FINANCIAL INFRASTRUCTURE AND PAYMENT INSTRUMENTS REPORT

ISSN - *PENDING*

2024

BANCO DE LA REPÚBLICA COLOMBIA

2024

FINANCIAL INFRASTRUCTURE AND PAYMENT INSTRUMENTS REPORT

Banco de la República
Bogotá, D. C., Colombia

ISSN Pending

FINANCIAL

INFRASTRUCTURE AND PAYMENT INSTRUMENTS REPORT

Prepared by
the Financial Infrastructure Oversight Department of the Office
for Monetary Operations and International Investments

Office of the Deputy Technical Governor
Hernando Vargas
Deputy Technical Governor

Office for Monetary Operations and International Investments
Andrés Murcia
Chief Officer

Financial Infrastructure Oversight Department
Clara Lía Machado
Director

Carlos Alberto Cadena
Freddy Hernán Cepeda
Aura María Ciceri
Jefferson Marín
Jorge Ricardo Mariño
Constanza Martínez
Javier Miguélez
Carlos Eduardo Ramirez
Diana Carolina Velásquez
Jhonatan Villalobos

Contents

Graphs

Tables

Diagrams

Glossary

ACH: Automated Clearing House
ACH-Cenit: National Interbank Electronic Settlement System, managed by *Banco de la República*
ACH-Colombia: Automated Clearing House of Colombia
ATH: A Toda Hora S.A. (an ATM network)
BDBR: Board of Directors of the *Banco de la República*
BIS: Bank for International Settlements
BVC: Colombian Stock Exchange
CCDC: Foreign Exchange Clearing House of Colombia
CDT: Term deposit certificate
CEDEC: Electronic clearing system for checks and other payment instruments, managed by *Banco de la República*
CIF: Collective investment fund
CRCC: *Cámara de Riesgo Central de Contraparte S.A.* (the Colombian Central Counterparty)
CR5: Concentration index constructed as the sum of the five largest shares
CUD: Deposit Accounts System, managed by *Banco de la República* and used to settle large-value money transfers. It is also known as the large-value payment system.
DANE: National Bureau of Statistics
DCV: Central Securities Depository, managed by *Banco de la República*
Deceval: Centralized Securities Depository of Colombia
DGCPTN: General Directorate of Public Credit and the National Treasury - Ministry of Finance and Public Credit
DvP: Delivery-versus-payment method applicable to securities settlement
FINAGRO: Agricultural Sector Financing Fund
GDP: Gross domestic product (GDP)
IBR: Benchmark Reference Index
MEC: Colombian Electronic Market, owned by the Colombian Stock Exchange
NDF: Non-deliverable forwards
PSE: Secure online payments (SOP)
SEN: Electronic trading system, managed by *Banco de la República*
SET-ICAP-FX: Foreign exchange electronic transaction system, managed by *Servicios Integrados en Mercado Cambiario S.A.* and backed by the Colombian Stock Exchange and SIF-ICAP of Mexico
SET-ICAP Securities: Electronic and voice system for trading and registering financial instruments. It is also a financial information provider.
TES: Bonds issued by the Colombian government and managed by *Banco de la República*
TRM: Representative market exchange rate
TTS: Temporary transfer of securities

Introduction

During 2023, the local financial infrastructure provided its services normally, demonstrating its proper functioning. Thanks to efficient management, the infrastructure provided stability and confidence to participants in the payment system and financial markets.

The activity of the large-value payment system of *Banco de la República* (the Central Bank of Colombia, Banrep), through the Deposit Accounts System (CUD in Spanish), increased compared to the previous year, as a result of greater transactions in the public debt market (sell/buy-backs and purchase/sales), expansion repos, and direct transfers of funds between participants. Similarly, there was greater dynamism in other financial market infrastructures, such as the Central Securities Depository (CSD) and the Central Counterparty Clearing House (CCP), reflecting an increase in flows in local financial markets.

In the retail payments market, according to the most recent survey by *Banco de la República* (2023), cash remains the most used for low amount routine payments by Colombians. The most important reasons explaining cash preference are the ease and speed of paying, and the tradition of users to make low-cost purchases. However, the share of cash in routine purchases decreased in favor of greater use of electronic payment instruments, such as electronic funds transfers and debit and credit cards, which increased significantly in 2023, continuing its growth path of recent years.

This edition of *Report* includes a new section on payment instruments, which presents a complete overview of trends in the use of different instruments, as well as international comparisons. Consequently, as of this edition the name of this publication changes to *Report on Financial Infrastructure and Payment Instruments (RIFI in Spanish).*

The payments industry in the goods and services market is constantly evolving and innovating throughout its value chain. There is a tendency in the world to move towards immediacy in payments and towards the creation of new payment initiation options for electronic funds transfers and the use of electronic commerce. Colombia has not been oblivious to these trends, which is why these issues are addressed in this edition of RIFI.

At the end of 2023, a new private initiative system called Entre-Cuentas, offered by *Redebán*, began to operate, which helps facilitate payments from people to businesses. *Banco de la República*, for its part, is advancing all the necessary developments to guarantee the full interoperability of the instant payments ecosystem through instruments complementary to those developed by the private sector, which will become operational in 2025. In that context, *Banco de la República* will create its own instant payments chamber and provide existing chambers with centralized directory and real-time settlement services (Operational Settle-

ment Mechanism). The latter will contribute to mitigate the settlement, credit, and system liquidity risks.

In addition to monitoring the performance and operation of the payment system in figures, this RIFI has developments in applied research to detect possible challenges to financial stability that could arise from problems or disruptions in financial market infrastructures (FMI). In particular, some results of simulation exercises are presented in order to make the first approximations to estimate potential effects of simultaneous cyberattacks on systemically important entities in the Deposit Accounts System (CUD) or on the telecommunications providers of the participants in that system. The results of these exploratory years indicate that, in the face of a hypothetical and extreme scenario, it would be possible for significant defaults to be caused in the payment system. However, the effects would largely depend on the active reactions of CUD participants, by continuing to make payments with the available liquidity, thereby mitigating the effect on the payment system. In addition, a series of recommendations are proposed to promote higher levels of cyber resilience.

Finally, this RIFI describes some international projects and initiatives aimed at understanding in depth the possible use of wholesale digital currency issued by central banks (known as wCBDC). Such a digital currency would essentially consist of tokenizing deposits of financial institutions in the central bank and could help lower costs, increase speed, and improve the clearing and settlement of wholesale payments between such entities. Similarly, the wCBDC could complement the traditional channels through which cross-border payments are processed, thus helping to reduce inefficiencies and costs in these payments.

It should be noted that *Banco de la República* recently published on its website a document discussing the relevance of issuing in Colombia a central bank digital currency.[1] The document concludes that, in contrast to the issuance of wCBDCs (which may contribute to the development of payments in the future), a retail central bank digital currency (rCBDC) could generate significant risks and it is not clear that its eventual benefits will be greater than those that can be expected from an interoperable instant payments system such as the one to be launched by *Banrep* in 2025.

Leonardo Villar
Governor

1 Available at banrep.gov.co: "Relevance and Risks of Issuing a Central Bank Digital Currency in Colombia".

Key Messages, 2024

During 2023, *Banco de la República* kept a continuous monitoring of the financial market infrastructures (FMI) in Colombia.

In addition to monitoring the performance and operation of the payment system in figures, *Banrep* uses risk assessment methodologies and implements developments in applied research to detect possible challenges to financial stability, which could arise from problems or disruptions in FMI.

As proof of this, the financial infrastructure maintained its services continuously, showing its proper functioning. Thanks to its efficient management, the payments system and the financial markets were able to operate normally, providing stability and confidence to their participants.

The Local financial infrastructure was safe and efficient in 2023.

During 2023, the FMI reflected the flows in local financial markets.

Mainly the fixed income sector, which, in a context of higher valuations supported by lower inflation expectations and a more favorable perception of local risk, showed a positive evolution in the volumes and amounts traded. The foreign exchange market, which exhibited some volatility during the year, reflected significant momentum in products indexed to the representative market exchange rate (TRM) cleared and settled through the CCP.

The activity of the large-value payment system of *Banco de la República* (CUD) increased compared to the previous year, as a result of greater activity in the public debt market (sell/buy-backs and purchase/sales), expansion repos, and direct transfers of funds between participants.

Increased dynamics were observed in the large-value payment system.

As a result of the activity in the CUD, there was greater dynamism in the financial market infrastructure.

Higher amounts cleared and settled were observed in the Central Securities Depository (DCV in Spanish) due to an increase in repo and sell/buy-backs transactions. In the Deceval, the growth of settled volumes and the value of securities in deposit are based on the growth of certificates of deposit (CDT in Spanish) issues by financial institutions, derived from the adaptation of intermediaries to the requirements of the net stable funding ratio (NSFR). In the Central Counterparty Clearing House (CCP), there was an increase in managed transactions, due to the consolidation of temporary transfers of securities (TTS) in the fixed income segment and the positive evolution of the products underlying TRM (futures, NDFs, and options).

During 2023, it was observed that ACH Colombia reduced the times to complete its interbank transfer settlement process. This is related to the implementation of the automatic debit implementation on deposit accounts in their settlement processes. As a consequence, lower liquidity pressures were observed in the system, which contributes to mitigate intraday liquidity risk.

It was observed that the implementation of the automatic debit service on the deposit accounts provided by *Banrep* to the FMI, which provide settlement services in the CUD, contributed to the mitigation of the intraday liquidity risk of their participants.

In order to contribute to the mitigation of settlement, credit, and liquidity risks, participants in instant payment systems will settle transactions in real time in the large-value payment system.

In 2025, *Banrep* will begin to offer the real-time settlement service for fast payment systems (FPS) through the operational settlement mechanism (MOL in Spanish), based on a new high-availability platform with which it will be possible to debit or credit the deposit accounts that IPS participants have in *Banrep* to comply with payment orders, transfers, or both.

Recent studies of multilateral bodies, related to the practices used by some CCPs to manage the possible losses generated by business risks, show that there are a variety of strategies, practices, and mechanisms to contrast the practices defined by the CCP. In this regard, it was determined that there are areas for improvement, including the design of test scenarios to measure the capacity of liquid resources in the face of the simultaneous default of multiple members and the materialization of business risk, as well as the exploration of new sources of liquidity, among others.

***Banrep* recognizes the importance of risk management of central counterparties (CCPs) unrelated to defaults by settlement members. Thus, in order to identify areas for improvement in local practices, it monitors the practices used by CCPs in other jurisdictions and contrasts them with those observed in the CCP.**

Simulation exercises made it possible to quantify the potential impact of some cyberattack scenarios on the large-value payment system, CUD, and to propose recommendations to contribute to its mitigation.

The vulnerability of the financial system, and in particular of FMI, to cyber risk is increasing, given its dependence on information technologies and critical service providers. Through simulation exercises, it is possible to estimate potential effects of simultaneous cyberattacks on systemically important entities or telecommunications providers that could affect the stability of the system. To mitigate these risks, it is important to strengthen cybersecurity systems, ensure alternative communication channels with different providers, promote moderate levels of concentration in communications providers, and encourage active reactions of entities to payment defaults.

The most widely used instrument has been that of electronic funds transfers thanks to the development of new payment schemes, such as the payment button, instant payments, and mobile wallets. The growth of e-commerce has been supported by the use of this instrument.

In the retail payments market, the use of electronic payment instruments, such as electronic funds transfers and debit and credit cards, increased in 2023.

In Colombia, the adoption rate of electronic funds transfers and debit and credit cards has increased in the last ten years.

After making an international comparison, Colombia has room to improve its position compared to other countries with a higher adoption rate.

According to the survey on the perception of use of payment instruments carried out by *Banrep* (2023), the most commonly used payment instrument by Colombians in routine low-value payments continues to be cash, although during the last decade it has registered a decrease of 12.1 percentage points (from 90.7% to 78.6%).

The use of cash as payment instrument in the usual purchases of Colombians has decreased, although it remains the most used in Colombia.

As part of *Banrep's* monitoring of new solutions for payment settlement, some international projects aimed at understanding in depth the use of the wholesale central bank digital currency (wCBDC) are described in an informative manner.

In some jurisdictions wCBDC could be a new form of central bank money for the exclusive use of financial institutions. Worldwide, it is being studied whether its introduction for local use would increase the speed and improve the clearing and settlement of wholesale payments. It would also complement the traditional channels used for cross-border payments by increasing their speed and decreasing their cost.

While financial integrations bring a number of benefits, such as allowing capital to flow more efficiently to where it is needed, or increasing the liquidity and depth of markets, these types of processes face challenges, such as coordination between financial authorities, central banks, and participants. Establishing interoperability between the financial market infrastructures of the integrated countries becomes an aspect of special relevance.

The regional integration of financial markets between Colombia, Chile, and Peru will require FMIs to overcome some challenges to ensure that the clearing and settlement processes of transactions are safe and efficient.

Key Figures for, 2024

(Daily Average for 2023 and Annual Percentage Change)

By Infrastructure

		Value (trillions of pesos)	Change Nominal	Change Real	Number	Change
Transactions Settled in CUD		**COP 78.5**	**28%**	**17%**	**7,518**	**11%**
Payments in Financial Markets	DCV	COP 50.8	18%	8%	2,833	17%
	CRCC	COP 40.4	28%	17%	7,690	-10%
	Deceval	COP 3.9	23%	13%	8,350	25%
		COP 95.1	**22%**	**12%**	**18,873**	**7%**
Retail Payments	ACH Colombia	COP 7.7	13%	3%	1.4 mills	17%
	ACH Cenit	COP 1.5	16%	6%	100,787	25%
	Card networks	COP 0.9	15%	5%	6.6 mills	22%
	Cedec	COP 0.5	-11%	-18%	14,755	-10%
		COP 10.6	**12%**	**2%**	**8.1 mills**	**19%**

By Instrument

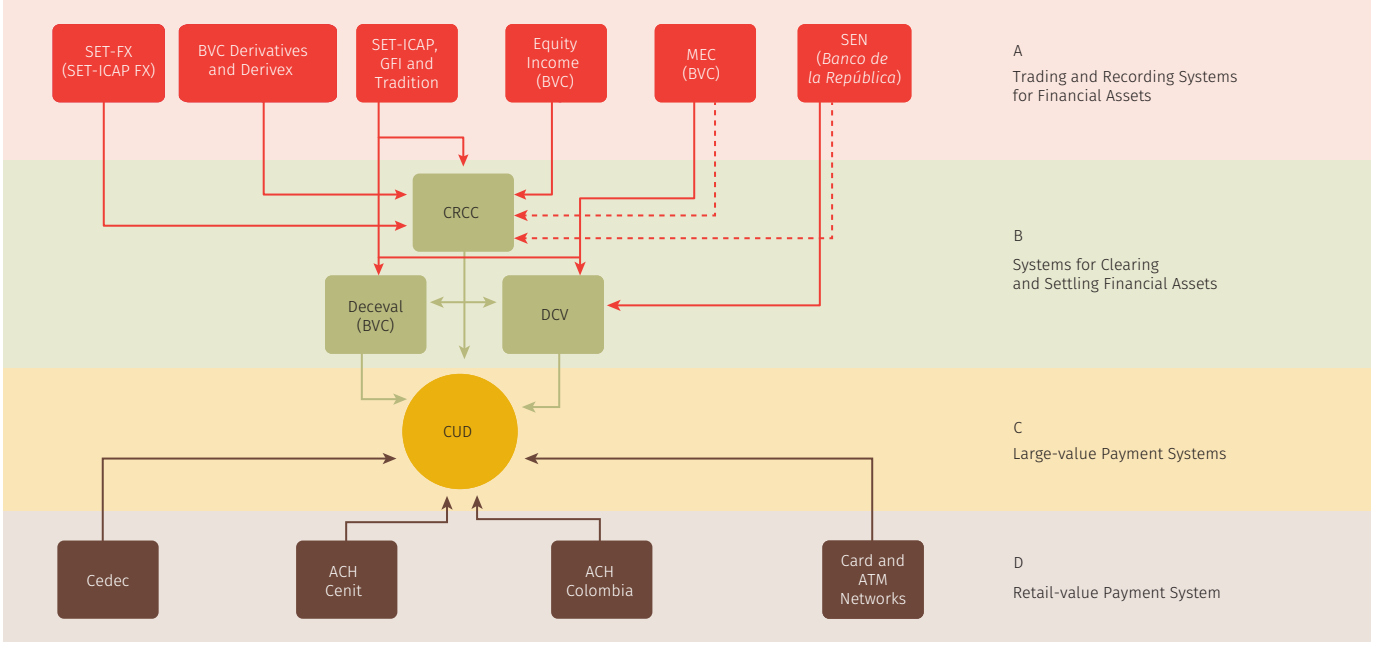
		Value (trillions of pesos)	Change Nominal	Change Real	Number	Change
Electronic Transfers	Intra	COP 14.2	11%	1%	9.5 mills	51%
	Inter	COP 9.2	14%	4%	1.5 mills	8%
		COP 23.4	**12%**	**2%**	**11.0 mills**	**43%**
Card Transactions	Debit	COP 1.1	5%	-4%	4.3 mills	11%
	Credit	COP 0.3	8%	-1%	1.4 mills	11%
		COP 1.4	**6%**	**-3%**	**5.6 mills**	**11%**
Check Transactions	Intra	COP 0.2	5%	-4%	9,652	-14%
	Inter	COP 0.5	-11%	-18%	14,755	-23%
		COP 0.8	**-7%**	**-15%**	**24,407**	**-20%**

1. General Overview of Colombia's Financial Infrastructure

The Bank for International Settlements (BIS) defines financial market infrastructures as multilateral systems in which participating institutions clear, settle, and record payments, securities, derivatives, and other financial assets.[1] These infrastructures include payments systems (PS), securities depositories (SDs), central counterparties (CCPs), and systems for recording operations,[2] as well as other existing clearing and settlement infrastructures.

Diagram 1.1 shows the infrastructures that take part in the clearing and settlement of securities and other financial assets in Colombia. It also illustrates the main platforms for trading and recording these assets, thereby providing an overview of the entire value chain. The core role of the large-value payment system managed by *Banco de la República*, known as the Deposit Account System (CUD), is unmistakable. It is the central axis and foundation of the entire infrastructure and is where the cash legs of operations with the local financial assets and bank payment instruments are settled.

Diagram 1.1
Overview of Financial Market Infrastructures (FMI) and Other Participants[a/] (2023)



a/ The dotted lines refer to the fact that the CRCC manages the risks in sell/buy-backs with TES coming from SEN and MEC, parallel to gross settlement in the DCV-CUD
Source: *Banco de la República* (DSIF).

1 The Committee on Payment and Settlement Systems and the Technical Committee of the International Organization of Securities Commissions (2012). "Principles for Financial Market Infrastructures," July; available at: https://www.bis.org/cpmi/publ/d94_es.pdf

2 The recording systems report information on over-the-counter market operations that are conducted by affiliated financial intermediaries in their own name and on behalf of third parties.

Band A at the top of Diagram 1.1 shows the trading and recording systems for securities as well as foreign exchange. The first one includes the Electronic Trading System (SEN in Spanish), managed by *Banco de la República*, where the transactions with sovereign debt instruments are traded and recorded, and the Colombian Electronic Market (MEC in Spanish), managed by the Colombian Stock Exchange (BVC in Spanish), where government and private debt is traded and recorded. The BVC also manages the equity market and standardized financial derivatives with underlying assets other than energy-related *commodities*.

There is a system called Derivex, which manages the market for standardized derivatives where underlying assets are energy-related commodities, and other trading and recording systems[3] that allow for trading and recording transactions between participants using hybrid mechanism (voice and data).

As for foreign currency, the Forex Market Electronic Transaction and Information System (SET-FX), managed by SET-ICAP FX S. A.[4], and the platforms for several trading and recording systems[5] provide trading and recording infrastructures.

Band B in Diagram 1.1 shows the systems for clearing and settling operation. Business use these infrastructures to settle the securities, foreign currency, and derivatives legs resulting from the obligations they contract in those markets. The systems concerned with securities, as indicated in Diagram 1.1, include the Central Securities Depository (DCV), which is managed by *Banco de la República* and used solely for sovereign debt instruments; the Centralized Securities Depository of Colombia (Deceval), which is for all types of securities, both government and private; the Central Counterparty Clearing House of Colombia (CCP), which handles term operations, standardized derivatives (both financial and energy derivatives) and non-standardized derivatives, such as interest rate forwards and swaps (IRF and IRS), as well as equity securities on the spot market. With respect to foreign exchange, the CCP compensates and settles both spot transactions and standardized derivatives at the representative market exchange rate (TRM in Spanish) and non-standardized (COP/USD) non deliverable forwards (NDF). Band C shows the large-value payment system (CUD), which is the core of the country's financial infrastructure. It is where the settlement of cash legs of operations converge for settlement, including those of operations in the clearing and settlement systems for financial assets, as well as the cash legs of operations in retail-value payment system.

The retail-value payment systems are grouped into Band D. They include the clearing and settlement of multilateral positions generated by the use of debit and credit cards, checks, and electronic funds transfers. Annex 3 offers a description that helps to identify and understand the role financial infrastructures play, according to the markets they support.

Table 1.1 contains a detailed description of the type of operations channeled through each system, and the daily average value and quantity of operations conducted over the last two years. These figures reflect the extent of the resources

3 These are ICAP Securities Colombia, GFI Securities Colombia, and Tradition Securities Colombia.

4 As of 2012, SET-ICAP FX S.A. replaced Integrated FX as the manager of the SET-FX system. This change was the result of a corporate agreement between ICAP Colombia Holdings S. A. S., ICAP Latin America Holdings B. V., and the BVC. The intention is to jointly supply Colombia's capital market with mixed system management services for forex and securities trading and recording.

5 GFI Exchange Colombia and Tradition Colombia.

mobilized on a gross basis. However, the amount, in value, does not necessarily coincide with the flow of money used to settle the obligations contracted there by agents, either because those obligations do not imply the movement of money or because the systems use net settlement mechanisms.

Table 1.1
Financial Market Infrastructures in Colombia
(Main Operations in Number and Value)

	Daily Averages[a/]						Main Operations
	Number of Operations		Value				
			2022		2023		
	2022	2023	Nominal (trillions of pesos)	Percentage of GDP	Nominal (trillions of pesos)	Percentage of GDP	
Large-value Payment System							
Large Value							
CUD	6,765	7,518	61.3	4.17	78.5	4.99	- Settlement of the cash leg of operations cleared by the DCV, Deceval, the BVC, the CRCC, and retail-value payment systems. - Payment of the cash leg of monetary operations; monetary policy operations: repos and interest-bearing deposits. - Funds transfers ordered directly by the participants. - Debit to accounts for items such as interbank clearing, VAT, GMF, and commissions, among others.
Systems for Clearing and Settling Financial Assets							
Securities Depositories							
DCV[b/]	2,425	2,833	43.0	2.93	50.8	3.23	- Pertains to transactions with government securities on the primary market (trusteeship), the secondary market, and monetary operations by *Banco de la República*.
Deceval[c/]	6,678	8,350	3.1	0.21	3.9	0.25	- Comprised of transactions with government securities, corporate debt and shares of equities on the primary and secondary markets. Includes cash collateral.
Central Counterparty Clearing Houses							
CRCC S.A.	8,503	7,690	31.5	2.14	40.4	2.57	- The CRCC clears and settles through the novation of fixed-income products, equity, financial and energy derivatives transactions, and the peso-dollar foreign currency spot. - For forward transactions on TES, the CRCC performs the respective risk management, while the gross clearing and settlement is performed at the DCV-CUD. During 2023, it managed a daily average of 946 transactions for a value of COP 13.35 trillion.
Retail-value Payment Systems							
ACH Colombia	1,318,505	1,413,908	6.8	0.51	7.7	0.49	- Recurring payments such as payroll, pensions, suppliers, social security, dividends and, in general, invoicing for the purchase of all types of goods and services, as well as automatic collections for these same items.
ACH Cenit	91,315	100,787	1.3	0.09	1.5	0.09	- Mainly drafts and payments from the National Treasury to territorial entities.
Cedec	19,256	14,755	0.6	0.04	0.5	0.03	- Checks for the purchase and sale of goods and services, and to discharge obligations, among others.
Cards Networks	5,435,317	6,610,978	0.8	0.05	0.9	0.06	- Transactions using debit and credit cards.

a/ Averages calculated based on the days each infrastructure was operating.
b/ Corresponds to the settled value of transactions cleared and settled through the DCV and originating in the primary, secondary, and money markets. It includes operations settled with delivery versus payment and free of payment. In the case of sell/buy-backs, repos, and TTS, it includes initial agreements and reverse operations.
c/ Pertains to the settled value sent by the investor in the acquisition of a security.
Sources: *Banco de la República*, Deceval, BVC, ACH Colombia, CRCC, *Credibanco*, Mastercard, *Redebán*, Visa, and *Visionamos*.

As mentioned before, towards the settlement of obligations from other external systems[6] for operations conducted by financial intermediaries and all other agents in the securities, forex, derivatives, and domestic currency markets in both large and retail values, converges in the large-value payment system (CUD). The average daily value of the transactions settled there in 2023 came to COP 78.5 trillion (t), equivalent to 4.99% of annual gross domestic product (GDP), recording an increasing trend compared to its historic trend. After that, there are operations in the securities market (COP 54.5 t): DCV for a value of COP 50.8 t, and Deceval for COP 3.9 t. Following, in order of importance with respect to value, are the operations with derivatives and repos, spot transactions, and temporary transfers with equities, and spot foreign exchange cleared and settled by the CCP (COP 40.4 t); the sum of the two ACHs (Cenit and Colombia) COP 9.2 t; operations for clearing cards and ATMs (COP 0.9 t), and, finally, the interbank clearing settled through the Cedec system (COP 0.5 t).

6 The External Resolution 05 issued in 2009 by the Board of Directors of *Banco de la República* (BDBR) defines as "external system" as any payment system other than in determined large-value payment system, as well as any securities clearing and settlement system, currency clearing and settlement system, or a system that clears and settles futures, options and other financial assets, including central counter-party risk clearing houses, provided they are duly authorized by the competent authority to operate in Colombia.

2. The Financial Infrastructure in Colombia

The life cycle of operations in financial markets begins with a purchase or sale instruction and ends with delivery of the traded asset (government and private bonds, equities, foreign exchange, and financial derivatives). Finalizing these operations requires the respective financial asset to be cleared and settled through financial market structures (securities depositories, central counterparties, among others) and the money to be transferred (backed by central bank currency). In Colombia, the large-value payment system (CUD) of *Banco de la República*, as the backbone of the infrastructure, settles the cash legs of transactions in the clearing and settlement systems for financial assets, and in the retail-value payment systems.

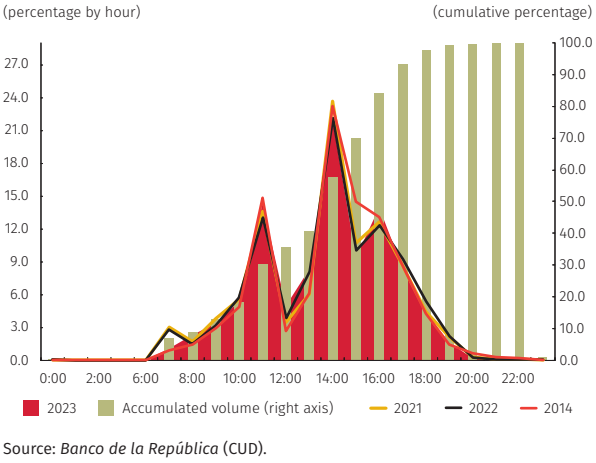
The domestic financial infrastructure was safe and efficient throughout the year.

The services of the financial infrastructure were provided on a continuous basis, displaying good performance overall.

The operational availability of the entire infrastructure in the local market exceeded 99% of the total amount of time established for service during the year. Specifically, the CUD offered continuous service during 99.6% of its normal business hours. The DCV was available 99.8% of the time; Deceval, 99.9%, and the CCP services for participants were available 99.4% of the time, on average, for all segments. In other words, the availability of services was quite good.

Over 80% of the transactions handled through the country's infrastructures were settled before 5:00 p.m.[1], which indicates the risk of operations being left unsettled after the systems close was mitigated to a large extent. During 2023, the degree of timeliness in the CUD went from 82.8% to 85.34% of operations settled before 5:00 in the afternoon (Graph 2.1). The DCV and Deceval settled 97% and 92%, respectively, before that time.[2] To know in detail the evolution of the main payments made in the CUD, Annex 1 contains a timeline graph that allows you to observe hour after hour how the settlement of operations progresses from opening to closing.

Graph 2.1
Distribution of Transactions in the CUD System, by Hourly Range in Value



Source: *Banco de la República* (CUD).

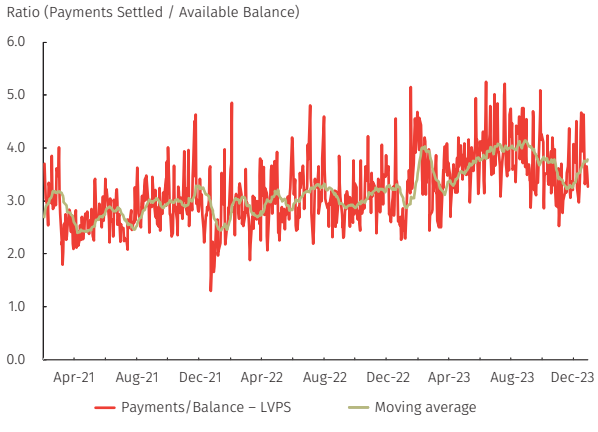
1 It is important to point out that the CUD, in line with what has been implemented by other large-value payment system managers, has a fee scheme that offers participants incentives not to wait until the end of the day to settle pending transactions. The charge before 5:00 p.m. is per transaction settled (i.e. the amount does not matter), while the fee after that time is determined by the amount of the transaction (COP 2.5 per million). On average, a transaction settled between one hour and another can range from COP 3,370 to COP 40,000.

2 The closing time for the CUD and the DCV is 8:00 p.m., but infrastructure participants may request an extension of this schedule until midnight.

As in previous years, there are sharp transaction settlement peaks in the CUD at certain times of the day (Graph 2.1). This is due mainly to automatic activation of the CUD's netting mechanisms that aim to settle as many pending transactions as possible with the liquidity at hand.[3] In particular, the 23.6%, 22.1%, and 22.0% peaks in payments observed at around 14:00 hours in 2021, 2022, and 2023, respectively, were generated because of the liquidity saving mechanisms (simulated netting) offered by DCV to the securities leg and cash leg, and *BanRep* reverse repos to increase money supply.

Efficiency in the settlement of transactions in the CUD, measured as the ratio between the value of payments made and the liquidity participants have on hand to make those payments, increased slightly with respect to the previous year (Graph 2.2). For every COP 3.0 settled in 2022, there was COP 1 in daily average available balance; in 2023, this ratio increased to COP 3.7 per COP 1 as a result of an increase in payment activity compared to the observed balance. Although the indicator suggests greater efficiency in the use of banks' liquidity, the growth in efficiency rates achieved by the DCV's liquidity-saving mechanisms that facilitate the settlement of public debt market operations impact on the year's results. This is consistent with what is reported in Table 2.2, which shows a significant increase in the amounts traded in the secondary and money market that is instrumentalized with these securities.

Graph 2.2
Changes in the Ratio between Payments Made and the Available Balance (Daily averages)



Source: *Banco de la República* (DSIF).

2.1 Payments in Financial Markets

There was more momentum in the large-value payment system.[4]

Banco de la República's large-value payment system (CUD) saw an increase in activity with respect to the previous year, thanks to more momentum in the sovereign debt market (purchase/sales and sell/buy-back transactions), in repos to increase the supply of money, and direct transfers of funds between participants.

The value and number of CUD operations increased (Graph 2.3 and Table 2.1). The daily average number of operations (7,518) was up by 11.13% in 2023 compared to the previous year; likewise, the nominal value (COP 78.5 t) increased 28.05% with respect to that same year (15.75% in real terms). In the annual total, the value of the amount paid represented 12.1 times

Graph 2.3
Statistics on the Number and Value of Operations in the Large-value Payment System (CUD) (Daily averages)

Source: *Banco de la República* (CUD).

3 Currently, the DCV activates its simulated netting mechanisms at 11:50 a.m., 2:20 p.m., 3:30 p.m., 4:15 p.m., 4:50 p.m. and 5:45 p.m.

4 For more information on the performance of financial markets that clear and settle trades through FMIs, see *Reporte de Mercados Financieros*: https://www.banrep.gov.co/es/terminos-busqueda/reporte-mercados-financieros-0

Table 2.1
Number and Value of Operations in the CUD System

Year	Daily Average					Annual Value			
	Number of Operations	Value		Average Transaction Value		Number of Operations	(Trillions of pesos)	(Trillions of 2023 constant pesos)	(Number of times GDP)
		(Trillions of pesos)	(Trillions of 2023 constant pesos)	(Billions of pesos)	(Billions of 2023 constant pesos)				
2014	7,570	35.9	60.0	4.7	7.9	1,847,039	8,766	14,638	11.5
2015	7,430	41.8	65.3	5.6	8.8	1,805,454	10,149	15,875	12.6
2016	7,574	52.1	77.0	6.9	10.2	1,863,090	12,812	18,951	14.8
2017	7,921	55.3	78.6	7.0	9.9	1,932,687	13,494	19,175	14.7
2018	8,007	55.0	75.7	6.9	9.5	1,969,837	13,524	18,626	13.7
2019	6,774	50.8	67.3	7.5	9.9	1,652,880	12,383	16,430	11.7
2020	6,537	55.5	72.5	8.5	11.1	1,589,352	13,517	17,648	13.5
2021	6,188	53.3	65.8	8.6	10.6	1,516,294	13,047	16,128	10.9
2022	6,765	61.3	67.0	9.1	9.9	1,657,332	15,027	16,421	10.2
2023	7,518	78.5	78.5	10.4	10.4	1,819,312	19,007	19,007	12.1

Source: *Banco de la República* (CUD).

Colombia's gross domestic product (GDP) in 2023; i.e., a daily average of 4.99% of GDP, higher than that observed in 2022, when it accounted for 4.17% of GDP.

The increase in the value settled through the CUD is explained primarily by the considerable degree of activity in the financial markets for sovereign debt instruments, by monetary operations on the part of *Banco de la República*, and direct transfers of funds between participants. The high points were *BanRep* repos to expand the money supply (with an increase of COP 0.3 t), the purchase and sell activity (increase of COP 1.4 t), and the transfers of funds between participants, which increased COP 11.5 t, stand out. Faced with the latter, it is important to highlight that these transfers come from interactions both between financial institutions (e.g., transfer of resources between checking accounts and deposit accounts, services associated with the custody of securities, interbank payments), and between an entity and an FMI (e.g., return of collaterals, collection of debit positions in a retail-value payment system, etc.).

Payment activity in the CUD remained dominated by direct transfers of funds, followed by operations that instrumentalize monetary policy activity and financial market activity with securities deposited in the DCV. While funds transfers occupied 55.1% of CUD activity, the settlement of the expansion repos' money leg and the provision of intraday liquidity to the payment system that *Banco de la República* manages, represented 22.4%. Likewise, the settlement of sales and purchase, repo, and sell/buy-backs transactions between agents whose collateral is sovereign debt instruments deposited in the DCV had a 22% share.

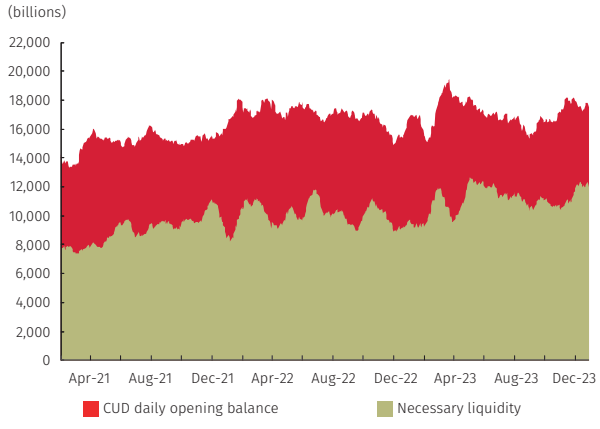
The liquidity entities had at the beginning of the day, which is a source for timely payment, remained adequate. This is a contribution to reducing potential intra-

Table 2.2
Origin and Item of Operations for which Deposit Accounts in the CUD System Are Debited, Number, and Value of Operations (Daily averages in Billions of Pesos)

Sovereign debt operations in the DCV[a/]	Year 2022		Year 2023		Year 2022		Year 2023	
	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value
					(Percentage)			
Primary market[b/, c/]	55	425	55	444	0.8	0.7	0.7	0.6
Secondary market[d/]	835	3,516	1,047	4,874	12.3	5.7	13.9	6.2
Money market[d/]	752	12,075	942	11,853	11.1	19.7	12.5	15.1
Others DCV[e/] (2)	28	159	27	288	0.4	0.3	0.4	0.4
Total sovereign debt operations in the DCV (1)	1,671	16,176	2,072	17,459	25	26	28	22
Monetary policy[f/, g/, h/]	107	11,793	137	14,825	1.6	19.2	1.8	18.88
Provision of liquidity in the payment system (*Banco de la República*)[i/]	81	2,598	80	2,819	1.2	4.24	1.1	3.59
Direct transfers of funds in the CUD[j/, k/, l/]	3,355	24,364	3,569	35,896	49.6	39.7	47.5	45.7
Deceval[m/]	662	1,308	734	1,876	9.8	2.1	9.8	2.4
Colombian Stock Exchange (BVC)[n/]	0.0	0.0	0.1	1.1	0.0	0.0	0.0	0.0
Central Counterparty Clearing House (CRCC)[o/]	19	144	19	168	0.3	0.24	0.3	0.21
Central Counterparty Clearing House (CRCC)[p/]	16	1,223	16	1,246	0.2	1.99	0.2	1.59
Retail-value payment systems[q/]	266	3,569	290	4,115	3.9	5.82	3.9	5.24
Total direct transfers of funds in the CUD	4,318	30,608	4,628	43,303	63.8	49.90	61.6	55.13
Other transactions[r/]	588.2	160.4	601.9	133.6	8.7	0.26	8.0	0.2
Total operations debited in the CUD	6,765	61,335	7,518	78,540	100	100	100	100

a/ Transfers of funds in the CUD system, originating with securities transactions in the DCV.
b/ Placement of securities that effectively implied an outlay of resources. Does not include reinvestments in agricultural development titles (TDA), tax refund certificates (CERT), sovereign debt securities (TES) of court rulings, and agricultural and constant-value bonds, among others
c/ Pertains to money effectively transferred in the CUD for the payment of principal or yield on securities deposited with the DCV, excluding payments for *Banco de la República* investments.
d/ Does not include cross trades; that is, operations where the same financial entity is both the originator and recipient of the cash leg.
e/ Deposit account debits originating with the collection of fees, penalties, and commissions in the DCV.
f/ Pertains to reverse repos. In the case of repo chains, it includes only net value and interest.
g/ Establishment of reverse repos.
h/ Establishment of interest-bearing deposits. This includes DGCPTN.
i/ Pertains to reverse intraday repos. In the case of repo chains, it includes only net value and interest.
j/ Clearing and settlement of operations from external systems or operations processed by deposit account entities directly at their CUD stations.
k/ Transfer of funds (money uploads) from the leading banks to brokerage firms, trust companies, and pension funds (known as clients), so they have enough liquidity in their deposit accounts to cover the cash leg of their securities operations. The banks debit this money from the client's current account, in advance.
l/ Transfers of funds from Deceval to the creditors in securities transactions (through delivery versus payment), with the initial transfers from the debtors to Deceval are broken down according to the elements in item m/; transfers of funds from the ACH account and from the networks' clearing systems to institutions with a multilateral creditor position in each clearing cycle; initial transfers from debtors to the ACH and the networks are in item q/; Operations – Paragraph 10 in Article 879 of the tax statute; transfers between accounts belonging to the same institution; transfers of funds from the Foreign Exchange Clearing House account to foreign exchange market intermediaries (IMCs) with a multilateral creditor position in pesos (payment-versus-payment mode); initial transfers from IMCs with a debtor position to the Foreign Exchange Clearing House are in item p/; credit disbursements; payment by issuers of securities; transfers of funds from the account of the Central Counterparty Clearing House to institutions with a multilateral creditor position in pesos; initial transfers from institutions having a debtor position with the Central Counterparty Clearing House are shown in item o/; and constitution-return of collateral.
m/ Payment of principal and yield, and transfers of funds from debtor institutions to Deceval, so it can guarantee the settlement of operations through delivery-versus-payment modality; includes, among others, purchase and sale, sell/buy backs, repos, and change of depositor of securities deposited with Deceval.
n/ Multilateral net clearing and settlement of the cash leg in stock trades.
o/ Transfers of funds from institutions with a debtor position in pesos to the Central Counterparty Clearing House, so it can guarantee the settlement of derivatives clearing (daily settlement and at contract maturity). Does not include the cash Forex segment.
p/ Transfers of funds from IMCs with a debtor position in pesos to the CRCC, so it can guarantee settlement through payment-versus-payment modality.
q/ Transfers of funds from institutions with a multilateral debtor position to the ACH and the *Credibanco*, *Redebán*, *Servibanca*, and ATH networks, so they can guarantee the settlement of clearing for electronic funds transfers and transactions with debit, credit cards, and ATMs. It also includes check clearing and settlement.
r/ Provision of cash from *Banco de la República*'s Treasury to financial institutions with deposit accounts, payment of services, commissions and fees, liens, and financial transaction tax (GMF) collection.
Source: *Banco de la República* (CUD).

Graph 2.4
Evolution of the CUD Balance at the beginning of the Day
(20-day moving average)



Source: *Banco de la República* (CUD).

day liquidity pressure and helps the system to operate safely. Graph 2.4 shows the system's aggregate balance averaged COP 19.4 t daily and was up by 0.6% with respect to the previous year (-7.95% in real terms). However, the liquidity required by the system[5] for its safe operation increased by 10%, from COP 10.0 t to COP 11.0 t. This average increase in intraday liquidity needs could be related to a liquidity situation experienced since the second quarter of the year and which is characterized by: i) significant deviations between the Benchmark Reference Index (IBR in Spanish) and the monetary policy rate (MPR), ii) the definitive implementation of the NSFR regulations, and iii) concentration of maturities of CDT[6] in certain periods of the year. It is important to note that in the midst of this situation the system's liquidity levels were adequate, since the ratio between available liquidity and necessary liquidity remained around 1.5. This means that by 2023 for each COP 1 required to make payments in the CUD system, COP 1.5 was available.[7]

Central securities depository (DCV and Deceval) and the CCP are the components of the financial infrastructure responsible for clearing and settling transactions with financial assets (securities, derivatives, and foreign exchange). They interact with the CUD to settle the money leg of their transactions.

Financial market infrastructures saw greater momentum.

Larger amounts cleared and settled were observed through the Central Securities Depository (DCV) because of an increase in repo and sell/buy-backs transactions. Likewise, there was an increase in the transactions managed in the CCP, mainly due to an increase in the products of the fixed income segment, those with underlying TRM and the contracts non-delivery forward (NDF) peso/dollar.

The average daily value of transactions settled in the DCV rose by 18% (8.0% in real terms); i.e., from COP 43 t to COP 50.8 t (Graph 2.5, panel A), mainly due to a greater dynamism of 51% (38% in real terms) in repo and sell/buy-back transactions. Similarly, trading grew 37% (25% in real terms) and primary market transactions grew 46% (33.5% in real terms). On the other hand, the services of the DCV for *Banco de la República* (OMO and provision of liquidity to the large-value payment system) had nominal values similar to 2022.

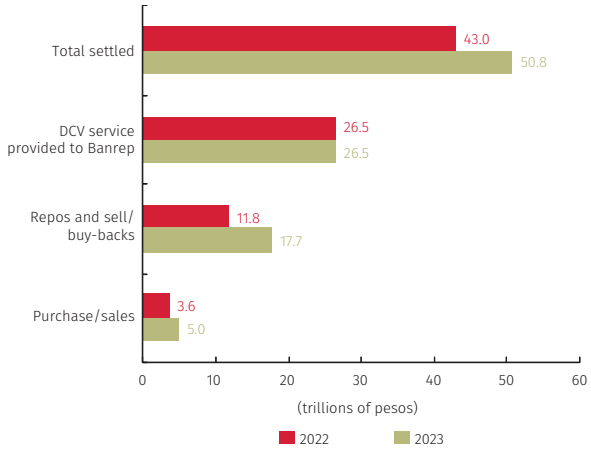
5 The minimum liquidity required for a LVPS to function properly was determined based on the document entitled "Monitoring Tools for Intraday Liquidity Management": https://www.bis.org/publ/bcbs248.pdf

6 In this regard, please consult the box "Recent Liquidity Situation and the Role of *Banco de la República*" available at: https://www.banrep.gov.co/es/publicaciones-investigaciones/reporte-mercados-financieros/recuadro-1-tercer-trimestre-2023

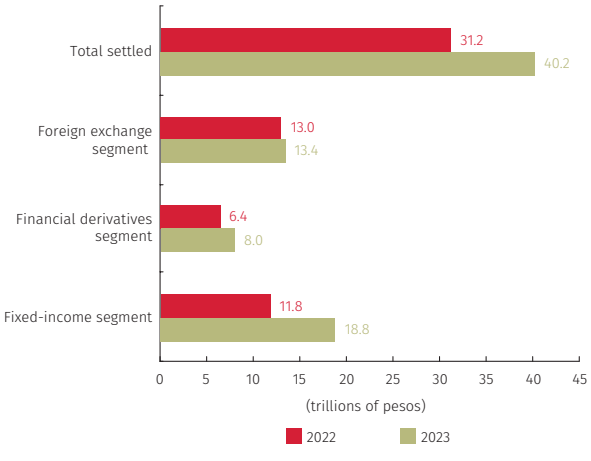
7 For more information on the relationship between reserve requirements and excess liquidity in the CUD, please consult the box "Importance of the Initial balance in the Large-Value Payment System as a Source of Liquidity that Contributes to Mitigating Intraday Liquidity Risk," published in the 2023 financial infrastructure report (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/10690/RIF_2023.pdf).

