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The degrees of central bank digital currency adoption across countries: A preliminary analysis

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Abstract

This study empirically examines factors affecting the different stages of CBDC adoption using a sample of 55 countries engaged in CBDC projects from 2014 to 2021. The findings indicate that anti-money laundering and terrorist financing and the financial market development, inflation and technological factors are critical determinants of CBDC adoption at different stages.

Keywords: central bank digital currencies, AML, financial market development, retail CBDC, wholesale CBDC
JEL Classification Codes: C23, E58, G28

1. Introduction

Along with the emerging growth of cryptocurrencies, central bank digital currencies (CBDCs) have received much more attention than ever from worldwide policymakers, market participants, and academics. For example, 80% of surveyed central banks (Auer et al., 2020) and approximately 100 countries (Georgieva, 2022) have engaged in CBDC projects (e.g., retail and wholesale). The potential benefits of CBDCs may include (1) enhancing efficiency, safety, and robustness of payments, decreasing transactions costs with more convenience (Zhang & Huang, 2022), (2) offering a real-time overview of economic activity in a particular jurisdiction or area as well as provide more precise and timely data for GDP and inflation calculation than are available as present (PwC, 2019), (3) benefiting for monetary regulation, monitoring and supervision (Fernández-Villaverde et al., 2021), (4) potentially promoting financial stability by appropriately and timely adjusting monetary policy, mitigating the reliance of shadow banking, reducing systematic risk (Larina & Akimov, 2020), and (5) helping anti-money laundering and anti-terrorist financing, anti-bribery and anti-corruption, and anti-tax evasion (Dupuis et al., 2022).

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Given the promising benefits, several studies have attempted to examine different perspectives related to CBDCs. The first strand has discussed the characteristics, classifications, models and designs, and potential implications of CBDCs in terms of their advantages and disadvantages (Allen et al., 2022; Li & Huang, 2021). The second strand has focused on design theory, model optimisation, and technological innovation (Lee, Son, Jang, et al., 2021; Wagner et al., 2021). The third strand has illustrated the security and privacy aspects of CBDCs (Borgonovo et al., 2021; Lee, Son, Park, et al., 2021). The fourth strand has examined the potential impact of CBDCs on monetary systems and policies with positive views (Davoodalhosseini, 2022; Meaning et al., 2021) and negative concerns (Viñuela et al., 2020). The fifth strand has investigated the relationships between CBDCs and the financial market. Some researchers argue that CBDCs may torture the conventional banking system (Williamson, 2022b), for example, the crowding-out effect of bank deposits (Keister & Sanches, 2022) and may increase shifting safe assets from private banks to a narrow and effective banking facility (Williamson, 2022a). However, Andolfatto (2020) asserted that CBDC is not likely to affect bank lending activity, thus not threatening financial stability. Chiu et al. (2022) reemphasized that CBDC would theoretically serve as an additional option for households, thus enhancing the effectiveness of bank intermediation. Nonetheless, Wang et al. (2022) found a mixed impact of CBDC on the financial market. The sixth strand has attempted to identify the determinants of CBDC adoption. Notably, Auer et al. (2020), using univariate ordered probit regression for a sample of 175 countries from 2013 to 2019 where 120 countries have zero value of CBDC index, showed that CBDC adoption is positively affected by digital infrastructure (e.g., mobile phone use or internet use), innovation capacity, government effectiveness, higher GDP per capita, financial development, and search interest. Similarly, Luu et al. (2022), using a conventional regression model for a sample of 53 countries from 2014 to 2021, indicated that CBDC adoption is significantly affected by national cultural values but varies among individual cultural values. For example, the positive link is found in the case of more power distance, masculinity, and long-term orientation cultures, while uncertainty avoidance shows the opposite sign.

Our study contributes to the existing literature in several ways. First, our study extends the sixth strand of the literature to examine the determinants of different stages of CBDC adoption using multinomial logistic regression for a sample of 55 countries that have engaged in CBDC projects. In this sense, it can provide a detailed and insightful picture on the progress of CBDC adoption across the globe, supplementing the finding of Auer et al. (2020). CBDC tracker database has documented five statuses of CBDC adoption, including Research, Proof of Concept, Pilot, Launched, and Cancelled. Therefore, the second contribution of this study is to investigate which factors can explain the different stages of CBDC adoption across nations. Furthermore, the above argument suggests that the CBDC adoption is potentially associated with anti-money laundering and anti-terrorist financing. Thirdly, our study is the first attempt to provide empirical evidence for the relationship between the risk of money laundering and terrorist financing and CBDC adoption. Consequently, our study would offer policymakers a better overview of CBDC adoption worldwide.

