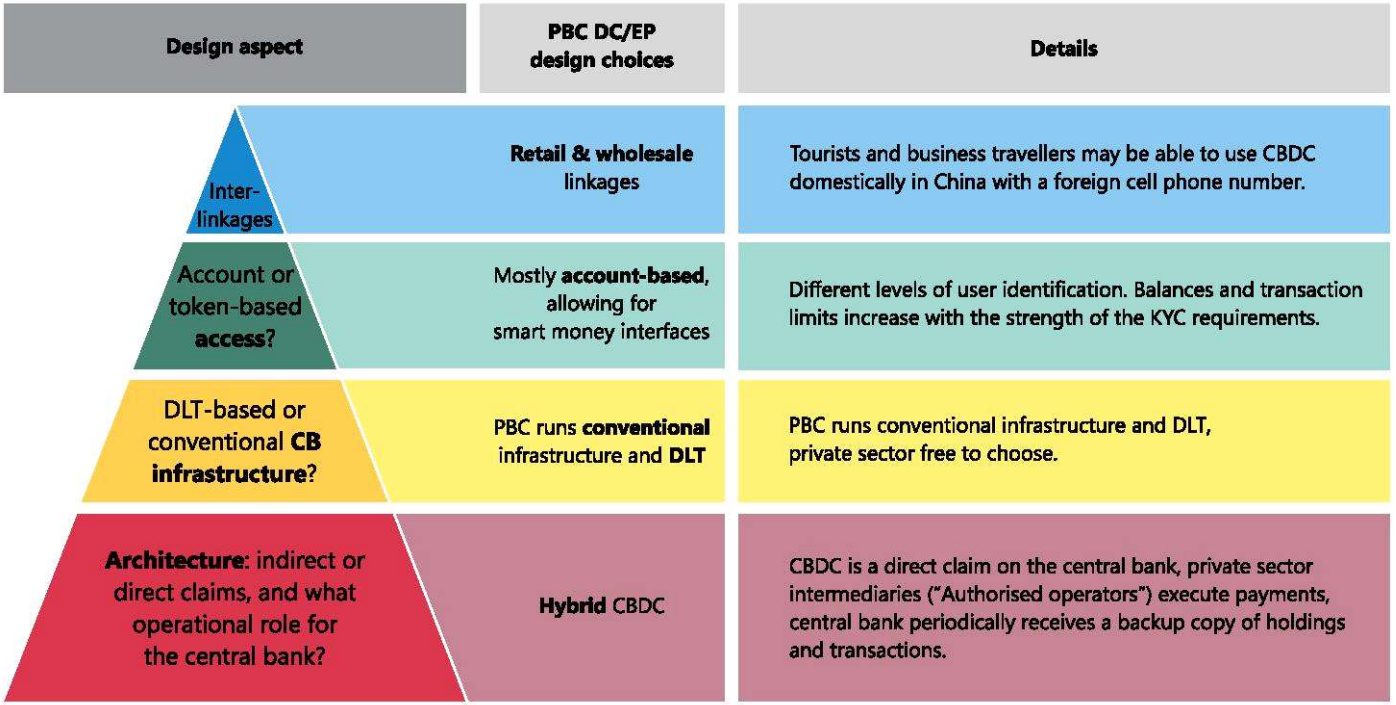
Digital infrastructure						
Mobile cellular subscriptions	0.01**					
(per 100 people)	(0.004)					
Broadband subscriptions		0.037***				
(fixed line, per 100 people)		(0.01)				
Innovation capacity						
Innovation output score			0.037***			
(WIPO)			(0.01)			
Fast payment system dummy				1.023***		
				(0.3)		
Institutional characteristics						
Government effectiveness					0.762***	
					(0.193)	
Informal economy						–0.059**
(% of GDP)						(0.025)
Number of observations	169	167	118	175	175	122
Pseudo R^2	0.071	0.119	0.101	0.108	0.191	0.147

Univariate ordered probit regressions on wholesale CBDC project index (2)