Graph 2.5
Daily Average for Transactions Carried Out through Financial Market Infrastructures

A. DCV



B. CRCC



Sources: *Banco de la República* (DCV) and Central Counterparty Clearing House (CRCC).

The number of average daily transactions increased by 17%, from 2,425 in 2022 to 2,833 in 2023. This growth was mainly explained by higher sell/buy-back transactions and in purchase/sales, where there was growth of 26% and 21%, respectively. The balance in custody increased in current pesos by 10%, from COP 480 t to COP 529 t at the end of the year (94% TES).

***Banrep* has been working on the modernization of the DCV, aiming to incorporate new functionalities** (e.g., interoperability through ISO 20022 messages and universal entity code), strengthen the provision of services with strict IT security standards, and contribute to the proper functioning of payment systems.

It also seeks to improve the user experience through system design, reduce sources of operational risk through end-to-end process automation and efficient management of user management, maintenance, and support.[8]

At Deceval, the average daily value of cleared and settled transactions increased by 23% (13% in real terms), having gone from COP 3.1 t to COP 3.9 t. Regarding its function as a depository, the balance in custody in current pesos rose by 8.0% (-1.0% in real terms): from COP 565 t to COP 609 t. Out of this last amount, 44% pertained to equities; 34% to CDTs; 12% to bonds; and the remaining 11% to other securities.

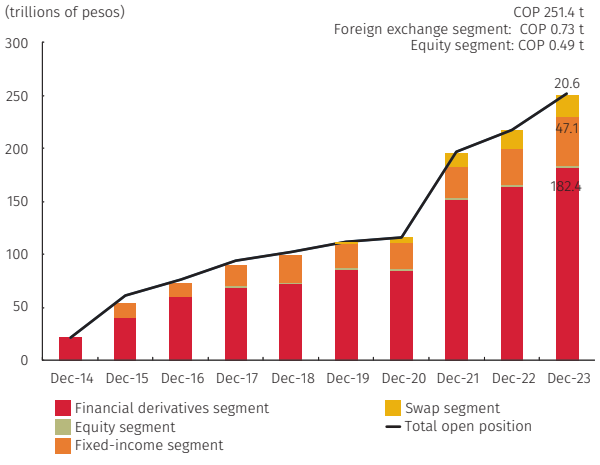
The CCP exhibited more momentum, having experienced an increasing by 26.8% (13.6% in real terms) the value of the cleared and settled transactions, this increase is mainly supported by the variations of the transactions of the fixed income segment and those with underlying TRM.[9] On a daily average for all segments, it compensated and settled COP 40.4 t, of which it stands out that: COP 8 t corresponded to the financial derivatives segment and COP 13.4 t to the foreign exchange segment. Growth compared to the previous year was 24.8% (12% in real terms) and 1.3% (-9.3% in real terms), respectively (Graph 2.5, panel b).

On the other hand, the value of sell/buy-backs and TTS operations on public debt managed by the CCP registered a daily average of COP 18.83 t, which represented an increase of 57.9% (41.5% in real terms). In addition, the CCP began to provide the central counterparty service for sell/buy-backs TES ope-

8 For more information, see *Banco de la República's* page, the section modernization of the Central Securities Depository (banrep.gov.co), and the implementation documents of the new Central Securities Depository (DCV) on the same page.

9 The high volatility in the foreign exchange market during 2023 explains, on the one hand, the increase in the value in pesos of the transactions cleared and settled by the CCP and, on the other, the incentive of market participants to make hedging transactions and search for better returns. In addition, in 2023 the public debt TTS operations were consolidated, which were incorporated by the CCP in the last quarter of 2022.

Graph 2.6
Evolution in the Open Position, by Segment and at the Close of Each Year



Sources: CRCC and *Banco de la República* (DSIF).

rations, negotiated in the MEC, between settlement members and third parties, as of September 2023.

The added momentum in operations was reflected in a higher value for the open positions with which the CCP closed out 2023 (COP 251.4 t), which meant an increase of 15.6% (-5.8 % in real terms) with respect to 2022. This was due to growth in positions in OIS futures, in long-term interest rate swaps, and in sovereign debt sell/buy-back operations, with respective increases of 241% (212% in real terms), 70.3% (56% in real terms), and 37.5% (26% in real terms). As for the share of the segments and values in the gross open position, the financial derivatives segment had an open position of COP 182.4 t (72.5%), the fixed income segment, COP 47.1 t (18.7%), the interest rate swaps segment, COP 20.6 t (8.2%), the equity income segment, COP 0.5 t (0.2%) and the foreign exchange segment, COP 0.8 t (0.3%) (Graph 2.6).

The impetus in transaction clearing and settlement and what it means in terms of an eventual increase in the CCP's exposure to its clearing members implies more risk and, therefore, more of a requirement for collateral. However, centralized clearing offers the market the possibility of offsetting this added value in collateral by clearing across products or maturities. This optimization of collateral is perceived as lower cash or securities requirements (collateral per position) when there are long positions (purchases) and short positions (sales) in the same product, but with different maturities (e.g., long and short positions in TES futures contracts for specific references with different durations), or when there are different positions in several instruments with correlated underlying assets, such as long positions in TRM futures contracts and short positions in NDF currency forwards (pesos/dollars). The percentages of these lower requirements during 2023 for the main products were: 62% for futures contracts on TRM and on peso/dollar NDF forwards; 68% for interest rate futures and swaps, and 27% for positions in sovereign debt sell/buy-backs.

In addition, multilateral clearing of peso/dollar spot transactions generated liquidity savings of 83% for CCP members. The average daily gross value traded was USD 1,396 m and the average daily net value settled was USD 237 m.[10]

The CRCC maintained the counterparty risk management scheme throughout the year. A disruption in the services it provides could have systemic implications for the markets and eventually for local financial stability due to the relevant role it plays in mitigating counterparty and liquidity risks in the local financial markets, to the constant increase in cleared and settled transactions (and, consequently, to the

10 Information on variations and details concerning operations, open positions and changes introduced by the CCP in 2023 can be found in Annex 1.

larger open positions of its clearing members), and to the lack of a substitute entity in event CCP service is interrupted. Therefore, the risk management model must be sufficiently robust and efficient to cope with extreme market scenarios, and local regulations for the resolution or liquidation of a central counterparty should include specific tools designed to provide for an orderly settlement of open positions.

It should be noted that the European Securities and Markets Authority (ESMA) certified the CCP as a central counterparty that complies with the regulations established for financial infrastructures in the European Union (EU), as of February 2023.[11] This recognition is of great importance due to the rigorousness of the assessment performed. Specifically, certification is granted once ESMA ensures that the institution meets the criteria established to determine whether a central counterparty established in a third country has or can acquire systemic importance for the financial stability of the EU or one or more of its Member States. Criteria are also considered to determine the approval of risk management models, corporate governance, the risk profile of the entity, activity indicators, transparency in relation to activities, etc.

Another sign of adequate risk management by the CRCC was the fact that none of the seven instances of delay in 2022 on the part of several clearing members in fulfilling their obligations impacted the provision of its services. In one of these instances, the CRCC was required to activate the liquidity risk mitigation tools[12] for the foreign exchange segment, thus, the simultaneous use of four of the nine-dollar liquidity providers was necessary. Its risk mitigation processes and mechanisms allowed the CRCC to continue the multilateral clearing processes without disrupting the normal functioning of the foreign exchange market.

2.2 Retail Payments

2.2.1 Retail-Value Payment Systems

The function of retail-value payment systems is to clear and settle transactions made with the various payment instruments that exist in Colombia; namely, checks, credit and debit transfers through the automated clearing houses (ACH) (electronic payments within the circuit of businesses and individuals), credit cards and debit cards, among others. Their main characteristics, value, and number of transactions are described in this section.

11 Delegated Regulation (EU) 2020/1303 of 14 July 2020 establishes the criteria and considerations for carrying out the assessment of aspiring counterparties.

12 The tools to mitigate liquidity risk in dollars involve the use of pre-approved lines of credit with liquidity providers through an overnight one-day operation swap peso/dollar. If the liquidating member who is in difficulty (in arrears) does not pay its obligation, the second part of the swap operation will have to be closed and final purchase of the missing amount in USD will have to be made with the same supplier or with an intermediary in the foreign exchange market (IMC in Spanish). To this end, the CCP is empowered to operate as an IMC and seek the necessary dollars directly in the foreign exchange market.

Box 1: Cyberattacks in the CUD Large-Value Payment System and its Systemic Impact

1. Introduction

The CUD large-value payments system is an essential component of the country's payments infrastructure. This is because there is compliance with the cash leg of the obligations contracted in the financial markets (i.e., foreign exchange market, fixed income, equities, derivatives), as well as the exchange of funds between financial institutions after the multilateral net clearing of electronic payment instruments.

Payments between entities participating in the CUD are highly interconnected because the payment made by one entity is the source of liquidity for another. Thus, the inability of one entity to make its payments can, in turn, affect others, which would trigger events of a systemic nature. Moreover, if it is considered that payments made in a system such as the CUD are of a critical and urgent nature.

The growing dependence on the financial system, and in particular in financial market infrastructures, of information and communications technologies for their operation and the processing of the substantial information they handle, increases their exposure to cyber risk. This vulnerability is intensified by relying on a set of critical providers of essential services (hardware, software, electric power, and communications) for the continuous operation of the system.

According to the document Cyber Resilience for Financial Market Infrastructures published by the Committee on Payment and Settlement System (CPMI) and the Technical Committee of the International Organization of Securities Commissions (Iosco) (CPMI-Iosco, 2012), cyber risk is defined as: the combination of the probability of an event occurring within the scope of information assets, the computing and communication resources of an organization, and the consequences of that event for an organization.

According to Aldasoro et al. (2022), the most common events or methods of cyberattacks are ransomware, data theft, malware, cross-site scripting, identity theft (phishing), password decryption, and denial of service attacks. In this regard, an alternative to approach the risk of cyberattacks is through the analysis of the consequences or impact on the dynamics of payments in the CUD if its participants were victims of a cyber-attack.

Using simulations, the issue of what could happen to intraday payments made by entities if they were the subject of a cyberattack is addressed. For this purpose, and based on what was indicated by Eisenbach, Kovner, and Lee (2022a; 2022b), an individual attack typology and a massive one are taken into consideration. In the first, entities with the greatest potential for systemic impact in the CUD are selected, in accordance with the indicators of systemic importance prepared by the Financial Infrastructure Oversight Department (DSIF in Spanish) for the monitoring of financial infrastructures.[1] In the second, the criterion is the unavailability resulting from a cyberattack on the main communication service provider used by the entities to connect to the CUD. In both cases, the CUD is assumed to remain operational.

This box presents the resulting payment defaults (value and number of entities affected) from the scenarios described and also proposes a series of measures that could be considered to mitigate the risks associated with a cyberattack. Thus, provide a technical outlook that addresses cybersecurity risk and, additionally, elements that can contribute to the stability and resilience of the financial system are shared.

1 Considering the number of counterparties, quantity, and amount of transactions, as well as the role that the distributor or receiver of payments may have.

This box is organized into five sections, including this introduction. The second explains the main elements considered for the construction of simulation scenarios. The third discusses the results, emphasizing how entities not affected by the cybersecurity event could react. The fourth includes policy considerations associated with strengthening cybersecurity. The fifth section presents the conclusions and recommendations.

2. Considerations on the Design of a Cyberattack Scenario

The design of the scenarios developed here is based on the taxonomy of hypothetical cyber risk scenarios that Kaffenberger and Koop (2019) built on the Atlantic Council's (2016) proposal. According to this scheme, the scenarios can be classified into three main groups: 1) high-impact operational risk, 2) upstream infrastructure failures, and 3) external shocks and other scenarios.

The list of hypothetical scenarios related to operational risk is made up of 1) blocking malware or ransomware in a financial institution, 2) fraudulent bank transfer, 3) data breach and targeted information leakage, 4) malware in trading systems, 5) large-scale cyberattack on a global messaging network for financial transactions, and 6) simultaneous attack on systemically important institutions. The group of scenarios linked to upstream infrastructure failures includes: 1) Disruption Attack to the Central Clearinghouse, 2) disruption attack on payment processing platforms, 3) massive infection by malware, 4) cloud service provider failures, and 5) disruption of public services with domino effects. In turn, the group of external shocks includes the following scenarios: 1) cyberattack in retaliation for sanctions and 2) armed conflict.

The hypothetical scenarios implemented here to evaluate the impact that a cyberattack would have on the settlement of transactions in the CUD are framed in the high-impact operational risk and upstream infrastructure failure groups of the proposal by Kaffenberger and Koop (2019) and correspond to Table B1.1.

Table B1.1
Simulated Cyberattack Scenarios on the CUD

Simultaneous cyberattack on systematically important financial institutions	Cyberattack on communications providers
This could occur due to a blockage that would cause most of the computers of a participant in the LVPS to become unusable following malware or ransomware cyberattacks. This type of attack occurred with the Shamoon virus and the WannaCry ransomware, which significantly affected the hardware and operation of a large number of computers.	This could occur due to the blockage caused by the absence of the communication channel between the entities and the CUD, as a consequence of a malware or ransomware cyberattack on the main telecommunications provider. This, recognizing that the dependence of the financial sector, including financial market infrastructures, on electricity services and telecommunications, exposes them to risks that can impact the functioning of financial markets and economic activity.
Within Kaffenberger and Kopp's (2019) taxonomy of cyber risk scenarios, this type of attack is part of the high-impact operational risk group and specifically corresponds to hypothetical scenarios 1: of operational blocking of a financial institution through a malware or ransomware attack, and 6: of simultaneous cyberattack on systemically important financial institutions.	Kaffenberger and Koop (2019) classify this scenario within the group of upstream infrastructure failures and correspond to scenario 5: disruption of public services, causing chain effects.
This type of simulated cyberattack is similar to the one conducted by Eisenbach, Kovner, and Lee (2022a; 2022b) on the five major banks participating in Fedwire.	

Note: Financial institutions' access to the electronic Sebra services offered by *Banco de la República* (*Banrep*) can be done through: 1) Dedicated communication channels, point-to-point, between their facilities and *Banrep*, or 2) the Internet.
Source: https://www.banrep.gov.co/sites/default/files/paginas/reque_tecnico_conex_sebra.pdf.

Data: For the simulation exercise, the transactions of the ten days with the large value of payments that occurred during 2023 between 7:00 *a.m.* and 9:00 *p.m.* in the CUD were taken. Transactions between *Banrep*, the General Directorate of Public Credit and the National Treasury, and the General System of Royalties are excluded.

Reference scenario: This considers the observed transactions that were settled, one by one, in the sequence in which they occurred under the real-time gross settlement (RTGS) modality with the available beginning-of-day balances in deposit accounts of its participants during the selected dates. The value and number of successfully settled payments in this scenario are the basis for comparison to measure the impact of a cyberattack on previously formulated scenarios.

How participants react: The cyberattack scenarios described are elaborated considering that, due to the operation of the large-value payment system, the counterparties, not knowing the identity of the attacked entity (which is the one subjected to the cyberattack and stops sending payments), react differently in sending payments. Thus, in the face of the insufficient balance caused by the defaults of the attacked entity, these counterparties try to comply with the payments in the sequence of the reference scenario. However, if they are not successfully settled, their response to retry the settlement can be passive or active.

In the passive response, the affected entities (AEs), that is, those with transactions that could not settle on the first attempt, as occurred in the reference scenario, would not retry to settle them and would accumulate in a batch of defaulted transactions. Thus, the liquidity of these defaulted payments would not reach their recipient entities and would determine the size of the chain of defaults and the number of AEs in the system.

In turn, in the active response counterparties store in a queue the transactions that initially could not be settled and, to the extent that they enter resources into their account for incoming payments, they try to settle their pending queued payments using an algorithm FIFO (first in – first out). Although in this form of reaction it is also feasible to assume the lack of knowledge of the identity of the AE, the response of the counterparties makes liquidity more efficiently managed and the impacts on the value of payments and the number of entities affected are less than the resultant under a passive response.

Under each scenario, simulations were carried out where the entities reacted passively or actively to the defaults of the attacked entity, to evaluate the potential impact of the cyberattack in terms of the value and number of defaulted payments and the number of entities affected.

3. Results

3.1 Simultaneous Cyberattack on Systemically Important Entities

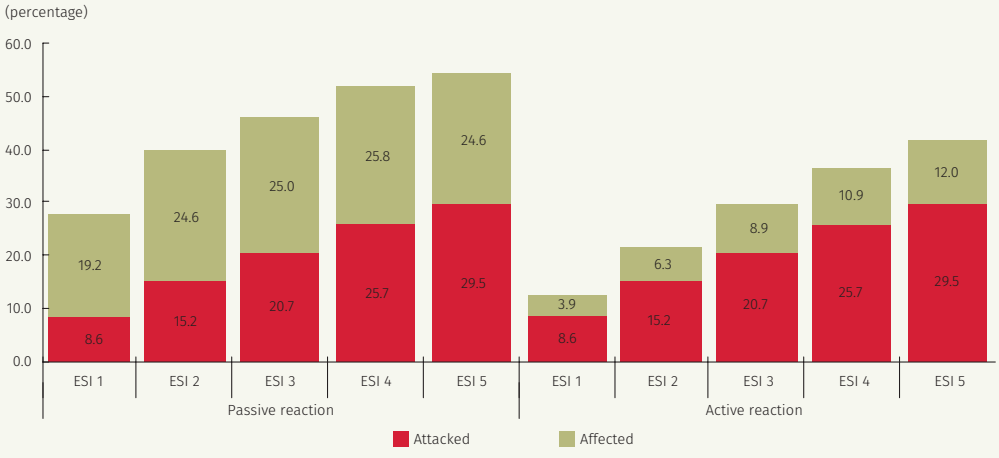
The simulation exercise, as Eisenbach, Kovner, and Lee (2022a) do for Fedwire is performed, by directing cyberattacks on up to five systemically important financial entities (ESI in Spanish) at the same time.

The selection criteria for ESI subjected to cyberattack for each of the days considered corresponds to that prepared by the DSIF to monitor the CUD. This is based on a scale of importance calculated through an analysis of major components including variables such as the number and amount of transactions carried out, the number of counterparties, as well as the role that each entity participating in the CUD may have as a distributor or receiver of payments.

Graph B1.1 exhibits the percentages of the value of payments that, concerning the reference scenario, ceased to be settled, both for the ESI subjected to simulated cyberattacks and those affected that could not comply with all their payment obligations when both a passive response and an active response are assumed.

This graph shows that when a passive response is assumed, the average value of defaulted payments, measured as a percentage of the value settled on the selected days, for the attacked ESI is between 8.6% for the main attacked ESI, to 29.5% when cyberattacks target the five most important ESI at the same time. Simultaneously, and in the same unit of measure, the average percentage of defaults of the affected entities fluctuated between a minimum

Graph B1.1
Value of Defaults as a Percentage of the Baseline Scenario: Passive and Active Reactions



Source: *Banco de la República* (DSIF).

of 19.2% when the cyberattack occurred to the main ESI, and a maximum of 25.8%, when the attack was directed to four ESI.

When affected entities are considered to take an active response, using the liquidity provided to them by their counterparties to retry the settlement of their defaulted payments, the impact on the system is significantly reduced. It can be seen in Graph B1.1 that, as the cyberattack in both the passive and active responses simulation targets the same ESI, the value of the defaults is the same. However, those of the affected entities are reduced due to the more efficient use of liquidity.

Indeed, in Graph B1.1 it is also observed that, under active response, the percentage of the default value of the affected entities is reduced in relation to the passive response. In this case, the average percentage of the value of the defaults, compared to the reference scenario, is 3.9% when the main ESI cannot send payments and 12.0% in the extreme case of a cyberattack on five ESIs.

The same Graph B1.1 exhibits that the values of defaults, measured as a percentage of observed payments (reference scenario), increase as the number of ESIs subjected to cyberattacks increases, regardless of the response assumed. It also reflects that while the defaulted payments of the attacked entities are the same, the total value of the defaults (attacked and affected entities) in the case of active response is 12.4% if it is the attack on one ESI and 41.5% if it is on five ESI. When a passive response is assumed in the simulation, the total value of defaulted payments increases to 27.7% in the event of a cyberattack on one ESI and to 54.1% when it is on five ESI.

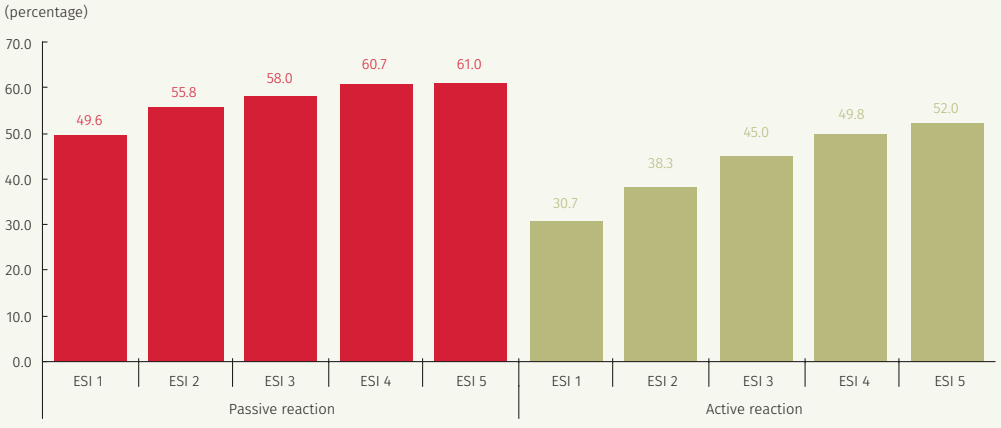
When the impact is quantified by the number of entities affected regarding the number of active ones, Graph B1.2 exhibits that by assuming a passive response in all cyberattacks (from one ESI to five ESIs), more than half (50%) of the active entities are affected; and in the extreme case of five ESIs the percentage reaches 61.0%. Under an active response, the same indicator is reduced to 30.7% for the cyberattack of an ESI, and only in the case of five ESI a little more than half of the active entities (52.0%) end up affected.

3.2 Cyberattack on Communications Providers

Cyberattacks on infrastructure service providers or their customers are classified as upstream attacks, and their knock-on effects can even impact the financial sector and the economy.

The financial sector, which includes a country's critical infrastructure, depends on electricity and the proper functioning of telecommunications and technology. Prolonged interrup-

Graph B1.2
Average Percentage of Affected Entities with respect to the Total Number of Active Ones: Passive and Active Reactions



Source: *Banco de la República* (DSIF).

tions in the operation of these providers can affect the ability of the infrastructure and its participants to operate and provide services.

One of the technical recommendations that *Banrep* makes to access the electronic services it provides,[2] as is the case of the CUD, is that its participants maintain independent alternative channels with a different provider for their connection. Thus, in the event of a contingency in which the main dedicated channel stops working, either due to an operational failure or a cyberattack, the prompt switching to the alternate channel would allow the entity to restore its connection and service as soon as possible.

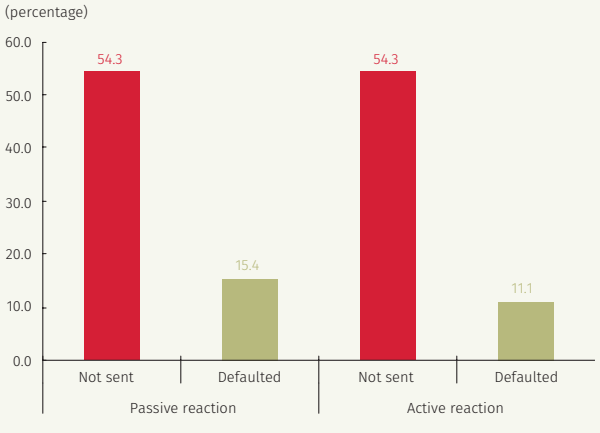
To the extent that there is a high concentration of payment system participants relying on a single telecommunications provider, the greater the impact that a cyberattack targeting this provider would cause. This situation could worsen if the entities do not comply with the recommendation to have a second line enabled.

The simulated cyberattacks here assume that entities connecting to the CUD with the primary or second telecommunications provider do not have the second dedicated line enabled and, therefore, by losing their connection, they cannot send payments.

In Graph B1.3, it is observed that, as a result of a cyberattack on the main telecommunications provider, the percentage of the value of the unsettled payments compared to those observed in the baseline scenario decreases on average by 54.3% due to the disconnection of its customers. Additionally, as a second-round effect, the default of the affected entities would be 15.4% under a passive response and 11.1% under an active response. The absence of an alternate channel, assumed in this extreme but plausible exercise, would exacerbate the potential impact of attacks on critical third parties, causing significant disruptions to the CUD.

Graph B1.4 exhibits that the cyberattack on the main provider connecting to the CUD would have a significant impact on settlement, causing the total value of defaults[3] to rise to 69.7% in the case of a

Graph B1.3
Value of Defaults due to Cyberattack on the Main Telecommunications Provider (as a Percentage of the Baseline Scenario)



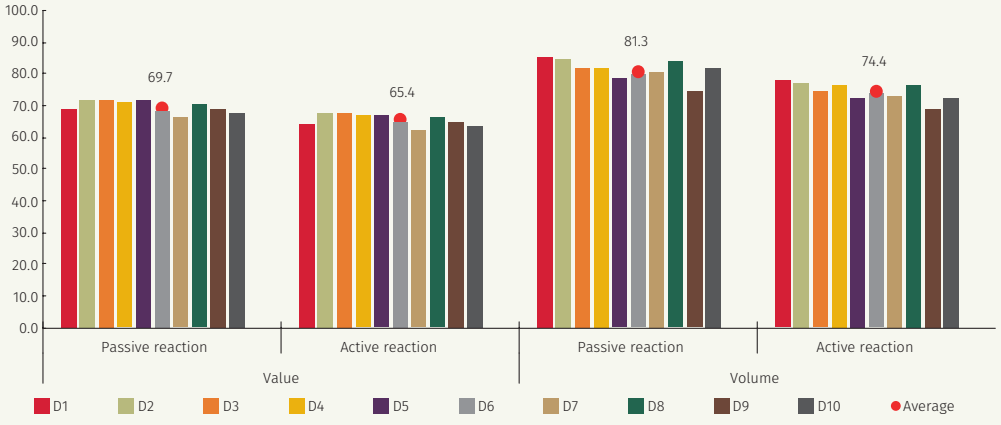
Source: *Banco de la República* (DSIF).

2 "*Requerimientos técnicos para los servicios electrónicos del Banrep Sebra*", May 2024, available at: https://www.banrep.gov.co/sites/default/files/paginas/reque_tecnico_conex_sebra.pdf

3 Both due to the direct effect of payments that disconnected entities fail to send, and as a second-round effect, payments whose counterparties use a different provider cease to be made due to the lack of liquidity received.

Graph B1.4
Value and Volume of Defaulted Payments due to the Cyberattack on the Main Telecommunications Provider

(as a percentage of observed payments in the baseline scenario)



Source: *Banco de la República* (DSIF).

passive response and only marginally reducing to 65.4% when the surviving entities react actively. Regarding the number of transactions, the cyberattack would result in 81.3% of the total transactions observed in the baseline scenario being unable to be settled under a passive response and 74.4% under an active response.

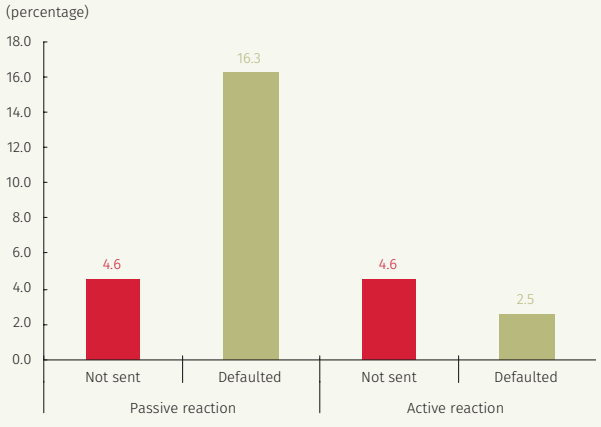
An explanation for this result is the high concentration of CUD participants in the main telecommunications provider, as shown in Table B1.2, where more than half of the active entities would be disconnected if this provider were to experience a cyberattack, preventing its clients from sending payments. Moreover, the liquidity not provided by the disconnected

Table B1.2
Percentage of Active and Affected Entities Post-cyberattack on the Main Telecommunications Provider on the CUD: Passive and Active Reactions

Day	Active post-cyberattack	Passive reaction Affected	Active reaction Affected
	As a percentage of active entities in baseline scenario	As a percentage of active post-cyberattack	
D1	50.8 %	68.9 %	65.6 %
D2	51.2 %	68.3 %	65.1 %
D3	51.6 %	68.8 %	68.8 %
D4	50.8 %	66.1 %	64.5 %
D5	50.8 %	64.5 %	64.5 %
D6	52.8 %	59.1 %	59.1 %
D7	51.6 %	60.9 %	60.9 %
D8	52.4 %	67.7 %	67.7 %
D9	53.5 %	55.1 %	55.1 %
D10	52.8 %	59.1 %	59.1 %
Average	51.8 %	64.2 %	63.4 %

Source: *Banco de la República* (DSIF).

Graph B1.5
Value of Defaults due to Cyberattack on the Second-Largest Telecommunications Provider (as a Percentage of the Baseline Scenario)



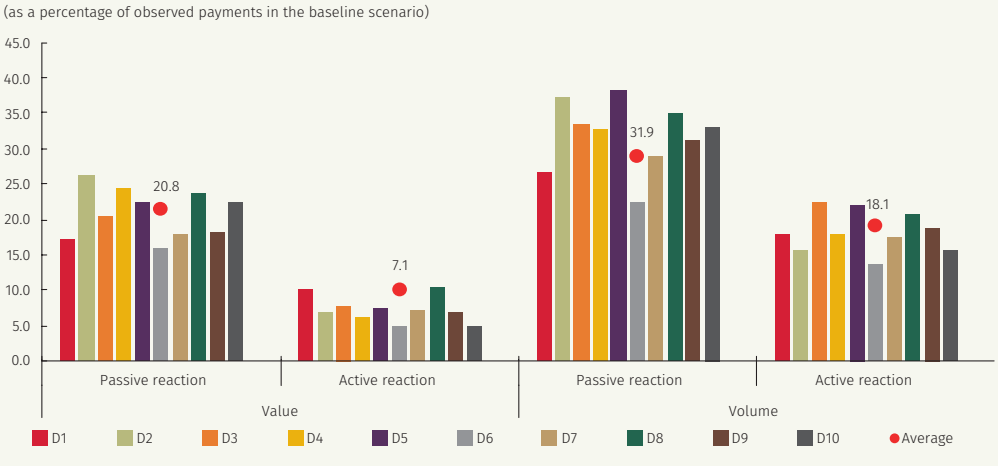
Source: *Banco de la República* (DSIF).

entities would mean that, of the surviving entities (whose connection to the system is established with another provider), two-thirds would end up affected with unsettled payments.

When a cyberattack targets the second primary telecommunications provider, which connects fewer participants to the CUD compared to the main provider, it is observed that the impact on the value and volume of unsettled payments is lower than that of the main provider. Indeed, disconnected entities would stop sending on average 4.6% of payments from the baseline scenario, and as a second-round effect, the affected entities would stop settling 16.3% of payments under a passive response and 2.5% under an active response (Graph B1.5).

Graph B1.6 exhibits that total daily and average defaults, both in value and volume, with an active response, mitigate the impact of the cyberattack compared to a passive response. Indeed, while in the passive response, the percentage of defaults concerning the baseline scenario is 20.8% in value and 31.9% in volume, under an active response, these figures decrease to 7.1% and 18.1%, respectively.

Graph B1.6
Value and Volume of Defaulted Payments due to the Cyberattack on the Second-Largest Telecommunications Provider



Source: *Banco de la República* (DSIF).

Recognizing that the number of participants connecting to the CUD is lower than that of the main provider, the direct and indirect impact of defaults generated is also reduced. According to Table B1.3, over 84% of the entities would remain active and send their payments, but 16% would cease to do so, leading to defaults by 54% of entities under a passive response and 37.3% under active response.

Given these results, it is advisable to strengthen the resilience of entities to the interruption of transactions due to the cyberattacks simulated here.

Table B1.3
Percentage of Active and Affected Entities Post-cyberattack on the Second-Largest Telecommunications Provider on the CUD: Passive and Active Reactions

Day	Active post-cyberattack	Passive reaction Affected	Active reaction Affected
	As a percentage of active entities in baseline scenario	As a percentage of active post-cyberattack	
D1	85.0 %	52.9 %	39.2 %
D2	84.6 %	57.7 %	39.4 %
D3	83.9 %	51.9 %	40.4 %
D4	84.4 %	59.2 %	36.9 %
D5	84.4 %	54.4 %	38.8 %
D6	84.8 %	45.3 %	33.0 %
D7	83.9 %	51.0 %	36.5 %
D8	83.9 %	54.8 %	40.4 %
D9	84.5 %	45.9 %	35.8 %
D10	84.8 %	51.9 %	33.0 %
Average	84.4 %	52.4 %	37.3 %

Source: *Banco de la República* (DSIF).

Diagram R1.1
Mitigation Mechanisms and Policies

- Regulatory framework and mitigation policies
- International cooperation
- Continuous education and training
- Simulation and scenario analysis
- Adoption of generative AI as a mitigation mechanism

Source: *Banco de la República* (DSIF).

4. Mitigation Mechanisms and Policies

The financial sector faces a growing cyber risk due to its interconnectedness and dependence on telecommunications providers. In addition to being a technical concern, cybersecurity has become an essential strategic priority to guarantee the stability and resilience of the global financial system. As shown in the *Financial Infrastructure Report* (2023), implementing robust policies and strategic recommendations is vital to mitigate this risk and its potential systemic impact. Among the mechanisms and policies identified to mitigate cyber risk and its potential systemic impact are (see Diagram B1.1).

- Regulatory Framework and Mitigation Policies: A robust regulatory framework is crucial to mitigating cyber risk in the financial sector. Several studies underscore the importance of developing and strengthening regulatory frameworks that promote better cybersecurity practices and adapt to evolving dynamics of threats and technologies. Additionally, fostering cooperation between the public and private sectors and harmonizing international standards is essential to improve global cybersecurity (Bank of England, 2018; BIS, 2020; Warren, Kaivanto, & Prince, 2018; Aldasoro, Gambacorta, Giudici, & Leach, 2020).
- Continuous Education and Training: Ongoing training for personnel in cybersecurity is essential to strengthen the first line of defense against cyberattacks. It is necessary to keep staff updated on the latest threats and mitigation tactics through regular drills and awareness programs. This ensures employees are prepared to properly identify and respond to cyberattack attempts (Zurich, 2014).
- Simulation and Scenario Analysis: Conducting simulations and scenario analyses is a critical tool for assessing the preparedness and resilience of financial institutions. Simulating coordinated

cyberattacks allows to identify systemic vulnerabilities and develop specific mitigation strategies. These exercises highlight the need for robust and effective business continuity and disaster recovery plans (Kaffenberger & Kopp, 2019; Eisenbach, Kovner, & Lee, 2022b).

- International Cooperation: International cooperation is essential to managing cyber risk given that cyberattacks can cross borders. The possibility of sharing threat intelligence and coordinating response strategies globally significantly improves the capacity to respond to cyberattacks and ensures a more robust defense against global threats (Aldasoro et al., 2021; BIS, 2020).

- Adoption of Generative Artificial Intelligence (AI) as a Mitigation Mechanism: Generative AI (Gen AI) comprises artificial intelligence technologies that, based on training data, can produce new and diverse content. AI introduces both opportunities and challenges[4] in cyber risk management within the financial system, including central banks (Aldasoro et al., 2024).

  In the cybersecurity field, gen AI emerges as an additional mechanism to mitigate cyber risk and its systemic impact. Among the possibilities identified by Aldasoro et al. (2024) that gen AI offers concerning cybersecurity are: 1) improved threat detection, 2) automation of routine cybersecurity tasks, 3) rapid and efficient response improving the ability to respond to cyberattacks, 4) continuous learning and adaptation of gen AI systems to emerging threats, 5) reduction in the likelihood of human error in cybersecurity threat management, 6) the possibility of creating customized behavior and risk profiles that improve the accuracy of security measures, and 7) facilitation of anticipation and neutralization of potential threats before they materialize (Diagram B1.1).

In summary, integrating gen AI into cybersecurity strategies not only strengthens existing capabilities but also introduces new ways to manage and mitigate cyber risk, reducing its potential impact on the financial system and improving systemic resilience.

5. Conclusions

- The supervisory authority can encourage CUD participants, and especially those entities that play a significant role in such infrastructure, to maintain sufficiently robust cybersecurity systems to reduce their vulnerability to cyberattacks and thus mitigate the potential negative impact of payment defaults that would arise in the system, given the interconnectivity of payments.

- It is essential to continue encouraging CUD participants to have two independent dedicated alternate channels with different providers to ensure that, in the event of a main provider failure, a rapid recovery of connection and operation is achieved through prompt switching to the alternate channel. A mechanism that could be considered by the industry, which would contribute to mitigating the impact on the system's liquidity from a cyberattack on communications providers, is to strive for moderate concentration levels in these providers. The negative impact of such an attack could be exacerbated if participants do not have an alternate channel and rely solely on a highly concentrated provider.

- Regarding how entities react to payment defaults by their counterparts, simulations conducted validate the mitigating effect obtained through more efficient liquidity use when reattempting payments by adopting an active response. The results obtained under these assumptions in the simulations aim to raise awareness among participants about how institutions can respond to payment defaults by their counterparts.

- Financial infrastructures are essential for the proper functioning of the financial system. The provision of their services is highly dependent on a high technological component, which makes them particularly vulnerable to cyberattacks. It is important to have good

4 Aldasoro et al. (2024) identifies that with the sophistication of gen AI tools and their expanded use, the frequency, speed, and complexity of cyberattacks increase. Specific threats associated with gen AI include social engineering, zero-day attacks, and malware attacks for data infiltration.

coordination between the industry and the supervisory authority to implement robust cyber resilience frameworks and well-defined response and recovery plans to ensure the continuity of critical services during and after an attack (IMF, 2024).

- Cybersecurity also plays a fundamental role in financial stability as cyberattacks can lead to direct financial losses and loss of confidence in the financial system, potentially resulting in massive withdrawals of deposits, asset liquidation, and adverse market reactions. Measures aimed at facilitating the implementation of a national cybersecurity strategy, effective regulation, adequate supervision of this risk, as well as consolidating a cybersecurity workforce, establishing national and international information-sharing agreements, and international cooperation, would strengthen the cyber resilience of the financial sector (IMF, 2024).
- Incorporating a cybersecurity component into liquidity indicators would allow financial institutions to better assess their response capacity to cyber incidents to ensure the continuity of their operations, thereby contributing to financial stability. Along these lines, the IMF's (2024) practical proposal to evaluate the potential effect of cyber incidents on banks' liquidity position consists of calculating the deposit withdrawal rate at which the liquidity coverage ratio would fall below the regulatory requirement of 100%.

References

Aldasoro, I.; Doerr, S.; Gambacorta, L.; Notra, S.; Oliviero, T.; Whyte, D. (2024). "Generative Artificial Intelligence and Cyber Security in Central Banking," *BIS Paper*, No. 145 (May), Bank for International Settlements.

Aldasoro, I.; Frost, J.; Gambacorta, L.; Whyte, D. (2021). "Cyber Risk in the Financial Sector," Bank for International Settlements.

Aldasoro, I.; Gambacorta, L.; Giudici, P.; Leach, T. (2020). "Operational and Cyber Risks in the Financial Sector," Bank for International Settlements.

Atlantic Council (2016). "Understanding Systemic Cyber Risk," Global Agenda Council on Risk and Resilience, World Economic Forum (WEF), *White Paper* (October)

Bank of England (2018). "The Bank's Approach to Operational Resilience."

Bank of International Settlements [BIS] (2020). "Principles for Operational Resilience and Cyber Risk", Bank for International Settlements.

Banco de la República (2023). Recuadro 4: Altos niveles de ciberresiliencia como factor clave para la estabilidad de las infraestructuras financieras", *Financial Infrastructure Report*, Financial Infrastructure Oversight Department (DSIF).

Eisenbach, T. M.; Kovner, A.; Lee, M. J. (2022a). "Cyber Risk and the U.S. Financial System: A pre-Mortem Analysis", *Journal of Financial Economics*, vol. 145, no. 3.

Eisenbach, T. M.; Kovner, A.; Lee, M. J. (2022b). "When it Rains, It Pours: Cyber Risk and Financial Conditions", Staff Reports, No. 1022/June, Federal Reserve Bank of New York.

International Monetary Fund [IMF] (2024) "Cyber risk: a growing concern for macrofinancial stability" – Global financial stability report: The Last Mile: Financial Vulnerabilities and Risks. Chapter 3, International Monetary Fund. (April)

Kaffenberger, L.; Koop, E. (2019). "Cyber Risk Scenarios, the Financial Systems and Systemic Risk Assessment," Cyber Policy Initiative Working Paper Series *Cybersecurity and the financial systems*, No. 4, September, Carnegie Endowment for International Peace.

Warren, G.; Kaivanto, K.; Prince, D. (2018). "Could a cyber-attack cause a systemic impact in the financial sector?", *Quarterly Bulletin*. Bank of England. (2018 Q4)

Zurich (2014). "Beyond Data Breaches: Global Interconnections of Cyber Risk," *Risk Nexus* (April).

Box 2: Practices of Central Counterparties for Managing Risks Not Associated with Member Defaults

1. Introduction

Following the publication of the main regulatory framework on the risk management of financial market infrastructures, *Principles for Financial Market Infrastructures* (PFMI) (CPMI and IOSCO, 2012), some financial authorities and international organizations have studied, established standards, and issued recommendations on risk management and control in Central Counterparties (CCPs). As stated in the PFMI, the goal is to have safe and efficient CCPs that contribute to maintaining and fostering financial stability and economic growth.

Examples of the topics studied include: 1) the review and analysis of practices in the handling and management of initial and variation margins, 2) the establishment of guidelines on the design and structure of recovery and resolution plans for CCPs, 3) the review of practices used to address scenarios with systemic incidences caused by procyclical events in margin management, and 4) the quantification of the equity levels of CCPs to support the materialization of risks other than member defaults, among others. This reflects significant progress in understanding the risks faced by CCPs, creating mechanisms to mitigate these risks, and establishing practices and plans to recover the viability of CCPs concerning exposures with clearing members.

However, while the PFMI address risks not associated with member defaults, there is a limited understanding of CCPs' current practices to address potential losses unrelated to counterparty and liquidity risks.

This box shows an overview of the practices of some CCPs to manage risks not associated with member defaults, such as business and operational risks. Additionally, it analyzes the risk management practices in Colombia, specifically those implemented by the Central Counterparty Clearing House of Colombia S.A. (CRCC in Spanish). Furthermore, this box complements the analysis presented in the article "Capital Requirements for Central Counterparties: An Analysis of the Colombian Case," published in the 2021 edition of the *Payment Systems Report*, which evaluated capital requirements for CCPs regarding risks not associated with defaults by clearing members.

2. Context

In line with the guidance of the PFMI, BIS, and IOSCO (2014), Wendt (2015), Wilkes (2020), and Mariño et al. (2020), among others, CCPs play a significant role in the security and development of financial markets by mitigating credit and liquidity risks in transactions they clear and settle. Therefore, it is essential to maintain the services provided by these entities, not only for the benefits they offer to the markets but also for the impact that the resolution or liquidation of one of these entities would represent in the markets, participants, and the financial stability of the jurisdictions where they operate.

In general terms, there are two scenarios in which a CCP might need to suspend its services and initiate a liquidation process. The first scenario occurs when its main clearing

members are declared in default, and the CCP's risk management model proves insufficient to cover the losses incurred in closing the open positions of the defaulted members, affecting the CCP's capital. The second scenario relates to issues in business management or the materialization of operational, legal, investment, and other risks that negatively affect the viability of the CCP.

As mentioned, progress has been made in regulation and in ongoing efforts to calibrate risk management models to avoid a potential financial impact of CCPs in the first scenario. In contrast, there has been less progress in understanding practices, analyzing, identifying, and quantifying impacts on CCPs, and ensuring transparency for participants and markets in the second scenario, where a CCP's continuity could be compromised. Additionally, there are various interpretations of the considerations raised by BIS and IOSCO in the treatment of these risks.

The overall framework for addressing the management of risks involved in the second scenario is provided by the PFMI, particularly Principles 3, 15, 16, and 17, which establish guidelines and considerations for assessing comprehensive risk management, overall business risk, custody and investment risks, and operational risks, respectively. Furthermore, the documents *Recovery of Financial Market Infrastructures* (BIS and IOSCO, 2014 [revised July 2017]) and the regulation on over-the-counter derivatives, CCPs, and trade repositories (EMIR) (European Parliament and Council of the European Union, 2012; European Commission, 2012) provide additional guidance to identify and quantify scenarios that could result in non-default losses for the CCPs. These documents are complementary and share a common goal: to strengthen the resilience of CCPs to deal with scenarios that threaten the viability of the company and avoid negative impacts on markets and the financial system. The Annex provides further detail on the main considerations observed in these documents.

Based on these recommendations, BIS and IOSCO conducted an exercise in 2023 to review the practices and strategies used by some CCPs to identify, quantify, and manage scenarios that could result in losses associated with the materialization of the mentioned risks. The main results are presented below.