2. Methodology and data

2.1 Methodology

Our baseline model takes the form as:

$$CBDC_{i,t} = \alpha_0 + \alpha_1 AML_{i,t} + \alpha_2 FD_{i,t} + \alpha_3 INF_{i,t} + \alpha_4 GDPPC_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $CBDC_{i,t}$ is the degree of adoption of central bank digital currency in country i at time t. Following CBDC Tracker and Luu et al. (2022), the value of CBDC ranges between 1 and 4.

Equation (1) implies that the (stage of) CBDC adoption in a country depends on its level of risk in terms of money laundering and terrorist financing (AML) (Dupuis et al., 2022), level of financial development (FD) (Larina & Akimov, 2020; Wang et al., 2022; Zhang & Huang, 2022), and macroeconomic development including inflation rates (INF) and GDP per capita ($GDPPC$) (Auer et al., 2020; PwC, 2019). Note that AML index is calculated based on five dimensions, including quality of AML/CFT framework, bribery and corruption, financial transparency and standards, public transparency and accountability, and legal and political risks. A higher value of AML implies greater risk. FD index is a relative score of a jurisdiction on the depth, access and efficiency of its financial markets and financial institutions.

We also conduct several robustness tests regarding different alternative variables of financial development (e.g., the financial markets depth index (FMD), financial markets access index (FMA), and financial markets efficiency index (FME)), different sample groups (e.g., retail versus wholesale CBDCs), as well as the inclusion of technological factors, e.g., mobile cellular subscription per 100 people ($MOBILE$), the percent of individuals using the Internet over the population ($INTERNET$), and the overall innovation index ($INNOVATION$). These results are reported in Section 3 below.

2.2 Data

Our data were obtained from four primary sources. The data on the degree of CBDC adoption ($CBDC$) were collected from the open-source CBDC Tracker database. CBDC Tracker database provides information on CBDC initiatives for 70 countries from 2014 to 2021. It is worth noting that if countries are excluded from the CBDC Tracker database, this does not necessarily reflect that they may not have taken any actions on central bank digital currency because this database is still ongoing project. To avoid bias and subjectivity, we only focus on data availability officially published on CBDC Tracker from 2014 to 2021.

The data on Anti-Money Laundering Index (AML) were gathered from Basel AML Index database published by Basel Institute on Governance, which covers 110 countries from 2012 to 2021. Data on macroeconomic variables (e.g., INF and $GDPPC$) were extracted from World Development Indicators held in the World Bank database. The data on financial development (FD) and its components (e.g., FMD, FMA, and FME) were derived from the Financial Development Index database constructed by Svirydzenka (2016). After matching these databases, this arrives at a sample of 55 countries from 2014 to 2021, yielding a total of 118 observations. According to the CBDC Tracker database, the number of countries that engaged in the Research stage was 66.67%, followed by the Proof of Concept stage (15.90%), Pilot stage (9.74%), Cancelled stage (5.13%), and Launched stage (2.56%). Additionally, Table 1 shows that the average AML score and FD index over the examined period were 5.119 and 0.505, respectively, with a low standard deviation.

Table 1. Descriptive statistics of variables used in this study.

Variables	Obs	Mean	Std	Min	Max
AML	156	5.119	0.859	3.19	7.4
FD	136	0.505	0.252	0	0.948
INF	183	5.418	14.043	-2.318	18.704
GDPPC	191	22,253.931	22,320.458	514.906	93,457.4

Notes: AML= the Anti-Money Laundering Index; FD= the financial development index; INF= the inflation rate; $GDPPC$= the real GDP per capita. Obs stands for the number of observations, and Std stands for standard deviation.

Table 2. Correlation matrix of variables used in this study.

	AML	***FD***	***INF***	***GDPPC***
AML	1			
FD	-0.314***	1		
INF	0.212***	-0.292***	1	
GDPPC	-0.208***	0.329***	-0.119	1

Notes: AML= the Anti-Money Laundering Index; FD= the financial development index; INF= the inflation rate; $GDPPC$= the real GDP per capita. *** denotes significant result at the 1% level.