Development and financial inclusion						
Ln(GDP per capita)	0.479***					
	(0.128)					
Account ownership		0.03***				
(% age 15+)		(0.009)				
Financial development			3.532***			
index[2]			(0.739)			
Public interest in CBDCs						
Search interest index				0.526***		
(Google/Baidu)[3]				(0.117)		
Cross-border transactions						
Remittances[4] to GDP					–0.219**	
					(0.097)	
Trade openness[5]						0.005*
						(0.003)
Number of observations	168	135	158	175	110	134
Pseudo R^2	0.145	0.185	0.267	0.218	0.119	0.037

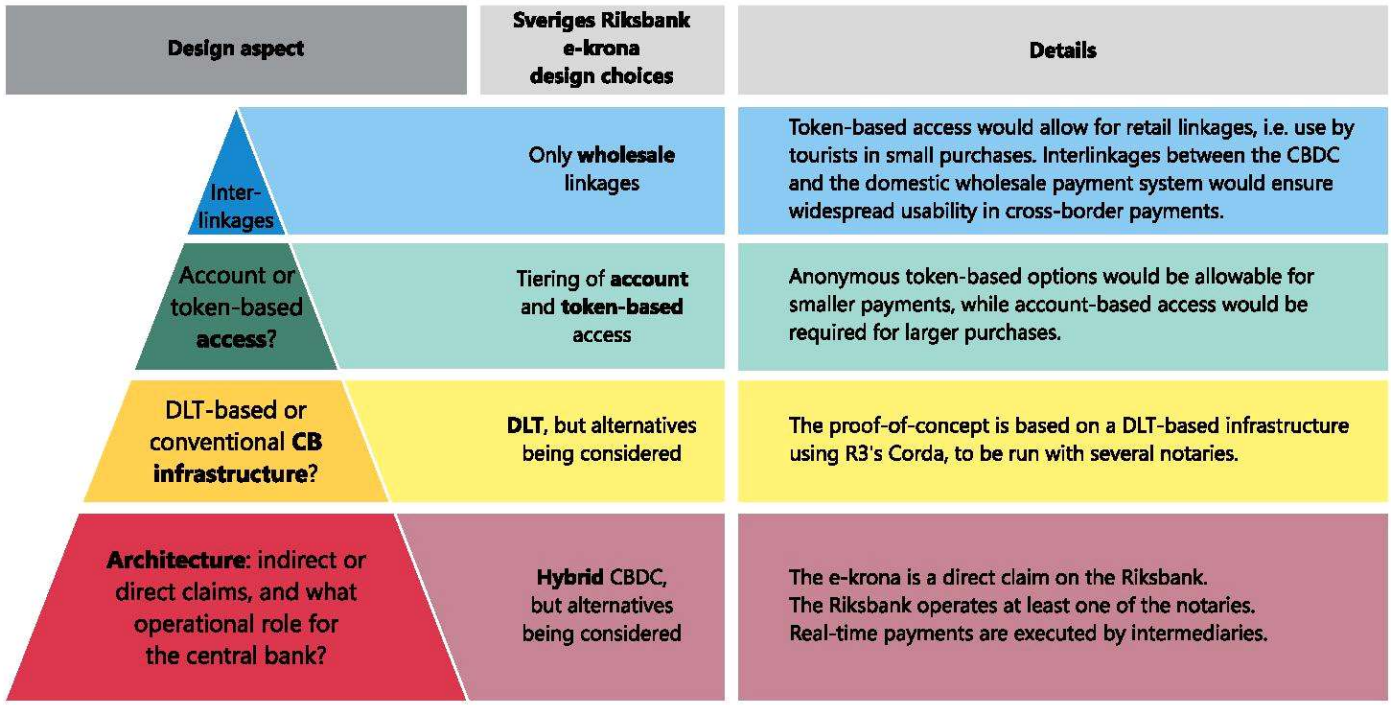
Three case studies

Design characteristics of the PBC's e-CNY project (pilot)