3. Practices, Strategies, and Management of Risks Not Associated with Member Defaults

3.1 Identification and Quantification of Non-Default Losses from Clearing Members

As a result of this exercise, in August 2023, BIS and IOSCO published the document *Report on Current Central Counterparty Practices to Address Non-Default Losses*, which examines the practices currently employed by some CCPs to manage risks not caused by member defaults. Specifically, the report reviews the current practices implemented by CCPs to address potential non-default losses (NDLs) arising from clearing members.

Overall, it was found that CCPs exhibit a varied level of sophistication in how they define their strategies and plans to address NDLs. On the one hand, CCPs consider a variety of scenarios to identify potential sources of NDL separately, considering business, operational, investment, custody, and legal risks. On the other hand, some CCPs consider the possibility of loss given default episodes alongside NDL episodes and incorporate these scenarios into their recovery plans.

Additionally, it was found that, although CCPs mitigate non-default risks as part of their usual activities, some do not include certain scenarios in their planning. For example, they assume that regulated financial institutions or central securities depositories do not pose deposit or custody risks or that legal risks cannot cause an NDL, which could be inconsistent with the established standards (Table B2.1).

Regarding the quantification of NDLs, it was found that some CCPs conduct analyses to quantify potential NDLs and thus maintain adequate resources. These approaches include considering NDL scenarios separately for each relevant risk type, as well as analyzing the inherent challenges in quantification, such as the scarcity of historical data. Moreover, some CCPs consider lessons learned at other financial institutions when assessing NDL exposures, adapting best practices for risk assessment and Basel II frameworks. While considering the perspectives of other parts of the financial industry is helpful, there may be challenges in accurately assessing NDL risk on this basis and adapting industry-specific data sources to CCPs' markets and risk frameworks.

Table B2.1
Summary of the Main Recommendations on CCP Risk Management NOT Associated with Clearing Member Defaults

	PFMI (BIS-Iosco, 2012)	Recovery of financial market infrastructures (BIS-Iosco, 2014) (revised July 2017)	Regulation on over-the-counter derivatives, central counterparties and trade repositories (European Parliament and Council of the European Union, 2012).
Principle 3: Framework for the Comprehensive Management of Risks	• An FMI should have risk management policies, procedures, and systems that enable it to identify, measure, monitor, and manage the range of risks that arise in or are assumed by the FMI. Risk management frameworks should be subject to periodic reviews. • An FMI should identify scenarios that could potentially prevent it from providing its most important activities and services as a going concern and should assess the effectiveness of a full range of recovery or orderly wind-down options. • It should identify those risks that could materially affect its ability to operate or provide services as planned. Typically, these risks would include legal, credit, liquidity, and operational risks. An FMI should also consider other material and relevant risks, such as market (or price) risks, concentration risks, and general business risks, as well as risks that may not appear significant in isolation but may be material [...]	3.2.1 FMIs may be exposed to legal, credit, liquidity, general, custody, investment, and operational risks. The incidence of trading losses is often unrelated to a participant default and may crystallize over a very short period of time or over a much longer period of time.	Business risk refers to the risk that a CCP assumes due to its efficiency and the potential for changes in general business conditions that could adversely affect its financial condition as a result of a decline in its revenues or an increase in its expenses that would result in a loss to be charged against its capital. Since the level of business risk largely depends on the individual situation of each CCP and may arise from factors such as inefficient procedures, an adverse market environment, ineffective response to technological developments, or poor execution of business strategies, capital requirements should be based on a CCP's own estimates, subject to the approval of the competent authority. A minimum level should be introduced in order to ensure a prudent level of capital requirements.
Principle 15: General Business Risk	• An FMI should have robust control and management systems in place to identify, monitor, and manage general business risks, including losses from poor execution of business strategy, negative cash flows, or excessively high or unexpected operating expenses. • Business-related losses may arise from risks covered by other principles, for example, legal risk (such as legal actions challenging the FMI's custody arrangements), investment risk affecting the FMI's resources, and operational risk (in the event of fraud, theft, or loss). In these cases, the general business risk may cause an FMI to experience an extraordinary one-time loss rather than recurring losses. • General business risk refers to the risks and potential losses arising from the management and operation of an FMI as a business, which are not related to any default by a participant and are not separately covered by financial resources under the principles relating to credit or liquidity risk [...] • Once an FMI has identified and assessed its business risk, it should measure and monitor these risks on an ongoing basis and develop appropriate information systems as part of a robust business risk management program.	3.2.4 General business risk refers to risks and potential losses arising from the management and operation of an FMI as a commercial enterprise that are not related to participant default or separately hedged and includes any other potential impairment of the FMI's financial or capital position. Business-related losses may also arise from legal, custodial, investment, or operational risks. Any loss arising from business risk may materialize as an extraordinary one-time loss or as an ongoing loss and could therefore occur over a very short period of time or over a longer period of time. If general business risk is not managed, an FMI's business operations may be disrupted or threaten its long-term viability as a going concern.	The business risk capital requirements will correspond to the CCP's approved estimate and will be subject to a minimum amount equal to 25% of its annual gross operating expenses.

Table B2.1 (continuation)
Summary of the Main Recommendations on CCP Risk Management NOT Associated with Clearing Member Defaults

	PFMI (BIS-Iosco, 2012)	Recovery of financial market infrastructures (BIS-Iosco, 2014) (revised July 2017)	Regulation on over-the-counter derivatives, central counterparties and trade repositories (European Parliament and Council of the European Union, 2012).
Principle 16: Custody and Investment Risks	An FMI should safeguard its own and its participants' assets and minimize the risk of loss and delay in accessing those assets. investments from an FMI should be in instruments with minimal credit, market, and liquidity risks.	3.2.5 Investment risk is the financial risk an FMI faces when investing its own or its participants' resources, such as cash or other collateral. Investment risk could jeopardize an FMI's viability if it results in significant financial losses. For example, if an FMI were to invest, at the FMI's own risk, collateral by its participants in instruments subject to market or credit risk, and such risks were to materialize, financial difficulties could arise, and the FMI may be unable to meet the claims of participants seeking the return of collateral posted. Similarly, an FMI may be exposed to custody risk and could suffer losses on assets held in custody in the event of a custodian's (or sub-custodian's) insolvency, negligence, fraud, mismanagement, or improper administration, fraud, poor administration, or inadequate record-keeping.	The calculation method should use the risk weights established for investment companies and credit institutions in Europe as a benchmark.
Principle 17: Operational Risk	An FMI should identify credible sources of operational risk, both internal and external, and mitigate their impact by using appropriate systems, policies, procedures, and controls. Systems should be designed to ensure a high degree of security and operational reliability and should have adequate and versatile capacity. Business continuity management should aim for timely transaction recovery and fulfillment of the FMI's obligations, including in the event of a major or large-scale disruption.		A CCP should calculate its capital requirements for operational risk, including legal risk, using either the basic indicator approach or the advanced measurement methods provided for in Directive 2006/48/EC, which defines the minimum own funds requirements for operational risk for credit institutions.

Sources: Bank for International Settlements (BIS), European Central Bank, and ESMA. Table prepared by *Banco de la República*.

3.2 Financial Tools and Resources to Manage NDLs

A variety of tools and resources available to CCPs to address NDLs was observed. Available tools include equity, rule-based loss allocation[1], external financing, insurance, and capital replenishment. However, it was identified that there is no standard scheme for the use of resources; rather, there is a variety in the sophistication of risk management approaches among CCPs. Some rely on the minimum regulatory capital requirements (e.g., those established by the EU), while others conduct additional analyses to ensure the sufficiency of resources. CCPs also consider the need for insurance coverage, although the claims and payment process can take time.

Specifically, for each source of financial resources, the following was observed:

- *CCPs' Equity:* Some CCPs rely solely on the minimum regulated capital amounts, which may not be sufficient to implement comprehensive recovery plans. Additionally, there are differences in how CCPs calculate the necessary amount of equity to cover losses.

1 The allocation of losses to members due to the materialization of risks aims to make members jointly and severally liable for these losses; in most cases, they are of second order after insurance coverage.

- *Rule-Based Loss Allocation:* CCPs use rule-based loss allocation mechanisms for members to address losses associated with operational, legal, and business risks, in addition to custody and investment losses. On the other hand, clarity in describing how losses will be allocated and dedicated governance arrangements are essential for the effectiveness of these mechanisms and member acceptance.
- *External Financing:* CCPs consider various external financing sources, such as credit lines, debt or equity issuance, and intra-group loans. The availability and reliability of this financing may be affected by market responsiveness and the global financial situation.
- *Insurance:* Insurance is a tool commonly used by CCPs to cover losses associated with operational and legal risks. Regular review of insurance policies and a detailed understanding of contractual terms are essential to ensure adequate coverage.

3.3 Timeliness in the Use of Resources to Manage NDLs

Delays in access to financial resources arise from the unavailability of funds at the time losses materialize. For example, the use of insurance poses additional problems due to the time required for claims adjudication and payment. Similarly, during periods of stressed market conditions, the severity and consequences of liquidity gaps may increase while a CCP's ability to close these gaps may be reduced.

On the other hand, it was found that the CCPs employ a diverse combination of tools and resources to mitigate these risks, including prefunded own resources and committed credit lines. However, some CCPs still face challenges, such as the inability to access available tools or an exclusive reliance on central bank support to address liquidity gaps.

In addition to developing *ex ante* approaches to quantify potential NDLs and assess the sufficiency of resources, CCPs also take into account other considerations, as shown below.

3.4 Other Considerations in Managing NDLs

The report emphasizes that, to assess the effectiveness of their NDL management plans or strategies, CCPs must consider factors such as legality, due diligence, and continuous monitoring of third-party service providers, as well as the understanding and preparedness of participants in the processes and requirements activated during an NDL materialization scenario. Furthermore, according to the CPMI-IOSCO recovery guidelines, it is recommended to conduct periodic tests and reviews of recovery plans at least once a year to ensure their effectiveness. In this regard, some CCPs participate in crisis drills coordinated with multiple industry CCPs to address additional NDL scenarios and strengthen coordinated crisis management.

Additionally, effective governance and transparency in the planning and execution of strategies to address these types of losses are of utmost importance. Thus, CCPs must have clear and transparent governance structures that promote market security and efficiency, participant confidence, and overall financial system stability. To this end, CCPs must maintain documented processes, especially those related to decision-making during a crisis. Additionally, CCPs must provide participants with understandable information about the risks and costs associated with participation in the CCP. Prior disclosure of management frameworks, regulatory documents, tools used to address NDLs, and how losses would be allocated in different scenarios will allow participants to provide effective feedback and limit potential legal implications when applying or executing these mechanisms.

4. Analysis of the Colombian Case

In Colombia, the Financial Superintendency of Colombia (SFC in Spanish) requires financial market infrastructures to conduct a self-assessment of the PFMI as follows: "providing the review and self-assessment processes regarding compliance with the aforementioned principles. If applicable, they must determine the action plans to be followed. Such self-assessments must be conducted at least every three years and published on each entity's website" (2022). Additionally, the Central Counterparty Clearing House of Colombia (CRCC in Spanish), the only CCP operating in Colombia that offers clearing and settlement services for financial products through a novation mechanism, was certified in 2023 by the European Securities and Markets Authority (ESMA) as a third-country entity complying with the European Union's regulation on CCPs. These two conditions ensure that the CRCC adheres to the considerations established by BIS, IOSCO, and ESMA regarding the management of non-defaults risks from clearing members.

Furthermore, based on the CRCC's internal regulations, risk management model, corporate governance structure, and self-assessment of compliance with principles, the characteristics and tools available to the CRCC to mitigate risks that could likely lead to NDLs were determined. Below is a summary of the observed strategies and tools.

- *Identification, Quantification, and Management of Risks that Could Generate NDLs:* The CRCC identifies and evaluates general business risks, which are permanently monitored and managed. It establishes a policy to maintain net liquid assets funded by its equity at a minimum equivalent to the sum of (i) net liquid assets required to cover the liquidation or restructuring of its activities, (ii) net liquid assets required to cover specific equity ("skin in the game"), (iii) net liquid assets required to cover business risk, and (iv) net liquid assets required to cover operational risk. It also determines the sufficient net liquid assets to continue operating for the necessary time to achieve an orderly recovery or liquidation.

- *Financial and Tools Resources to Manage NDLs*: In addition to the mentioned net liquid assets, the CRCC has: i) overdraft lines granted by banks, ii) the ability to access central bank liquidity in Colombian pesos, iii) a fidelity and financial risks insurance policy, and iv) the company's bylaws establish a capital obligation for shareholders, whereby shareholders are obliged to subscribe for shares in proportion to their participation in the social capital when, by a legal norm or an order from a competent authority, a capitalization of the company is required.

- *Considerations regarding Custody and Investment Risks:* The CRCC holds its members' or third parties' assets in Centralized Securities Depositories (DCV and Deceval)[2], cash in Colombian pesos received as collateral in accounts at *Banco de la República*, and cash in U.S. dollars in an account at a correspondent bank. For investments of the cash collateral provided by members, the CRCC defines general policies and conservative investment criteria in its operational regulations, in line with its risk management strategy. Additionally, an investment policy approved by the Board of Directors of the CRCC was established for investments of its own assets, with compliance monitored by the Administrative and Financial Committee, which is responsible for defining policies, parameters, counterparties, eligible investments, and investment limits per issuer, counterparty, and financial asset for the CRCC's portfolio.

2 The central securities depositories, the Centralized Securities Depository (DCV) and Deceval are subject to the laws of the Republic of Colombia and are supervised by the Financial Superintendency of Colombia. Due to their characteristics, these entities have a sound financial structure and follow strict accounting practices and controls that adequately protect assets to mitigate any type of risk.

Finally, it is important to mention that the exercise conducted to validate the adequacy of the CRCC's own liquid resources, calculated based on European regulations, exhibited that the CRCC's equity would be sufficient to cover various non-default risks from clearing members.

In accordance with the results of the BIS-IOSCO study, there is an opportunity to explore some practices observed in other CCPs. For example, designing and evaluating scenarios that combine defaults by clearing members with the materialization of one or more risks that generate NDLs and establishing the corresponding tests to validate the adequacy of net liquid resources. It may also be helpful to discuss the advisability of incorporating practices such as rule-based loss allocation and prior disclosure to members of the management frameworks and tools used to address NDLs.

5. Final Comments

BIS and IOSCO have worked to guide the management of risks faced by financial market infrastructures, particularly CCPs. Significant progress has been made in managing risks related to defaults by clearing members, specifically counterparty and liquidity risks. However, business, operational, legal, custody, or investment risks have not seen the same level of development. Nevertheless, a variety of strategies, practices, and mechanisms for managing NDLs have been evidenced by the CCPs evaluated by BIS and IOSCO. Therefore, it may be necessary to undertake additional work on NDLs across FMI and to provide guidance on the treatment and implementation of the recommendations established regarding the overall business risk of PFMI.

In Colombia, the CRCC is considered systemically important as it is the only CCP operating in the country due to the variety of markets to which it provides central counterparty services and its contribution to mitigating counterparty and liquidity risks. Accordingly, any disruption of services could impact the normal functioning of payment systems and financial stability. The CRCC complies with the PFMI observance requirements required by the SFC and quantifies capital requirements to support NDLs based on parameters established in the European Union. However, the findings in the recent BIS-IOSCO study could be useful to explore some areas for improvement in the management of NDLs by the CRCC, such as the design of new scenarios, the exploration of new sources of liquidity, and the construction of tests to validate the adequacy of net liquid resources in the face of the new scenarios, among others.

References

Committee on Payments and Market Infrastructures [CPMI]; International Organization of Securities Commissions [IOSCO] (2012). "Principles for Financial Market Infrastructures" [online], *CPMI Papers,* no. 101, Bank of International Settlements, available at: https://www.bis.org/cpmi/publ/d101a.pdf.

Committee on Payments and Market Infrastructures [CPMI]; International Organization of Securities Commissions [IOSCO] (2014, revised 2017). Recovery of financial market infrastructures" [online], *CPMI Papers*, no. 162, Bank of International Settlements, available at: https://www.bis.org/cpmi/publ/d162.pdf.

Committee on Payments and Market Infrastructures [CPMI]; International Organization of Securities Commissions [IOSCO] (2023). "Report on current central counterparty practices to address non-default losses" [online], *CPMI Papers*, Bank of International Settlements, available at: https://www.bis.org/cpmi/publ/d217.pdf

Mariño, R.; León, C.; Cadena, C. (2020). "Las entidades de contrapartida central en la mitigación del riesgo de contraparte y de liquidez: el caso de los derivados cambiarios en Colombia", *Borradores de Economía*, no. 1101, Banco de la República.

European Parliament and Council of the European Union (2012). "On Over-the-Counter Derivatives, Central Counterparties, and Trade Repositories," Delegated Regulation (EU), no. 648/2012, July.

European Commission (2012). "Supplementing Regulation (EU) No. 648/2012 of the European Parliament and of the Council with regard to regulatory technical standards on capital requirements for central counterparties", Delegated Regulation (EU), no. 152/2013, December.

Wendt, F. (2015) "Central Counterparties: Addressing their Too Important to Fail Nature," *IMF Working Papers*, no. 2015/21, International Monetary Fund, January.

Wilkes, S. (2020). "EU hands CCP members a narrow win on skin in the game" [online], *Central Banking*, available at: https://www.centralbanking.com/central-banks/financial-market-infrastructure/7670116/eu-hands-ccp-members-a-narrow-win-on-skin-in-the-game.

Box 3: Instant Payments and their Interbank Settlement

When referring to instant payments, it is understood that these are orders for the transfer of resources through wire transfers, which move from the account of one payer to the account of a payee within seconds, seven days a week, and twenty-four hours a day (24/7) (CPMI, 2021: 2).

While from the user experience perspective, the transfer is "instant" (i.e., regarding the crediting of the payee's account and the debiting of the payer's account, it takes just seconds), the final settlement of obligations among the financial institutions participating in the fast payment system may not be instant (CPMI, 2021: 8). This is because achieving immediacy in interbank settlement requires the appropriate infrastructure. In other words, a real-time interbank payment system is necessary to settle each transaction individually, allowing final funds to be made available to the beneficiaries immediately after interbank settlements occur.

According to international experience, the decision to introduce instant payments is often accompanied by the option of using or improving the pre-existing large-value payment system or building a new infrastructure for the instant settlement of such payments between financial institutions (BIS, 2024: 36).

Such is the case in Colombia, as *Banco de la República* (*Banrep*) will soon offer real-time settlement services for fast payment systems (FPS) through the operational settlement mechanism (MOL in Spanish), based on a new high-availability platform. This platform will enable participants in the FPS to debit or credit their deposit accounts held at *Banrep* to fulfill payment orders, transfers, or both. This new *Banrep* service will allow FPS participants to settle transactions in real-time and in central bank money[1], seeking to mitigate settlement, credit, and liquidity risks.

1. Large-Value Payment Systems and the Importance of Settling in Central Bank Money

In general, central banks manage large-value payment systems, where financial institutions settle the cash leg of the transactions traded in financial markets, as well as the results from the multilateral netting of the various electronic payment instruments. In this context, central bank money exists in the form of reserves held at the central bank on behalf of financial institutions, accessed through an electronic system that manages the obligations of the participants. These reserves serve as the means of payment used by entities to fulfill their business transactions (*Banrep*, 2015).

Public trust in various means of payment partly stems from the ability to transfer these means at any time to other accounts within the financial system or convert them into money issued by the central bank (Manning et al., 2009: 34). However, while the final settlement of

1 Central bank money is a liability of a central bank, in this case in the form of deposits held at the central bank itself, which can be used for settlement.

transactions using commercial bank money may be subject to uncertainty (for example, if a bank faces difficulties in meeting its obligations), central bank-issued means of payment are free from that risk (Couture and Bélisle, 2015: 35-36). For this reason, monetary systems have institutional frameworks designed to protect public trust and money, with instruments such as deposit insurance and the regulation and oversight of financial institutions by state agencies. Likewise, for the smooth functioning of the payment system and the financial system in general (BIS, 2003: 1), it is essential that governments and central banks ensure that payments are settled securely, efficiently, and promptly.

Thus, *Banrep*, like most central banks, provides payment system services to commercial banks and other authorized financial institutions by opening deposit accounts at the central bank, allowing them to settle transactions in financial markets and make direct fund transfers among themselves. This function aligns with the tiered structure of the financial system where individuals and non-financial institutions manage part of their liquidity with commercial banks, while these banks manage their liquidity at the central bank (BIS, 2003: 2).

2. Settlement, Credit, and Liquidity Risks

One of the key risks faced by financial market infrastructures (FMIs) is the settlement risk, which refers to the failure to settle as intended. An FMI faces this risk whether the settlement of a transaction occurs on its own books or those of another FMI, as well as on the books of a third party (for example, a central bank or a commercial bank) (CPMI-Iosco, 2012).

FMIs are also exposed to credit risk, which may arise when a settlement bank defaults on its obligations (e.g., if the settlement bank becomes insolvent). When an FMI settles on its own books, participants face credit risk arising from the FMI itself. Liquidity risk can arise in monetary settlements if, once a payment obligation is settled, participants or the FMI itself are unable to easily transfer their assets from the settlement bank to other liquid assets, such as deposits at the central bank (CPMI-Iosco, 2012).

In light of the above, CPMI-Iosco (2012), in its principles for financial market infrastructures, recommends that settlements of transactions between financial institutions (i.e., interbank settlements) be conducted in central bank money, as established in Principle 9: "Money Settlements: An FMI should conduct its money settlements in central bank money where practical and available. If central bank money is not used, an FMI should minimize and strictly control the credit and liquidity risk arising from the use of commercial bank money" (CPMI-Iosco, 2012).

3. Settlement Models

Over the past twenty years, fast payment systems (FPS) have been implemented globally, primarily focusing on achieving immediacy for the end user, allowing for the settlement of transactions between financial institutions to occur either on a deferred or real-time basis.

One major advantage of the deferred model is that financial institutions participating in the FPS do not need to maintain liquidity at all times. However, it exposes the financial institution receiving the payment or transfer to credit risk, as the customer receives the payment, but the financial institution will only materialize it once the net settlement occurs. To manage this risk, participants are generally required to maintain certain levels of collateral. In contrast, the gross settlement model avoids the credit and liquidity risks associated with interbank settlement (e.g., in the event of a participant's default). However, it generally requires a higher level of liquidity than net settlement, implying that the settlement system must have operational tools to manage this risk.

In the past, deferred net settlement was preferred by most fast payment systems, mainly due to technological limitations and the benefits this model offered for liquidity management through cost savings. Nevertheless, today, thanks to technological developments, it is easier to create systems capable of processing high volumes of transactions continuously. This, combined with a growing interest in managing credit risk, has led to most fast payment systems developed worldwide after 2015 being based on real-time gross settlement (Bank of Korea, 2002: 4).

3.1 Deferred Settlement

Transactions are transmitted, confirmed, and reported in real-time to the financial institutions involved, and settlement occurs after the beneficiary's financial institution has credited the funds to the beneficiary's account. In other words, the fulfillment of individual payment obligations between the payer and the payee is separated from the fulfillment of the existing obligations between the participating financial institutions. Multilateral net positions between participating institutions can be settled once or multiple times a day. Settlement may occur in a dedicated infrastructure or in a system also used for other participants to hold accounts, such as a real-time gross settlement system (*Banrep*, 2017).

3.2 Real-Time Settlement

This model involves executing credits and debits among various participants in the payment chain (i.e., payers, payees, and their respective banks) at high speed, including settlement between financial institutions. This means that the payer's financial institution sends funds via the FPS to the payee's financial institution before it credits the funds to the holder. In this model, transactions are transmitted, confirmed, established, and reported in real-time to the financial institutions involved. The model can incorporate two forms: with or without net clearing before settlement. If there is no net clearing, each individual payment obligation between end users generates an equal obligation among participating institutions, which are settled on a gross basis. If there is net clearing, it applies to a high number of very short settlement cycles so that it can occur in almost real-time (*Banrep*, 2017).

This model may require the operator of the real-time gross settlement system (RTGS) to have additional operational tools, such as configuring the model within the existing RTGS accounts, which would mean making it available 24/7 for interbank settlement or a model with a dedicated account different from the existing RTGS account (CPMI, 2021: 8). In this case, the system that manages the dedicated accounts must be open 24/7 for interbank settlement.

4. Settlement for Fast Payments in Colombia

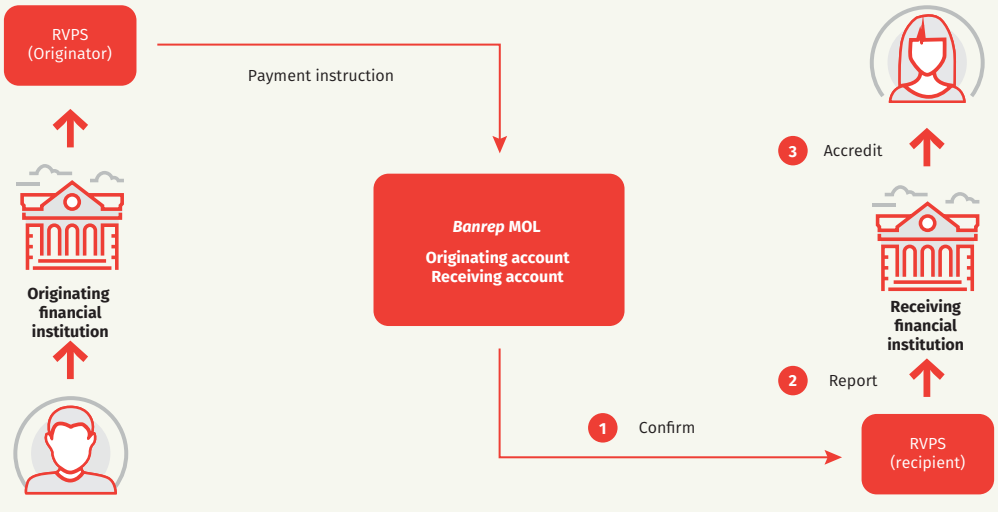
Among the new services *Banrep* will provide in the country's fast payment ecosystem are a centralized directory, a FPS, and an operational settlement mechanism (MOL) of fast payments. The latter is the solution that *Banrep* aims to provide to the financial institutions participating in the various FPSs to settle interbank fast payments in central bank money. This system will allow for real-time gross settlement exclusively in deposit accounts at *Banrep*, including the ability to reserve funds in the participants' deposit accounts for each payment order/funds transfer (PO/FT) to ensure the legal acceptance of the transactions. In accordance with Article 15 of External Resolution 6 of 2023 from *Banrep*'s Board of Directors: "[...] the settlement of Fast Payment Orders and/or Funds Transfers will be executed through the Operational Settlement Mechanism exclusively in the deposit accounts at *Banco de la República*."The MOL will have a large-value independent settlement configuration and will allow each participant in the FPS to link one of their existing deposit accounts at the central bank for settlement of POs/FTs. The MOL will be available 24/7 for

interbank settlement as ordered by the FPS. The large-value payment system will continue to operate on business days from Monday to Friday, from 7:00 a.m. to 8:00 p.m. It is worth mentioning that participants in the FPS who are not authorized to have a deposit account at *Banrep* can settle their POs/FTs through a deposit account opened by an authorized participant (indirect model).

This model includes a functionality that allows the participant, at their discretion, to allocate the total balance of a single deposit account: 1) how much to retain for transactions in the large-value system, and 2) how much to allocate for settling POs/FTs in the MOL.

The settlement characteristics were established in External Circular 465, specifically in Annex 2. In summary, after sending the payment instructions and having the transaction passed through the risk controls established in the originating and receiving FPSs, thus resulting in legal acceptance by the originating FPS, the most relevant steps in the settlement flow are as follows: 1) in the MOL, the money from the instant transaction is transferred from the originating participant's deposit account to the receiving participant's deposit account, 2) the MOL confirms the settlement to the receiving FPS, which informs the receiving participant that they can disburse the funds to the final beneficiary, as they are already secured in their deposit account in the MOL of *Banrep*, and 3) the receiving participant credits the funds to the final beneficiary (Diagram B3.1).

Diagram B3.1
Interbank Settlement Flow



Source: *Banco de la República*

Thus, in the fast payment ecosystem in Colombia, not only from the user experience perspective is the transfer "instant" (i.e., the crediting to the payee's account and the debiting from the payer's account takes seconds), but the final settlement of obligations among the financial institutions participating in the fast payment systems will also be instant. The MOL of *Banrep* will facilitate the mitigation of settlement, credit, and liquidity risks in the POs/FTs from the perspective of interbank settlement.

References

Banco de la República (2017). *Payment Systems Report*, August.

Banco de la República (2015). "El Banco de la República como banquero de bancos y agente fiscal del gobierno," *Revista del Banco de la República*, no. 1058.

BIS (2003). “La Función del dinero del banco central en los sistemas de pago (extracto)”, Comité de Sistemas de Pago y Liquidación, p. 1.

Bank of Korea (2022). *Payment and Settlement Systems Report*, April.

CPMI-Iosco (2012). *Principles for Financial Market Infrastructures*, BIS.

CPMI (2021). *Developments in Retail Fast Payments and Implications for RTGS Systems*, BIS, p. 2.

BIS (2024). “Fast Payments: Design and Adoption,” *BIS Quarterly Review*, p. 36.

Couture, T.; Bélisle, C. (2015). “The ‘Bank’ at the Bank of Canada”, *Bank of Canada Review*, vol. 2015, pp. 35-36.

Manning, M.; Erlend, N.; Jochen, S. (2009). *The Economics of Large Value Payments and Settlement: Theory and Policy Issues for Central Banks*, Oxford: Oxford University Press. 34.

2.2.1.1 Automated Clearing Houses (ACH)

There are two automated clearing houses operating in Colombia: ACH-Cenit (managed by *Banco de la República*) and ACH-Colombia, which is owned by commercial banks.

Together, they cleared 367.9 million transactions during 2022, 6.5% more than in 2022. On average, this amounts to 1,514,695 payment instructions per day (100,787 processed by ACH-Cenit and 1,413,908 by ACH-Colombia), for a total value of COP 9.2 t (COP 1.5 t in ACH-Cenit and COP 7.7 t in ACH-Colombia). In 2023, the total gross amount cleared by these ACH, together, came to COP 2,224.9 t; that is, 12.2% more than in 2022 (2.7% in real terms) and 1.5 times the nominal GDP in 2023. The net amount settled by these clearing houses in 2023 was COP 770.0 t in total (an average of COP 3.2 t per day). This is equivalent to 34.7% of the gross value and results in a liquidity savings of 65.3%.

It is important to note the increase in the average daily value of the amount mobilized over the past ten years (2014 to 2023), with a nominal compound annual growth rate (CAGR) of 11.0%. As for the number of transactions, variation during the same period has been positive, with a CAGR of 9.6%.

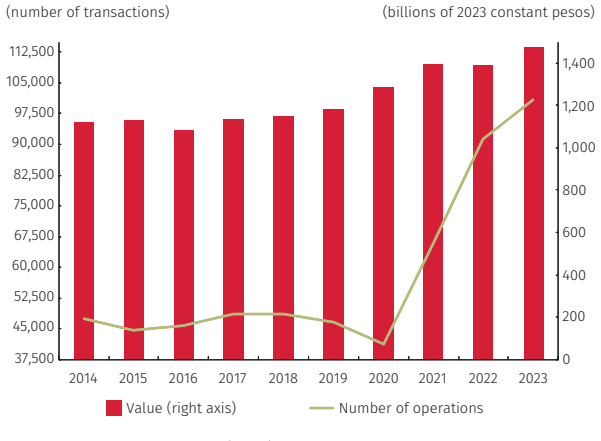
2.2.1.1.1 ACH-Cenit

As shown in Graph 2.7 and Table 2.3, more than 24.3 million transactions (100,787 daily, on average) were processed through ACH-Cenit during 2023, including credit (credit of funds) and debit (discount of funds) operations. The respective gross amount was over COP 356.3 t (COP 1,472.3 b daily, on average). These figures, when compared to those for 2022, reflect an increase of 10.4% in the number of operations and 5.9% growth in value (-4.1% in real terms). The low amount of liquidity savings (1.8% in 2023) resulting from the net amounts cleared through ACH-Cenit is due to payments sent by the DGCPTN and the General Royalties System, which accounted for the majority (86.9%).

Credit transactions represented the bulk of all transactions in 2023, both in number (93.0%) and value (99.1%) Debit transactions registered increases of 163% in number and 66.1% in the value, compared to 2022 (Table A2.1).

As for operational efficiency, ACH-Cenit's availability in 2023 was 99.65%. In other words, there were occasional interruptions that affected the provision of the service for a period equivalent to 0.35% of the time.

Graph 2.7
Value and Number of Transactions in ACH Cenit
(Daily averages)



Source: *Banco de la República* (Cenit).

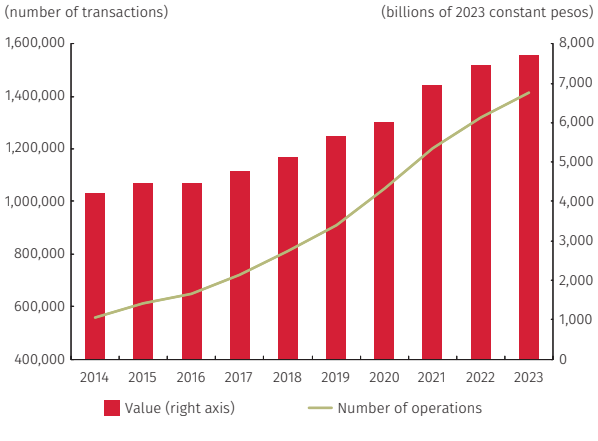
Table 2.3
Statistics of the ACH Cenit[a/]

Year	Daily Average				
	Number of transaction	Value		Average Transaction Value	
		(Trillions of pesos)	(Trillions of 2023 constant pesos)	(Trillions of pesos)	(Trillions of 2023 constant pesos)
2014	47,586	0.7	1.1	14.1	23.5
2015	44,743	0.7	1.1	16.2	25.3
2016	45,697	0.7	1.1	16.1	23.8
2017	48,572	0.8	1.1	16.4	23.3
2018	48,484	0.8	1.2	17.2	23.8
2019	46,741	0.9	1.2	19.0	25.3
2020	41,327	1.0	1.3	23.9	31.2
2021	66,225	1.1	1.4	17.1	21.1
2022	91,315	1.3	1.4	13.9	15.2
2023	100,787	1.5	1.5	14.6	14.6

Year	Annual Total							
	Number of Transactions			Value of Transactions (Trillions of pesos)			Annual Value (Trillions of 2023 constant pesos)	Number of times GDP
	Credit	Debit	Total	Credit	Debit	Total		
2014	11,035,981	574,941	11,610,922	163.2	0.4	163.7	273.3	0.21
2015	10,410,511	417,239	10,827,750	174.4	0.5	174.9	273.6	0.22
2016	10,909,837	285,842	11,195,679	179.2	0.6	179.8	265.9	0.21
2017	11,549,242	205,292	11,754,534	192.5	0.6	193.0	274.3	0.21
2018	11,567,335	165,728	11,733,063	201.8	0.5	202.4	278.7	0.20
2019	11,249,571	201,856	11,451,427	217.5	0.5	218.0	289.3	0.21
2020	9,817,581	266,197	10,083,778	240.3	0.6	240.9	314.5	0.24
2021	15,905,326	319,814	16,225,140	276.2	0.7	276.9	342.3	0.23
2022	21,722,190	649,955	22,372,145	310.7	1.1	311.8	340.7	0.21
2023	22,682,844	1,707,674	24,390,518	353.1	3.2	356.3	356.3	0.23

a/ Includes credit and debit transfers.
Source: *Banco de la República* (Cenit).

Graph 2.8
Value and Number of Transactions in ACH Colombia
(Daily averages)



Source: ACH Colombia.

2.2.1.1.2 ACH-Colombia

During 2023, ACH-Colombia processed 343.5 million transactions in total, including credit and debit operations, for more than COP 1,868.6 t gross. These figures represent a 6.4% increase in the number of transactions and an 11.8% rise (2.3% in real terms) in value compared to 2022 (Graph 2.8 and Table 2.4).

ACH-Colombia settles the net values that result from clearing in five intraday trading cycles. Once the net positions are calculated, the participants with net debtor positions transfer funds to ACH-Colombia's account. Then, ACH-Colombia ultimately distributes them from its deposit account to the participants with net creditor positions. The net value settled in all of 2023 was COP 374.6 t (an average of COP 1,736.7 b per day), which is equivalent to 22.6% of the gross value. This results in a liquidity savings of 77.4%.

Table 2.4
Statistics of ACH Colombia

Year	Daily Average					Annual Value			
	Number of Transactions	Value		Average Transaction Value		(Number of transactions)	(Trillions of pesos)	(Trillions of 2023 constant pesos)	Number of times GDP
		(Trillions of pesos)	(Trillions of 2023 constant pesos)	(Millions of pesos)	(Millions of 2023 constant pesos)				
2014	556,449	2.5	4.2	4.5	7.5	135,773,574	619	1,033	0.8
2015	611,228	2.9	4.5	4.7	7.3	147,917,150	696	1,089	0.9
2016	648,858	3.0	4.4	4.6	6.9	158,970,262	734	1,085	0.8
2017	721,067	3.3	4.7	4.6	6.6	174,498,262	808	1,149	0.9
2018	808,832	3.7	5.1	4.6	6.3	196,546,261	911	1,255	0.9
2019	909,622	4.2	5.6	4.7	6.2	221,947,874	1,028	1,365	1.0
2020	1,048,593	4.6	6.0	4.4	5.7	255,856,641	1,117	1,458	1.1
2021	1,201,214	5.6	6.9	4.7	5.8	294,297,520	1,376	1,701	1.2
2022	1,318,505	6.8	7.5	5.2	5.7	323,033,757	1,672	1,827	1.1
2023	1,413,908	7.7	7.7	5.4	5.4	343,579,588	1,869	1,869	1.2

Source: ACH Colombia.

Table 2.5 shows the CR5 concentration index, which is constructed as the sum of the five largest portions of the transaction value, was 73.0% for credit transactions in 2023. This amounts to a decrease of 0.58% from 2022. For debit transactions, the CR5 index reflects a decrease of 9.5 percentage points, having gone from 88.6% in 2022 to 79.05% in 2023.

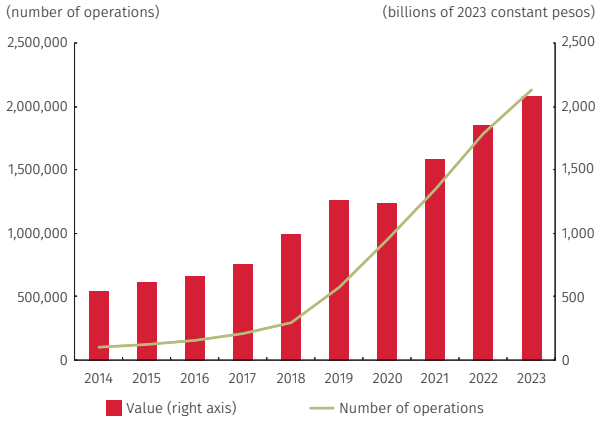
Graph 2.9 shows how use of the SOP button has evolved. This service, which is provided by ACH Colombia, saw a 19.5% increase in the number of transactions and a 22.4% rise in monetary value (12.0% in real terms) compared to 2022.

Table 2.5
ACH Colombia (Participants and Concentration in the Value of Payments Sent)

Year	Credit transactions			Debit transactions		
	Number of participants	CR5 (percentage)	Number of participants who clear 70% of the value	Number of participants	CR5 (percentage)	Number of participants who clear 70% of the value
2014	20	70.2	5	15	92.1	5
2015	20	70.2	5	15	88.1	5
2016	20	73.5	5	15	85.3	5
2017	23	73.80	5	15	91.0	5
2018	25	74.32	5	16	92.9	5
2019	27	74.00	5	14	92.0	5
2020	27	74.37	5	15	89.30	5
2021	31	72.20	5	15	85.60	5
2022	32	73.60	5	15	88.60	4
2023	35	73.02	5	15	79.05	4

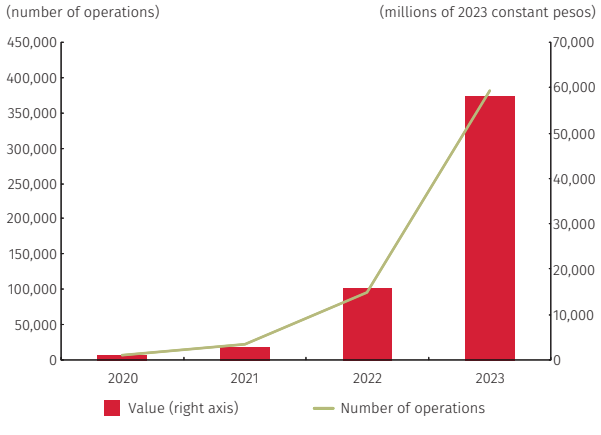
Source: ACH Colombia.

Graph 2.9
Value and Number of Transactions Using the SOP Service (ACH Colombia) (Daily averages)



Source: ACH Colombia.

Graph 2.10
Value and Number of Monthly Transactions Using the Fast Payment Service: Transfiya (ACH Colombia) (Daily averages)



Source: ACH Colombia.

ACH Colombia inaugurated a fast payment service called "*Transfiya*" at the beginning of 2020. It allows a person to transfer or receive money from another person in less than ten seconds, using a mobile phone number. Graph 2.10 shows the annual evolution of the use in number and value of transactions, where in 2023 the largest number and value is presented. Compared to the previous year, the daily average of transactions went from 96,526 to 382,889 (396% increase), while the amount transferred went from COP 14.5 billion to COP 58.3 billion (302% nominal increase). It is important to note that while the amount mobilized through *Transfiya* is equivalent to 0.8% of the amount corresponding to the clearing and settlement services of ACH Colombia, the number of operations represents 27% (Table 2.4). The above shows *Transfiya's* orientation in dealing with very low amount transfers.

To complement the statistics on the use of electronic funds transfers as a payment instrument, Table 2.6 shows figures for intrabank transfers in which the sender and the receiver of the funds share the same bank. For that reason, these transfers are not cleared through ACH.

Intrabank transfers during 2023, in terms of the number of transactions, accounted for 621.9% of all interbank transfers. In terms of value, they were 1.5 times more than intrabank transfers.

2.2.1.2 Debit and Credit Card Clearing and Settlement Systems

By 2023, Colombia had five retail-value payment systems (RVPS) dedicated to clearing and settling debit and credit card transactions conducted on site, at retail establishments, as well as through digital channels.[13] According to the information reported by the administrators of these systems, at the end of the year 6.6 million transactions were reported with a daily average of COP 866 billion. Compared to the previous year, these figures represent an aggregate growth of 21.6% in the number of transactions and 15.1% in value (Graph 2.11).

Depending on the operational arrangement of each system, transactions can be settled through a bank, or a deposit account maintained by the manager in the CUD. In the first case, the RVPS manager instructs the debtor entities in the payment cycle to deposit the funds in a savings or checking account the manager has at a bank. Subsequently, the manager instructs the bank to distribute the funds to the creditor entities in the cycle. In the second case, however, the debtors transfer the funds directly to the manager's CUD account, thereby enabling

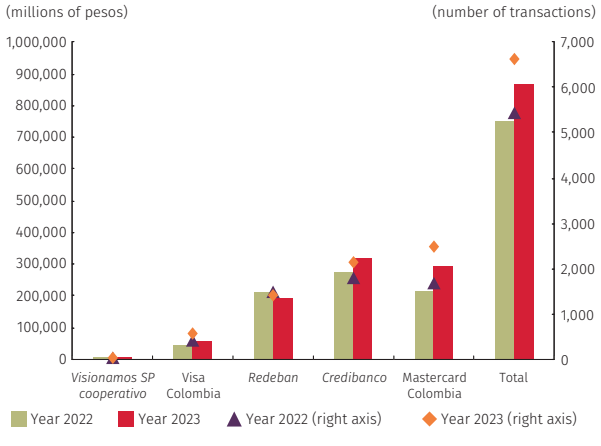
13 Although there are six RVPSs operating in Colombia under the authority of Financial Superintendency of Colombia (SFC in Spanish), those dedicated to clearing and settling obligations resulting from ATM transactions are not included for the purpose of this section.

Table 2.6
Annual Comparison of the Value and Number of Interbank Transfers with Intrabank Transfers

Year	Interbank Clearing[a/]		Intrabank Transfers[b/]			
			Number of operations		Value	
	Number of operations	Value (Trillions of pesos)	(Number of operations)	(As a percentage of interbank operations)	(Trillions of pesos)	(Number of times interbank operations)
2014	147,384,496	782	112,103,184	76.1	1,026	1.3
2015	158,744,900	871	145,895,871	91.9	1,582	1.8
2016	170,165,941	914	189,358,265	111.3	2,394	2.6
2017	186,252,796	1,001	179,104,744	96.2	2,139	2.1
2018	208,279,324	1,114	304,602,311	146.2	2,965	2.7
2019	233,399,301	1,247	353,430,214	151.4	2,774	2.2
2020	265,940,419	1,358	498,345,093	187.4	3,236	2.4
2021	310,522,660	1,653	815,131,209	262.5	3,315	2.0
2022	345,405,902	1,984	1,530,690,810	443.2	3,149	1.6
2023	367,970,106	2,225	2,288,273,642	621.9	3,441	1.5

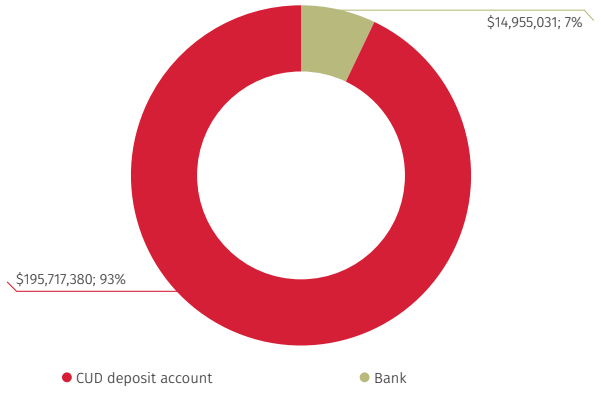
a/ Pertains to the number and value of operations cleared through ACH Cenit and ACH Colombia.
b/ Transfers that are settled within each financial institution and do not go through the ACHs.
Sources: Commercial banks and ACH.