Furthermore, Table 2 indicates no high correlations among independent variables used in the baseline models. Also, it is noted that the variance inflation factor (VIF) of our independent variables *AML*, *FD*, *INF*, and *GDPPC* are small at 1.12, 1.29, 1.09, and 1.11, respectively. We, therefore, believe that the multicollinearity issue would not affect our estimation results.

3. Empirical findings

Due to the dependent variable ($CBDC$) taking four values, the multinomial logistic regression should be used. Table 3 reports the results of the baseline model and allows us to identify which independent variables significantly predict whether a country falls into the comparison groups (i.e., Proof of Concept, Pilot, Launched, and Cancelled) versus the baseline category (i.e., Research adoption).

For the Proof of Concept stage, the FD predictor is positive and significant, implying that higher financial development is more likely to induce countries to adopt the Proof of Concept stage relative to Research adoption. Regarding Launched stage, the positive coefficient on AML may imply nations with greater risk of money laundering and terrorist financing tend to speed up the official launching of central bank digital currency relative to Research adoption. This is comparable with the argument of Dupuis et al. (2022). Additionally, the negative coefficient on FD may argue that countries with higher financial development seem more cautious and hesitant about launching their CBDCs and more engaged in Research progress. Last, FD is negatively and significantly associated with the CBDC Cancelled stage, implying that less financial development may increase the probability of CBDC project Cancellation relative to CBDC Research adoption. It is because CBDC development requires a certain financial infrastructure and ecosystem level. The negative coefficient on INF may suggest that a country with better control of the inflation rate tends to abandon the CBDC project relative to CBDC Research progress.

When observing the subsamples, as shown in the last two columns of Table 3, our main explanatory variables play essential roles in retail CBDC. Regarding wholesale CBDC, financial development and the level of income and wealth contribute an increase in Proof of Concept relative to Research adoption. However, the interpretation in wholesale CBDC should be cautious because of the small sample size. Nonetheless, this finding is somewhat comparable with the early suggestion of Luu et al. (2022).

When decomposing the financial development index (the results are available upon request), we found that the financial market index (FM) predictor is negative and significant in CBDC Launching and Cancellation models, reemphasizing the critical role of financial markets in CBDC adoption as suggested by Auer et al. (2020). For further robustness, we include the financial markets depth index (FMD), financial markets access index (FMA), and financial markets efficiency index (FME) into the original model. Table 4 shows the negative coefficients on FMA, demonstrating that greater financial markets access tends to induce a jurisdiction to

Table 3. The result of our baseline model.

	Whole sample		Retail CBDC	Wholesale CBDC
Research	**Base outcome**			
Proof of Concept				
AML	0.398(0.342)	0.417(0.398)	0.021(0.652)	-0.039(0.698)
FD	2.521*(1.411)	3.281*(1.816)	2.976(3.013)	7.32*(4.083)
INF	-0.024(0.065)	-0.03(0.064)	-0.046(0.108)	0.048(0.306)
GDPPC	-0.006(0.005)	0.009(0.006)	-0.003(0.012)	-0.0001***(0.0001)
Const	-5.456(2.24)	-6.39***(2.48)	-4.254(3.877)	0.39(4.702)
Pilot				
AML	-0.313(0.392)	0.725(0.546)	-0.633(1.088)	0.564(0.765)
FD	-0.971(1.862)	-1.162(1.937)	0.579(7.323)	-4.624(4.52)
INF	-0.131(0.128)	-0.029(0.132)	0.419(0.278)	-0.448(0.281)
GDPPC	-0.014*(0.007)	-0.014*(0.008)	-0.45*(0.027)	-0.0001*(0.000)
Const	1.701(2.481)	-2.937(2.947)	0.524(6.46)	3.556(3.942)
Launched				
AML	1.484*(0.867)	3.464*(1.94)	3.179*(1.828)	
FD	-7.614**(3.457)	-11.639*(5.95)	-10.489*(5.713)	
INF	-0.458(0.323)	-0.178(0.307)	-0.246(0.39)	
GDPPC	0.022(0.014)	-0.0001(0.016)	0.004(0.023)	
Const	-9.526(5.901)	-16.57*(9.95)	-15.494(9.75)	
Cancelled				
AML	0.07(0.45)	-0.357(0.593)	0.158(0.614)	
FD	-3.77**(1.79)	-2.875(2.174)	-2.523(2.33)	
INF	-0.279***(0.183)	-0.65***(0.23)	-0.822***(0.312)	
GDPPC	0.0004(0.008)	0.005(0.01)	0.008(0.012)	
Const	0.422(2.828)	1.175(3.478)	-1.05(3.45)	
FE control[1]	No	Yes	Yes	Yes
No. Obs	118	118	84[2]	38[2]
χ^2	41.99***	65.69***	54.56***	24.44**
Pseudo R^2	0.158	0.247	0.331	0.317