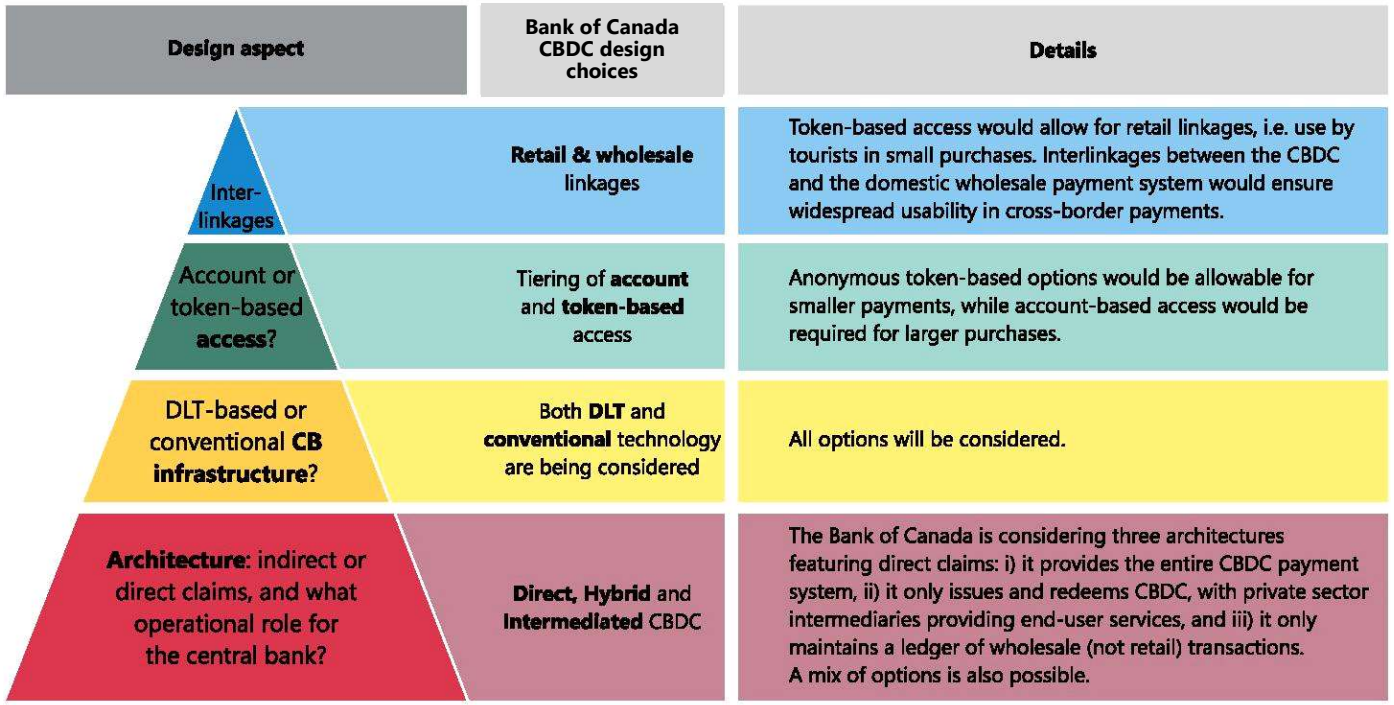
Sources: Adapted from R Auer and R Boehme (2020), "The technology of retail central bank digital currency", *BIS Quarterly Review*, March, p85-100; Fan (2020) and conversations with PBC staff.

Sveriges Riksbank's e-krona (proof-of-concept)



Sources: Adapted from R Auer and R Boehme (2020), "The technology of retail central bank digital currency", *BIS Quarterly Review*, March, p85-100; conversations with Sveriges Riksbank staff.

Bank of Canada's CBDC contingency plan



Sources: Adapted from R Auer and R Boehme (2020), "The technology of retail central bank digital currency", *BIS Quarterly Review*, March, p85-100; conversations with Bank of Canada staff.