Graph 2.11
Amounts of Payments Made with Cards



Sources: *Visionamos*, Visa SS, *Redebán*, *Credibanco*, and Mastercard Colombia

Graph 2.12
Settlement Distribution



Source: *Banco de la República* (DSIF).

the manager to subsequently transfer these funds independently to the creditors.

As shown in Graph 2.12 for 2023, approximately 93% of the amount resulting from debit and credit card payment obligations was processed through deposit accounts held by RVPS managers, while the remaining 7.0% was settled through accounts or ledger systems that support the RVPS settlement processes.

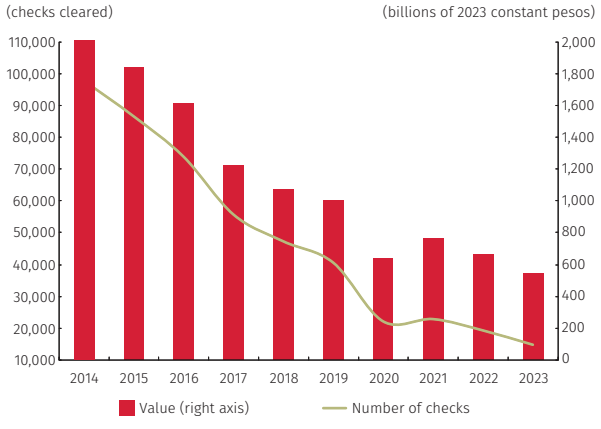
2.2.1.3 Check Clearing Houses and Banco de la República's Cedec System

2.2.1.3.1 The Cedec Check Clearing House

In 2023, 3.6 million checks were cleared (14,755 per day, on average) for a total of COP 131.8 t (an average of COP 0.5 t per day)[14], which represents 8.0% of GDP. These figures are below the 4.7 million checks and COP 149.4 t in value recorded for 2022 and signify respective reductions of 24.3% and 11.8% (19.3% in real terms) (Graph 2.13 and Table 2.7).

14 These figures on the use of checks consider only interbank payments, i.e., between customers of different financial entities. Therefore, they do not include intrabank checks, which are settled within the bank and do not pass through the check clearing house. Statistics on intrabank payments are provided at the end of this section.

Graph 2.13
Value and Number of Checks Cleared through Cedec
(Daily averages)



Source: *Banco de la República* (Cedec).

As for liquidity requirements, Table 2.7 shows average gross clearing at COP 545 billion per day in 2023. However, due to multilateral netting, only COP 134.0 billion were required to settle the obligations between financial institutions (Table A1.2). Accordingly, this meant a liquidity savings of 75.4%.

The data provided by commercial banks indicates that intra-bank checks (the drawer and the drawee share the same bank and the checks are not sent to Cedec or physical clearing houses) accounted for 42.4% of the value and 65.4% of the total number of interbank checks cleared in 2023. Presenting an increase in the value by 3.3% and a decrease in the number by 15.4%, with respect to 2022 (Table 2.8).

In the last ten years (2014 to 2023) there has been a substantial decrease in the average daily value of the amount mobilized in interbank checks stands out, with a CAGR of -7.7% in nominal terms. As for the number of transactions, they had a negative variation in the last ten years with a CAGR of -17.3%.

Table 2.7
Statistics on Checks Cleared through Cedec

Year	Daily Average					Annual Value			
	Number of checks (number of operations)	Value		Average transaction value		(Millions of checks)	(Trillions of pesos)	(Trillions of 2023 constant pesos)	(Number of times GDP)
		(Trillions of pesos)	(Trillions of 2023 constant pesos)	(Millions of pesos)	(Millions of 2023 constant pesos)				
2014	97,762	1.2	2.0	12.3	20.5	23.9	293	489	0.38
2015	86,537	1.2	1.8	13.6	21.3	20.9	285	446	0.35
2016	73,852	1.1	1.6	14.8	21.9	18.1	268	396	0.31
2017	55,674	0.9	1.2	15.5	22.0	13.5	209	297	0.23
2018	47,254	0.8	1.1	16.4	22.6	11.5	189	260	0.19
2019	40,553	0.8	1.0	18.7	24.8	9.9	186	246	0.18
2020	22,097	0.5	0.6	22.1	28.8	5.4	119	155	0.12
2021	22,819	0.6	0.8	27.2	33.7	5.6	152	188	0.13
2022	19,256	0.6	0.7	31.7	34.6	4.7	149	163	0.10
2023	14,755	0.5	0.5	36.9	36.9	3.6	132	132	0.08

Source: *Banco de la República* (Cedec).

Table 2.8
Comparison of Value and Number of Interbank Checks with Intrabank Checks

Year	Interbank Checks Cleared[a/]		Intrabank Checks[b/]			
		Value	Number		Value	
	Number of checks	(Trillions of pesos)	(Number of checks)	(As a percentage of interbank checks)	(Trillions of pesos)	(As a percentage of interbank checks)
2014	23,853,920	293	13,745,083	57.6	109	37.3
2015	20,900,000	285	11,207,337	53.6	106	37.2
2016	18,093,721	268	9,530,565	52.7	89	33.1
2017	13,472,000	209	7,990,110	59.3	90	42.9
2018	11,482,000	189	7,004,212	61.0	73	38.5
2019	9,935,390	186	6,019,882	60.6	73	39.6
2020	5,369,615	119	4,039,429	75.2	47	39.8
2021	5,590,533	152	3,192,381	57.1	56	36.8
2022	4,717,777	149	2,761,681	58.5	54	36.2
2023	3,570,715	132	2,335,846	65.4	56	42.4

a/ Pertains to the number and value of the checks cleared through Cedec.
b/ Checks that are settled within each financial institution and do not go through the check clearing house.
Sources: commercial banks and *Banco de la República* (Cedec).

Table 2.9
Cedec (Participants and Concentration)

Year	Total participants	CR5 (percentage)	Number of participants who clear 70% of the value
2014	25	72.1	5.0
2015	27	72.1	5.0
2016	25	72.2	5.0
2017	25	73.3	5.0
2018	25	71.3	5.0
2019	26	70.1	5.0
2020	25	70.5	5.0
2021	25	71.4	5.0
2022	22	73.1	5.0
2023	25	73.1	5.0

Source: *Banco de la República* (DSIF).

2.2.1.3.2 Concentration and Operational Efficiency Indicators

Compared to 2022, the number of entities involved in the check clearing process declined, ending up with 25 entities in 2023 (Table 2.9). In addition, the concentration of transactions observed from a while ago was maintained, as indicated by the CR5 index, which represents the share the five largest participants have in the amount cleared. This trend has been observed for some time. As to operational efficiency during 2023, Cedec had an availability rate of 99.79%. In other words, there were occasional interruptions in service for a period equivalent to 0.21% of the entire time.

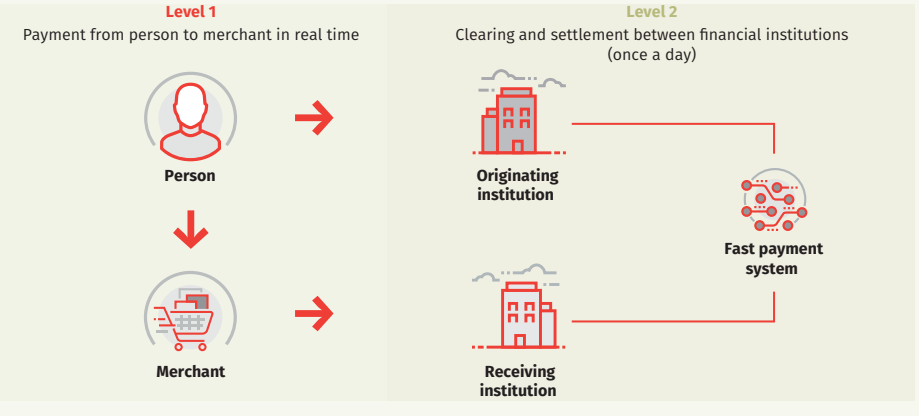
Shaded Section 1: *Entre-Cuentas*: The new Instant Payment Service by *Redebán*

Fast payments or real-time funds transfers between end users, such as individuals, merchants, businesses, or public institutions, at any time (24/7), have significantly increased worldwide. In terms of the number of transactions in 2022, the largest transactions were recorded in India (48,600 million), China (18,500 million), Thailand (9,700 million), and Brazil (8,700 million) (Frost et al., 2024). In Colombia, the implementation of the fast payment system offered by *Banco de la República* is expected in 2025.

As a background, Colombia started implementing fast payment services through interbank payment systems to ensure the availability of funds in real time for payment recipients. In 2020, ACH Colombia launched the *Transfiya* payment service for instant person-to-person (P2P) transfers.[1] In 2023, Entre-Cuentas was created as *Redebán*'s fast funds transfer service, focused on person-to-commerce (P2C) transactions.

Entre-Cuentas is characterized by starting the payment process through a QR code, which allows the connection to initiate transfers from the customer to the merchant. Both parties must have accounts with any of the financial institutions registered as participants in the fast payment system.[2] Consequently, within the payment process, each transaction occurs at two different levels: one at the end-user level and the other at the financial institution level. The first corresponds to the payment between the customer and the merchant, which is characterized by the merchant's (payment recipient's) availability of funds within a few seconds. The second corresponds to the part of the process where the transaction is cleared and settled by the retail-value payment system, a process conducted between the financial institutions of the individual and the merchant (Diagram S1.1), known as *interbank settlement*.

Diagram S1.1
Instant Payment Transaction (Two Levels)



Source: *Redebán* (2024); prepared by *Banco de la República*.

1 Use cases are recognized by the acronyms P2P: person-to-person; P2C: person-to-commerce, and G2P: government to person.

2 Among the banking institutions registered or participating with access to the *Redebán* payment system for instant transfers (enabled in the Entre-Cuentas service) are: Bancolombia, Davivienda, Scotiabank, BBVA, Banco AV Villas, Banco Caja Social, Banco de Bogotá, Banco Popular, and Banco de Occidente. Among the electronic deposit institutions are Nequi, Daviplata, Movii, and Dale.

Image S1.1
Interoperable Codes (Digital and Physical)

Source: *Redebán* (n.d.). News.

As mentioned, this service began with person-to-commerce (P2C) transactions. However, a second phase is planned, including commerce-to-commerce (C2C) and government-to-person (G2P) transactions (*Redebán*, 2024). For the person-to-commerce use case, *Redebán* links individuals to a directory, which is a database containing the keys and other information associated with customers of the participating financial institutions of Entre-Cuentas and provides open and interoperable QR codes that allow merchants to receive payments in various ways (Image S1.1):

- Digital: with the QR code on their mobile phone or website.
- Physical: with the physical QR code at the store counter or through *Redebán*'s payment terminals.

Below is a general description of level 1 with an example of the instant payment process via *Redebán* (Diagram S1.2): the individual initiates a payment transaction for 100,000 Colombian pesos, which requires authorization from both the individual's financial institution[3] and the merchant's[4], an authorization that is processed by *Redebán*. To facilitate this payment, *Redebán* maintains bridge accounts in each financial institution (the individual's and the merchant's) to facilitate the transfer of debited and credited funds to these accounts. The debited funds are transferred to the bridge account of the individual's institution, while simultaneously, the funds are deducted from the bridge account of the receiving institution and credited to the merchant's account. This process occurs in approximately four seconds.

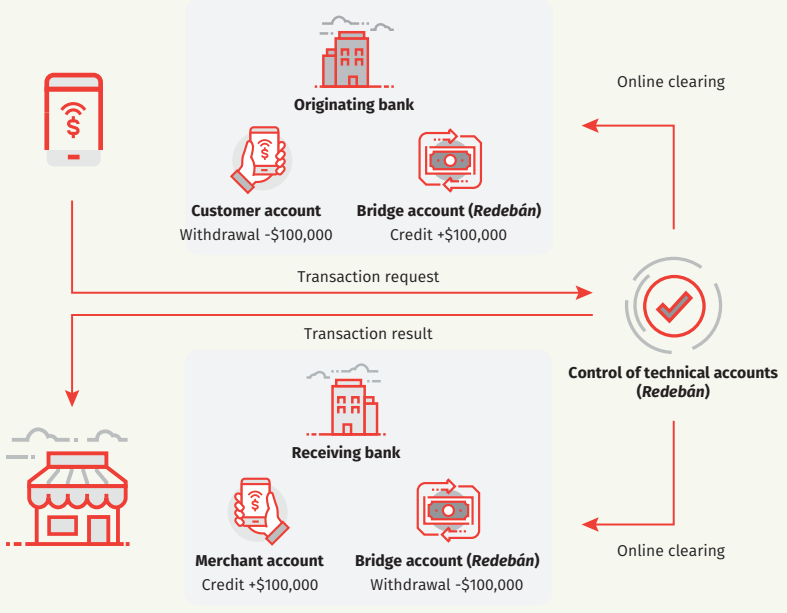
The sequence of the process is as follows (*Redebán*, 2024):

1. The originating institution requests *Redebán* to process a transfer order.
2. *Redebán* validates, using the liquidity accounts control system, the risk limits established by the originating institution.

3 Originating Institution: Any participating entity or group providing financial services. After joining Entre-Cuentas, it enables services for its customers (account holders) to act as originators, allowing them to make payments to merchants through real-time interoperable transactions (*Redebán*, 2023).

4 Receiving Institution: Any participating entity or group providing financial services. After joining Entre-Cuentas, it enables services for its customers (merchants), who must previously register through *Redebán* channels or the institution itself, allowing them to act as receivers, having a QR code to receive real-time interoperable payments (*Redebán*, 2023).

Diagram S1.2
Redebán, Person-to-Merchant Instant Payment



Source: *Redebán* (2024).

3. *Redebán* requests authorization from the originating institution for the *debit* transaction to the customer's account. The institution conducts an internal money transfer between a "customer account" and an "accounting account" and confirms the transaction result to *Redebán*.

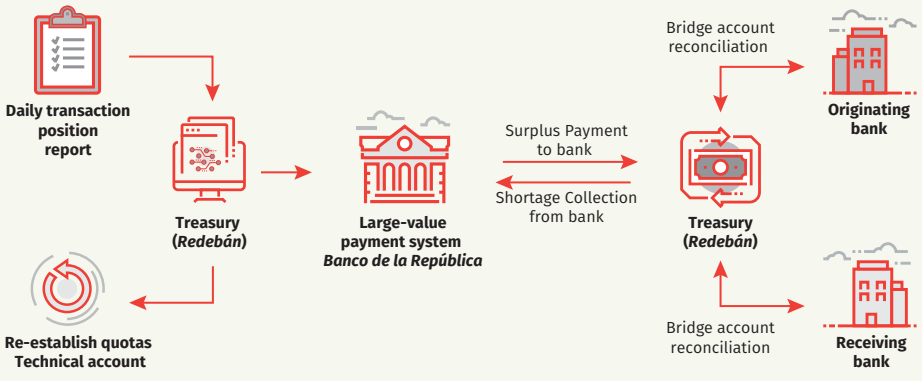
4. If the result of the previous step is "approved," *Redebán* validates the risk limits established by the receiving institution through the technical accounts control system.

5. *Redebán* requests authorization from the receiving institution for the credit transaction to the merchant's account. The institution conducts an internal money transfer between the "accounting account" and the "merchant's account" and confirms the transaction result to *Redebán*.

6. *Redebán* confirms the transaction status to both the originating institution and the merchant via text message. If there is any inconsistency, the system will automatically and immediately send a technical reversal to each participating institution.

The movement of resources that enabled the availability of the 100,000 pesos in the merchant's account entails for this transaction, and for all those generated under *Redebán*'s fast payments, the process of clearing and settlement of these transactions in the system (Level 2). At the end of the established period, *Redebán* determines the balance due to each participant as a result of the transactions processed in the payment system to extinguish their obligations among themselves, based on a consolidated transaction report (daily movement position) and the netting of transactions, which closes at 11:00 p.m. and is delivered at 7:00 a.m. daily. Diagram S1.3 illustrates both the components and the sequence of activities that allow each participating institution to establish its debit or credit balance at the end of the day.

Diagram S1.3
Redebán, Clearing and Settlement between Participating Institutions within the Instant Payments Framework



Source: *Redebán* (2024).

In the first eight months of operation, and as of April 2024, Entre-Cuentas processed 26,468,665 transactions, totaling approximately COP 1.7 trillion, indicating an average transaction value of around COP 66,000.

As detailed, the Entre-Cuentas fast payment service begins with the person-to-commerce use case, for which the debit and credit of funds occurs almost in real-time. The clearing and settlement are performed by *Redebán*'s retail-value payments system, once a day, following the established protocols for the day-to-day clearing and settlement for debit and credit cards.

References

Frost, F.; Koo Wilkens, P.; Kosse, A.; Shreeti, V.; Velasquez, C. (2024). "Fast Payments: Design and Adoption," *BIS Quarterly Review*, 3 March.

Redebán (2022). *Reglamento de funcionamiento*, 30 March.

Redebán (2023). "Procedimiento compensación consolidada tesorería," 17 May.

Redebán (2024). Entre-cuentas, February.

Redebán (n.d.). News, available at: https://www.rbmcolombia.com/wps/portal/index/noticias.html

Box 4: Automatic Debit Mechanisms in Retail-Value Payment Systems and their Contribution to Risk Mitigation: The Case of ACH Colombia

As the administrator of the Deposit Accounts System (CUD), since 2010, *Banco de la Republica* (*Banrep*) has offered automatic debit services for deposit accounts. This allows an external system[1] to send a series of debits to one or more deposit accounts of its linked participants automatically.

In 2023, ACH Colombia began a process to obtain authorizations from its affiliates to enable a more efficient allocation of resources within the framework of interbank transfer settlements through this operational facility. As a result, the institution has reduced the time taken to complete the settlement cycles.

This is crucial since the quicker ACH receives the funds, the faster it can distribute them to the receiving institutions. This, in turn, allows institutions to access resources more promptly to meet other intraday payment obligations (e.g., settlement of securities market transactions). In this regard, anticipating the settlement of transactions generates lower liquidity pressures for the system participants towards the end of the day.

In this context, this box seeks to analyze the contribution of the automatic debit functionality to the times taken by ACH Colombia to complete its settlement cycles. This is particularly relevant considering that this institution is the third most important financial infrastructure as a global liquidity distributor in the Colombian large-value payment system (León & Pérez, 2014). Therefore, it is necessary to quantify the benefits in terms of intraday liquidity needs for participants in the CUD. This analysis is based on a methodological approach proposed by the Bank for International Settlements (BIS).

This box is organized into five sections. The first provides context on the operation of ACHs, emphasizing the settlement process. Subsequently, sections two and three describe key elements of the functioning of ACH Colombia, its stages, and the time taken for payment order settlements. Sections four and five present the methodological approach and analysis of results regarding the effects that the reduction in settlement cycle times may have had on the intraday liquidity needs of the institutions. The last section contains the conclusions.

1. Lifecycle of an ACH Transaction

BIS-CPSS (2003) defines Automated Clearing Houses (ACH) as electronic clearing systems where payment orders are exchanged between financial institutions, primarily through magnetic means or telecommunications networks. McAndrews (1994) defines them as electronic systems that allow the transfer of funds between accounts at different banks, particularly for recurring retail-value payments, such as payroll, insurance premiums, and utility payments.

1 It refers to any clearing and settlement system for securities transactions, foreign exchange clearing and settlement system, clearing and settlement system for futures, options, and other financial assets, central counterparty clearing house, or payment system other than the CUD, duly authorized by the competent authority to operate in Colombia.

This funds transfer occurs through electronic transfers of two types: credit and debit transfers. The difference between the two lies in who originates the transaction. Thus, credit transfers are initiated by the payer, while debit transfers are initiated by the payment recipient (payee). For example, credit transactions occur when an individual pays a utility bill, a company pays an invoice from a supplier or pays employee salaries, or where a securities issuer pays dividends. Debit transactions, on the other hand, include, for example, instructions initiated by a company to collect co-ownership management fees, insurance premiums, or loan repayments from banking institutions whose clients hold deposit products with another entity.

The processing of these transactions results in what is known as clearing and settlement. Clearing corresponds to the definition of obligations among participants, where an ACH uses a net multilateral scheme that establishes a debit (against) or credit (in favor) position for each institution in the face of the ACH, where the total sum of positions equals zero. Thus, the total for debit positions equals the total for credit positions.

To illustrate this, Table B4.1 presents the total number of credit transfer orders to be cleared in a settlement cycle. Thus, bank B has an obligation to A for COP 300 and to D for COP 400. At the same time, institutions A and C have obligations to B for COP 100 and COP 400, respectively. Instead of each institution settling its obligations bilaterally with its counterparties, a net clearing balance is generated with a debit obligation for institutions B, C, and D. In contrast, a credit obligation arises in favor of institution A (Table B4.2).

Table B4.1
Transactions to be Processed by ACH in a Settlement Cycle

Transaction	Originator	Recipient	Type of transfer	Gross value (COP)
1	A	B	Credit	100
2	B	A	Credit	300
3	C	B	Credit	400
4	D	C	Credit	200
5	B	D	Credit	400
6	D	A	Credit	600
Total amount of orders to be processed				2,000

Source: *Banco de la República*; DSIF calculations.

Table B4.2
Result of the Multilateral Net Clearing Process

Entity	Type of transfer	Position	Resulting net value (COP)
A	Credit	In favor	800
B	Debit	Against	-200
C	Debit	Against	-200
D	Debit	Against	-400

Source: *Banco de la República*; DSIF calculations.

The second process (i.e., settlement) consists of extinguishing the obligations in Table B4.2; that is, when institutions B, C, and D effectively transfer the resources to the ACH, which then re-transfers them to institution A. Once this is complete, the transactions in the Table are processed, and each institution proceeds to make the corresponding credits in the savings/checking accounts of its own ledger or core banking system. Thus, institution B credits COP 100 from transaction 1, which was initiated by a customer of institution A, and COP 400 from transaction 2, which was initiated by a customer of institution C, and so forth. As a result of multilateral netting, a 60% savings in participants' liquidity needs was achieved since pro-

cessing payment orders for COP 2,000 required only a fund transfer of COP 800 (i.e., 1-[800/2000]).

Regarding how often the settlement process occurs (i.e., cycles), the World Bank (2023) indicates that about 63% of the ACH surveyed worldwide have multiple settlement cycles within a single day. Locally, ACH Colombia conducts five settlement cycles during the day on business days.

As for how these net resources are transferred, there are various operational arrangements. According to the World Bank (2023), the model used by 89% of ACHs globally is characterized by performing the final settlement of positions in a large-value payment system (LVPS). This is the case of ACH Colombia, where, through its own settlement account in the CUD, it receives funds from debit-position institutions and then transfers them to credit-position institutions. It is important to note that in the case of Colombia, the institutions participating in the ACH Colombia also have a deposit account in the CUD.

In this final settlement stage, the use of automatic debit facilities becomes relevant. As debit-position institutions collect funds more efficiently, credit-position institutions experience shorter wait times for the receipt of funds.

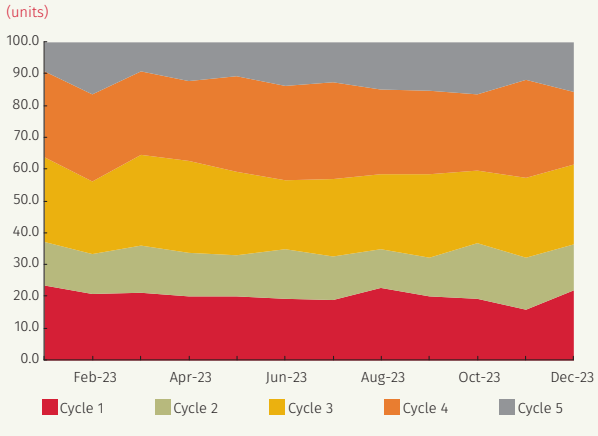
2. Settlement Process of ACH Colombia

As outlined in the previous section, transactions processed by ACH Colombia are cleared and settled under a multilateral netting arrangement in the LVPS. This results in the movements of funds in the CUD being lower than the gross value of the transactions, thus generating savings in the liquidity needs of the institutions. Particularly, in 2023, the average daily gross value processed by ACH was COP 7,690 billion (b), while the value of the movement resulting from multilateral netting in the CUD was COP 1,736 b. This equates to a savings in the liquidity needs of ACH participants of approximately 78% (i.e., [1 - [1 - [1,736/7,690]), which has remained at similar values in recent years.[2]

Regarding the amounts settled in the CUD, in line with its operational regulations, ACH Colombia performs five daily settlement cycles. Graph B4.1 exhibits the contribution of each cycle to the fund transfer process from ACH Colombia's account to the institutions. Notably, cycles three and four have the largest shares, at 24% and 28%, respectively.[3]

The cycles consist of a series of stages that can be classified as follows: 1) the transfer of resources from debtor institutions to ACH Colombia's account in the CUD; 2) internal validation processes during which ACH Colombia holds the resources in its CUD account for a short period, and 3) the transfer of resources from ACH Colombia's account to the institutions with credit positions (see Diagram B4.1). The analysis presented here focuses on this fund transfer stage (stage 3) under the premise that these times are shortened as stage 1 times are also reduced as

Graph B4.1
Percentage Distribution of the Settlement Conducted by the CUD (Contribution by cycle)



Source: *Banco de la República* (CUD).

2 Section 2.2 of this Report outlines the recent transactional evolution of the institution.

3 Transactions processed by financial institutions in these cycles were requested by their customers between 11:30 a.m. and 4:00 p. m. This is consistent with the regular cash management hours of companies, which represent more than 85% of the transfers processed by ACH Colombia.

Diagram B4.1
Stages of an ACH Colombia Settlement Cycle

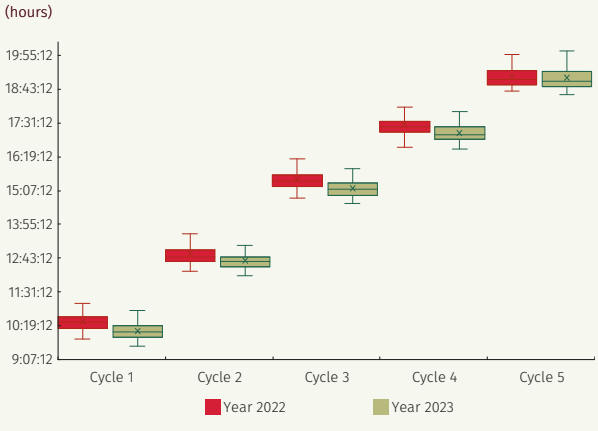
Source: *Banco de la República*, prepared by authors.

a result of the automatic debit process, while stage 2 times remain unchanged.

3. Evolution of Settlement Times

Considering what was explained in the previous section, Graph B4.2, and Table B4.3 exhibit the observed times when ACH Colombia transferred the resources to the institutions with credit positions. In general, it is observed that the transfer times decreased in all cycles between 2022 and 2023, although some cycles showed a more pronounced reduction than others.[4]

Graph B4.2
Distribution of Hours of Occurrence of the ACH Colombia Payment Dispersion



Source: *Banco de la República* (CUD); DSIF calculations.

It should be noted that these transfer times are associated with the time slots that the institution has established according to its operating regulations. That is, ACH Colombia can carry out the settlement for cycle 1 between 10:00 a.m. and 10:30 a.m., for cycle 2 between 12:30 p.m. and 1:00 p.m., and so forth. Thus, ACH Colombia went from transferring resources from the end of the established time slot to the beginning.

This is relevant in terms of operational management and risk mitigation because, on the one hand, it allows the ACH to have greater flexibility in addressing operational incidents. On the other hand, the participants receiving the resources can access them earlier and thus meet other intraday payment obligations (e.g., tax transfers and compliance with securities market operations).

4. Reduction of Intraday Liquidity Risk as a Result of Earlier Settlement of Transactions

Intraday liquidity risk arises from an institution's inability to manage its intraday payments effectively. Consequently, an uncompleted payment situation is created, affecting not only its liquidity position but also that of other participants in the LVPS.

To meet its intraday payment obligations, an institution generally has three sources of liquidity: 1) balance at the beginning of the day, 2) incoming payments (e.g., resources received by an institution with a credit position from ACH Colombia), and 3) liquidity facilities obtained through the central bank (ECB, 2021; McAndrews and Rajan, 2000). This, together with the synchronization between fund inflows and

4 When applying a statistical t-test for equality of means, it is found that the average value of dispersion hours has decreased between 2022 and 2023, with a confidence level of 95%. The decrease is most robust in the first four cycles (99% confidence level).

Table B4.3
Changes in ACH Colombia's Funds Dispersion Times towards Institutions with a Credit Position

		2022	2023	Decrease	Dispersion band according to operating regulations
Cycle 1	Average	10:27:55	10:08:11	0:19:43	10:00 a. m. to 10:30 a. m.
	Median	10:26:04	10:05:07	0:20:58	
Cycle 2	Average	12:53:38	12:37:58	0:15:40	12:30 p. m. to 1:00 p. m.
	Median	12:46:17	12:35:35	0:10:42	
Cycle 3	Average	15:31:37	15:12:36	0:19:02	3:00 p. m. to 3:30 p. m.
	Median	15:26:48	15:09:31	0:17:17	
Cycle 4	Average	17:28:37	17:10:50	0:17:47	5:00 p. m. to 5:30 p. m.
	Median	17:23:03	17:06:35	0:16:29	
Cycle 5	Average	19:10:44	19:07:22	0:03:21	6:45 p. m. to 7:00 p. m.
	Median	19:04:48	19:01:08	0:03:40	

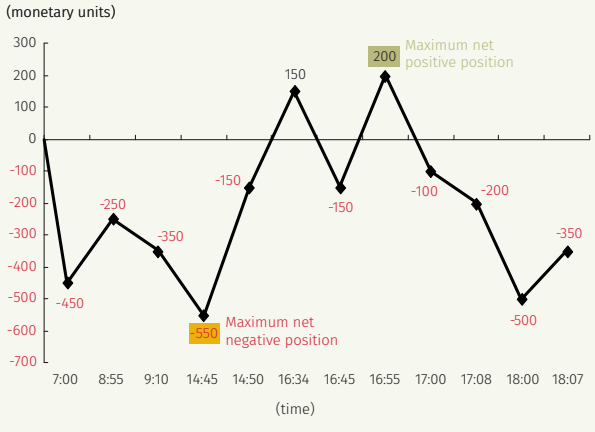
Source: *Banco de la República* (CUD); DSIF calculations.

outflows (i.e., the sequence and timing in which payments materialize), determine the daily liquidity needs.

To determine these needs, it is important to note that in 2013, the Basel Committee on Banking Supervision, together with the Committee on Payments and Market Infrastructures of the Bank for International Settlements (BCBS-CPSS, 2013), developed a set of tools to monitor and control intraday liquidity risk. One of these tools is the calculation of an indicator that includes the maximum daily liquidity use, which requires institutions to record the cumulative net value of payments they send and receive throughout the day. As seen in Graph B4.3 and Table B4.4, this is equivalent to constructing the movement in the deposit account, assuming an initial balance of zero, and recalculating the cumulative net balance as payments are received or made.

For example, one can see the maximum cumulative net positive position (highlighted in green in Table B4.4) is reached at a point in the day when the institution has received more payments, in terms of value, than it has sent (i.e., 16:55 hours). This situation may reflect the participant's strategy of funding outgoing payments with the liquidity received from incoming payments. The maximum cumulative net negative position is identified as well (highlighted in yellow in Table B4.4). It represents the maximum daily use of intraday liquidity. This occurs when the difference between the accumulated value of payments sent and received is at its peak (i.e., 14:45 hours). This value is interpreted as the minimum balance the institution needed to have on hand, at the start of the day, to ensure its daily payments could be made on time.

Graph B4.3
Evolution in the Cumulative Net Position



Source: *Banco de la República* (DSIF).

Table B4.4
Summary of Observed Payments

Time	Payments		Cumulative Net Position
	Sent	Received	
7:00	-450		-450
8:55		200	-250
9:10	-100		-350
14:45	-200		-550
14:50		400	-150
16:34		300	150
16:45	-300		-150
16:55		350	200
17:00	-300		-100
17:08	-100		-200
18:00	-300		-500
18:07		150	-350

Source: *Banco de la República* (DSIF).

5. Quantifying the Benefits Associated with Shortened Settlement Cycles

Based on the above, it is possible to quantify the benefits associated with a decrease in intraday liquidity risk due to earlier settlement of transactions through simulation exercises. In this case, the variable to analyze is the potential changes in the calculation of the daily minimum liquidity required by all institutions participating in ACH Colombia before and after the introduction of automatic debit.

For this purpose, all payments made in the CUD during 2023 are taken as a baseline simulation scenario. This includes both transactions made by ACH that benefit from automatic debit and other transactions made in CUD (e.g., purchases and sales of TES, tax transfers). The counterfactual scenario results from taking the same set of transactions of the baseline scenario and only modifying the settlement time of the transactions where ACH Colombia transferred resources towards institutions with credit positions, adding the average times found in Table B4.3. Thus, all settled transactions in cycle 1 would have an additional 19 minutes, while those in cycle 2 would have an additional 15 minutes, and so forth through the fifth cycle. In other words, the counterfactual scenario: i) supposes a delay in ACH Colombia's fund transfer transactions to isolate the benefits of automatic debit and ii) maintains the observed settlement times of the rest of the transactions that occurred in the CUD.

Table B4.5 presents the main statistics from the daily simulation of the payments observed during 2023, at the aggregate level. Particularly, compared to the counterfactual scenario: 1) liquidity needs decreased by 96% of the 242 days studied; 2) about 3.2 institutions reported benefits daily; 3) the benefits, understood as a reduction in liquidity needs, averaged COP 45.8 b, equivalent to 7.1%, and 4) 77% of the institutions experienced a decrease in their liquidity needs on at least one of the analyzed days.

Upon reviewing the decrease in liquidity needs experienced by participants in detail, the results are heterogeneous; that is, some institutions reflected greater benefits than others. Moreover, some institutions experienced decreases in their liquidity needs for a longer duration than others. This variation is reasonable given that the transactions involved are

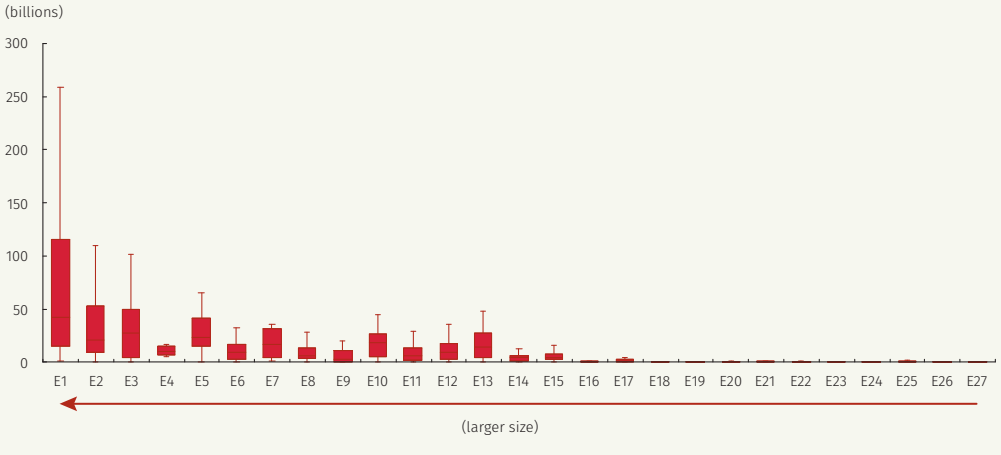
determined not by the institutions but by their customers. However, when ranking the entities according to their asset levels in the financial system, it is observed that larger entities experienced greater benefits (Graph B4.4).

Table B4.5
Main Simulation Results

Concept	Value
Operating days	242
Days when liquidity needs decreased	231
Days when liquidity needs increased	0
Days when liquidity needs remained stable	11
Participating entities	45
Entities benefited	35
Average	3.2
Maximum	9
Minimum	1
Median	3
Decrease in liquidity needs (amounts)	
Average	$ 45,864,432,822
25th percentile	$ 53,244,606,161
50th percentile	$ 25,901,195,978
75th percentile	$ 8,817,719,335
Decrease in liquidity needs (percentage)	
Average	7.1%
25th percentile	1.6%
50th percentile	3.3%
75th percentile	8.0%

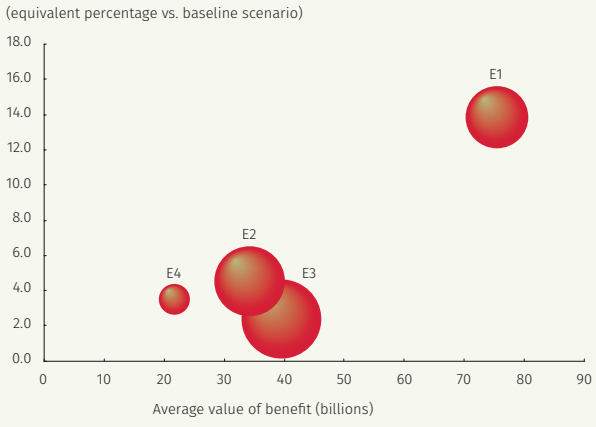
Source: *Banco de la República* (DSIF).

Graph B4.4
Decrease in Liquidity Needs by Entity



Source: *Banco de la República* (DSIF).

Graph B4.5
Results for Entities of Greater Importance in the CUD



Source: *Banco de la República* (DSIF).

Graph B4.5 exhibits an additional analysis of the results obtained by entities E1, E2, E3, and E4, which are the largest according to their asset value and were also the most relevant according to network centrality criteria.[5] The x and y axes represent the average decrease in liquidity needs and the equivalent percentage value of this decrease, while the bubble size represents the number of days in the year on which such a decrease was recorded. Thus, for entity E1, it is observed that, computing the results of the 29 days where benefits were experienced, it is found that, on average, the entity reduced its liquidity needs by 13%, compared to the calculation found in the counterfactual scenario, which is equivalent to COP 75 b.

Another interesting case is that of entity E3, which benefited for 36 days and during those days, due to the earlier receipt of resources from ACH Colombia, experienced a decrease in its intraday liquidity needs of about 4.5% (i.e., COP 34.2 b).

6. Final Comments

In order to provide new products for its customers and increase its operational efficiency[6], during 2023, ACH Colombia successfully implemented the automatic debit facility in its settlement processes affecting the deposit accounts of its participants. As a result of the monitoring activities conducted by *Banrep* on the financial infrastructure, it has been preliminary observed that in four of the five settlement cycles, their times have decreased on average by 18:03 minutes.

This reduction is significant as it benefits both ACH Colombia and its participants in two ways. First, it allows ACH to complete its settlement cycle earlier, providing greater flexibility to address any eventualities affecting the settlement process. Additionally, by closing the cycle earlier, the related entities increase the timeliness with which they accredit payment orders in their core banking systems, thus promoting the smooth functioning of the payment system within the economy. Second, upon receiving the funds earlier, entities can use them as a source of liquidity to meet other intraday payment obligations (e.g., collateral requirements in a clearing house, settlement of securities market transactions, tax transfers to the national government), thus contributing to a decrease in their daily liquidity needs.

In this regard, using simulation tools, this box aims to quantify how the decrease in settlement times of a payment infrastructure interconnected to the CUD system can reduce the overall intraday liquidity needs of institutions. Specifically, based on metrics proposed by the BIS, it was preliminarily determined that the time reductions achieved by ACH Colombia in 2023 resulted in an average decrease of 7.1%

5 In particular, the number of incoming and outgoing connections, the number of counterparties they interact with, and the hub and centrality indicators that measure an entity's capacity to be a distributor or receiver of liquidity were taken into account for each entity. More information in Newman (2010).

6 In approaches with the entity's product area, it was pointed out that the use of automatic debit was mainly motivated by: i) the need for a faster transfer of resources to financial institutions so that they could credit funds to users' checking/savings accounts; and ii) the goal of reducing some fees and charges associated with delays in settlement processes.

in the calculation of liquidity needs for the benefiting entities. Considering that at the end of 2023, six banks still did not allow the automatic debit of resources by ACH Colombia, the resulting benefits could be even higher. This is especially relevant since these entities represent 35% of the amount of payment orders processed by ACH.

From this case study, it is also evident that the use of the operational tools provided by *Banrep* as CUD administrator, for a more efficient management of the payment processes of other infrastructures, contributes to the effective management of intraday liquidity risk of financial institutions. In this regard, it is crucial that both entities and financial infrastructure work in a coordinated manner to ensure that the functional arrangements and settlement processes carried out in the CUD minimize potential liquidity pressures. In the specific case of retail-value payment infrastructures (such as ACH Colombia) this is of additional interest to financial authorities, as their proper functioning contributes to maintaining public confidence in the payment system and currency, while promoting an efficient economy (ECB, 2003; Cirasino and García, 2008; ECB, 2010; Hasan et al., 2013).

References

Bank for International Settlements (BIS). Committee on Payment and Settlement Systems (CPSS) (2003). *Glossary of terms used in payment and settlement systems*. Bank for International Settlements, available at: https://www.bis.org/cpmi/publ/d00b_es.pdf

Basel Committee on Banking Supervision (BCBS). Committee on Payment ans Settlement Systems (CPSS) (2013). *Monitoring Tools for Intraday Liquidity Management*, April, Bank for International Settlements (BIS), available at: https://www.bis.org/publ/bcbs248.pdf

Cirasino, M.; Garcia, J. A. (2008). *Measuring Payment System Development*, Working Paper, The World Bank, Financial Infrastructure Series, available at: https://documents1.worldbank.org/curated/en/790981468147564125/pdf/490030WP0Measu10Box338937B-01PUBLIC1.pdf

European Central Bank (2004). *Oversight Standards for Euro Retail Payment Systems*, Frankfurt am Main, European Central Bank, available at: https://www.ecb.europa.eu/pub/pdf/other/retailpsoversightstandardsen.pdf

European Central Bank (2004). *The Payment System: Payments, Securities and Derivatives, and the Role of the Eurosystem*, Frankfurt am Main, European Central Bank, available at: https://www.ecb.europa.eu/pub/pdf/other/paymentsystem201009en.pdf

European Central Bank (2021). *Economic Bulletin,* issue 3, available at: https://www.ecb.europa.eu/press/economic-bulletin/html/eb202103.en.html

Hasan, I.; De Renzis, T.; Schmiedel, H. (2013). "Retail Payments and the Real Economy", Working Paper Series, No. 1572, European Central Bank available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1572.pdf

León, C.; Perez, J. (2014). "Assessing Financial Market Infrastructures' systemic Importance with Authority and Hub Centrality," *Journal of Financial Market Infrastructures*, vol. 2, no. 3, pp. 67-87, available at: https://www.risk.net/journal-of-financial-market-infrastructures/2335148/assessing-financial-market-infrastructures-systemic-importance-with-authority-and-hub-centrality

McAndrews, J. (1994). "The Automated Clearing House System: Moving toward Electronic Payment," *Business Review*, July, Federal Reserve Bank of Philadelphia, available at: https://www.philadelphiafed.org/-/media/frbp/assets/economy/articles/business-review/1994/brja94jm.pdf

McAndrews, J.; Rajan, S. (2000). "The Timing and Funding of Fedwire Funds Transfers," Economic Policy Review, Federal Reserve Bank of New York, July, available at: https://www.newyorkfed.org/research/epr/00v06n2/0007mcan.html

Newman, M. (2010). *Networks: An Introduction*, Oxford University Press, Inc., United States.

World Bank (2023). A Snapshot Payment Systems Worldwide - Summary Outcomes of the Sixth Global Payment Systems Survey (English). Washington, D.C.: World Bank Group, available at: http://documents.worldbank.org/curated/en/099011624132054588/P1787031cca90801019d011a41f21efe348

3. Payment Instruments

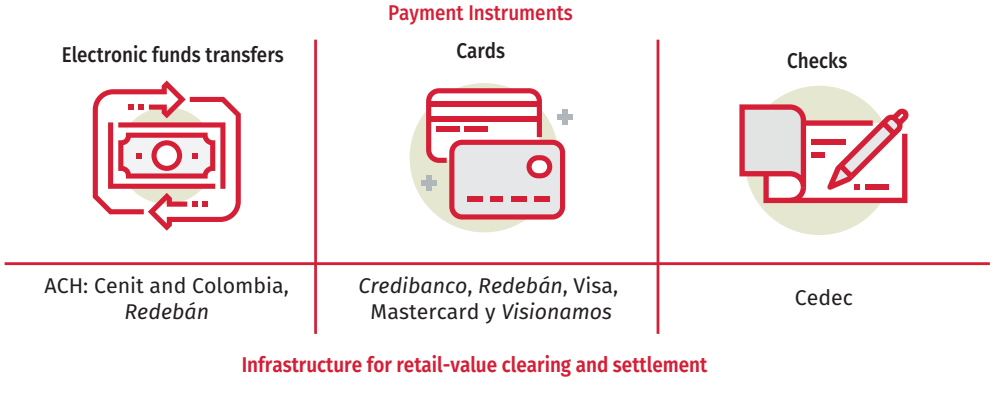
Retail payments are usually understood as those made in the market for goods and services and have a particular characteristic of their own: at least one of the parties to the transaction - the payer or the beneficiary - is not a financial institution (BIS, 2016). This makes them different from payments made in the market for financial assets. Retail payments are often used for different types of transactions between persons, businesses, and national or local governments (legal institutions). They are also involved, daily, in trade and business activity in general, in the distribution and collection of payments made by government entities, and in payments between individuals, among others (BIS, 2016).