Notes: [1]Country group is classified by World Bank. Several countries have approached both retail and wholesale CBDC simultaneously. No countries had been yet engaged in wholesale CBDC launched and cancelled stages in the sample. Standard errors are in parentheses. *, **, and *** denote significant results at the 10%, 5%, and 1% levels, respectively.

lower the probability of launching its CBDC relative to CBDC Research adoption. Also, a positive coefficient on FMD suggests that countries with greater financial markets depth may opt for CBDC Proof of Concept and tend to decrease CBDC Research adoption. The negative coefficient on FMA may imply that financial market access seems to decrease CBDC Proof of Concept relative to Research adoption.

When controlling for the technological capability, Table 4 also indicates the essential roles of $INTERNET$ and $MOBILE$ in launching the CBDC relative to Research adoption. However, negative coefficients on $INNOVATION$ argue that with a higher innovation, countries are less likely to launch their CBDCs and tend to increase Research adoption. This reflects the exponential growth of cryptocurrencies in recent years. R&D potential to develop alternative digital currencies may be less likely to issue CBDCs.

Table 4. The results of robustness checks for whole sample.

	FM components		Technological factors
Research	**Base outcome**		
Proof of Concept			
FMD	3.006*(1.665)	*MOBILE*	-0.004(0.008)
FMA	-5.779***(1.968)	*INTERNET*	0.025(0.028)
FME	0.542(1.172)	*INNOVATION*	-0.072(0.048)
Control variables	Yes	*Control variables*	Yes
Const	-3.69(2.328)	Const	-5.864(3.709)
Pilot			
FMD	2.781(2.143)	*MOBILE*	-0.008(0.013)
FMA	-2.505(1.845)	*INTERNET*	0.079(0.051)
FME	-2.914(1.963)	*INNOVATION*	-0.003(0.057)
Control variables	Yes	*Control variables*	Yes
Const	-2.455(3.131)	Const	-10.323(6.977)
Launched			
FMD	-4.132(4.066)	*MOBILE*	0.422***(0.087)
FMA	-4.263*(2.354)	*INTERNET*	5.098***(0.202)
FME	-27.509(20.903)	*INNOVATION*	-4.071***(0.262)
Control variables	Yes	*Control variables*	Yes
Const	-9.25(8.474)	Const	1.051(13.989)
Cancelled			
FMD	-2.821(2.001)	*MOBILE*	-0.068(0.045)
FMA	-3.391(3.429)	*INTERNET*	0.072**(0.034)
FME	-0.438(1.642)	*INNOVATION*	0.068(0.102)
Control variables	Yes	*Control variables*	Yes
Const	2.037(3.093)	Const	-0.627(7.012)
FE control[1]	Yes	FE control[1]	Yes
No. Obs	117	No. Obs	115
χ^2	1617.66***	χ^2	85.37***
Pseudo R^2	0.32	Pseudo R^2	0.338

Notes: [1]Country group is classified by World Bank. The same set of control variables in equation (1) is used. Standard errors are in parentheses. *, **, and *** denote significant results at the 10%, 5%, and 1% levels, respectively.

4. Conclusions

This paper investigated the determinants of CBDC adoption at different stages, including the proof of Concept, Pilot, Launched, and Cancelled, in 55 countries during the 2014-2021 period. The findings indicate that financial development plays a critical role in adopting Proof of Concept, Launched, and Cancelled relative to Research stage. Also, the results shows that issuing CBDC relative to Research adoption is more developed in countries with a greater risk of money laundering and terrorist financing. Inflation rate is found to reduce the probability of Cancelled CBDC adoption and increase the Research CBDC stage. These findings are more robust in the case of retail CBDC. Nonetheless, the findings suggest that depending on the objective of CBDCs (e.g., AML and inflation control) and the status of financial market devel-

opment (e.g., financial markets depth, financial markets access, and financial markets efficiency), and technological conditions, the authorities may opt for an appropriate stage of CBDC adoption.

However, this study may suffer limitations. Future research may consider the relationship between fintech and bigtech development and CBDC adoption if data on fintech and bigtech credit are available. Future research may extend a longer period and sample size, especially wholesale CBDC, to confirm our findings.

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