Electronic payments increased in 2023.

According to the data on transactions, all electronic payment instruments increased in nominal value versus 2022 (electronic funds transfers and debit and credit cards). The use of checks continued to decline, continuing the trend observed in years past. Regarding electronic funds transfers, the growing participation of closed schemes is an aspect that stands out, driven by the use of mobile wallets (49% of the number and 3.0% of value of intrabank transfers).

Some of the country's financial infrastructures are associated with a particular retail payment instrument used in the economy:[1] i) such as the automated clearing houses for electronic payments (ACH) of which there are two: ACH-Cenit (managed by the central bank) and ACH Colombia, which receive electronic payment orders for the transfer of funds; ii) the Credibanco, *Redebán*, Mastercard, Visa, and *Visionamos* networks, which process debit and credit card transactions made at commercial establishments and ATMs; and iii) the Electronic Check Clearing House (Cedec) (Diagram 3.1).

Diagram 3.1
Retail-value Infrastructures Operating in Colombia, by Use of Payment Instruments



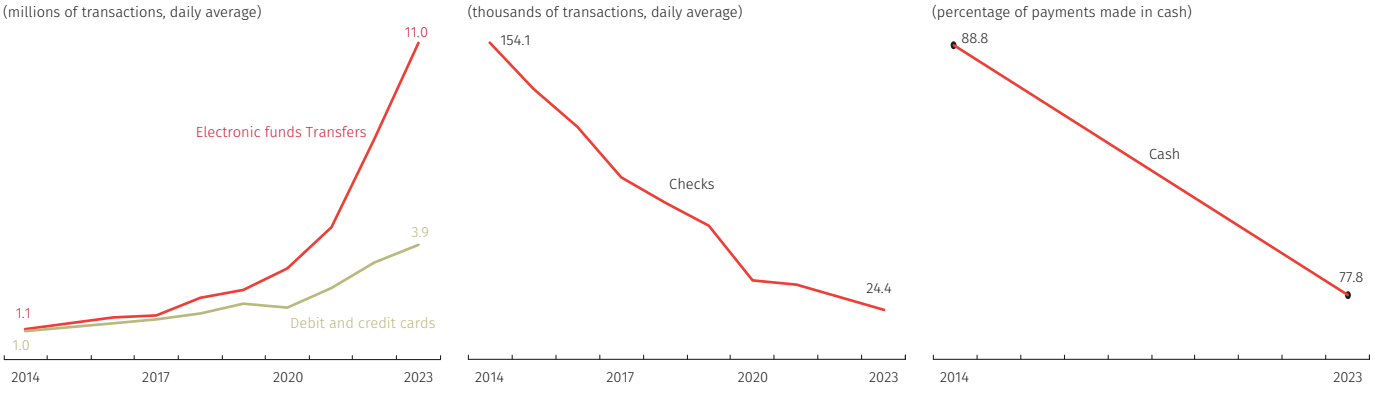
Source: *Banco de la República* (DSIF).

1 These instruments are used to transmit orders for the transfer of funds from the account a payer has with a financial institution to a payment beneficiary, for reasons such as the exchange of goods and services or for the transfer of resources themselves. They are characterized by having an electronic process or by incorporating an electronic format at some point in the chain of the payment process chain (e.g. checks).

In the last decade, in general, the number of retail payments shows an increasing trend. However, by payment instrument, it is possible to identify that the most used are electronic funds transfers and debit and credit cards. In turn, check and cash show a marked downward trend (Graph 3.1).[2]

The following is a description of the performance of each of the payment instruments.

Graph 3.1
Trends in the Use of Payment Instruments



Sources: *Banco de la República,* financial institutions, ACH Colombia, and Financial Superintendency of Colombia.

3.1 Electronic Funds Transfers

The use of electronic funds transfers has increased in recent years (Graph 3.2) and they continue to be the most widely employed electronic instrument of retail payment in the country. Transfers are made up of both inter transactions (or between financial institutions) and intra transfers (in the same financial institution). The adoption rate of electronic funds transfer has trended upward in the last few years: in 2014, it represented six transfers per person and the number reached in 2022 was 36.

In 2023, these transfers (inter and intrabank) reached an average daily payout of COP 23.4 trillion and 11.0 million transactions in number. The increase in value between 2023 and 2022 was 12.0% (2.3% in real terms). Intrabank transfers accounted for a large percentage of all electronic funds transfers in both number and value in 2023 (86% and 61%, respectively), and continue to exhibit high growth rates, with an average variation during the 2013-2022 period of 40% in number and 0.9% in real value (1.2% in the last year).[3] As for interbank, their average variation, in the same period, was 11% in number and 7.0% in value, respectively.

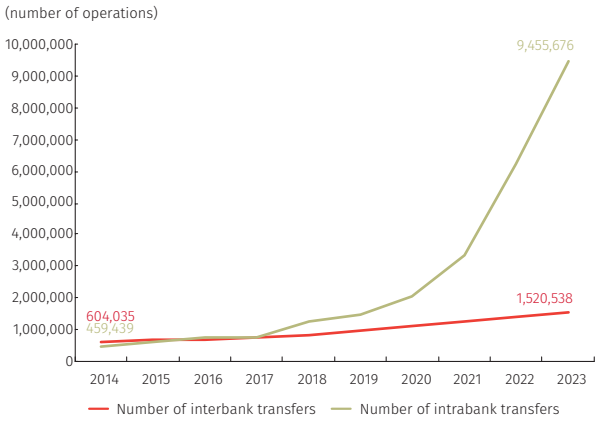
By type of person, 86% (in number) of electronic funds transfers originated by individuals, while 90%, in terms of value, were generated by legal entities (Graph 3.3).

2 Both the transfers and the check are characterized because they mostly originate from legal entities. For their part, debit and credit cards originate mostly from individuals (Table A2.1).

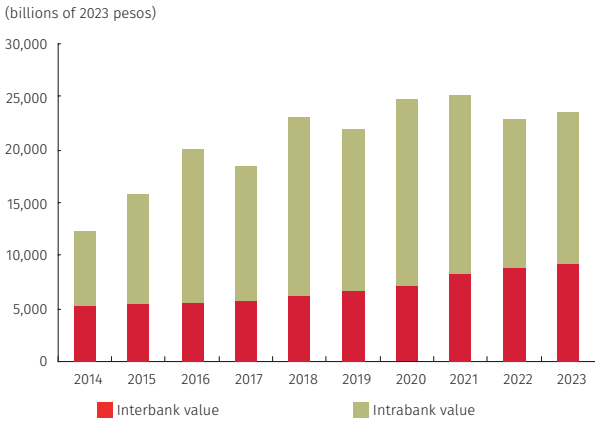
3 In average transaction terms, intrabank transfers by legal entities are similar in amount to checks. This indicates electronic funds transfers have been a substitute instrument, given the downward trend in the use of checks (see section 3.5).

Graph 3.2
Electronic funds Transfers
(Daily average)

A. Number



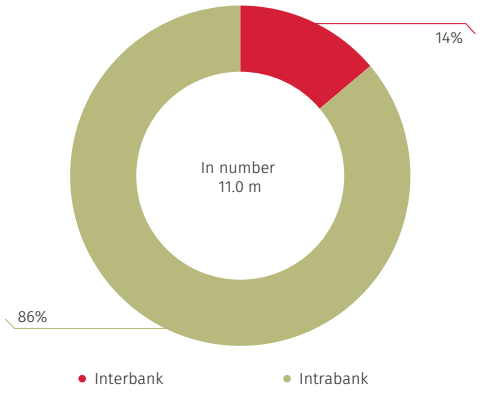
B. Value



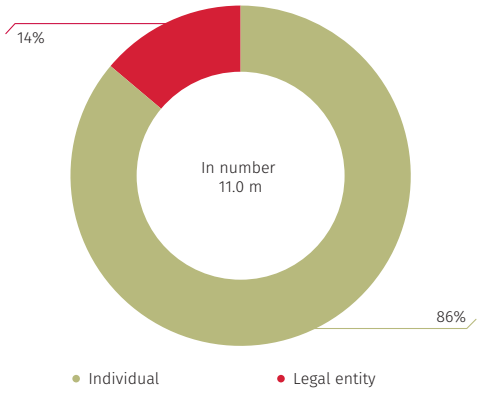
Sources: *Banco de la República*, ACH Colombia, and financial institutions.

Graph 3.3
Electronic Funds Transfers, 2023
(Daily average)

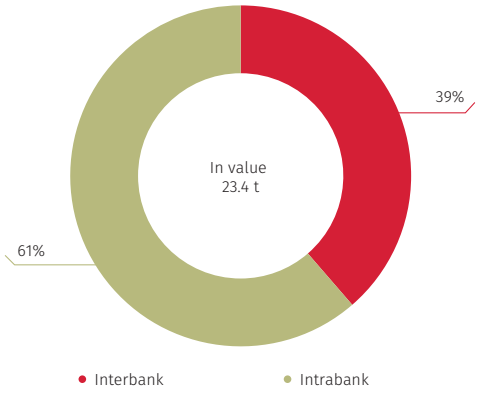
A. Number



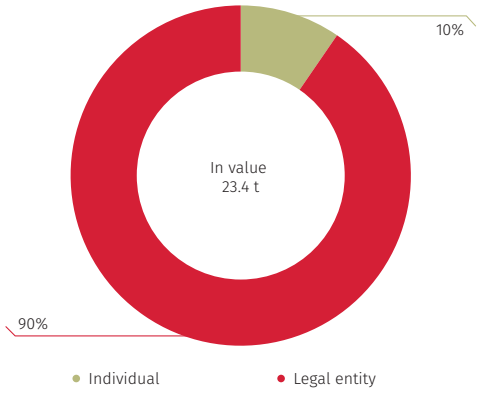
B. Number by originator



C. Value



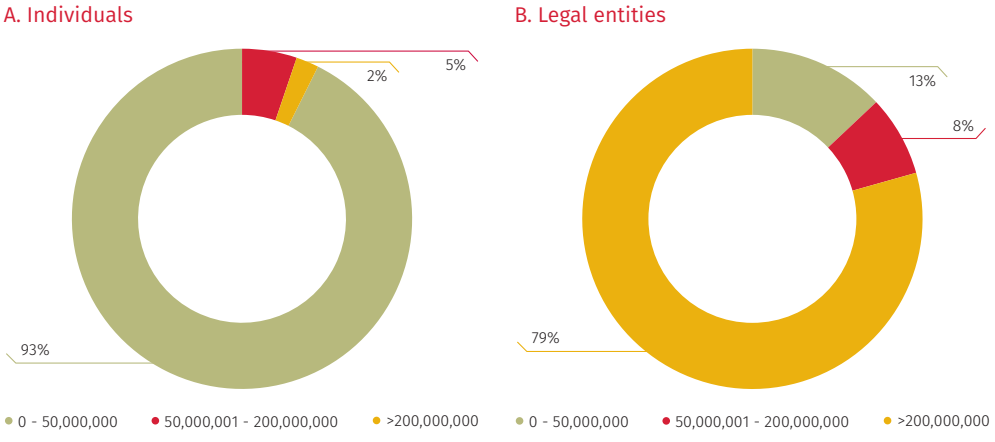
D. Value by originator



Sources: *Banco de la República*, ACH Colombia, and financial institutions.

In total transfers (inter and intrabank), 79% of those made by businesses (legal entities) are above COP 200 million and, in terms of individuals, 93% are below COP 50 million (Graph 3.4).

Graph 3.4
Transfers by Originator and Value Range, 2023
(Share in value)



Sources: ACH Colombia and financial institutions.

3.1.1 Trends in the use of electronic funds transfer

Electronic funds transfers have been the instrument most widely used in the development of new payment schemes, such as the SOP payment button (initiator), instant payments and mobile wallets. The first two services are characterized by the use of interbank transfers (between financial institutions) while mobile wallets by the use of intrabank transfers (in the same entity) (Diagram 3.2).

The SOP payment button of ACH-Colombia has been in operation since 2005. Through its use, 2,132,177 transactions were carried out in 2023, on average daily, with a value of COP 2.0 trillion. Growth compared to the previous year was 19.5% and 22.4%, respectively.

As mentioned in section two of this report, instant payments are made through the services of *Transfiya* (from ACH-Colombia) and *Entrecuentas* (from *Redebán*). *Transfiya* went into operation in 2020, offering the ease of making instant person-to-person transfers. During 2023, an average daily of 382,899 transactions were managed through *Transfiya* per day, worth 58,375 million. Growth, compared to the previous year, was around 300% for both number and value of transactions. *Entrecuentas*, in turn, began its operation in September 2023, allowing the use of instant person-to-merchant transfers (see Shaded Section 1: "*Entrecuentas*: The New Service to Make Instant *Redebán* Payments").

On the other hand, the transactionality of mobile wallets rose 98% in number and value (while that of intrabank transfers was 51% in number and 1.2% in value) and was mainly used by individuals (99%). The performance of mobile wallets is summarized in more detail in the following section. The conclusion is that electronic deposits in Colombia are used on the basis of *electronic funds transfers* as the payment instrument, mainly in purchase transactions (principally intra, which indicates that mobile wallets have developed in closed schemes) and mostly for small amounts.

Diagram 3.2
Electronic funds Transfers as a Payment Instrument in New Schemes

New payment schemes			Transfer used[a/]
Payment buttons		Makes payments from customers to the merchant through the Internet. Debits funds from the user's financial institution and deposits them in the financial institution's account defined by the company or business.	**Interbank transfer (between entities)**
Instant payments		The beneficiary of the payment receives and has the availability of the funds in seconds.	**Interbank transfer (between entities)**
Mobile wallets		Replicating physical wallets, a mobile application provides payment instruments. Payments are made through the Internet or mobile network. As in the previous point, the beneficiary of the payment has the availability of the funds in seconds.	**Intrabank transfer (within the same entity)**
Payment links		They are mainly found on merchant websites and correspond to digital methods that allow receiving payments for non-face-to-face sales.	**Inter- and intrabank transfers (between entities and within the same entity)**

a/ The electronic funds transfers payment instrument is used by these payment schemes; however, it is not necessarily the only instrument. Depending on the scheme, other instruments, such as payment cards, may be available.
Source: *Banco de la República.*

Schemes such as payment links have been used in parallel in e-commerce development (this topic is developed in the Shaded Section 1: "E-commerce and Payment Links").

3.1.2 Mobile Wallets: Transactional Use of Electronic Deposits

At the end of 2011, the Colombian government determined that electronic deposits offered by credit institutions are demand deposits in the name of individuals or legal entities,[4] different from current and savings accounts. The objective was to promote electronic payments, transactions, and collections. Later, to strengthen access to transactional financial services, through Decree 4687 of 2011 and Law 1375 of 2014, specialized electronic deposit and payment entities (Sedpes) were created as new financial institutions.

As in previous editions of this *Report*, there is a description of the transactional use of this means of payment, which has been mainly with mobile wallets. These replicate physical wallets on a mobile device, allowing users to employ instruments such as transfers and debit cards for their payments. Mobile wallets are used through the Internet and via cell phone payment channels.

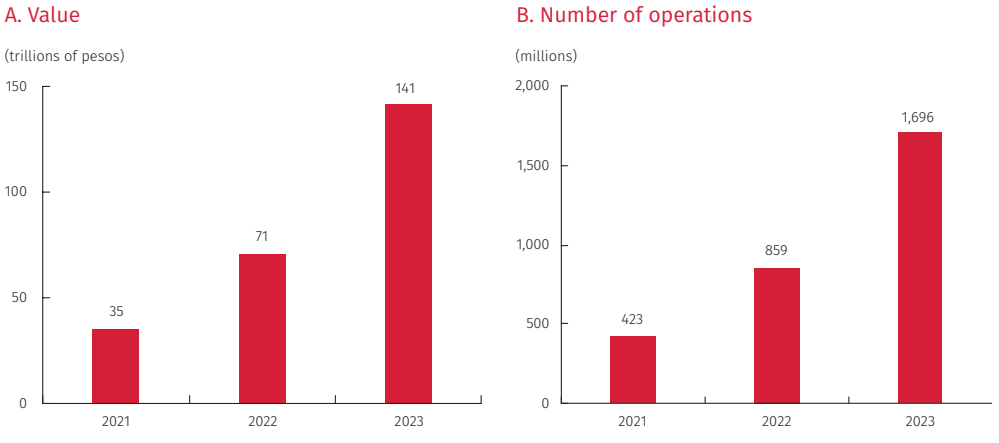
According to information provided by commercial banks and Sedpes, in 2023, payments (purchases) made through electronic deposits, using the payment instruments noted above, amounted to COP 141.2 trillion and 1,696.2 million in

4 With electronic deposits, there is the need to take advantage of technological advances for electronic transactions. Special conditions are established, such as simplified opening procedures, limits on their amounts, rules for the use of channels, means of handling, and risk management.

transactions (on average, it would be COP 386.8 billion in value and 4.6 million transactions per day). The variation with respect to 2022, both in value and the number of transactions, was very significant and was around 98% (Graph 3.5).[5]

Approximately, all transactions in both value and number originated with individuals (99.5% and 99.6%, respectively). This suggests a wide range of potential use in the corporate sector. On the other hand, transactions made through electronic deposits with the use of electronic funds transfers represented approximately 92%

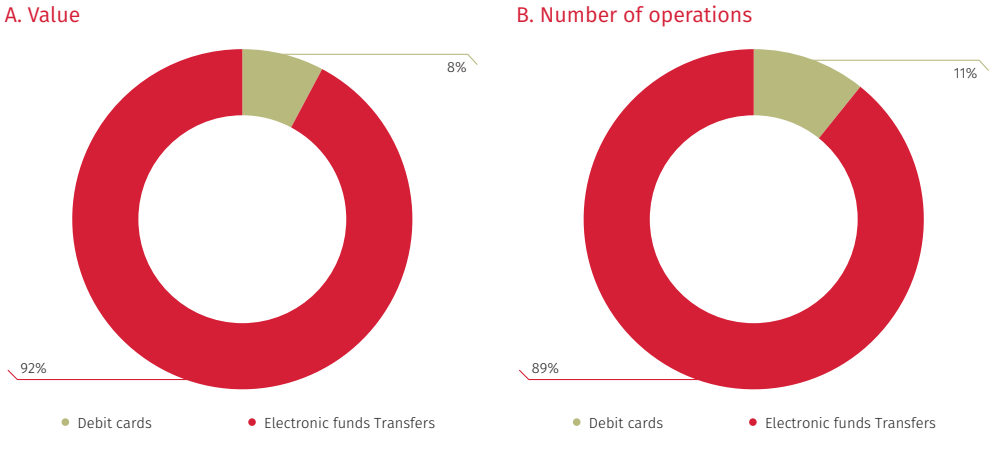
Graph 3.5
Share by Type of Payment Instrument, Electronic Deposit



Sources: commercial banks and Sedpes.

in value, while those with debit cards (debit or prepaid) accounted for 8%. In terms of the number of transactions, electronic funds transfers represented 89% and card transactions 11% (Graph 3.6).

Graph 3.6
Share by Type of Payment Instrument, Electronic Deposit



Sources: commercial banks and Sedpes.

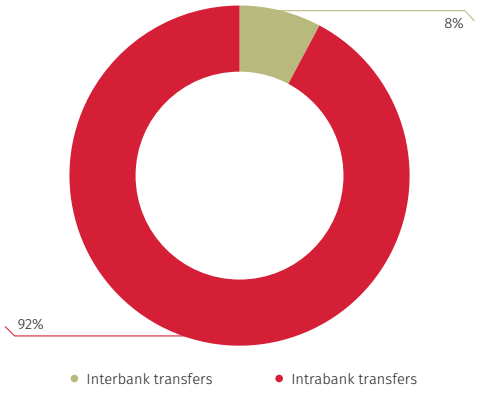
In general, electronic funds transfers are the instrument used the most. Mobile wallets in Colombia have the potential for use in interoperable transactions (end users in different entities). However, their use has evolved primarily within closed schemes. According to the intra (transactions where the payer and the beneficiary

5 At the end of December 2023, the balance for the electronic deposit payment accounted for 1.71% of the balance for the savings account payment method.

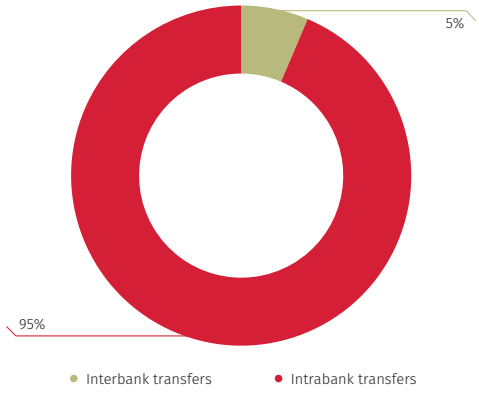
have electronic deposits with the same financial institution) and inter (transactions where the payer and the beneficiary have electronic deposits with a different financial institution) classification, the former accounted for 92% of the value, and the latter, 8.0%. In number, intrabank transfers represented 95%, and interbank transfers the remaining 5.0%. This higher share for intrabank transfers, both in value and number, indicates the transactional use of mobile wallets have developed in closed schemes (Graph 3.7).

Graph 3.7
Share by Type of Electronic Transfer, Electronic Deposit

A. Value



B. Number of operations



Sources: commercial banks and Sedpes.

As for transactions according to ranges in value expressed in Colombian pesos, there is a high concentration in low values. Transactions for amounts up to COP 500,000 accounted for 68% of the total, followed by the range of COP 500,001 to COP 1,000,000, with 17%. In terms of the number of operations, 97% were in the range up to COP 500,000 (Graph 3.8).

Graph 3.8
Payments, by Ranges in Pesos, Electronic Deposit

A. Value

B. Number of operations

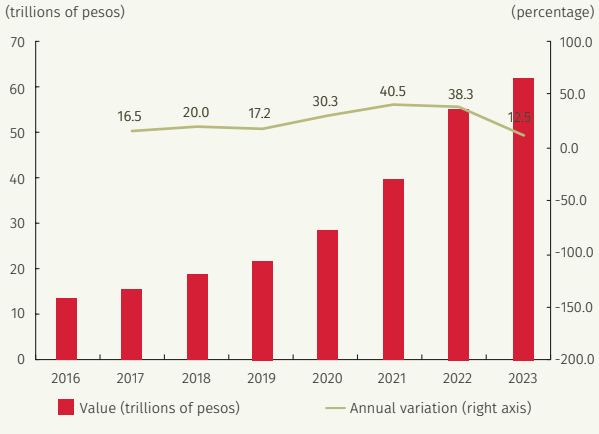
Sources: commercial banks and Sedpes.

It is possible to conclude that there is a high potential for the use of electronic deposits in the economy. Despite significant increases in the use of mobile wallets, the use of electronic deposits in Colombia remains focused on individuals use to transfer small amounts within closed schemes. This reaffirms the need for the country's payment industry to continue efforts to achieve interoperability in instant payments for different types of use, by involving individuals, businesses, and the government.

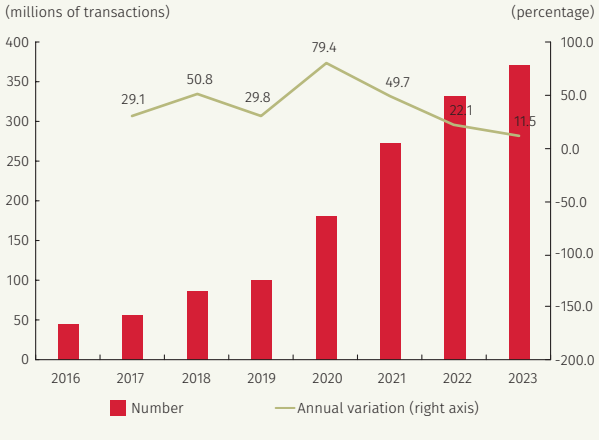
Shaded Section 2: **E-commerce and Payment Links**

Graph S2.1
E-commerce in Colombia

A. Value of operations



B. Number of operations



Sources: Ministry of Information and Communication Technologies (2023) and Chamber of Electronic Commerce (2024).

1. Some Figures on Online Sales

As internet use has increased and digital technologies have been more widely adopted, payments methods for commerce have diversified, introducing new mechanisms for purchasing and paying for goods and services. In Colombia, about 9 out of 10 people have access to mobile internet and there are approximately 17 mobile phone lines per 10 inhabitants (Ministry of Information and Communication Technologies, 2024).

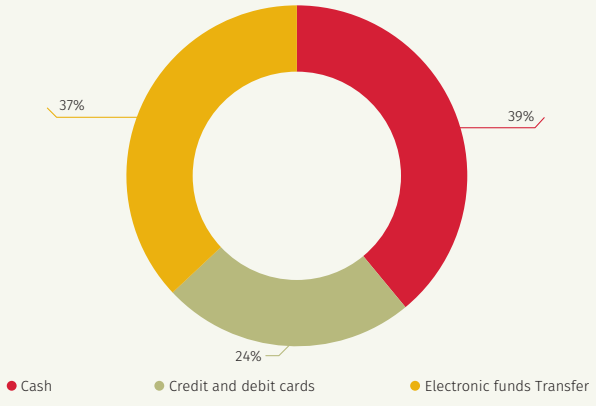
The definition of e-commerce provided by the Organization for Economic Co-operation and Development (OECD), which has been used in official documents such as Conpes 4012 (2020) and the diagnosis for the measurement of the value added of e-commerce in Colombia (DANE, 2021), is "the sale or purchase of goods or services made through computer networks using methods specifically designed for the purpose of receiving or processing orders, regardless of whether payment and delivery of goods or services occur online" (OCDE, 2011).

In Colombia, e-commerce (online sales) has shown an average annual increase of 25% and 39% in the value and number of transactions, respectively, from 2016 to 2023. In 2023, online transactions amounted to COP 62.1 trillion (t) (3.9% of GDP), with an average ticket of COP 165,370 (Graph S2.1).

Globally, e-commerce was estimated at USD 5,920 billion (b) (Insider Intelligence eMarketer, 2023), with China and the United States accounting for about 78% of the total (Ministry of Information and Communication Technologies, 2024). In Latin America, e-commerce reached a value of USD 509 b in the same year, with Colombia ranking third, behind Brazil and Mexico (Payments & Commerce Market Intelligence, 2024).

In Colombia, the population that made online purchases represented 16.4% of people over 18 years of age (around 6 million) (Chamber of Electronic Commerce, 2023). According to DANE (2022), of the people who used the internet to purchase goods or services, 76.8% purchased clothing, shoes, accessories, and sports items, 62.6% ordered prepared meals, and 31.9% purchased electronic equipment (TV, sound systems, cameras, etc.).

Graph S2.2
Use of Payment Instruments by Individuals in E-commerce Purchases, 2022



Source: Observatory *eCommerce* (2023, updated April 2024); calculations by *Banco de la República.*

2. Online Payment Links

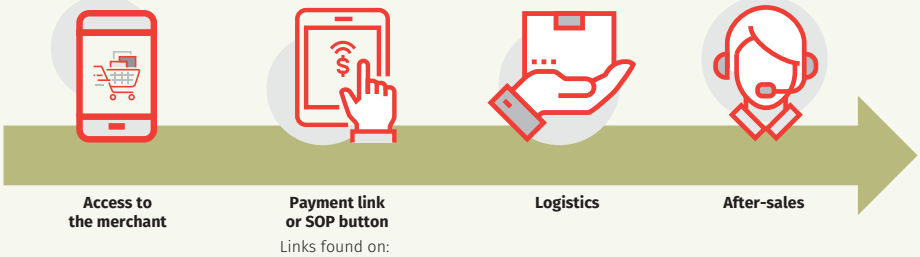
The most commonly used payment instruments for online purchases in Colombia in 2022 were: cash (39%), electronic funds transfers (37%), and credit and debit cards (24%) (see Graph S2.2).

In Colombia, there is a greater use of electronic payment instruments such as electronic funds transfers and debit and credit cards. Between 2014 and 2022, the adoption levels for these three instruments increased significantly: electronic funds transfers grew from 6 transactions per capita to 36, debit cards from 5 to 17, and credit cards from 4 to 8 transactions per capita.

Despite the high participation of cash payments, mainly in the cash-on-delivery model, the use of electronic payment instruments for online sales has been driven by the industry through options such as "payments links" or "payment buttons." These digital methods allow businesses to sell and receive payments, requesting the necessary information to complete a non-face-to-face sales transaction.

These methods are offered by financial institutions or payment gateways, allowing payment recipients (merchants) to provide their customers easy access to payment instruments through the websites of financial institutions, merchants, gateways, or social networks (such as WhatsApp, Instagram, or Facebook). Once customers have added items to their cart, they go to the payment page, made possible by the technological service of payment links or technological connections that allow communication between channels (internet or cellular network) and instruments (electronic funds transfers and cards). These instruments, along with the payment order, operate the retail-value payment systems (Diagram S2.1).

Diagram S2.1
E-commerce Value Chain



Links found on:
Financial institution websites
Merchant websites
Payment gateways
Social networks (WhatsApp, Instagram, or Facebook)

Source: *Banco de la República.*

In conclusion, payment links or payment buttons are links that have made it easier for buyers to use the same electronic instruments, such as debit and credit cards and electronic funds transfers through websites and social networks[1]. Innovation is at the first stage of the payment process, in the initiation methods, where, with the availability of digital technology, various accesses to such instruments have been designed, characterized by ubiquity (entry to the business and their respective payment from different electronic devices such as computers, tablets, and mobile phones). The growth of e-commerce has been supported by adaptation to digital technology by consumers, financial institutions, payment providers, and merchants, among others.

References

Chamber of Electronic Commerce (2023). *Informe del comercio electrónico en 2022 y perspectivas 2023.*

Chamber of Electronic Commerce (2024). *Informe de cierre del comportamiento del comercio electrónico en Colombia.*

National Administrative Department of Statistics [DANE] (2021, updated June 2022). *Encuesta de Tecnologías de la Información y las Comunicaciones en Hogares (ENTIC Hogares).*

National Administrative Department of Statistics (2021). Diagnóstico para la medición del valor agregado del comercio electrónico en Colombia, Convenio 864.

National Planning Department (2020). CONPES 4012, Política Nacional de Comercio Electrónico.

Insider Intelligence eMarketer (2023). *Retail Ecommerce Sales Worldwide, 2021-2027 (trillions, % change, and % of total retail sales)* [online], available at: https://www.emarketer.com/chart/263530/retail-ecommerce-sales-worldwide-2021-2027-trillions-change-of-total-retail-sales

Ministry of Information and Communication Technologies (2024). *Boletín trimestral de las TIC* [online], available at: https://colombiatic.mintic.gov.co/679/w3-article-338221.html, April.

Ministry of Information and Communication Technologies (2023). *Indicadores del comercio electrónico 2022* [online], available at: https://observatorioecommerce.mintic.gov.co/797/articles-275625_recurso_1.pdf

Organization for Economic Co-operation and Development (2011). *OECD Guide to Measuring the Information Society*. OECD Publishing.

Payments & Commerce Market Intelligence (2024). Radiografía del comercio electrónico en Colombia. Conozca cómo compran los colombianos por internet [online], available at: https://paymentscmi.com/wp-content/uploads/2024/01/2024_PCMI_Radiogradia-Comercio-Electronico-Colombia_ES.pdf

1 The payment instruments used in e-commerce include cash, debit and credit cards, and electronic funds transfers. In 2015, the use of electronic funds transfers represented 11%, and in 2023, it increased to 37%.

3.2 Cards

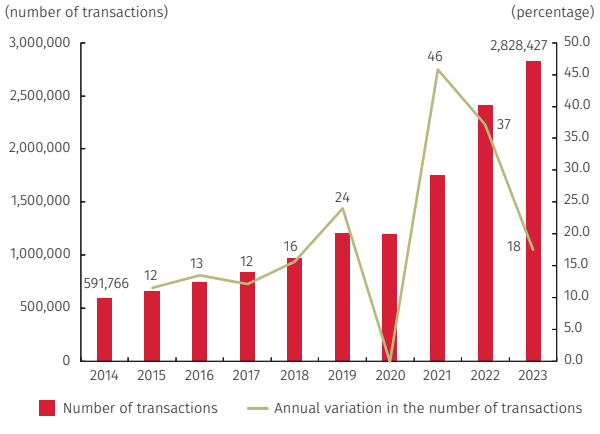
Debit and credit card purchases have trended upward in recent years. This trend continued in 2023, with growth in both the number and nominal value of transactions.

For 2023, on a daily average, the value reached by transactions with debit cards was COP 286 billion, and the number amounted to 2.8 million, with variations compared to the previous year of 4.0% (-5.0% in real terms) and 18%, respectively (Graph 3.9). For those with credit cards, the average daily value in 2023 was COP 222.2 billion, and the number of transactions amounted to 1.1 million, with positive variations compared to the previous year of 11% (1.0% in real terms) and 16%, respectively (Graph 3.9).

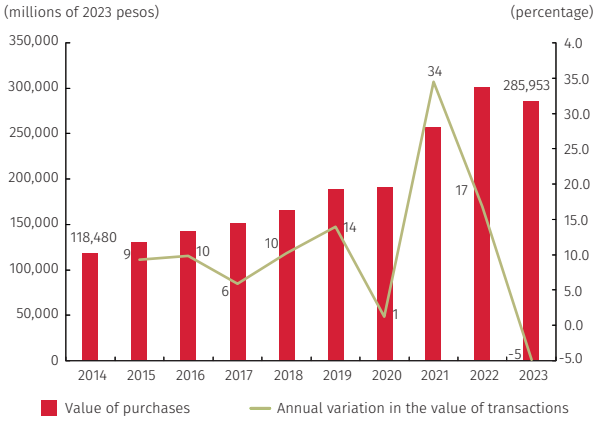
Debit and credit card purchases have trended upward in the last few years. In 2023, the average daily value was COP 508.1 billion, and the number of transactions

Graph 3.9
Debit Cards
(Purchase transactions, daily average)

A. Number



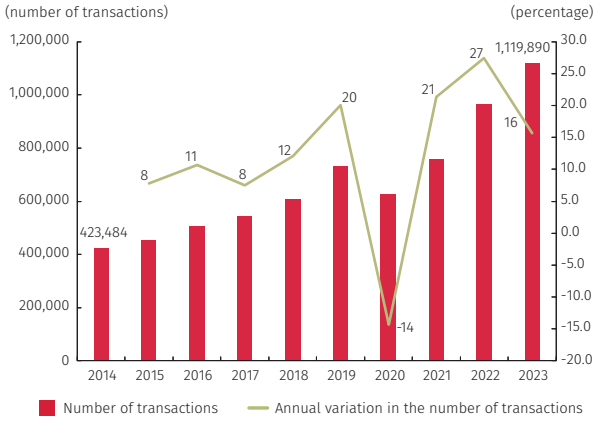
B. Value of transactions



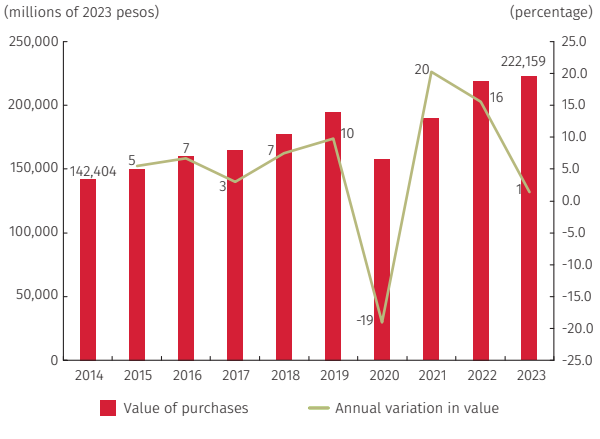
Source: Financial Superintendency of Colombia; calculations by *Banco de la República*.

Graph 3.10
Credit Cards
(Purchase transactions, daily average)

A. Number

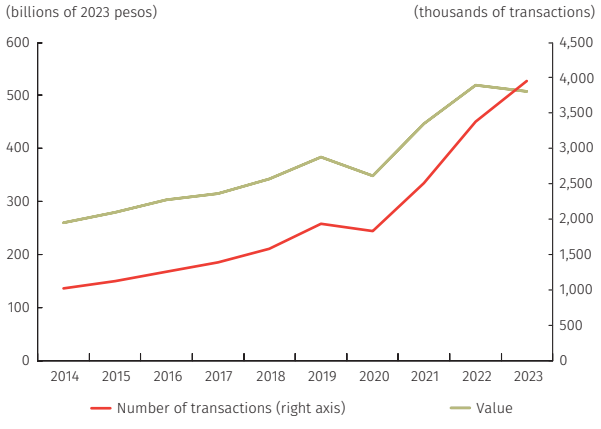


B. Value of transactions



Source: Financial Superintendency of Colombia; calculations by *Banco de la República*.

Graph 3.11
Debit and Credit Card Purchases
(Daily average)



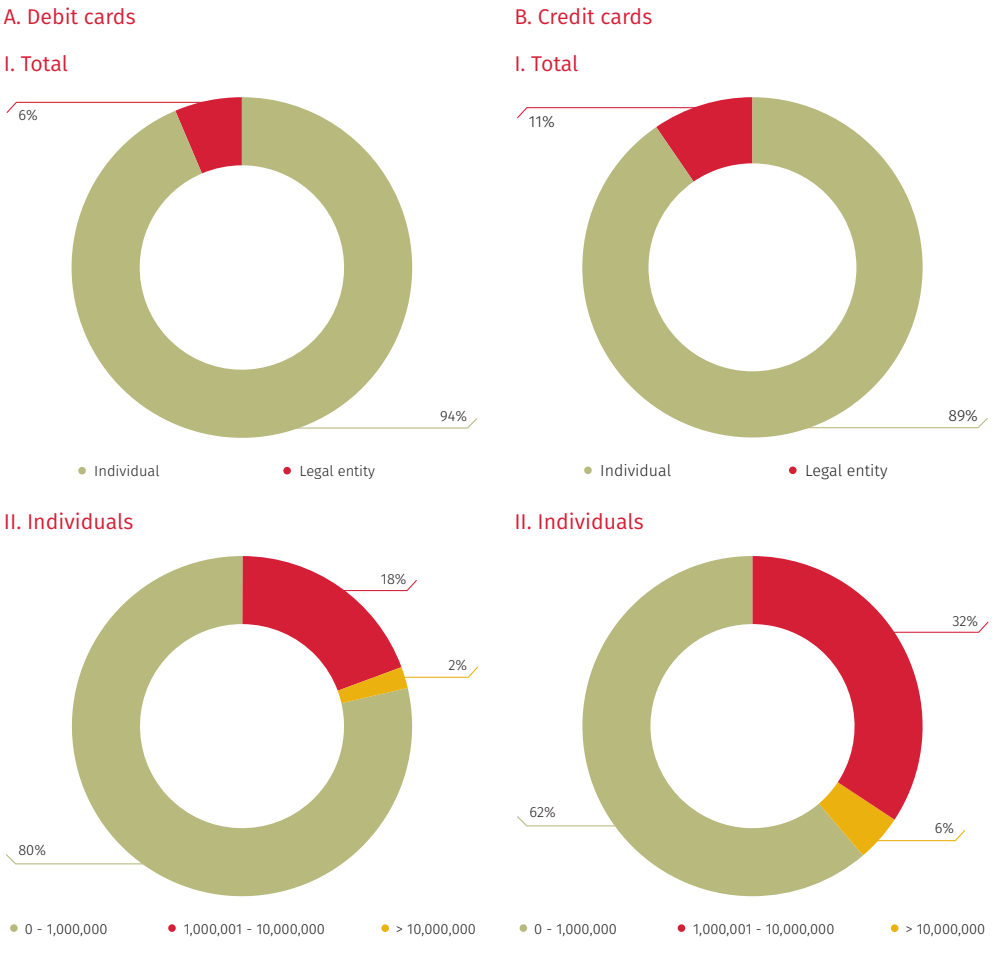
Source: Financial Superintendency of Colombia; calculations by *Banco de la República* (DSIF).

amounted to 3.9 million, with real negative variations of -2.2% in value,[6] and positive variations of 17.0% in number compared to the previous year (Graph 3.11). The real negative variation is consistent with the slowdown in the country's economy and macroeconomic tightening.

As for the value of purchases, 94% of those made with debit cards and 89% with credit cards originate from individuals. Most of the transactions by individuals correspond to transactions for amounts up to COP 1 million (80% for debit cards and 62% for credit cards) (Graph 3.12).

Annex 2 presents the performance over the last few years of both debit and credit cards, as well as their other transactions, such as withdrawals (in the former) and cash advances (in the latter).

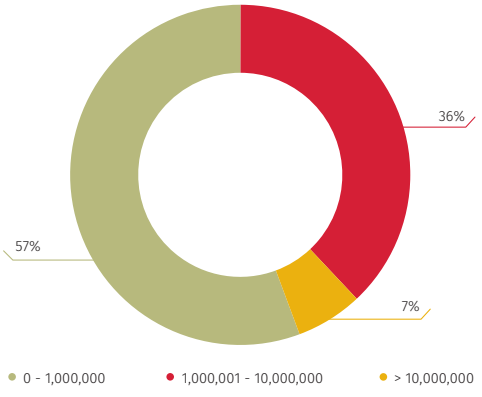
Graph 3.12
Debit and Credit Cards, by Originator, 2023
(Share in value)



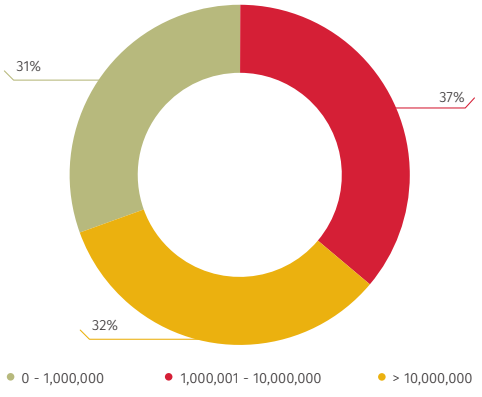
6 The variation in nominal value was 6.9%.

Graph 3.12 (continuation)

III. Legal entities



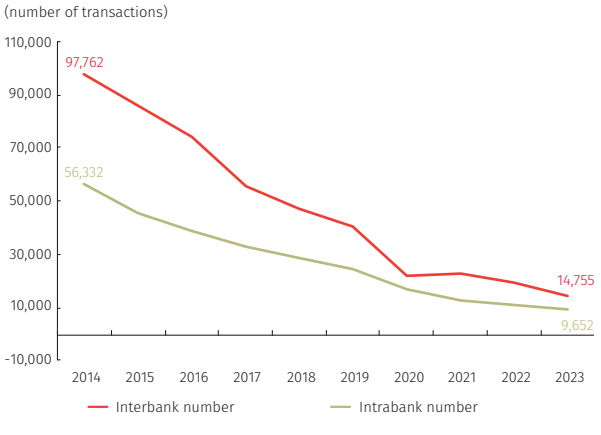
III. Legal entities



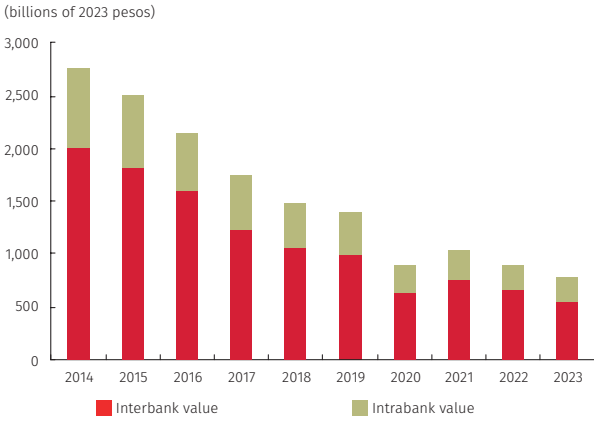
Source: financial institutions.

Graph 3.13
Checks
(Daily average)

A. Number



B. Value



Sources: *Banco de la República* and commercial banks.

3.3 Checks

There has been a downward trend in checks (inter and intra-bank) during the last ten years. The decrease in nominal value was 7.0% (-15% in real terms) between 2022 and 2023, from COP 831 billion to COP 776 billion (daily average). In terms of numbers, there was a decrease of 20%, going from 30,500 (2022) to 24,400 transactions on a daily average (2023) (Graph 3.13).

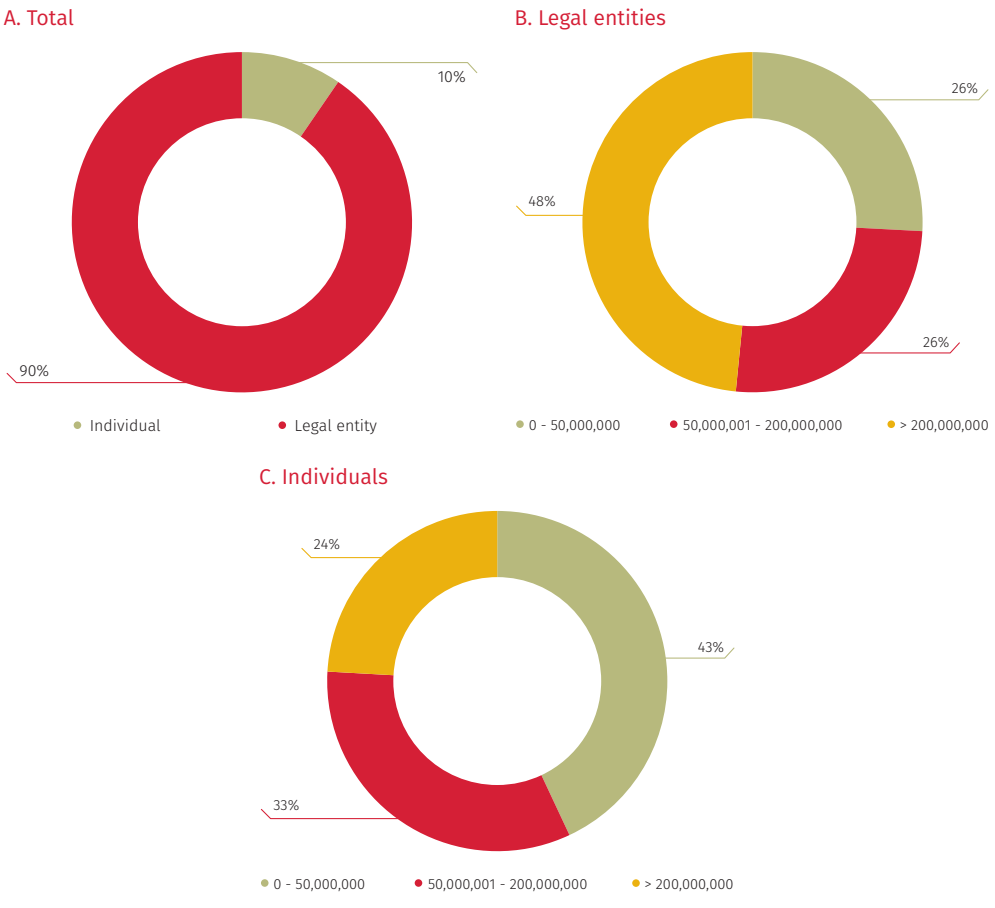
Ninety percent (90%) of the settled value of checks in 2023 came from legal entities and the remaining from individuals. Most of the checks drawn by businesses (48%) correspond to amounts greater than COP 200 million. At the same time, 43% of the checks drawn by individuals are for amounts up to COP 50 million (Graph 3.14).

3.4 Cash

To identify how banknotes in circulation have evolved up to 2022,[7] Graph 3.15 shows an average annual increase of 4.5% in the number of units during the 2014-2023 period, with 3,815 million units in 2023. By monitoring the amount of currency in circulation, an approximation to the potential use of this instrument in the economy, but not as a direct reference to cash payments, is achieved.

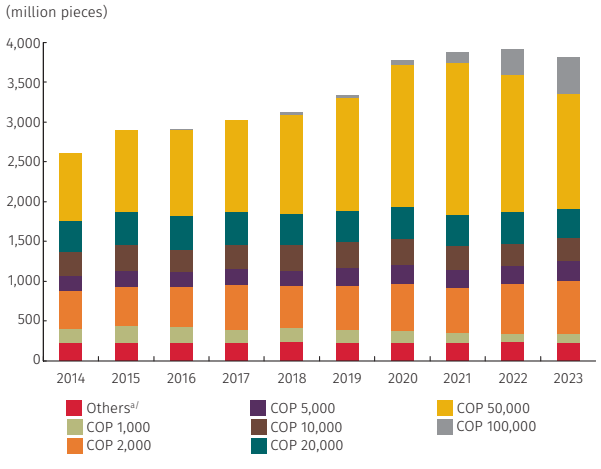
7 Only the change in banknotes is included, since they accounted for 97% of the total value of currency in circulation during the 2014-2023 period, while coins accounted for the remaining 3.0%.

Graph 3.14
Checks by Originator, 2023
(Share in value)



Source: commercial banks.

Graph 3.15
Banknotes in Circulation



a/ This item includes the following denominations: COP 500, COP 200, COP 100, COP 50, COP 20, COP 10, COP 5, COP 2, COP 1.
Source: *Banco de la República.*

As for the number of units by denomination, high-denomination banknotes (100,000 pesos, 50,000 pesos, 20,000 pesos, and 10,000 pesos) represented around 67% in 2023, while the lower denominations (5,000 pesos and 2,000 pesos, along with coins) accounted for the remaining 33%.[8]

Graph 3.16 illustrates how the real value of all banknotes in circulation changed during 2014-2023. Average growth in real value during this period was around 6.0% and represented close to COP 130.7 trillion in value in 2023. However, there was a 9.3% decline in real terms between 2023 and 2022.

Regarding denomination in terms of value, the 50,000-peso banknote accounted for 55% of the total value of currency in circulation in 2023, while the 100,000-peso banknote accounted for 35%, and the 20,000-peso banknote, 6.0%. The other denominations accounted for 4.0%.

8 In the high denomination category, by quantity, the 50,000-peso banknote accounted for the largest share, with 38%; in the low denomination category, it was the 2,000-peso banknote, with 18%.

¿How do Colombians make their regular payments?

Public

79% pay in cash

14% pay via electronic transfers

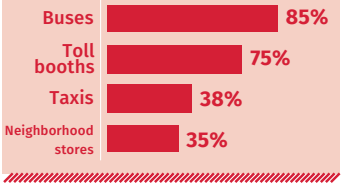
6% pay with a debit card

Commerce

All commerce channels accept cash

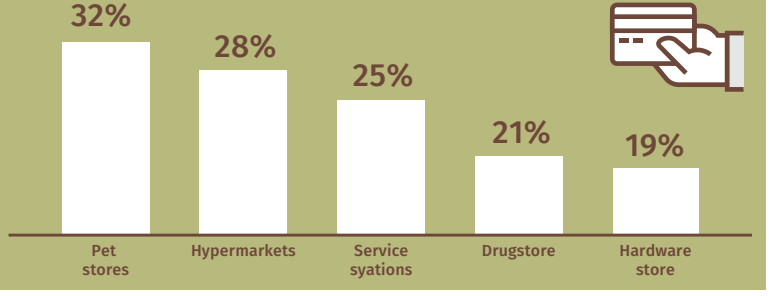
100% of toll booths report that all payments they receive are made in cash

Percentage of channels that only accept cash



More than 60% of commercial establishments accept electronic transfer payments. Debit and credit cards are most widely accepted in stores such as drugstores, gas stations, hypermarkets, and pet stores.

The five trading channels that receive the most electronic payments for their sales (transfers and cards)



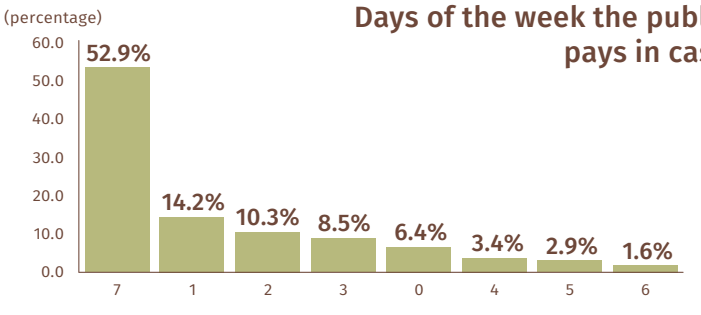
Daily Cash Payments

More than half of the population uses cash daily for their payments.

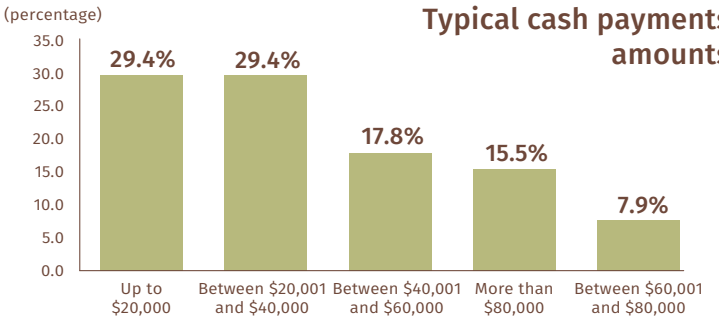
Colombians pay an average of

$40,000 in cash per day.

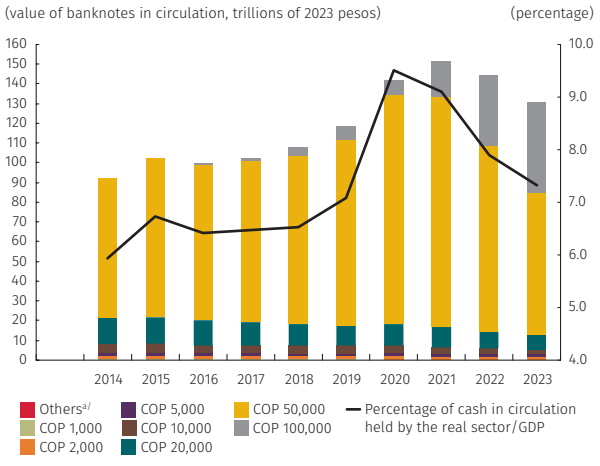
Days of the week the public pays in cash



Typical cash payments amounts



Graph 3.16
Value of Banknotes and Cash in Circulation/GDP



a/ This item includes the following denominations: COP 500, COP 200, COP 100, COP 50, COP 20, COP 10, COP 5, COP 2, COP 1.
Source: *Banco de la República*.

On the other hand, the ratio of cash in circulation in the real sector to GDP averaged 7.3% between 2014 and 2023, with a downward trend in recent years. In 2023, this share was 7.3%, lower than in 2022 (7.9%), reaching pre-pandemic levels.

Cash continues to be the instrument most used by the public for routine payments.

Banco de la República conducts a survey to monitor the use of cash as a payment instrument.[9]

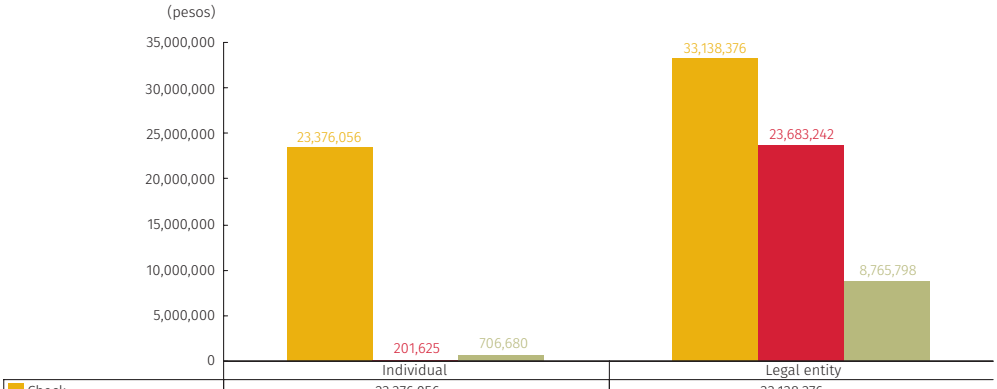
According to the survey in the first half of 2023, most usual payments for food, beverages, clothing, transportation, housing, and public utilities, among other items, are made in cash (77.8% in cash, according to the number of transactions, and 78.6% in terms of value). In the same sense, commerce ratifies the public's response and indicates that cash is the preferred instrument for customers payments. **However, during the last ten years, the trend in the use of cash has decreased: in number 12.1 pp and in value 11 pp (in 2014, the perception of cash payments was 88.8% in number and 90.7% in value).**

3.5 Average Value of Electronic Payment Transactions

In terms of average transactions, legal entities (businesses) conduct transactions for larger amounts than those of individuals. This applies to all payment instruments (Graph 3.17). Checks are the instrument with the largest average transaction value for both legal entities and individuals (between COP 23 million and COP 33 million). On the other hand, intrabank transfers by legal entities register an amount similar to that

Graph 3.17
Transaction Value: Daily Average, 2023

A. Check and transfer

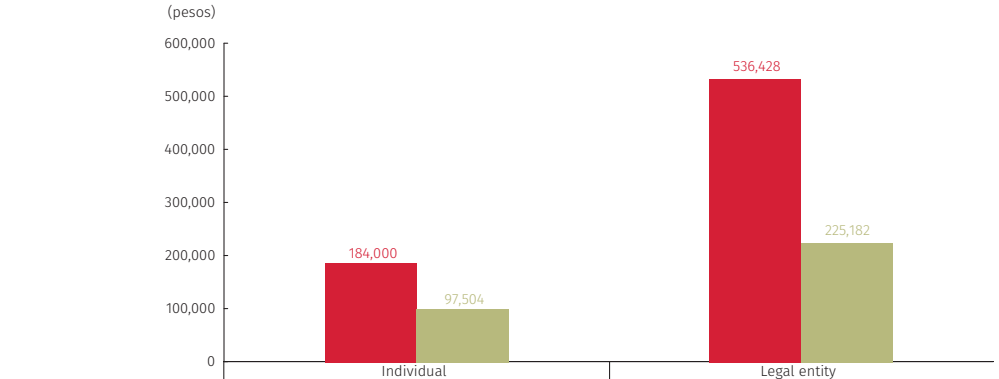


	Individual	Legal entity
Check	23,376,056	33,138,376
Intrabank transfer	201,625	23,683,242
Interbank transfer	706,680	8,765,798

9 The main findings of this survey are found in the document *Results of the perception survey on the use of instruments for regular payments in Colombia, 2023*, which can be consulted on the website of Banco de la República.

Graph 3.17 (continuation)

B. Credit and debit cards



	Individual	Legal entity
Credit card purchases	184,000	536,428
Debit card purchases	97,504	225,182

Sources: *Banco de la República*, ACH Colombia, Financial Superintendency of Colombia, financial institutions; calculations by *Banco de la República.*

of checks. This indicates electronic funds transfers have become a substitute for checks, due to the downward trend in the use of checks.

Individuals use checks as the instrument of payment for large-value payments (averaging around COP 23 million). The other instruments, in order of importance, are used for payments in amounts under COP 707,000; namely, interbank transfers, followed by intrabank transfers, credit cards, and debit cards (with payments averaging COP 97,504).

3.6 International Comparison of Payment Instruments

The following is a graphic comparison of the use of payment instruments; namely, electronic funds transfers, checks, debit cards, and credit cards, using different indicators, such as the number of transactions per capita, transaction value per capita in US dollars,[10] and transaction value as a percentage of GDP, with data up to 2022.[11] The per capita value in US dollars and the value relative to GDP with respect to cash in circulation are also shown. The comparison includes twenty-five countries, in addition to Colombia (nine of Latin America).[12]

Placing the information in the international context, according to Graph 3.18, in the indicator of number of transactions or adoption, Colombia has significantly increased the number of transactions per capita, positioning in the lower quartile of the distribution, with room to improve its ranking compared to the countries with the highest adoption rate.

10 In general, indicators that include value are presented in dollars, average annual exchange rate.

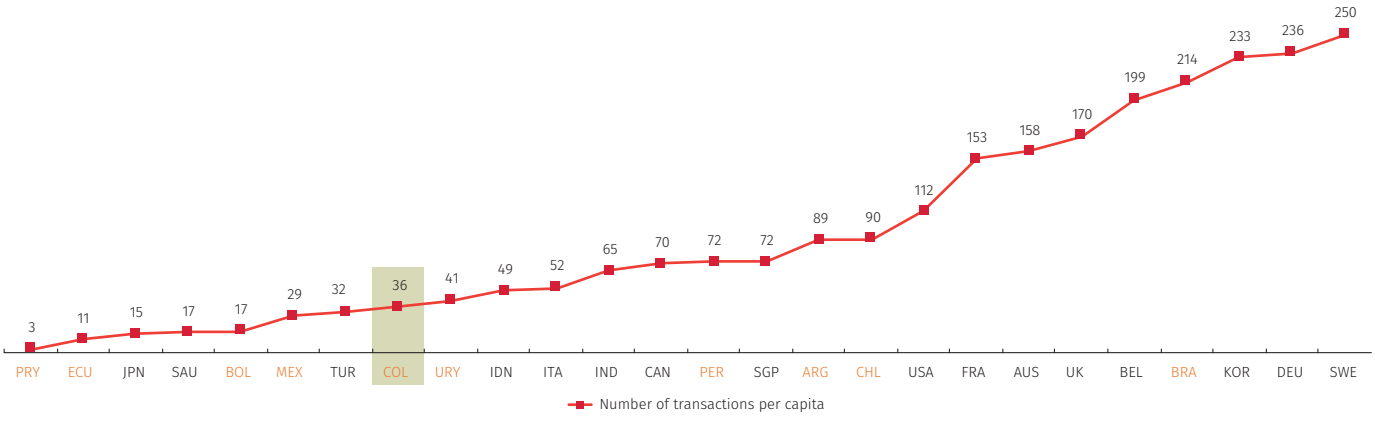
11 Most recent data as of April 2024.

12 Among the countries that report to the BIS are Germany, Saudi Arabia, Argentina, Australia, Belgium, Brazil, Canada, South Korea, the United States, France, the United Kingdom, Indonesia, India, Italy, Japan, Mexico, Singapore, Sweden, and Turkey. The information for Colombia is prepared following the BIS Red Book methodology. Among the Latin American countries with source "South American Payment Systems Report 2023" led by the Central Reserve Bank of Peru, are: Bolivia, Chile, Ecuador, Paraguay, Peru, and Uruguay.

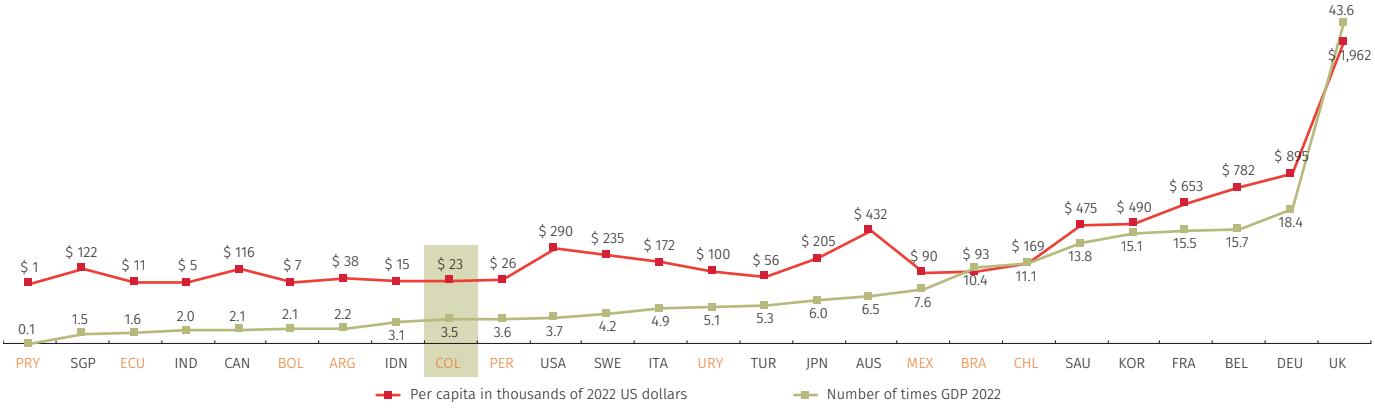
Graph 3.18
Payment Instruments, International Comparison, 2022

A. Transfers

I. Adoption rate

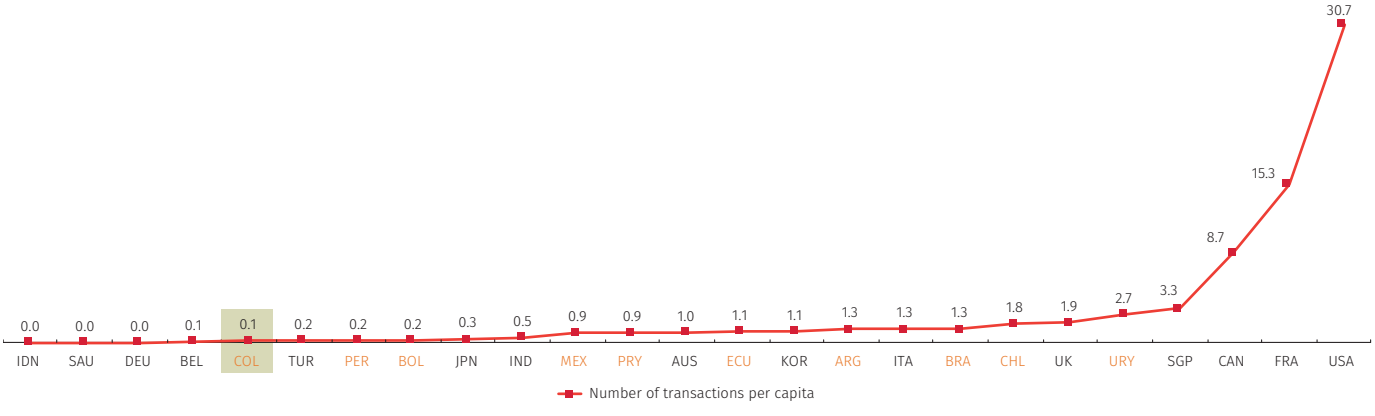


II. Economic importance



B. Checks

I. Adoption rate

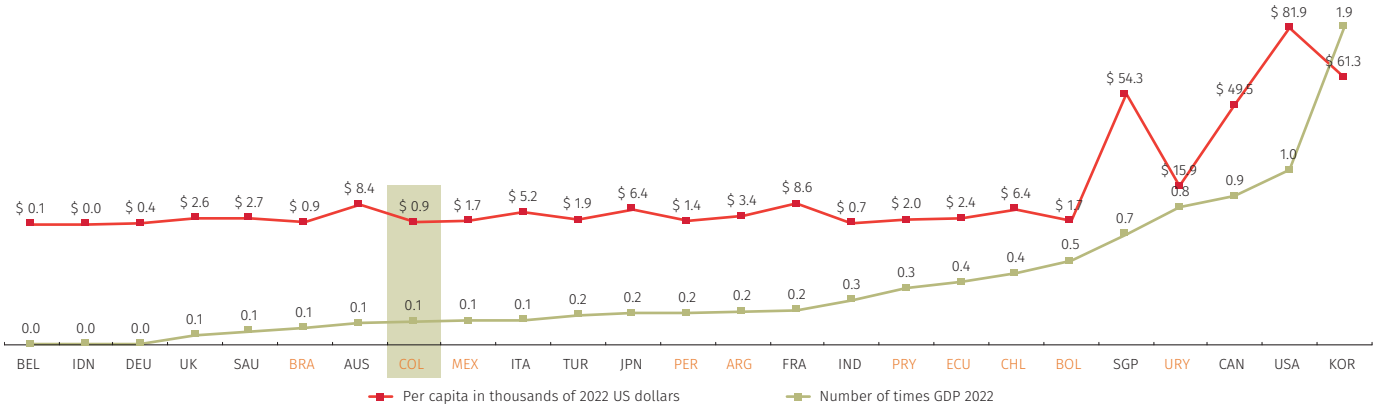


Note: Data for Sweden is not available.

Graph 3.18 (continuation)

B. Checks

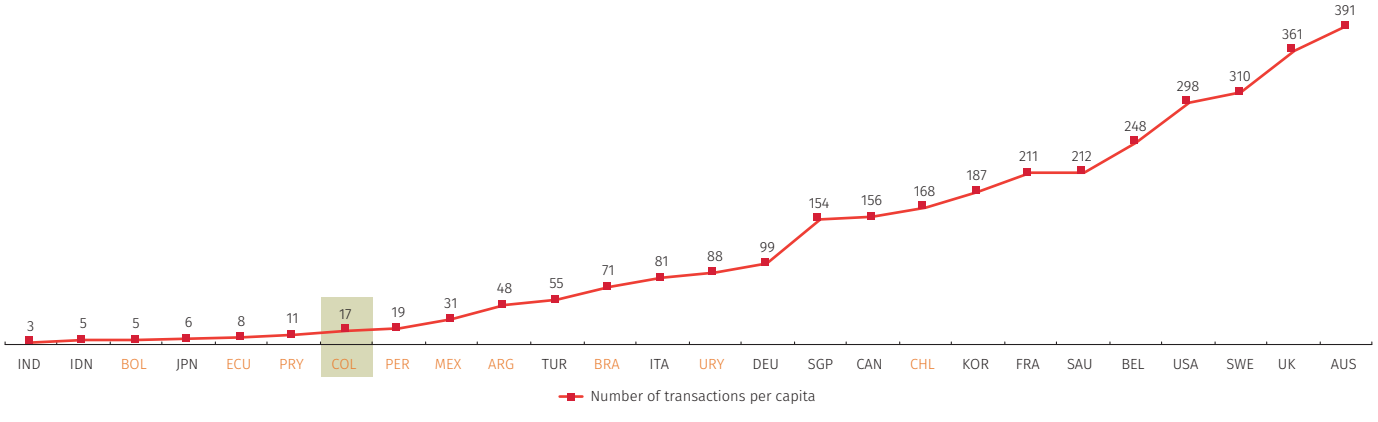
II. Economic importance



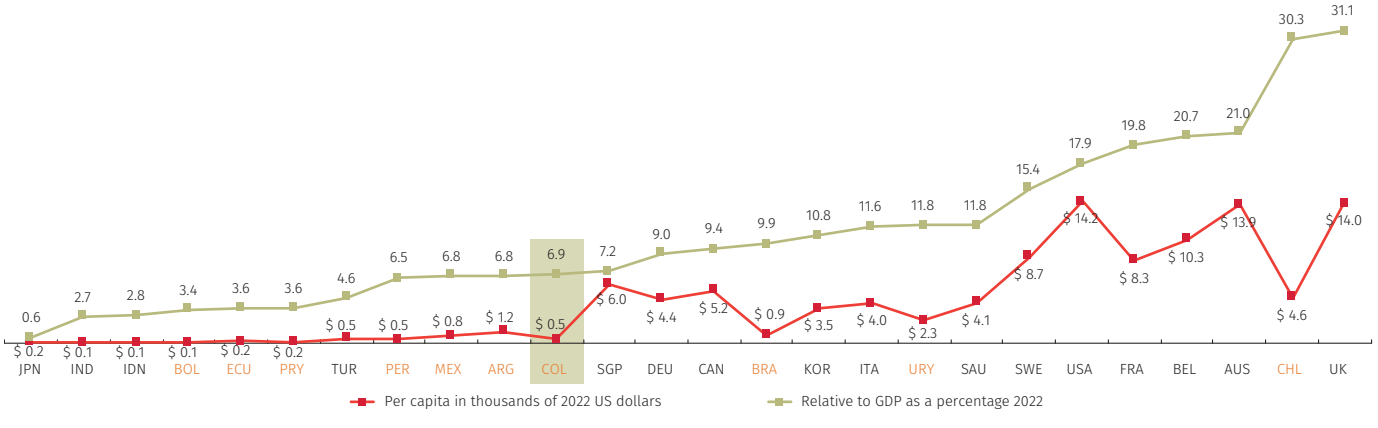
Note: Data for Sweden is not available.

C. Debit cards

I. Adoption rate



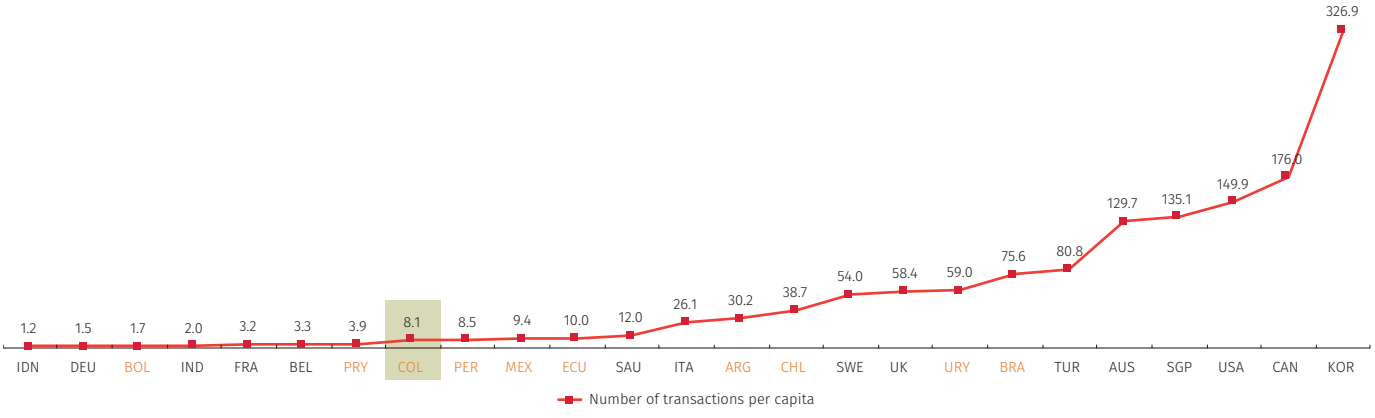
II. Economic importance



Graph 3.18 (continuation)

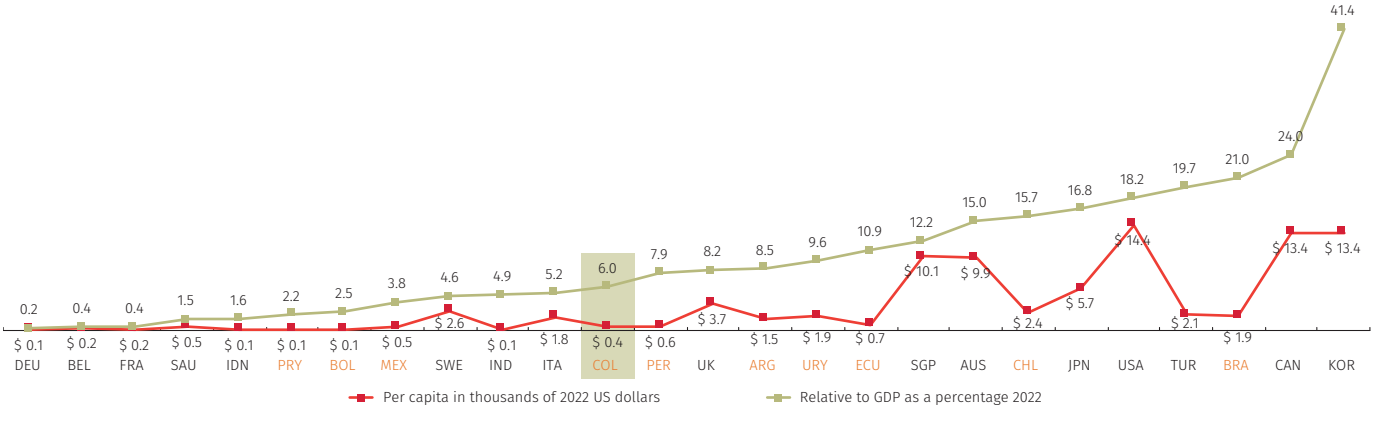
D. Credit cards

I. Adoption rate



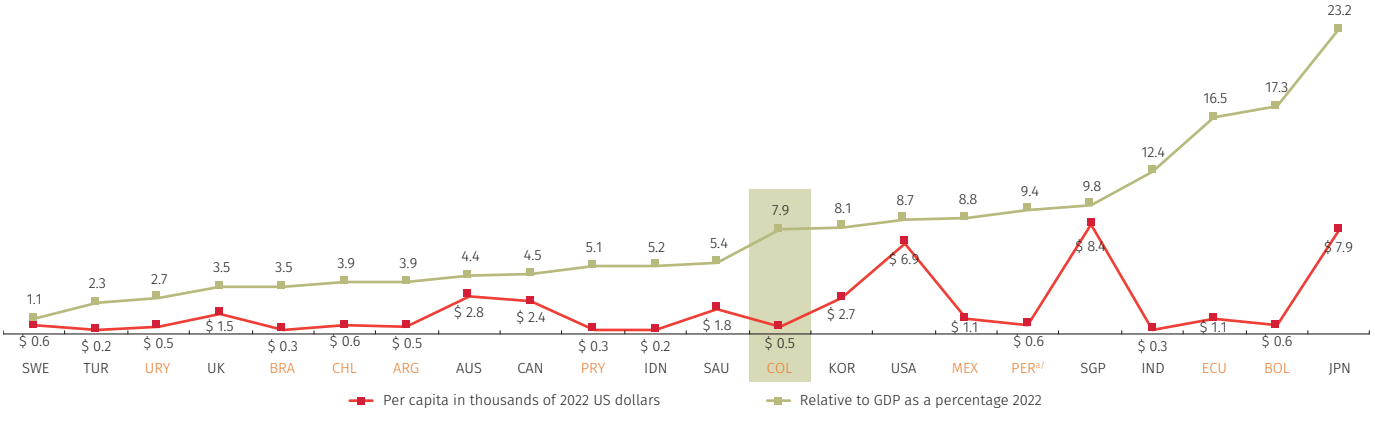
Note: Adoption data for Japan is not available.

II. Economic importance



E. Cash in circulation

I. Economic importance



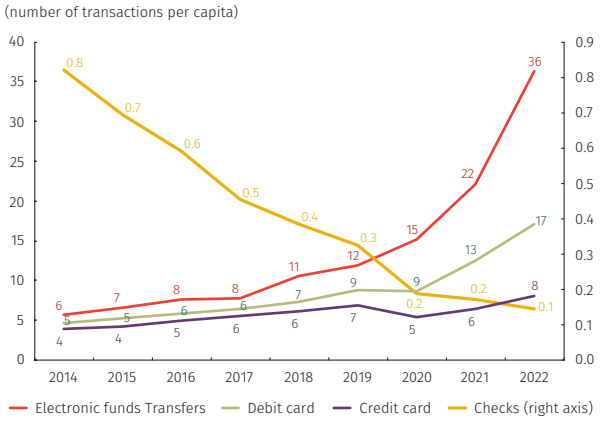
Note 1: Information for Germany, Belgium, France, and Italy is not available.
Note 2: The countries marked in orange correspond to Latin America.
a/ Peru's data is from 2021.
Sources: BIS Red Book, ACH Colombia, Financial Superintendency of Colombia, *Banco de la República* (DSIF), and RSP Sudamérica BCRP.

On the other hand, in the indicator of economic importance, value relative to GDP (excluding cash), Colombia holds an intermediate position among the group of selected countries. By type of instrument, the value of electronic funds transfers relative to GDP was 3.5 times GDP (for the group of countries, the range is between 0.1 to 43 times GDP). For checks, it was 13.9% (the country with the highest value was 1.9 times the GDP). For debit cards, it was 6.9% (the country with the highest value was 31% of GDP). For credit cards, it was 6.0% (the country with the highest value was 41% of GDP). Finally, in cash, it was 7.9% (the countries in the sample range from 1.1% to 23.2% of GDP).

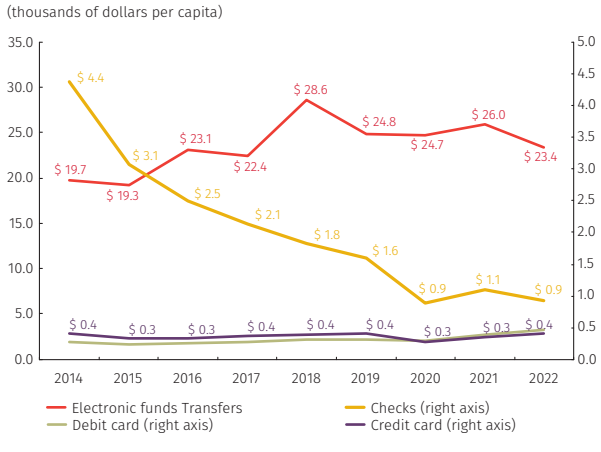
Graph 3.19 shows the historical change of the use of payment instruments in Colombia. Between 2014 and 2022, electronic funds transfers have been the most widely used instrument, registering the highest adoption rate (number of transactions per capita) and the greatest economic importance (value relative to GDP). Checks show a downward trend in all indicators; however, they remain the second most significant instrument relative to GDP and in per capita value. On the other hand, cards are the second most used instruments per capita in terms of transactions. Although debit cards outnumber credit cards by nearly double in quantity, their per capita value and their value relative to GDP are similar. As for cash in circulation, since 2020, it has shown a decline both in per capita value and in its value as a percentage of GDP.

Graph 3.19
Historical Evolution of the Use of Instruments in Colombia

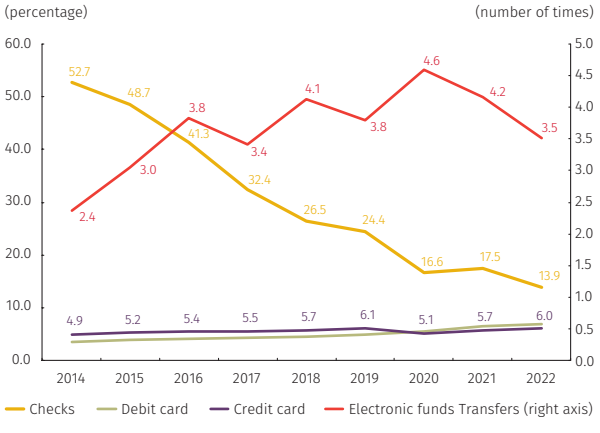
A. Adoption rate



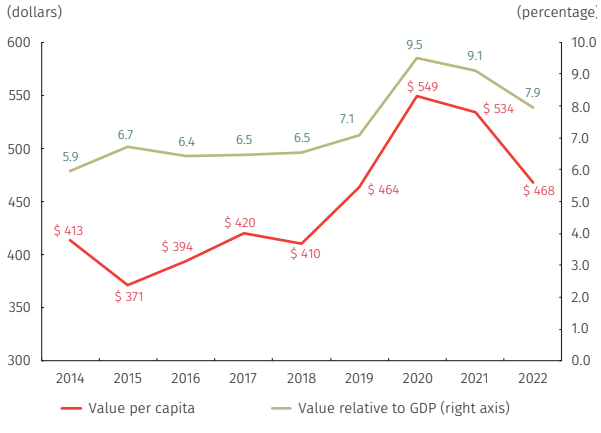
B. Economic importance



C. Economic importance (relation to GDP)



D. Cash in circulation



Sources: ACH Colombia, Financial Superintendency of Colombia, and *Banco de la República* (DSIF).

4. Trends and Innovations in Payments

As part of its ongoing monitoring efforts, *Banco de la República* tracks trends and innovations in payments. For this edition of the *Financial Infrastructure Report,* two topics of particular interest have been identified for the central bank, academia, and the financial industry in general. One of these is central bank digital currency (CBDC) for wholesale transactions, and the other is the integration of three Latin American stock markets (Chile, Colombia, and Peru).

The CBDC continues to be one of the most studied topics by central banks due to the potential benefits and challenges it may represent for transactions carried out by the public and financial institutions. Expected benefits include the permanent availability of central bank money for transactions in a 24/7 framework, as well as the greater speed of settlement. Challenges include the increased vulnerability of the issuer and users of digital currency to fraud on the digital level due to various types of cyberattacks. This section describes the wholesale version of digital currency and identifies its main functionalities.

To date, no central bank has formally issued its digital currency for payments between financial institutions; however, experimental issues have been conducted in controlled environments to understand the technological requirements necessary for effective operation. This section provides a brief overview of local (e.g., the Helvetia project) and global (e.g., the mBridge project) central bank digital currency projects, many of which involve cooperation with the Innovation Hubs of the Bank for International Settlements.[1]

The growing interest of central banks in technological solutions that facilitate the use of digital currency has been enhanced by the emergence of decentralized technologies and improved financial services offered by the private sector. In this regard, the transformation of traditional financial assets into digital representations (*i.e. tokenization*) has played a key role in the development of local digital currency projects. Similarly, the study of global digital currency has coincided with several initiatives, such as the G20, aimed at improving efficiency in the settlement of cross-border transactions.

In line with the above, another topic of particular interest to the central bank and the financial industry is the integration of the stock markets of Chile, Colombia, and Peru, scheduled to be completed in 2027. This section describes the basic principles of this integration, as well as the expected changes upon its implementation. Beyond technological challenges, such as the development of a unified trading platform, its success will require the cooperation from both public and private sectors across different jurisdictions. This cooperation will require specific actions in a number of areas such as clearing and settlement of transactions by participants in this new market. Challenges related to the financial infrastructures responsible for clearing and settling these transactions (*i.e.,* central securities depositories and large-value payment systems) are foreseen. Another critical aspect for the proper functioning of this stock market is the regulatory and supervisory harmonization that will govern the transactions carried out by its participants.

1 According to Carstens (2024), Innovation Hubs aim to facilitate the development of new technologies to make the financial system more modern, efficient, and inclusive. See https://www.bis.org/press/p240613.htm

Additionally, as a result of the stock market integration, there are some concerns about the increased risks of contagion from external shocks, particularly during times of financial stress. Mitigating the effects of such situations will require close collaboration among local supervisory authorities, as well as central counterparties that will manage the risks associated with such processes. Early detection of adverse effects resulting from incidents with the potential to impact the stock market formed by the three countries will be crucial for effective risk management by these entities.

4.1 Modernizing Financial Markets: Wholesale CBDC Projects for Local and Cross-Border Use

Recent literature on payment economics frequently discusses central bank digital currency for the exclusive use of commercial banks and other financial institutions. This new form of money, known as wholesale CBDC (wCBDC), would be issued by the central bank as *tokenized* assets, fulfilling the same function as electronic money used by financial institutions to settle real-time transactions, whether for their own purposes or those ordered by third parties.[2] Electronic money currently used in such transactions is issued by the central bank and takes the form of deposits that financial institutions hold in their accounts at the central bank.

This section provides a brief overview of some wCBDC projects for local and cross-border use, which is part of *Banco de la República's* ongoing monitoring of new payment settlement technology solutions. The section is purely informative and should not be taken as an indicator of *Banco de la República's* interest in issuing this form of digital money in the short or medium term.

4.1.1 A New Form of Central Bank Money for Wholesale Markets

The wCBDC is a form of public money that, if issued, would enable settlement of transactions by financial institutions participating in local and global wholesale markets. The rapid and continuous advancement of digital services, supported by a boom in financial innovations, seems to be geared towards the emergence of new platforms that would increase speed and improve clearing and settlement of wholesale payments. The central bank digital currency mentioned above would play a crucial role in a highly *tokenized* scenario, as it would be the necessary asset to settle transactions, whether they consist of money transfers or operations related to *tokenized* assets (see Yue, 2024). As a form of central bank money, the wCBDC would have several potential uses, such as interbank transactions in local wholesale markets and cross-border payments internationally. Both types of transactions are described in more detail in the following sections.

The study of wCBDC has attracted the interest of central banks, international organizations, and academia, which have delved into the benefits and challenges its introduction could pose for the economy. Identifying these benefits and challenges is an ongoing process, as it draws on completed and ongoing experiments and proofs of concept; some of which are summarized in this section.

One argument in favor of wCBDC suggests that its main benefit would be achieving greater efficiency in payment settlement in an increasingly technology-dependent world. This advantage is particularly pronounced at the international level, where

2 Tokenized assets are the representation of real assets in the form of digital tokens, with tokens being a dematerialized representation of the asset in question.

the introduction of this form of money would complement the traditional rails used for cross-border payments, increasing the speed and decreasing the costs of such transfers (see IMF, 2023).[3]

The potential benefits of wCBDC are in contrast to the main counterargument, which concerns the challenges of mitigating the risks of cyberattacks against the issuer and users of the digital currency (see Jamilov, Rey, and Tahoun, 2023). The joint work of issuing central banks and regulatory authorities will be essential to mitigate such attacks and their effects on users of central bank digital currency.

However, it is difficult to determine in advance whether such a technology solution could provide more benefits than challenges compared to the way wholesale payments are currently settled. Its smooth functioning would depend on additional services such as electricity, the internet, and new technologies such as distributed ledger technology (DLT), which are still under development. This is why some central banks and BIS Innovation Hubs have ventured into different types of projects (technological experiments or proofs of concept) to deepen their understanding of these aspects.

4.1.2 Wholesale CBDC (wCBDC) for local use

Helvetia is the only wholesale central bank digital currency project focused exclusively on the local scope.[4] Its purpose is to study the wCBDC (denominated in Swiss francs) as an instrument for securely and efficiently settling the cash leg of transactions with *tokenized* assets, such as bonds and repos. In this context, this project also aims to deepen the understanding of technological aspects and policy implications related to wCBDC (Swiss National Bank, BISIH, and SIX, 2020).

In the first two phases of the project, proof-of-concept tests were conducted to evaluate two types of settlement for *tokenized* assets. The first phase assessed settlement using the central bank digital currency, requiring an understanding of its issuance (1:1 conversion of large-value payment system balances to wCBDC), redemption (1:1 conversion of wCBDC to large-value payment system balances), use in the settlement of *tokenized* assets via delivery versus payment, and transfers of wCBDC.

In the second phase, also a proof of concept, the settlement of *tokenized* assets was evaluated by connecting a new decentralized DLT platform for trading and settling transactions (*i.e.* SDX) to the Swiss Interbank Clearing (SIC)[5] large-value payment system. The delivery of the *tokenized* assets in this phase took place on the SDX platform and its settlement in the SIC (Swiss National Bank et al., 2020).[6]

---

3 In this regard, it was also noted that the introduction of retail CBDCs (rCBDCs), which would cover cross-border transactions, could help mitigate the consequences of overwhelming international flows during times of high volatility by allowing the implementation of automatic measures for better management of capital flows. These measures, known as capital flow management (CFM) measures, would be introduced as algorithms in the design of the rCBDC to determine whether international transfers would be allowed under a set of pre-established conditions (see IMF, 2023).

4 The Helvetia project is led by the Swiss National Bank and the BIS Innovation Hub in Switzerland.

5 The Swiss stock exchange (SIX) is building a new complementary DLT platform (called SDX) for the issuance, trading, settlement, and custody of tokenized assets. SDX will be both a digital stock exchange and a centralized securities depository.

6 This form of settlement contrasts with the use of centralized infrastructures (such as centralized securities depositories) currently operating.

The third phase, which started on 01 December 2023 and will end on 20 June 2024, involves moving the proof-of-concept tests from phases 1 and 2 to a production environment. This phase will pilot the issuance of the wCBDC and the settlement of transactions with *tokenized* assets using digital currency. This consists of experiments that allow for the settlement of such transactions through the delivery versus payment mechanism. The large-value payment system (SIC), the stock exchange (SIX), and six commercial banks are participating in this final phase of the project (Swiss National Bank et al., 2020).

Another wCBDC pilot for local use was announced by the Monetary Authority of Singapore in November 2023, scheduled to start in 2025. According to the central bank, this pilot will focus on evaluating the real-time settlement of payments between commercial banks, for which it is expected that some banks will participate in the project (Chiang, 2023).

4.1.3 Wholesale CBDC for Global Use

The other projects (completed or ongoing) have focused on exploring the functionalities of wCBDC at the global level. Some of these projects have emerged from the G20 initiatives to improve the speed, cost, and transparency of cross-border payments. This section provides a brief overview of digital currency projects for cross-border use, all indicating that each central bank would issue its wCBDC directly, either on its own local platforms, such as the Mariana, mBridge, Inthanon-LionRock2, and Dunbar projects, or on platforms managed by a third party, such as the Jura project (Bech, et al., 2022).

- The Mariana project is a proof of concept with two objectives. The first is to deepen the understanding of the global interbank market for spot transactions in foreign currency, using three wCBDCs (Euro, Singapore dollar, and Swiss franc) in automated market makers (AMMs). AMMs are smart contracts that act as counterparts in liquidity-requiring transactions, such as foreign exchange transactions.[7] Additionally, this project seeks to determine whether introducing AMMs in the trading and settlement of foreign currency would improve cross-border payments through greater transparency and reduced settlement risk. The second objective is to assess whether providing liquidity to commercial banks would facilitate their foreign currency transactions. This project emerged from collaboration between the BIS Innovation Hub in Singapore, the Bank of France, the Monetary Authority of Singapore, and the Swiss National Bank (BIS-IH, Banque de France, MAS, Swiss National Bank, 2023).
- The Inthanon-LionRock2 project is a proof-of-concept that aims to explore the use of DLT technology for real-time cross-border transfers, using an atomic payment-versus-payment mechanism for settling foreign currency transactions between two jurisdictions.[8] The project is led by the BIS Innovation Hub in Hong Kong, the Hong Kong Monetary Authority, and the Bank of Thailand (Bech et al., 2022).

7 The prices of these transactions with AMMs are determined by algorithms (see Auer et al., 2023; BIS-IH et al., 2023).

8 The atomic settlement mechanism occurs when money and assets are tokenized, reside in a unified ledger, and there is an integrated settlement model linking the securities leg and the money leg (Bech et al., 2022).

- The Jura project is a prototype exploring direct wCBDC transfers between French and Swiss commercial banks on a single DLT platform operated by a third party. It also explores the settlement of *tokenized* assets, such as foreign currency transactions, using delivery-versus-payment and payment-versus-payment mechanisms. This project settled transactions in real value, denominated in euros and Swiss francs. Participating entities include the Bank of France, the Swiss National Bank, and a private consortium (Bech et al., 2022).
- The Dunbar project evaluates different DLT prototypes to support a multi-CBDC platform for settling international transfers. The multi-CBDC platform designed in this project was shared among the participating central banks: Reserve Bank of Australia, Bank Negara Malaysia, the Monetary Authority of Singapore, and the South Africa Reserve Bank. This project allowed commercial banks to trade directly in the currency of other jurisdictions (BIS, 2021; Bech et al., 2022) and involved the BIS Innovation Hub in Singapore and the central banks mentioned above.
- The mBridge project is the extension of the Inthanon-LionRock2 project that explores cross-border payments in multiple currencies using DLT technology. In this project, each central bank operates its own transaction validation node on a shared system. The participating entities include the BIS Innovation Hub in Hong Kong, the Hong Kong Monetary Authority, the Bank of Thailand, the People's Bank of China (the central bank of China), and the Central Bank of the United Arab Emirates (BIS-IH Hong Kong Center et al., 2021; Bech et al., 2022).

The main features of the projects described are summarized in Table 4.1. As shown in this table, most projects assess direct transfers using the wCBDC. Two of the projects are proofs of concept (Mariana and Inthanon-LionRock2), while the other four are in the experimentation phase (Helvetia, Jura, Dunbar, and mBridge).

When comparing the projects, three common elements emerge among those focused on settling international transactions, namely: Financial institutions are allowed access to wCBDCs from other countries, enabling them to make cross-border payments without intermediaries (i.e., correspondent banks).

1. All projects designed platforms for multiple currencies in a single system using DLT technology.
2. All projects reduce settlement risk by making use of the payment-versus-payment settlement mechanism.

Most projects identify some challenges that need to be solved, particularly related to DLT technologies (still under development), disparities in settlement cycles, as well as the necessary legal and regulatory harmonization, such as those aimed at limiting illicit activities in international transfers. The joint work of the jurisdictions involved in this type of initiative will be key in the search for agreements that facilitate solutions.

A project in the preparatory phase is the so-called Agorá, planned to explore transactions with *tokenized* deposits, cross-border payments and the use of smart contracts to facilitate payments between jurisdictions. This project will involve the BIS Innovation Hub and the central banks of France, Japan, South Korea, Mexico, Switzerland, England, and the Federal Reserve Bank of New York (BIS, 2024). In addition to projects exploring the possibility of introducing wCBDC for cross-border payments, there are a number of initiatives to increase efficiency and

Table 4.1
Projects with wCBDC

Name of the project	wCBDC Usage	Type of project	Project objective
Helvetia	Local	Proof of concept (phases 1 and 2), pilot (phase 3)	Settle transactions with tokenized assets
Mariana	Global	Proof of concept	Settle foreign currency transactions in AMMs
Inthanon-LionRock2	Global	Proof of concept	Settle foreign currency transactions
Jura	Global	Prototype	Direct transfers from wCBDC and settlement of transactions with tokenized assets
Dunbar	Global	Prototype	Settle international transfers
mBridge	Global	Prototype	Settle cross-border payments

Source: Prepared by DSIF.

modernize financial infrastructures, such as the integration of fast payment systems from different jurisdictions (see BIS-CPMI, 2024) or the design of payment engines for scalability. For example, the Fully Scalable Settlement Engine (FuSSE) project, which seeks to modernize financial market infrastructure to facilitate future transactions. One focus of the FuSSE project is to develop cutting-edge payment and settlement systems, which would bring multiple benefits both locally and globally, facilitating, in the latter case, the integration of payment systems from different jurisdictions. FuSSE is a project of the BIS Innovation Hub and Inter-American Development Bank (see BIS-IH, 2024).

4.1.4 Conclusions

The wholesale CBDC is a form of central bank digital currency for the exclusive use of financial institutions in wholesale transactions, such as money transfers or transactions involving *tokenized* assets. Its introduction into the economy could lead to greater efficiency in payment settlement by increasing the speed and reducing transfer costs. However, it may also increase the vulnerability of its issuer (the central bank) and its users (financial institutions) to different risks (e.g. cyberattacks).

The projects reviewed in this section help identify these issues both locally and globally. Most of these projects are aimed at improving understanding of direct transfers and settlement of *tokenized* assets using wCBDCs from different jurisdictions. As these are ongoing experiments, the benefits of these projects can only be verified upon their completion. To date, many of these continue to add phases of experimentation to delve into their requirements and results. The description provided in this section suggests the need for close collaboration between central banks, commercial banks, and financial infrastructures, as well as other aspects that need to be reviewed, particularly related to the necessary legal and regulatory harmonization to advance the potential implementation of these alternatives.

References

Auer, R.; Haslhofer, B.; Kitzler, S.; Saggese, P.; Victor, F. (2023). "The Technology of Decentralized Finance (DeFi)," *BPI Working Papers*, No. 1066, January.

Banque de France; BIS; Swiss National Bank (2021). "Project Jura: Cross-border Settlement Using Wholesale CBDC," December.

BIS (2021). "BIS Innovation Hub and Central Banks of Australia, Malaysia, Singapore and South Africa Will test CBDCs for International Settlements," September.

BIS (2024). "Project Agorá: Central Banks and Banking Sector Embark on Major Project to Explore Tokenization of Cross-border Payments," press release, 3 April, available at: https://www.bis.org/press/p240403.htm

BIS-IH; Banque de France; Monetary Authority of Singapore (MAS); Swiss National Bank. (2023) "Project Mariana: Cross-border Exchange of Wholesale CBDCs Using Automated Market Makers," September.

BIS-IH Hong Kong Centre; Hong Kong Monetary Authority; Bank of Thailand; Digital Currency Institute of the People's Bank of China; Central Bank of the United Arab Emirates (2021). "Inthanon-LionRock to mBridge: Building a Multi CBDC Platform for International Payments," September.

BIS-CPMI (2024). "Regional payment infrastructure integration: insights for interlinking fast payment systems," May.

BIS-IH (2024). "Project FuSSE aims to modernise financial market infrastructures," April, available at: https://www.bis.org/about/bisih/topics/fmis/fusse.htm

Bech, M.; Boar, C.; Eidan, D.; Haene, P.; Holden, H.; Toh, W. (2022). "Using CBDCs across Borders: Lessons from Practical Experiments," BIS Innovation Hub, June.

Chiang, Sh. (2023). "Singapore to Pilot Use of Wholesale Central Bank Digital Currencies in 2024," 17 November, available at: https://www.msn.com/en-us/money/other/singapore-to-pilot-use-of-wholesale-central-bank-digital-currencies-in-2024/ar-AA1k3yse

IMF (2023). Central bank digital currency- Virtual Handbook- Chapter 4. How Can Capital Flow Management Measures Be Implemented with CBDCs?, November.

Jamilov, R.; King, H.; Tahoun, A. (2023). "The Anatomy of Cyber Risk," NBER Working Paper, No. 28906.

Swiss National Bank; BISIH; SIX. (2020). "Project Helvetia: Settling Tokenized Assets in central bank money," December.

Yue, E. (2024). Keynote speech - International Conference on Central Bank Digital Currencies and Payment Systems, 11 April.

4.2 Market Integration: A Process with Multiple Challenges for Financial Infrastructures

4.2.1 Introduction

While there are various levels of economic and financial integration among countries or regions, a broad concept of integration addresses the gradual removal of borders between countries. This process includes eliminating barriers to promote trade of financial services and facilitating the free movement of capital. As a result, this facilitates the creation of economically integrated markets. One example of such integration is the European case, where the European Monetary Union (EMU) was created, a common currency (euro) was adopted, and the European Central Bank (ECB) centralized the design and implementation of monetary policy. Financial integration can also be limited exclusively to the integration of a specific market, such as the merger between the New York Stock Exchange (NYSE) and Euronext, which operated several European stock exchanges. This merger sought to create a more integrated and efficient financial market. Similarly, a regional integration process is underway among the stock exchanges of Chile, Colombia, and Peru.

According to Garcia-Herrero and Wooldridge (2007), an integrated financial market is one in which potential participants are governed by a single set of rules, have equal access, and receive equal treatment. In an international context, progress towards a market for financial instruments and services depends on broadening and deepening cross-border financial links. More specifically, the process of cross-border financial integration involves opening a country's markets and financial institutions to foreign agents, as well as allowing local market participants to invest abroad. As indicated by Andersen and Moreno (2005) and Baele et al. (2004), integration processes bring both advantages and challenges (Table 4.2).

Financial integration allows capital to flow more efficiently to where it is needed, which can lead to optimal allocation of financial resources across different regions and economic sectors. Thus, capital flows can boost investment and economic growth by providing and channeling access to financial resources. From the markets' outlook, financial integration can increase liquidity and depth by attracting more investors and facilitating a greater volume of transactions. Consequently, by having access to a wider range of financial instruments and markets, investors can diversify their portfolios more efficiently. The empirical evidence provided by Kalemli-Ozcan et al. (2001) suggests that risk-sharing between regions improves production specialization, resulting in economic benefits.

On the other hand, financial integration can facilitate access to capital for companies, governments, and individuals by offering various financing options at competitive interest rates. It can also boost international trade by facilitating financing of trade transactions and foreign investment. In addition, the resulting competition can stimulate innovation in financial products and services, which can lead to an improvement in their efficiency and quality and thus benefit consumers and the economy.

However, these financial integration processes are no easy feat and involve a variety of challenges that must be addressed in order to reap these benefits. From the macroeconomic point of view, financial integration could increase the possibility of financial contagion among interconnected economies, where problems in one country or sector spread quickly to other economies. A factor in transmitting these unintended effects is the volatility of capital flows, which can lead to financial instability and economic hardship.

Table 4.2
Main Benefits and Challenges of Financial Integration

Benefits	Challenges
More efficient allocation of financial resources	Possibility of financial contagion between interconnected economies.
Increased risk diversification	Volatility of capital flows, possibly causing episodes of financial instability.
Improved access to financing	Vulnerability to global financial crises
Increased international trade	Possibility of financial exclusion and inequality of access
Facilitates economic growth by enabling capital flows	Some loss of autonomy in economic policies
Increased financial market depth and liquidity	Need to coordinate financial regulation and supervision at the international level.
Encouraging financial innovation	
Strengthening competition between financial institutions	
Increased access to financial products and services	

Source: European Central Bank.

In general terms, financial integration processes face challenges from two outlooks, the first being the difficulty in coordinating financial regulation and supervision at the group level of the jurisdictions involved, and in making corporate adjustments and agreements within the value chain of market transactions. The second is the difficulties in harmonizing the post-trade and risk management services of transactions in the different jurisdictions.

4.2.2 Challenges of Financial Integrations in Terms of Regulations and Supervision

One of the main challenges faced by the countries or regions that are integrated is the coordination of the different regulatory and economic policy frameworks. In addition, financial integration often faces political and social resistance, as some actors may feel that it does not benefit parties equitably, or may even be perceived as a threat to economic sovereignty and national identity. To overcome these challenges, effective coordination is required between governments, financial authorities, central banks, and financial institutions or unions involved in the markets that are intended to be integrated.

The increase in interconnections between financial markets and institutions leads to an increased probability of the spread of financial crises across borders. Therefore, managing financial stability in an integrated environment may require more effective supervision and regulation. This implies establishing reporting and supervisory mechanisms that allow regulators to monitor activities and assess their ability to manage new risks, for example, those resulting from interoperability between different intermediaries or financial infrastructures and the concentration of the provision of a service in the same provider. In addition, it is necessary to establish communication and collaboration channels that facilitate cooperation between regulators and other stakeholders in the management of systemic risk.

From a corporate point of view, challenges may arise around the transformation or merger needs of some companies (e.g., stock exchanges, price information pro-

viders, etc.) to facilitate access to financial products and services by investors in different countries or regions.

Along with the institutional and business challenges already mentioned, it is necessary to overcome some challenges in the coordination and structuring of the activities related to the financial infrastructures of the jurisdictions involved, as will be mentioned below.

4.2.3 Challenges Along the Financial Markets Value Chain (Trading and Post-Trading)

From an operational and legal point of view, financial integration requires additional efforts to ensure the normal functioning of markets. Thus, it is essential to clearly establish the regulatory framework for the clearing and settlement processes of the transactions carried out between participants from different jurisdictions. Therefore, challenges related to interactions between Central Securities Depositories (DCV in Spanish) and large-value payment systems for settlement of the cash leg of transactions must be overcome, interoperability between central counterparties (CCPs), the risk management mechanisms and tools associated with clearing and settlement, the management of the different time zones and the different settlement currencies, among others. The main considerations or challenges are summarized in Diagram B4.1.

The integration process should ensure that market participants can access the trading platforms on an equal basis, therefore, the integration should ensure that certain participants are not excluded and that the requirements for access are transparent and inclusive.

From the point of view of multilateral clearing of transactions in integrated markets, legal, operational, and risk management challenges arise to guarantee the symmetry of the security of transactions. Therefore, CCPs should be highly similar in the tools established to manage the risks associated with the defaults of the liquidating members and those related to corporate, operational, and legal risk, among others.[9] As McPartland and Lewis (2016) indicate, it is necessary to create a regulatory framework to facilitate the interoperability of CCPs, thus, for example, in Europe, the right of market infrastructures to become members of another infrastructure was established, and additionally, recommendations have been issued to evaluate the agreements between CCPs (ESMA, 2013).

The interaction between DCVs also presents challenges. On the one hand, it is necessary to define the strategy for managing account structures and the use of intermediaries, such as custodians and sub-custodian networks, to guarantee proper registration of securities. On the other hand, it is important to establish and standardize the services that these platforms offer to make temporary loans of securities as an indispensable mechanism to support possible delays or defaults in the delivery of securities by market participants.

Lastly, settlement finality of the traded assets must be legally and operationally protected; thus, it is relevant to standardize the time at which the payment or transfer instructions of securities are not affected by any legal or operational

9 In general terms, CCPs should comply with the recommendations set out in the principles applicable to financial market infrastructures and the additional guidance on margin administration and recovery plans established by the Bank for International Settlements.

Diagram 4.1
Challenges of Financial Integration in the Financial Market Value Chain

Sources: BIS, European Central Bank, and *Banco de la República*. Diagram of *Banco de la República*.

act that hinders the certainty of compliance with the agreed. This becomes more important when monetary settlement is made in different currencies or currencies other than local ones. A possible alternative is the creation of a digital currency issued by the central banks (CBDC) of countries that seeks to facilitate cross-border payments between different financial markets. The latter alternative is being evaluated in different jurisdictions through exploratory projects and there is still no certainty of the benefits it would bring to the markets and financial infrastructures, as explained in this section of the report.

Concerning the regional integration between Colombia, Chile, and Peru, it has faced some of the aforementioned challenges. On the one hand, corporate mergers were necessary. In 2023, the company Nuam Exchange was created, a regional holding that manages a single equity securities trading platform between the three countries and, thus, generate economies of scale that benefit investors, issuers and intermediaries in the financial market. On the other hand, it is expected that by 2027, interoperability agreements will have been established between CCPs in each country and structured the flow of information on payment transactions and transfers through connections between DCVs and large-value payment systems.

References

Andersen, P.; Moreno, R. (2005). "Financial integration: an overview", *BIS Papers*, no. 23, Bank of International Settlements.

Committee on Payment and Settlement Systems (CPSS); Technical Committee of the International Organization of Securities Commissions (2012). "Principles for Financial Market Infrastructures", *CPMI Papers,* no. 101, Bank of International Settlements.

European Central Bank (2004). "Measuring financial integration in the euro area", *Occasional Paper Series*, no. 14, European Central Bank.

Garcia-Herrero, A.; Wooldridge, P. (2007). "Global and regional financial integration: progress in emerging markets", *BIS Quarterly Review*, September.

McPartland, J.; Lewis, R. (2016). "The challenges of derivatives central counterparty interoperability arrangements," April.

European Securities and Markets Authority [ESMA] (2013). Guidelines and Recommendations for establishing consistent, efficient and effective assessments of interoperability arrangements.

Annex 1: Payments in Financial Markets

1. Large-Value Payment System

1.1 Overview and Evolution

As of December 2023, 141 direct participants in *Banco de la República*'s large-value payment system (CUD) had a deposit account (Table A1.1). Although these participants are of different types, they can be grouped as follows: the national government and the central bank (3), intermediaries and other agents participating in the securities and/or foreign exchange market (121), financial market and retail-value payment infrastructures (7) and others (10).

Table A1.2 details the origin and items of operations that debit deposit accounts in the CUD system.

Table A1.1.
Number of Participants by Type of Institution

Type of Institution	Number of Participants
Trust Companies	26
Banks	29
Stock Brokerage Firms	16
Insurance Companies	13
Finance Companies	11
Public Financial Entities	8
Social Security Information Operators	8
Financial Cooperatives	5
Retail-value Payment Systems (ACH Colombia and networks)	4
Pension and Severance Funds	4
Investment banks	3
Companies Specialized in Electronic Deposits and Payments - SEDPE	4
Capitalization Companies	1
Banco de la República	1
General Directorate of Public Credit and the National Treasury	1
The Nation Ministry of Finance and Public Credit: The General System of Royalties.	1
Stock Exchange	1
Centralized Securities Depository	1
Central Counterparty Clearing Houses	1
Securitization firms	1
Employee Funds/Solidarity Economy Cooperatives	2
Total	141

Source: *Banco de la República* (CUD).

Table A1.2.
Origin and Item of Operations for which Deposit Accounts in the CUD System are Debited, Number and Value of Operations
(Daily averages, in billions of pesos)

Sovereign debt operations in the DCV[a/]	Year 2022		Year 2023		Year 2022		Year 2023	
	Number of operations	Value	Number of operations	Value	Number of operations	Value	Number of operations	Value
					(percentage)			
Primary market								
Placements[b/]	17	212.93	17	215.96	0.3	0.3	0.2	0.3
Payment of principal and yields[c/]	38	212.35	38	228.49	0.6	0.3	0.5	0.3
Secondary market[d/]								
Purchase/sales	835	3,516.40	1063	4,946.01	12.4	5.7	14.1	6.3
Money market[d/]								
Sell/buy-backs	372	5,852.98	471	5,925.54	5.5	9.6	6.3	7.5
Reverse sell/buy-backs	371	5,854.89	471	5,927.47	5.5	9.6	6.3	7.5
TTS MHCP	4	183.73	0	0.00	0.1	0.3	0.0	0.0
Reverse TTS MHCP	4	183.43	0	0.00	0.1	0.3	0.0	0.0
Third-party repos (repos between financial institutions)	0	0.00	0	0.00	0.00	0.00	0.00	0.00
Reverse third-party repos	0	0.00	0	0.00	0.00	0.00	0.00	0.00
Total sovereign debt operations in the DCV (1)	1,642	16,017	2,061	17,243	24.3	26.1	27.4	21.96
Other DCV[e/] (2)	28	159.42	27	287.76	0.4	0.3	0.4	0.4
Total (1) + (2)	1,671	16,176	2,088	17,531	25	26	28	22.3
Monetary Policy	**Number of operations**	**Value**	**Number of operations**	**Value**	**Number of operations**	**Value**	**Number of operations**	**Value**
					(percentage)			
Repos to increase money supply[f/]	59	8,274.23	61	7,939.80	0.87	13.5	0.8	10.1
Reverse repos[g/]	0	0.00	0	0.00	0.00	0.0	0.0	0.0
Definitive TES purchase/sales	10	49.52	16	72.12	0.15	0.1	0.2	0.1
Repos with private debt	2	8.34	0.00	0.00	0.02	0.0	0.0	0.0
Repos with promissory notes	0.2	10.78	0.0	0.00	0.00	0.0	0.0	0.0
Non-delivery forwards	0.0	0.00	0.0	0.00	0.00	0.0	0.0	0.0
Interest-bearing deposits[h/]	36	3,450.40	59	6,813.54	0.54	5.6	0.8	8.7
Total monetary policy operations	107	11,793	137	14,825	1.6	19.2	1.8	18.88
Provision of Liquidity in the Payment System (*Banco de la República*)	**Number of operations**	**Value**	**Number of operations**	**Value**	**Number of operations**	**Value**	**Number of operations**	**Value**
					(percentage)			
Intraday repos[i/]	81	2,597.65	80	2,818.68	1.20	4.2	1.1	3.6
Total operations to provide liquidity	81	2,597.65	80	2,818.68	1.20	4.24	1.06	3.59

Table A1.2 (continuation)
Origin and Item of Operations for which Deposit Accounts in the CUD System are Debited, Number and Value of Operations
(Daily averages, in billions of pesos)

Direct Funds Transfers in the CUD[i/]	Number of operations	Value	Number of operations	Value	Number of operations (percentage)	Value (percentage)	Number of operations (percentage)	Value (percentage)
Securities (money uploads/ downloads)[k/]	689	7,811.20	724	8,721.14	10.2	12.7	9.6	11.1
Intraday interbank loans	28	365.17	29	377.62	0.4	0.6	0.4	0.5
Reverse intraday interbank loans	17	173.55	16	176.84	0.3	0.3	0.2	0.2
Interbank loans at one or more days	20	602.91	20	611.05	0.3	1.0	0.3	0.8
Reverse interbank loans at one or more days	19	593.92	19	583.98	0.3	1.0	0.3	0.7
Interbank loans: IBR	16	320.00	16	320.00	0.2	0.5	0.2	0.4
Reverse interbank loans: IBR	16	320.09	16	320.16	0.2	0.5	0.2	0.4
Foreign currencies settled outside the clearing house	54	336.10	49	371.20	0.8	0.5	0.7	0.47
Taxes	145	886.64	147	1,076.69	2.1	1.4	2.0	1.37
Transfers from managers to custodians: CIF operations	154	2,804.73	124	2,289.40	2.3	4.6	1.6	2.9
Transfers from custodians to managers: CIF operations	190	1,913.78	208	2,236.63	2.8	3.1	2.8	2.8
Other transfers[l/]	2008	8,235.76	2200	18,811.55	29.7	13.4	29.3	24.0
Deceval[m/]								
Primary placement	86	355.24	73	458.91	1.3	0.6	1.0	0.6
Payment of principal and yield	213	338.65	236	525.12	3.2	0.6	3.1	0.7
Purchase/sales	84	256.40	128	522.79	1.2	0.4	1.7	0.7
Sell/buy-backs	57	78.08	73	118.32	0.8	0.1	1.0	0.2
Reverse sell/buy-backs	57	77.77	73	118.31	0.8	0.1	1.0	0.2
Repos	4	2.15	4	1.31	0.1	0.0	0.1	0.0
Reverse repos	5	2.30	4	1.31	0.1	0.0	0.1	0.0
Temporary transfer of securities	0	0.00	0	0.00	0.0	0.0	0.0	0.0
Change of depositor	133	159.26	111	109.62	2.0	0.3	1.5	0.1
Term transactions	6	0.60	5	0.48	0.1	0.0	0.1	0.0
CRCC-Deceval spot operations	18	37.67	26	19.92	0.3	0.1	0.3	0.0
Total Deceval operations	662	1,308.10	734	1,876.09	9.8	2.13	9.8	2.39
Colombian Stock Exchange (BVC)[n/]	0	0.00	0	1.10	0.0	0.0	0.0	0.0
Central Counterparty Clearing House (CRCC)[o/]	19	144.29	19	168.32	0.3	0.24	0.3	0.21
Central Counterparty Clearing House (CRCC)[p/]	16	1,222.66	16	1,245.84	0.2	2.00	0.2	1.59

Table A1.2 (continuation)
Origin and Item of Operations for which Deposit Accounts in the CUD System are Debited, Number and Value of Operations
(Daily averages, in billions of pesos)

Direct funds transfers in the CUD[i/]	Number of operations	Value	Number of operations	Value	Number of operations (percentage)	Value (percentage)	Number of operations (percentage)	Value (percentage)
Retail-value payment systems[q/]								
ACH	174	2,780.92	192	3,181.70	2.6	4.54	2.5	4.05
Card and ATM networks	56	584.65	62	799.28	0.8	0.95	0.8	1.02
Checks (Cedec and delegated clearing houses)	35	203.35	37	134.02	0.5	0.33	0.5	0.17
Total retail-value payment systems	266	3,568.93	290	4,115.00	3.9	5.82	3.9	5.24
Total direct funds transfers in the CUD	4,318	30,608	4,628	43,303	63.9	49.94	61.6	55.13
Other transactions	**Number of operations**	**Value**	**Number of operations**	**Value**	**Number of operations (percentage)**	**Value (percentage)**	**Number of operations (percentage)**	**Value (percentage)**
Total other transactions[r/]	588	160.39	602	133.64	8.7	0.26	8.0	0.2
Total debit transactions in the CUD	6,755	61,286	7,518	78,540	100	100	100	100

a/ Transfers of funds in the CUD system, originating with securities transactions in the DCV.
b/ Placement of securities that effectively implied an outlay of resources. Does not include reinvestments in agricultural development titles (TDA), tax refund certificates (CERT), sovereign debt securities (TES) to pay court rulings, and agricultural and constant-value bonds, among others.
c/ Pertains to money effectively transferred in the CUD for payment of principal or yield on securities deposited with the DCV, excluding payments for *Banco de la República* investments.
d/ Does not include cross trades; that is, operations where the same financial entity is both the originator and recipient of the cash leg.
e/ Deposit account debits originating with the collection of fees, penalties, and commissions in the DCV.
f/ Pertains to reverse repos. In the case of repo chains, it includes only net value and interest.
g/ Reverse repos.
h/ Interest-bearing deposits. This includes DGCPTN.
i/ Pertains to reverse intraday repos. In the case of repo chains, it includes only net value and interest.
j/ Clearing and settlement of operations from external systems or operations processed by deposit account entities directly at their CUD stations.
k/ Transfer of funds (money uploads) from leading banks to stock brokerage firms, trust companies, and pension funds (known as customers), so they have enough liquidity in their deposit accounts to cover the cash leg of their securities operations. The banks debit this money from the customer's current account, in advance.
l/ Transfers of funds from Deceval to the creditors in securities transactions (through delivery versus payment), with the initial transfer from the debtors to Deceval broken down according to the elements in item m/; transfers of funds from the ACH account and from the networks' clearing systems to institutions with a multilateral creditor position in each clearing cycle; initial transfers from debtors to the ACH and the networks are in item q/; Operations – Paragraph 10 in Article 879 of the tax statute; transfers between accounts belonging to the same institution; transfers of funds from the Foreign Exchange Clearing House account to foreign exchange market intermediaries (IMCs) with a multilateral creditor position in pesos (payment-versus-payment mode); initial transfers from IMCs with a debtor position to the Foreign Exchange Clearing House are in item p/; credit disbursements; payment by issuers of securities; transfers of funds from the account of the Central Counterparty Clearing House to institutions with a multilateral creditor position in pesos; initial transfers from institutions having a debtor position with the Central Counterparty Clearing House are shown in item o/; and constitution-return of collateral.
m/ Payment of principal and yield, and transfers of funds from debtor institutions to Deceval, so it can guarantee the settlement of operations through delivery versus payment; includes, among others, purchase-sale transactions, sell/buy backs, repos, and change of depositor of securities deposited in Deceval.
n/ Multilateral net clearing and settlement of the cash leg in stock trades.
o/ Transfers of funds from institutions with a debtor position in pesos to the Central Counterparty Clearing House, so it can guarantee the settlement of derivatives clearing (daily settlement and at contract maturity). Does not include the cash Forex segment.
p/ Transfers of funds from IMCs with a debtor position in pesos to the CRCC, so it can guarantee settlement through payment-versus-payment.
q/ Transfers of funds from institutions with a multilateral debtor position to the ACH and the *Credibanco*, *Redebán*, *Servibanca*, and ATH networks, so they can guarantee the settlement of clearing for electronic fund transfers and transactions with debit and credit cards and ATMs. It also includes check clearing and settlement.
r/ Provision of cash from *Banco de la República*'s Treasury to financial institutions with deposit accounts, payment of services, commissions and fees, liens, and financial transaction tax (GMF) collection.
Source: *Banco de la República* (CUD).

1.2 Concentration, Operational Efficiency, and Other Indicators

Table A1.3 presents estimates of the concentration level of payments among direct participants in the large-value payment system (excluding some payments). Taking 70% of total payments as a reference, it was established how many entities and what percentage of all participants are covered by this reference. Between 2022 and 2023, concentration remained at fourteen entities. Additionally, the total percentage of participants generating this con-

Table A1.3
Number and Percentage of CUD Participants Accounting for 70% of the Value of Payments

Year	Number of participants	Percentage of participants
2014	14	9.3
2015	14	9.9
2016	14	9.9
2017	13	9.6
2018	13	9.4
2019	15	10.7
2020	15	11.5
2021	15	10.9
2022	14	9.9
2023	14	9.9

Source: *Banco de la República* (DSIF).

centration remained at 9.9% for the year of analysis. It is important to note that the long-term trend of concentration has remained stable, with about 10% of participants concentrating approximately 70% of system's activity.

Particularly, for 2023, while 9.9% of the most active participants (fourteen entities) accounted for 71.9% of CUD payments – twelve banks: 63.1%; one trust company: 5.3%, and one stock brokerage firm: 3.5%—, the remaining 90.1% of participants sent only 28.1% of the total payments.

Table A1.4 exhibits the timeline of the CUD system, illustrating the accumulated settlement percentages of transactions for the most relevant items affecting deposit account balances by hourly timeframes, from the start of the transfer service to closing time. For example, 69.8% of secondary market transactions and 69.8% of intraday repos during the year 2023 had already been settled by 14:59 p.m., on average. In terms of aggregate value for the entire system, one can see, for example, that 34.4% of the transactions had already been settled by 13:59 p.m.

On the far right of Table A1.4, the total value settled (daily average) for each item is shown, allowing each cumulative percentage of compliance to be translated into its corresponding value. Continuing with the example of secondary market transactions, the 69.8% mentioned earlier corresponds to COP 3.4 t of COP 4.9 t.

Considering that Section 1 of the Report provides an analysis of the timeliness of transaction settlements by timeframes, an additional objective of presenting Table A1.4 is to detail the effects that the diversity of transactions imposes on the system's intraday liquidity. This information is relevant to both operational monitoring of the system and decision-making when it is necessary to schedule contingency scenario certification activities with the system in production.

To make tracking easier, the different effects on liquidity are detailed using colors. Specifically, 1) yellow denotes transactions that have a neutral or zero-sum effect on the aggregate, as funds debited from one participant are simultaneously credited to another for an equal amount; (2) red is for transactions that drain or withdraw liquidity from the payment system's aggregate, as funds debited from a participant are transferred to external agents, such as *Banco de la República* or the Ministry of Finance, or remain frozen in another external system (e.g. Deceval) for a certain period and are subsequently returned, and 3) green signals transactions that inject or add liquidity to the payment system's aggregate for reasons opposite to those mentioned above.

At the end of the timeline, the percentage of the number of transactions processed (not accumulated) is broken down by hour, allowing the intraday periods to be identified, where the CUD system experiences low or high transaction processing loads, regardless of the amounts.

2. Clearing and Settlement of Securities and Financial Derivatives

This section of the Annex provides additional information on the components of clearing and settlement of financial asset transactions with the Colombian financial infrastructure.

Table A1.4
Timeline for the Settlement of Transactions in the CUD (daily averages for 2022)

	0:00	7:00	8:00	9:00	10:00	11:00
Origin and items of operations						
Public debt operation in the DCV						
Primary market	Percentage of accumulated settlement in each time range					
Placements	0.00	0.00	0.00	0.80	2.85	8.39
Payment of principal and yield	41.57	43.57	50.67	52.55	53.87	55.65
Secondary market						
Purchase/sales	0.00	0.00	0.00	0.08	0.56	21.32
Money market						
Sell/buy-backs, repos, third-party repos and TTS	0.00	0.00	0.00	0.62	2.84	34.88
Reverse sell/buy-backs, third-party repos and TTS MHCP	0.15	0.86	5.35	9.75	14.85	59.05
Monetary policy						
Repos to increase money supply	0.00	0.00	0.00	0.00	0.05	0.57
Reverse repos to increase money supply	0.00	0.36	1.17	2.58	4.18	6.07
Provision of liquidity in the payment system (*Banco de la República*)						
Intraday repos	0.00	1.00	9.76	22.74	37.76	46.23
Reverse intraday repos	0.00	0.03	2.65	3.32	4.59	7.22
Direct funds transfers in the CUD						
Securities (money uploads/downloads)	0.25	4.37	9.42	12.18	16.00	19.61
Intraday interbank loans	7.46	7.89	15.32	17.96	18.31	19.45
Reverse intraday interbank loans	0.14	0.14	2.46	4.12	4.91	6.05
Interbank loans at one or more days	0.00	0.00	0.02	0.09	0.30	0.49
Reverse interbank loans at one or more days	0.00	0.00	0.08	0.83	3.77	10.89
Interbank loans: IBR	0.00	0.00	0.00	0.00	0.00	94.98
Reverse interbank loans: IBR	0.00	0.00	0.46	2.16	3.20	3.61
Taxes	0.00	0.10	30.26	68.87	95.51	99.71
Custodians	0.02	0.02	0.04	3.47	13.19	19.68
Foreign currencies settled outside the clearing house	0.00	0.00	0.07	0.43	2.62	7.49
Deceval						
Primary market						
Placements	0.76	0.76	0.76	0.86	1.61	3.92
Payment of principal and yields	0.00	0.00	0.02	0.03	0.91	2.02
Secondary market						
Purchase/sales	0.13	0.13	0.17	0.21	0.49	1.23
Money market						
Sell/buy-backs	0.01	0.01	0.01	0.13	2.13	8.26
Reverse sell/buy-backs	0.00	0.00	7.32	30.75	63.32	76.78
Repos	0.05	0.05	0.05	0.46	9.21	29.24
Reverse repos	0.00	0.00	81.77	85.79	89.51	93.93
Others						
Change of depositor	0.23	0.23	0.23	4.43	10.65	18.70

Neutral liquidity effect
Neutral effect of transactions settled with liquidity savings
Liquidity drainage effect
Liquidity injection effect

Source: *Banco de la República* (DSIF).

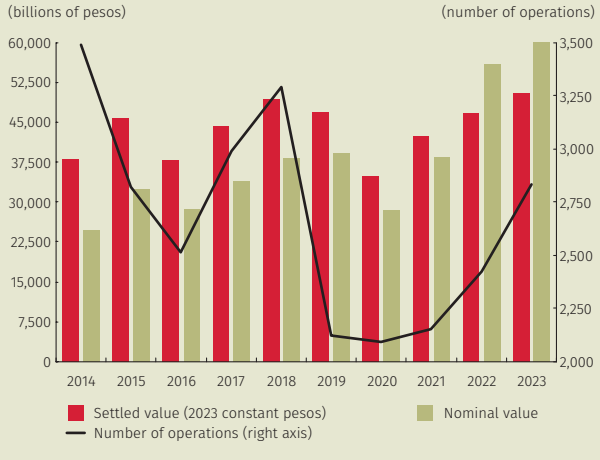
12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	Total value settled daily on average (billions)
Percentage of accumulated settlement in each time range										
23.66	50.39	69.56	81.68	93.05	98.57	99.65	100.00			215.96
57.04	57.47	58.48	58.48	58.48	58.48	58.48	58.48	58.48	100.00	228.49
25.23	28.49	69.83	79.63	93.40	98.53	99.84	99.97	100.00		4,946.01
39.94	43.48	84.98	90.22	97.45	99.35	99.92	99.97	99.99	100.00	5,925.54
63.46	64.88	90.24	93.52	98.70	99.65	99.95	99.99	99.99	100.00	5,927.47
1.46	38.86	59.68	79.50	94.32	99.24	99.95	99.99	100.00		8,273.58
7.91	41.81	84.99	92.03	98.16	99.60	99.97	100.00			7,978.92
55.80	63.26	69.77	76.12	86.41	95.29	98.35	99.95	99.99	100.00	2,818.68
10.41	15.92	21.48	30.79	52.10	82.58	97.23	99.89	99.92	100.00	2,821.05
22.71	25.98	30.69	44.13	65.00	81.75	91.93	97.84	99.44	100.00	8,721.14
27.68	34.36	36.95	39.58	40.84	41.81	42.00	42.08	86.99	100.00	377.62
17.89	33.45	37.02	40.84	41.99	42.92	81.91	99.63	100.00		176.84
0.89	1.38	7.75	36.64	72.62	94.14	99.49	99.99	100.00		611.05
17.61	23.69	37.16	54.29	82.29	96.00	99.66	100.00			583.98
94.98	94.98	99.74	99.81	100.00						320.00
3.84	4.39	93.87	96.12	98.83	99.48	100.00				320.16
99.95	99.96	99.99	99.99	99.99	99.99	100.00				1,076.69
24.02	28.22	34.02	44.11	64.53	86.68	98.20	99.84	99.94	100.00	2,289.40
13.54	22.81	37.08	58.95	79.63	93.84	99.73	99.99	100.00		2,236.63
4.50	5.58	9.22	24.63	60.57	87.10	98.22	99.22	99.86	100.00	458.91
7.02	7.18	12.99	28.65	92.25	96.51	98.69	98.76	99.81	100.00	525.12
2.78	5.60	17.23	41.55	74.02	94.11	99.20	99.82	99.92	100.00	522.79
15.56	22.47	52.82	75.98	91.95	98.64	99.85	99.96	100.00		118.32
82.81	86.60	93.38	97.09	98.95	99.73	99.99	100.00			118.31
48.25	67.80	88.89	95.39	97.52	98.28	99.66	100.00			1.31
96.61	98.72	99.80	100.00							1.31
23.42	25.38	29.67	42.78	64.57	88.76	97.62	98.17	99.20	100.00	109.62

Table A1.4 (continuation)
Timeline for the Settlement of Transactions in the CUD (daily averages for 2022)

	0:00	7:00	8:00	9:00	10:00	11:00
Central Counterparty Clearing House (CRCC)						
Institutions pay debit positions to the CRCC	0.00	73.55	74.98	75.20	76.37	77.14
CRCC pays credit positions to institutions	0.00	56.26	67.04	67.50	67.92	70.85
Central Counterparty Clearing House (CRCC)-Forex segment						
Institutions pay debit positions to the CRCC	1.24	5.12	11.59	18.33	26.66	33.14
CRCC pays credit positions to institutions	0.00	0.07	0.09	0.09	0.09	0.09
Retail-value payment systems						
ACHs	0.00	0.04	0.16	9.24	34.69	37.46
Card and ATM networks	0.00	0.00	0.00	0.08	1.51	9.50
Checks (Cedec and delegated clearing houses)	0.00	0.00	0.01	0.02	0.04	94.73
Aggregate timeline for the entire CUD system	1.40	2.14	4.22	7.22	12.39	22.02
Percentage of the number of operations processed per hour (not cumulative)	0.05	1.85	2.89	4.36	6.46	12.14

Neutral liquidity effect
Neutral effect of transactions settled with liquidity savings
Liquidity drainage effect
Liquidity injection effect
Source: *Banco de la República* (DSIF).

Graph A1.1
Central Securities Depository (DCV), Operations Performed (Daily averages)[a/]



a/ Pertains to the nominal value of the debt.
Source: *Banco de la República* (DCV).

2.1 Central Securities Depository (DCV)

Graph A1.1 exhibits how transactions settled in the DCV have evolved during the last ten years (2014 to 2023) in nominal value, settled value (cash value), and in number of transactions. Notably, there has been an increase in the average daily value of transactions with a compound annual growth rate (CAGR) of 9.8% in nominal terms and 2.9% in settled value. However, the number of transactions has exhibited a negative variation over the last ten years, with a CAGR of -2.1%.

Table A1.5 breaks down transactions conducted through the DCV according to their origin. In the secondary market, there has been significant growth in the average daily value of monetary operations (OMO and liquidity provisions) over the last decade, with a CAGR of 12.4% (6.8% in real terms) and in sell/buy-back transactions, with a CAGR of 8.7% (3.3% in real terms).

Regarding the primary market, which includes the placement of securities through different modalities (forced, agreed, and auctioned), as well as the payment of yield and repayment of principal by the National Government, there has been significant growth in the last year, leading to a CAGR of 14% (8.3% in real terms) over the last decade.

12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	Total value settled daily on average (billions)
77.70	77.92	80.23	92.20	96.76	99.24	99.98	100.00			168.32
80.83	84.30	87.72	94.24	98.74	99.68	99.94	99.99	99.99	100.00	168.32
37.79	87.39	89.92	89.92	89.92	89.92	89.92	89.92	97.80	100.00	1,245.84
0.09	2.62	98.03	99.62	100.00						1,245.84
45.35	49.69	59.79	68.65	80.97	88.38	94.81	99.83	99.97	100.00	3,181.70
30.83	48.29	66.97	91.37	99.31	99.87	99.91	100.00			799.28
97.26	97.72	98.65	99.17	99.48	99.73	99.94	99.99	99.99	100.00	134.02
25.69	34.39	50.67	58.71	70.14	76.92	80.52	89.84	91.09	100.00	78,539.51
5.76	5.32	17.25	11.04	13.59	8.33	4.01	1.66	0.62	1.60	7,517.8

Table A1.5
Average Operations Processed Daily in the DCV, by Type of Service
(Amounts in billions of pesos)

Year	Primary Market			
	Quantity	Nominal Value	Settled Value	
			Current	Constant
2014	113	440	412	689
2015	99	338	363	568
2016	82	399	407	602
2017	76	396	422	600
2018	77	446	453	624
2019	76	565	514	681
2020	143	733	511	667
2021	138	1,109	798	986
2022	158	1,675	1,045	1,142
2023	168	2,556	1,524	1,524

Table A1.5 (continuation)
Average Operations Processed Daily in the DCV, by Type of Service
(Amounts in billions of pesos)

Year	Secondary Market											
	Delivery versus Payment in Purchase/Sales				Monetary Policy Purchase/Sales				Transfers Free of Payment			
	Quantity	Nominal Value	Settled Value		Quantity	Nominal Value	Settled Value		Quantity	Nominal Value	Settled Value	
			Current	Constant			Current	Constant			Current	Constant
2014	2,006	5,936	6,575	10,979	2	7	7	12	439	3,603	0	0
2015	1,557	4,516	4,997	7,816	1	8	8	13	170	5,134	0	0
2016	1,451	3,873	4,141	6,125	9	61	63	93	136	4,388	0	0
2017	1,825	5,657	6,294	8,944	4	26	17	24	146	4,761	0	0
2018	2,107	8,424	9,220	12,698	1	26	27	37	147	4,705	0	0
2019	1,051	4,370	4,807	6,378	7	34	35	46	145	5,518	0	0
2020	875	3,308	3,675	4,799	4	19	20	26	200	3,258	0	0
2021	841	3,288	3,484	4,307	11	122	69	85	208	5,167	0	0
2022	931	4,113	3,631	3,968	10	68	50	54	254	8,287	0	0
2023	1,126	5,390	4,977	4,977	16	88	72	72	249	8,346	0	0

Year	Secondary Market							
	Transfers between Deposits				Repos and Sell/buy-backs			
	Quantity	Nominal Value	Settled Value		Quantity	Nominal Value	Settled Value	
			Current	Constant			Current	Constant
2014	1	5	0	0	722	7,026	7,703	12,864
2015	1	2	0	0	787	9,242	10,008	15,653
2016	0	1	0	0	656	9,363	10,035	14,842
2017	0	1	0	0	763	10,537	11,643	16,544
2018	0	2	0	0	787	12,405	13,600	18,730
2019	1	2	0	0	622	9,428	10,363	13,749
2020	0	1	0	0	684	11,702	12,874	16,808
2021	1	2	0	0	691	10,634	11,402	14,095
2022	2	5	0	0	756	13,094	11,759	12,850
2023	1	3	0	0	949	18,992	17,714	17,714

Year	Monetary Operations			
	Quantity	Nominal Value	Settled Value	
			Current	Constant
2014	210	7,884	8,213	13,715
2015	207	13,292	13,943	21,807
2016	180	10,748	10,971	16,227
2017	175	12,632	12,931	18,374
2018	171	12,388	12,564	17,303
2019	220	19,526	19,807	26,279
2020	184	9,604	9,823	12,826
2021	260	18,390	18,650	23,054
2022	315	28,750	26,480	28,936
2023	323	28,207	26,489	26,489

Source: *Banco de la República* (DCV).

Table A1.6
Total Value Held in Custody by the DCV at Year's End
(Billions of pesos)

Year	Current	Constant
2014	202,604	338,338
2015	207,943	325,238
2016	239,717	354,558
2017	265,680	377,522
2018	304,235	418,993
2019	323,440	429,135
2020	372,275	486,062
2021	424,035	524,173
2022	480,029	524,554
2023	529,401	529,401

Source: *Banco de la República* (DCV).

Regarding its function as a depository, all nominal values held at the end of each year from 2014, at current and constant prices, are shown in Table A1.6.

Over the last decade, the balance in custody exhibited a CAGR of 10.1% in current Colombian pesos and 4.6% at constant prices. Of this balance, 97% pertains to securities issued by the National Government, while the remaining 3.0% was explained by securities issued by the Agricultural Sector Financing Fund (Finagro).

Class B TES continued to be highly relevant among all the current issues managed by the DCV, accounting for 94.2% of the total balance and 97.2% with respect to domestic sovereign debt issued by the National Government. Solidarity bonds (TDS in Spanish) emerged as the second major item in terms of debt issued by the National Government, totaling approximately COP 9.74 t (Table A1.7).

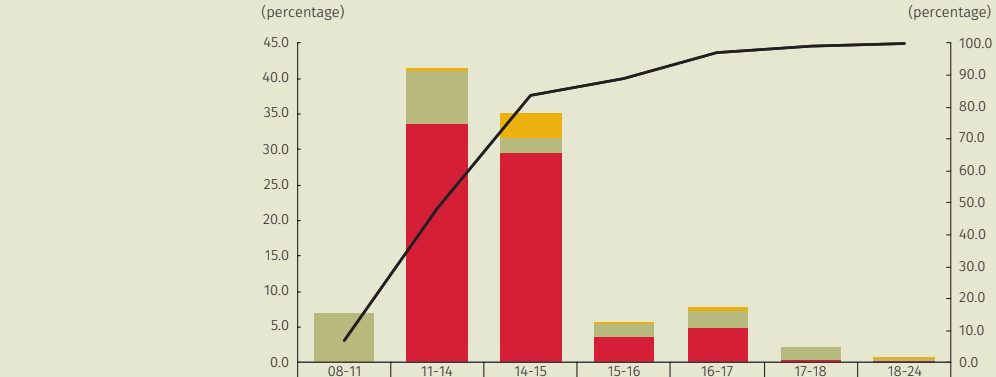
Graph A1.2 breaks down the activation mechanisms used to settle the transactions received by the DCV in the last year. It is observed that all participants activated their transactions manually between 8:00 and 11:00 a.m. Between 11:00 a.m. and 2:00 p.m., the liquidity savings facility, the mechanism that most contributes to the settlement of transactions, and the automatic retry of funds were also used. Thus, 77.3% of all transactions received by the DCV in 2023 were activated automatically (automatic retry of funds and liquidity savings facility), while 22.7% were activated by direct instruction from participants.

Table A1.7
Details on the Balance Held in Custody by the DCV at the Close of 2023 by Issuer
(Millions of pesos)

Issuer	Balance	Percentage
National government		
TES Class B	498,634,061	94.2
Solidarity Bonds (TDS)	9,741,703	1.84
TIDIS	2,971,996	0.56
Constant-value bonds – Series B	1,305,575	0.25
CERT	40,500	0.01
Constant value bonds – Series A	49,163	0.01
Solidarity Bonds for Peace	755	0.00
Security Bonds	0	0.00
National government total	512,743,754	96.9
Finagro		
Agricultural Development Bonds – Class A	11,614,818	2.19
Agricultural Development Bonds – Class B	5,042,554	0.95
Finagro total	16,657,373	3.15
General total	529,401,127	100

Source: *Banco de la República* (DCV).

Graph A1.2
Distribution of the Operation Activation Mechanism, by Type (2023)



	08-11	11-14	14-15	15-16	16-17	17-18	18-24
Automatic retry of funds (4.9%)	-	0.4	3.6	0.0	0.6	-	0.2
Manual activation (22.7%)	7.0	7.5	1.9	1.8	2.2	1.9	0.5
Liquidity savings (72.4%)	-	33.6	29.7	3.6	5.0	0.4	0.1
Cumulative percentage settled (right axis)	7.0	48.5	83.7	89.1	97.0	99.2	100.0

Source: *Banco de la República* (DCV).

2.2 Centralized Securities Depository (Deceval)

Table A1.8 and Graph A1.3 illustrate how the transactions carried out at Deceval have evolved. They include primary market transactions (issue of fixed-income and equity securities), secondary market transactions involving private fixed-income and equity securities (purchase/sale transactions between depositors and free-of-payment transfers), and money market transactions (repos, sell/buy-backs, and temporary transfers of securities [TTS]) with their respective reversals and cash collateral.

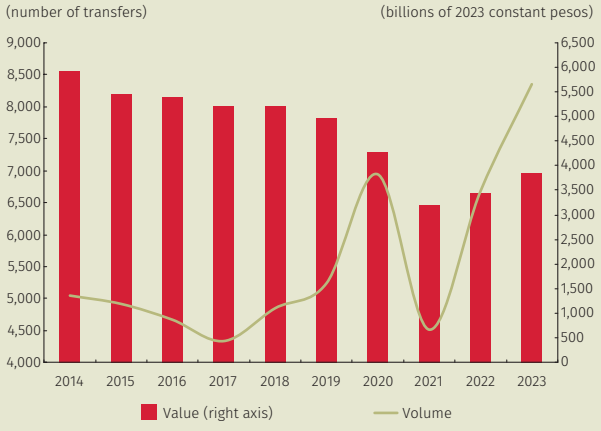
The average daily transaction volume, after declining between 2014 and 2017, grew continuously until 2020, when it averaged 6,941 transfers daily. It then experienced a setback in 2021 but surpassed the peak of transfers seen in 2020 in 2023. In turn, the average daily

Table A1.8
Deceval Statistics

Year	Transfers Processed								
	Daily Average					Annual Value			
	Volume	Value		Average Transfer Value					
	(Number of operations)	(Billions of pesos)	(Billions of 2023 constant pesos)	(Billions of pesos)	(Billions of 2023 constant pesos)	(Number of operations)	(Billions of pesos)	(Billions of 2023 constant pesos)	(Number of times GDP)
2014	5,046	3,539	5,910	701	1,171	1,231,272	863,508	1,442,013	1.13
2015	4,915	3,478	5,441	708	1,107	1,199,378	848,744	1,327,498	1.05
2016	4,668	3,652	5,402	782	1,157	1,143,678	894,841	1,323,529	1.04
2017	4,335	3,662	5,203	845	1,200	1,049,081	886,131	1,259,163	0.96
2018	4,849	3,778	5,203	779	1,073	1,178,228	917,961	1,264,216	0.93
2019	5,239	3,752	4,978	716	950	1,283,659	919,146	1,219,506	0.87
2020	6,941	3,278	4,280	472	617	1,686,627	796,526	1,039,984	0.80
2021	4,514	2,577	3,186	571	706	1,105,892	631,438	780,555	0.53
2022	6,678	3,127	3,417	468	512	1,636,110	766,030	837,084	0.52
2023	8,350	3,855	3,855	462	462	2,020,762	932,862	1,019,390	0.59

Source: Deceval.

Graph A1.3
Statistics on Deceval Value and Volume
(Daily averages)



Source: Deceval.

value of transactions grew over the last ten years, with a CAGR of 0.9% (-4.2% in real terms). However, considering the last three years, there has been an upward trend in value, with a CAGR of 14.4% (6.6% in real terms).

As for Deceval's function as a depository, Table A1.6 exhibits the total nominal values held at the end of each year from 2014, at current and constant prices.

Over the last decade, the balance in custody in current Colombian pesos exhibited a CAGR of 3.7% and -1.4% at constant prices.

Table A1.10 exhibits that common and preferred equities have the largest portion of all current issues managed by Deceval, accounting for 43.7%, followed by certificates of deposit (CDTs) for 33.5%, and bonds for 12.3%. Other instruments, such as participation securities, securitizations, among others, account for 10.5%.

Table A1.9
Total Value Held in Custody by Deceval at Year's End[a/]
(Billions of pesos)

Year	Current	Constant
2014	421,697	704,211
2015	381,310	596,397
2016	440,282	651,206
2017	486,555	691,378
2018	470,519	647,998
2019	560,596	743,789
2020	545,372	712,065
2021	535,794	662,324
2022	565,187	617,611
2023	609,070	609,070

a/ Balances valued on the last business day of each year. In the case of equity securities, the valuation price of each share is multiplied by the number of shares held in custody.
Source: Deceval.

Table A1.10
Details on the Year-end Balance of Securities Held in Custody by Deceval in 2023, by Type
(Millions of pesos)

Type	Balance	Percentage
Common equities	257,169,734	42.22
Term certificates of deposit	204,309,874	33.54
Bonds	74,653,632	12.26
Participation securities	60,708,970	9.97
Preferred equities	8,886,536	1.46
Securitization	2,516,145	0.41
Treasury bonds (TES)	811,027	0.13
Tax refund securities (TIDI)	14,048	0.00
Bank acceptances	30	0.00
General total	609,069,996	

Source: Deceval.

3. Central Counterparty Clearing House of Colombia S. A. (CRCC in Spanish)

3.1 Details of Changes in Operations and Open Positions by Product

The value of operations cleared and settled[4] by the CRCC for financial derivatives segment during 2023 reached COP 1,959.19 t, representing an increase of 24.8% (12% in real terms) compared to the value of transactions in 2022. The share by product type of the total of these transactions was: 18.54% (COP 363.22 t) on standardized financial derivatives and 81.46% (COP 1,595.96 t) on non-standardized derivatives, representing growths of 16.16% (4.7% in real terms) for standardized derivatives and 27.67% (14.31% in real terms) for non-standardized derivatives compared to the previous year.[1]

1 As a result of novation by the CRCC, a negotiated transaction is registered as two transactions cleared and settled in the CRCC, since the original link of the counterparties disappears and, in exchange, two links arise where the clearing house becomes the buyer and seller of the initial counterparties.

During 2023, the growth trend of products linked to the TRM continued, making them the fastest-growing in value within the financial derivatives segment. Therefore, the total value of cleared and settled transactions on NDF forex forwards (pesos/dollars) grew by 30.2% (16.8% in real terms), increasing from COP 1,137.17 t to COP 1,480.59 t, while TRM futures increased by 12.83% (1.88% in real terms), going from COP 257.64 t to COP 290.68 t. Additionally, futures on specific reference TES increased by 21% (8.2% in real terms), moving from COP 56.6 t to COP 68.53 t. The product with the greatest decline was the futures on stocks and indexes with -53.73% (-59.4% in real terms), moving from COP 0.82 t to COP 0.38 t.

The share by class of standardized futures contracts in the total of these products was: TRM futures at 80% (COP 290.7 t), TES futures on specific references at 18.87% (COP 68.53 t), OIS futures at 0.90% (COP 3.26 t), and 0.21% (COP 0.76 t) for other products, including futures on stocks, indexes, and electricity, and options on the TRM. On the other hand, the share of non-standardized products was: NDF forex forwards (pesos/dollars) at 92.77% (COP 1,480.59 t) and OIS IBR and OIS IBR formation forwards at 7.23% (COP 115.37 t).

On the other hand, the total value of the transactions of the fixed income segment, represented by sell/buy-backs of sovereign debt instruments and temporary transfer of securities (TTS) managed by the CRCC for subsequent gross settlement through the DCV, recorded a growth of 57.93% (41.5% in real terms), increasing its value to COP 4,547.6 t.[2]

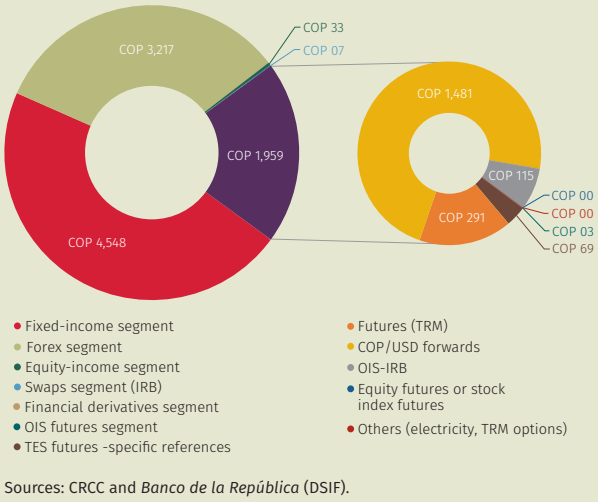
In the equity segment, all products declined compared to 2022. Repo operations on stocks and indexes decreased by -48.46% (-53.84% in real terms), from COP 7.24 t to COP 3.73 t, spot equity transactions fell by -49.42% (-55.04% in real terms), from COP 56.76 t to COP 28.71 t, and those on TTS fell by -61.04% (-65.5% in real terms), from COP 0.65 t to COP 0.25 t.

Finally, the foreign exchange segment grew by 1.27% in nominal values in pesos. However, due to the appreciation of the peso against the dollar, there was a decrease of -9.3% in real terms. The total of cleared and settled transactions of the spot market (peso-dollar) was COP 3,230.14 t: 87.77% (COP 2,823.51 t) with same-day settlement, 12.17% (COP 391.62 t) with one-day settlement, and 0.06% (COP 1.97 t) with two or three-day settlement (Graph A1.4). The decrease in dollars was 1.6%, from USD 756.74 b to USD 744.61 b.

The number of futures contracts[3] cleared and settled at the CRCC increased. The average daily number of contracts went from 7,382 in 2022 to 15,133 in 2023. The total value of the transactions accepted for net clearing of the financial derivatives segment went on average from COP 6.41 t in 2022 to COP 8.1 t in 2023.

On the other hand, the average daily value of gross cleared transactions in the fixed income segment (sell/buy-backs and TTS over TES) went from COP 11.75 t in 2022 to COP 18.8 t in 2023.

Graph A1.4
Central Counterparty Clearing House Share
in Trillions of Pesos, by Product
(Total Value of Operations in 2023)

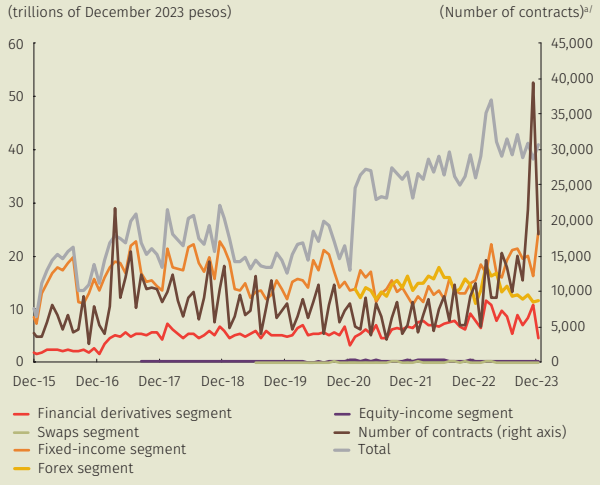


Sources: CRCC and *Banco de la República* (DSIF).

2 This value takes into account the two transactions resulting from novation on the date of incorporation.

3 It only includes standardized derivative products; therefore, it does not include exchange rate forwards or interest rate derivatives.

Graph A1.5
Values and Number of Transaction Contracts Accepted by the CRCC in Each Segment (Daily average)



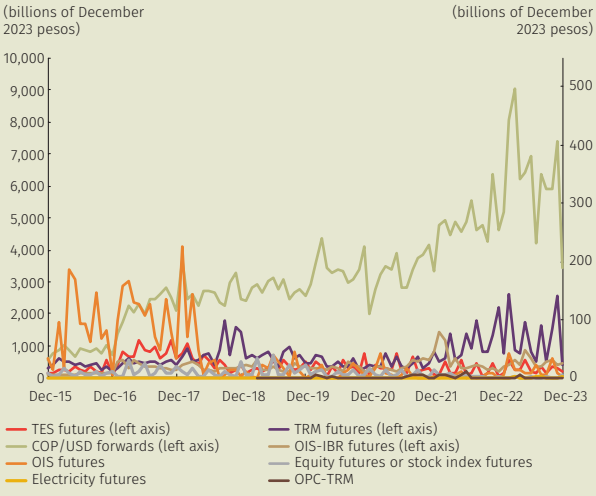
a/ The financial derivatives segment does not include exchange rate or interest rate forwards.
Sources: CRCC and *Banco de la República* (DSIF).

The average daily value of gross cleared transactions in the equity segment (repo operations, spot, and TTS with shares) went from COP 263.88 b in 2022 to COP 135 billion in 2023. The average daily value of transactions in the foreign exchange segment went from COP 13.03 t in 2022 to COP 13.35 t in 2023 (Graph A1.5).

When detailing the evolution by product in each segment during 2023, it was observed that July saw the highest average daily value accepted for sell/buy-backs and TTS on TES, reaching COP 24.66 t, and in September for spot transactions, repos, and TTS with equities, reaching COP 179.82 b. In the financial derivatives segment, the highest daily averages were recorded in May for futures on specific TES references at COP 553.77 b; in November for TRM futures at COP 2.54 t; in February for OIS futures at COP 39.32 b; in December for futures with stock at COP 4.68 b; in March for the NDF forex forwards (pesos/dollars) at COP 8.64 t, and in May for the OIS-IBR at COP 0.82 b (Graphs A1.5 and A1.6).

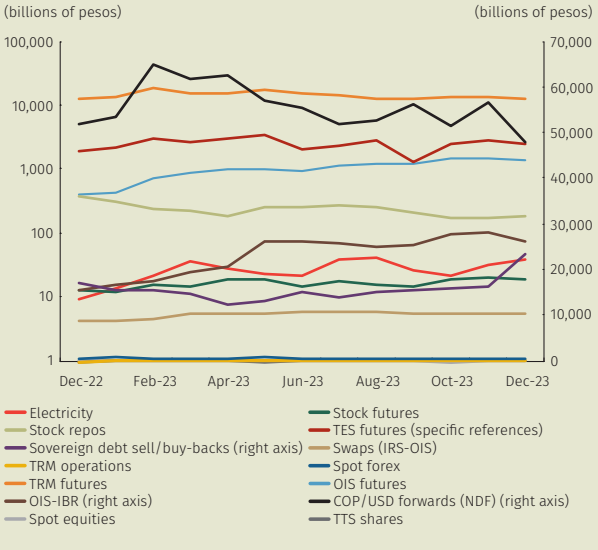
Open positions, at two ends, grew by 15.56% (5.75% in real terms) from COP 217.52 t to COP 251.37 t when comparing the end of 2023 and 2022. Products on standardized derivatives that recorded increases at the end of 2023 compared to the end of the previous year were: The electricity futures, OIS futures, and stock futures with positive variations of 300.19% (266.22% in real terms), 241.11% (212.15% in real terms), and 52.87% (39.89% in real terms), respectively. On the other hand, among non-standardized products, the one with the highest balance of open positions was the OIS-IBR, both in the financial derivatives and swaps segments, with variations of 70.26% (55.81% in real terms) and 17.21% (7.26% in real terms), respectively. In contrast, the products that decreased their open position balances included repos and the spot market of equities with -50.24% (-54.47% in real terms) and -34.92% (-40.45%), respectively. Similarly, the balances of the NDF forex forwards (pesos/dollars) fell by -7.21% (-15.08 in real terms) (Graph A1.7).

Graph A1.6
Evolution in Operations with Products in the Financial Derivatives Segment (Daily average)



Sources: CCP and *Banco de la República* (DSIF).

Graph A1.7
Evolution in Open Positions during 2023, by Product Groups (One leg)



Sources: CRCC and *Banco de la República* (DSIF).

Regarding operational efficiency in service delivery, the CRCC's systems were available to participants, on average, 99.43% of the time across all segments, according to the 2023 schedule. The operational incidents experienced did not disrupt the service provided by the CRCC (Table A1.11).

Table A1.11
Operational Efficiency: Availability of the System during 2023, by Segment

Segment	Percentage of System Availability	Number of Operational Incidents
Financial derivatives	99.43	5
Fixed income	99.43	5
Equity income: repos	99.43	5
Equity income: spot	99.43	5
Swaps	99.43	5
Forex	99.43	5

Source: CRCC S.A.

Annex 2: Payment Instruments

1. Use of Payment Instruments by Originator

Payment cards are primarily issued to individuals, while checks and electronic funds transfers are more common among legal entities (Table A2.1).

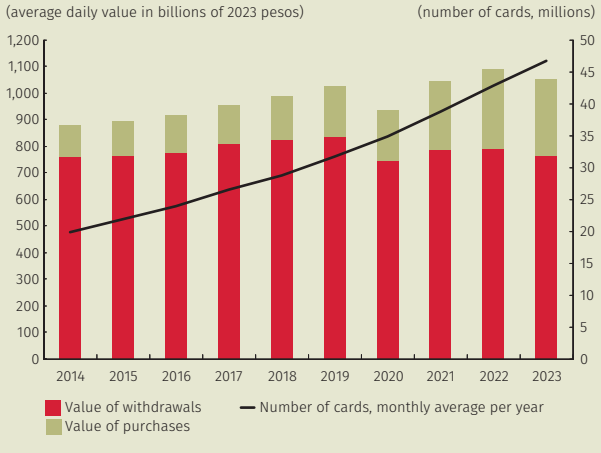
Table A2.1
Use of Payment Instruments 2023, Principal Originator

Market	Instrument	Usage in value by type of person (Percentage)	
		Individual	Legal entity
Goods and services	Debit card	93.7	6.3
	Credit card	89.0	11.0
	Check	10.2	89.8
	Electronic funds transfers	9.6	90.4

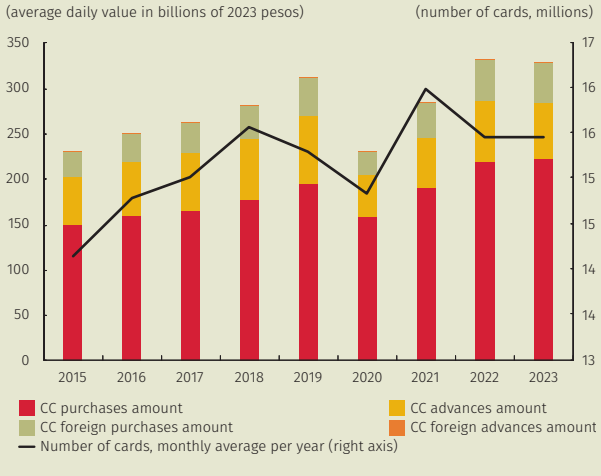
Source: *Banco de la República*, Financial Superintendency of Colombia, commercial banks, and *ACH Colombia*.

Graph A2.1
Use of Cards

A. Debit cards



B. Credit cards



Source: Financial Superintendency of Colombia; calculations by *Banco de la República*.

2. Use of Debit and Credit Cards

Debit cards facilitate payment for purchases and cash withdrawals. Credit cards also allow for payment of purchases as well as cash advances, and both types of transactions can be carried out abroad.

The use of debit and credit cards in 2023 exhibited growth in both the number of transactions and in nominal value compared to 2022, considering the possible transactions listed above. The number of debit cards in 2023 averaged 46.6 m monthly, with a usage value of COP 1.1 trillion (daily average), of which withdrawals accounted for 73% and purchases for the remaining 27%. In turn, in 2023, the number of credit cards was 15.5 m (monthly average), with a value reaching COP 327.7 b (daily average), with purchases being 68%, cash advances 19%, international purchases 13%, and international cash advances 0.1% (Graph A2.1).

3. International Grouping of Payment Instruments: Importance and Adoption

The k-means methodology is used in this exercise to group countries with similarities in the importance and adoption of payment instruments. Particularly, special attention is paid to the group that includes Colombia and its position relative to its closest peers.

3.1 Grouping of Countries by the Importance of Instruments in the Economy

To contextualize the data shown in the graphs of Section 3.6 and group countries with similar use of payment instruments, this Annex uses a clustering method that highlights these associations. Cluster analysis is a statistical tool that, in this case, allows for the grouping of countries with similar characteristics or patterns. This simila-

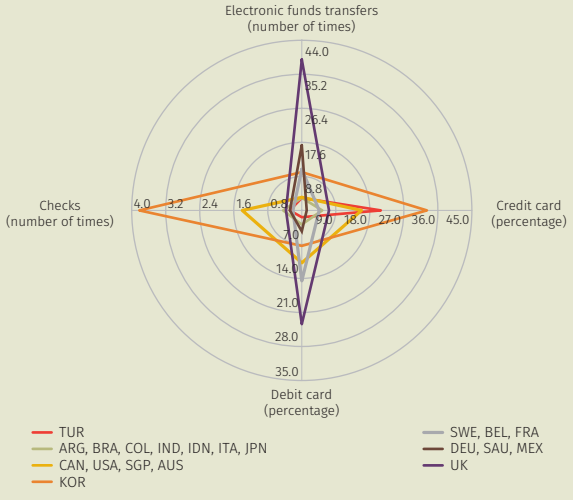
rity is calculated through a distance measure such as Euclidean distance.[1] The clustering of payment instrument usage between 2014 and 2022[2] is based on two dimensions: i) the importance of the instrument in the economy, measured as the total value of transactions relative to GDP (this provides insight into the significance of each instrument in a country's economy), and (ii) the adoption of the instrument, measured by the number of transactions per capita.

Below is a preliminary grouping of countries based on similarities according to the two dimensions outlined earlier, followed by the grouping of countries to which Colombia belongs according to the clustering method. The initial groupings reveal which countries are most similar in economic importance of payment instrument usage. In general terms, from 2014 to 2022, at the international level, there were average increases in GDP of 71 percentage points (pp) for transfers, 3.7 pp for debit cards, and 1.6 pp for credit cards. On the other hand, there was a decrease of 41.5 pp relative to GDP for checks.

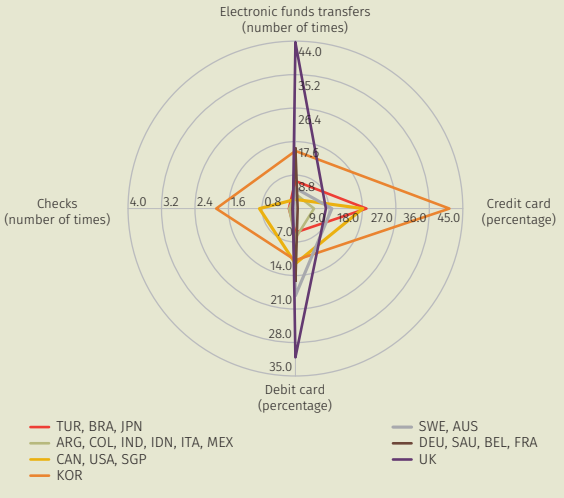
During the period studied, there was generally a decline in check usage and an increase in the use of other payment instruments, leading to changes in cluster formation[3] due to the unique dynamics of each country (Graph A2.2).

Graph A2.2
Value of Instruments Relative to GDP

A. International cluster (2014)



B. International cluster (2022)



Sources: BIS Red Book, ACH Colombia, Financial Superintendency of Colombia, *Banco de la República* (DSIF), and RSP Sudamérica BCRP.

In 2014, Colombia's group included Argentina, Indonesia, India, Italy, Brazil, and Japan. In 2022, this composition changed as Brazil and Japan exited the group due to increased usage of electronic funds transfers and credit cards. In turn, Mexico[4] joined the group, explained by its transfer value, which went from representing 13.7 times of GDP in 2014 to 7.5 times in 2022.

1 In the case of the k-means methodology, the measure of similarity between individuals is calculated, and based on it, the centroids of each group are calculated. Iteratively, it adjusts the individuals belonging to each group by positioning them around the centroid. The above, with the aim of reducing the distance between the members of the group and making the intergroup similarity as small as possible.

2 This section evaluates the countries that report their statistics to the BIS Red Book and Colombia.

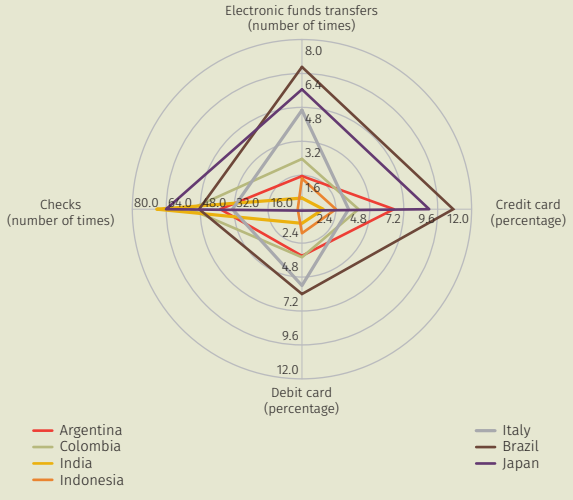
3 When one or more countries belong to the same cluster, it means that the value relative to GDP of the four payment instruments are so similar that the k-means methodology places it in the same group, and therefore, countries that are in another cluster have considerably different values.

4 Figures for Mexico in 2014 correspond to the total value of SPEI / GDP transfers.

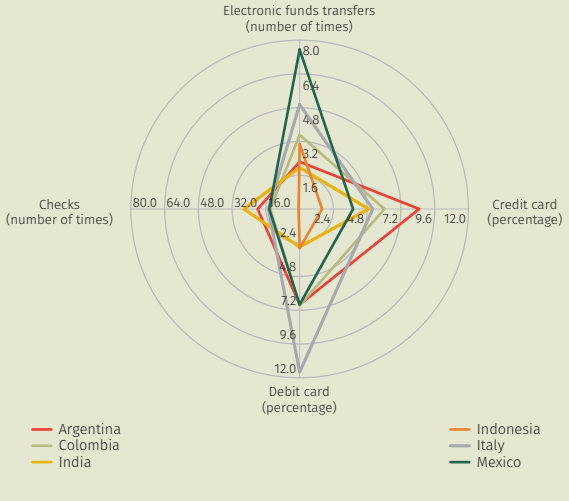
Additionally, Graph A2.3 illustrates the usage of instruments in the countries of the cluster to which Colombia belongs. Transfers relative to GDP showed average growth of 103 pp. Card usage registered increases of 3.2 and 1.4 pp relative to GDP for debit and credit cards, respectively. Checks showed a 25 pp decrease in GDP.

Graph A2.3
Value of Instruments Relative to GDP

A. Colombia cluster (2014)



B. Colombia cluster (2022)



Sources: BIS Red Book, ACH Colombia, Financial Superintendency of Colombia, *Banco de la República* (DSIF), and RSP Sudamérica BCRP.

In the graph above, we see that in 2022, Colombia ranked second in value in both debit card credit cards, behind Italy and Argentina, respectively. Furthermore, it was the third country with the highest transfer value. On the other hand, the check recorded one of the lowest amounts, only surpassed by Indonesia, where its value on GDP is approximately 0.5%.

3.2 Grouping of Countries by Adoption of Instruments

The adoption of various payment instruments shows that international preferences in usage have changed. As such, the average number of transfers per person increased from 61 in 2014 to 112 in 2022, representing an average annual growth rate (AAGR) of 7.9%. Similarly, debit and credit cards recorded a AAGRs of 10.6% and 7.0%, respectively, implying that transactions per person with debit cards went from 65 in 2014 to 147 in 2022, while credit card transactions increased from 40 to 67 year over year. In turn, checks were the only instrument to show a decline in use per person, falling from 8.5 checks in 2014 to 3.4 in 2022; that is, an AAGR of -10.9% (Graph A2.4).

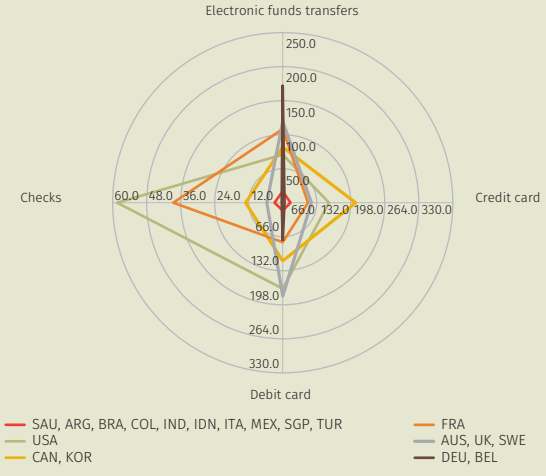
In 2014, Colombia, together with Saudi Arabia, Argentina, Brazil, India, Indonesia, Italy, Mexico, Singapore, and Turkey, formed a cluster. In 2022, Brazil (due to the increase in the use of transfers and debit cards) and Singapore (due to the increase in debit and credit card transactions) left this cluster.

Graph A2.5 highlights the usage of instruments in the countries of the cluster where Colombia is located. The average number of electronic funds transfers per person went from 9 in 2014 to 46 in 2022, which represents an AAGR of 22.3%. There is also an increasing trend in the use of debit and credit cards, with AAGRs of 26% and 11.2%, respectively. However, checks decreased from 1.3 to 0.5 transactions per person, representing a negative AAGR of -10.8%.

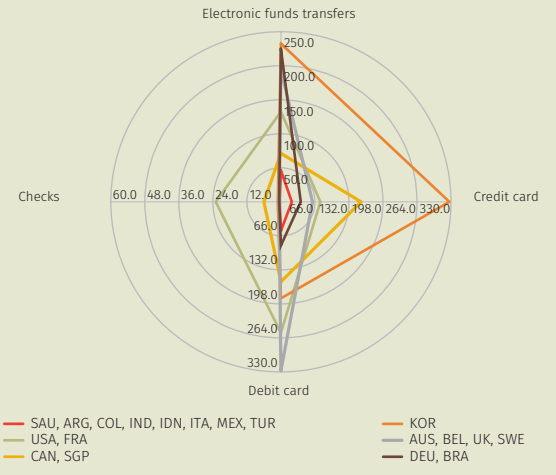
Looking at the countries in the 2022 cluster, it can be noted that Argentina recorded the highest adoption of transfers among its population, increasing from 3 to 89 transfers per

Graph A2.4
Value of Instruments Relative to GDP

A. International cluster (2014)



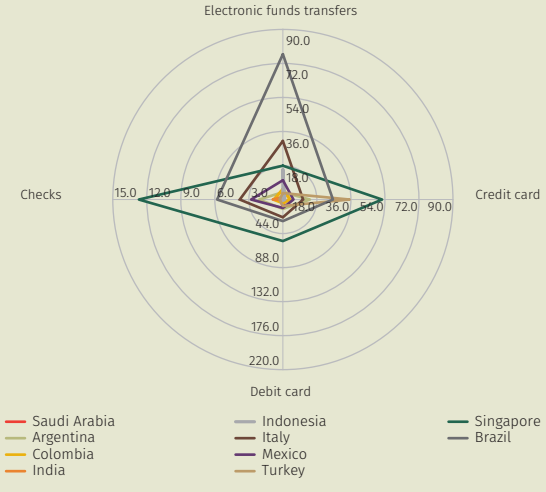
B. International cluster (2022)



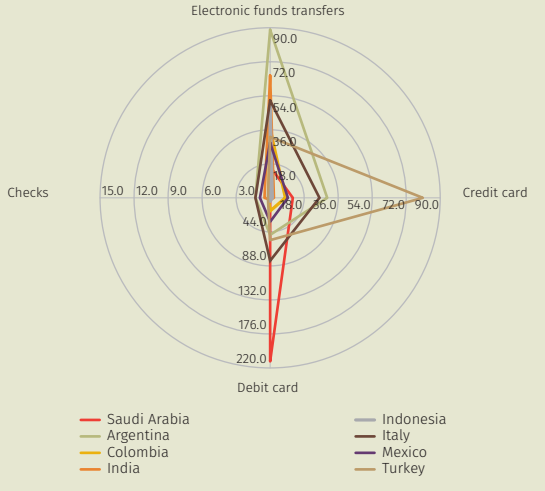
Sources: BIS Red Book, *ACH Colombia*, Financial Superintendency of Colombia, and *Banco de la República* (DSIF).

Graph A2.5
Value of Instruments Relative to GDP

A. Colombia cluster (2014)



B. Colombia cluster (2022)



Sources: BIS Red Book, ACH Colombia, Financial Superintendency of Colombia, *Banco de la República* (DSIF), and RSP Sudamérica BCRP.

capita. Turkey had the highest number of credit card transactions per person, from 35 in 2014 to 80 in 2022. Saudi Arabia ranked first in the use of debit cards, going from 10 transactions per person to 211. Finally, the countries with the highest use of checks were Argentina and Italy, each with 1.3 transactions per person.

In conclusion, the adoption of payment instruments such as electronic funds transfers and debit and credit cards, both internationally and nationally, shows an upward trend. Likewise, the value of transactions made with these instruments continues to gain economic importance year after year. Checks, however, represent a payment instrument with the lowest adoption trend and a decrease in value among the countries in this comparison.

Annex 3: Financial Infrastructures and Markets

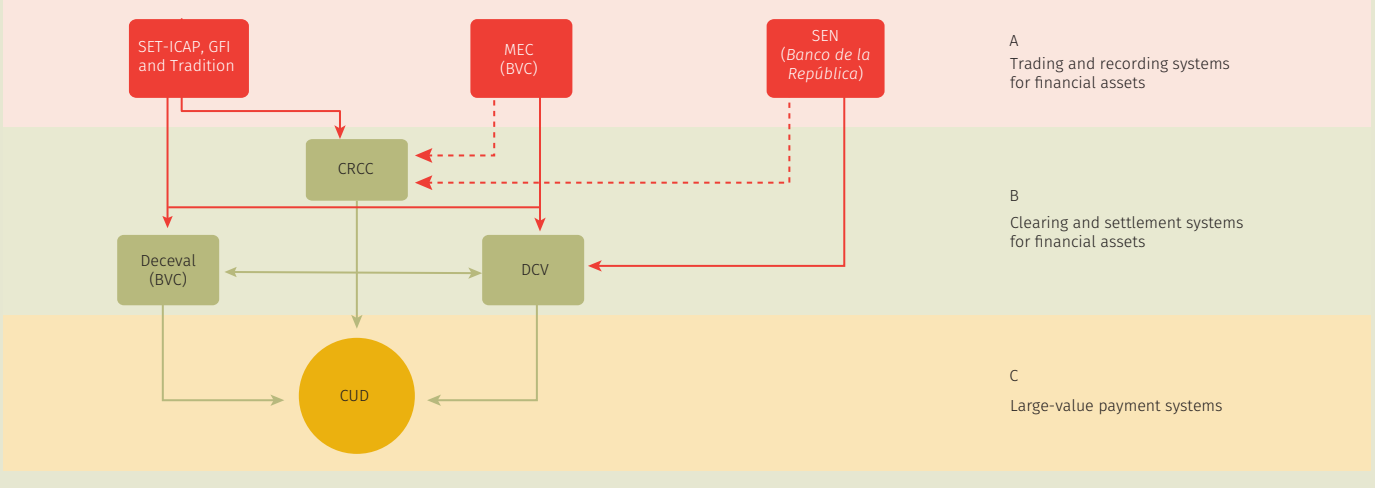
Below is a description that allows for the identification and understanding of the role that infrastructures play in the markets they support and the relationships among them. For this purpose, they have been grouped into fixed income, equity, foreign exchange, and standardized derivatives markets. Additionally, retail-value payment systems are expanded.

1. Fixed Income

Diagram A3.1 illustrates the infrastructures that provide trading, clearing, and settlement services for this market. The flow starts at the top with the trading and recording systems where participants carry out transactions using automatic matching mechanisms (SEN and MEC) and hybrid voice and data systems (SET-ICAP Securities, GFI, and Tradition). In each of these transactions, the seller must inform the system manager of the depository where the securities for delivery are held, so that these can be sent and the respective process and settlement can be completed. The securities leg is settled when the change in ownership in favor of the buyer with is recorded in the securities deposit account, while the cash leg is settled when the funds are transferred to the seller through the large-value payment system (CUD).

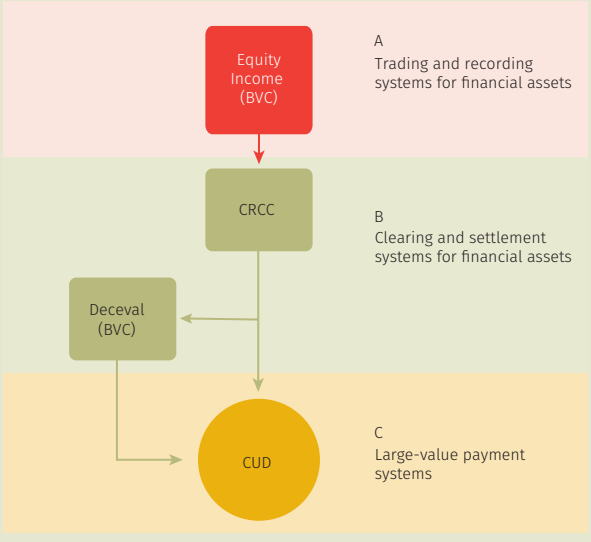
Forward operations (TES sell/buy backs) are sent from the SEN and MEC systems to the Central Counterparty Clearing House (CRCC) for risk management (dotted lines in Diagram A3.1); while gross clearing and settlement occur at the DCV-CUD (solid lines in the diagram).

Diagram A3.1
Flow of Operations in the Fixed-income Market



Source: *Banco de la República* (DSIF).

Diagram A3.2
Flow of Operations in the Equity-income Market



Source: *Banco de la República* (DSIF).

2. Equity

The BVC manages equity market trading in Colombia. Clearing and settlement of forward transactions (equity repos), as of August 2017, and of spot and TTS transactions, as of August 2020, are performed through the CRCC.[1]

As shown in Diagram A3.2, the flow starts in the trading system, where participants place bids on available securities. After closing, these transactions are confirmed and supplemented. The BVC sends the transactions to the CRCC for risk management, clearing, and settlement. The cash leg is settled at the CUD and the securities leg at Deceval.

3. Foreign Currency

SET-ICAP-FX, GFI, and Tradition manage the trading and recording systems in the Colombian foreign exchange market. The first does so through a matching system, where participants voluntarily decide which offers to accept, while the other two use voice and data systems to receive foreign exchange offers from each participant privately and then disclose them to the rest of the market.

On 27 October 2020, the Financial Superintendency of Colombia, through Resolution 0939, did not object to the merger by absorption between the CRCC, as the absorbing entity, and the CCDC, as the absorbed entity. The merger was completed on 14 December 2020, and the clearing and settlement of the spot foreign exchange market began to take place through the CRCC. However, transactions did not actually involve the CRCC until 01 February 2022.

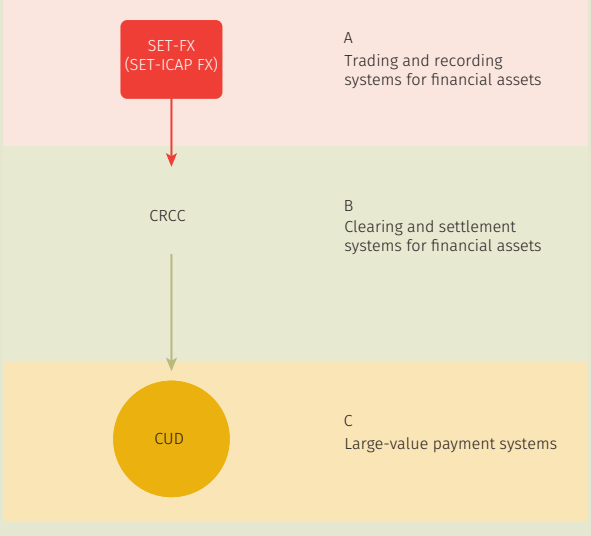
The CRCC is responsible for clearing and settling forex spot transactions (pesos-dollars)[2] and non-deliverable FX forwards (pesos-dollars) between its members, for the latter on their own account or on behalf of third parties (Diagram A3.3).

4. Standardized Derivatives

The BVC and Derivex manage the trading and recording systems for the standardized derivatives market. As shown in Diagram A3.4, the transactions carried out through these systems are sent to the CRCC for clearing and settlement.

At this point, the CRCC, as the central counterparty, does the novation for the transactions. In doing so, it becomes every buyer's seller and every seller's buyer. It then generates the obligations of its participants (clearing) and proceeds to settle them in the CUD large-value payment system. When settlement involves the delivery of the underlying asset, the CRCC uses the securities depositories (DCV and Deceval) to receive securities from the net debtor and deliver them to the net creditor.

Diagram A3.3
Flow of Operations in the Foreign Currency Market

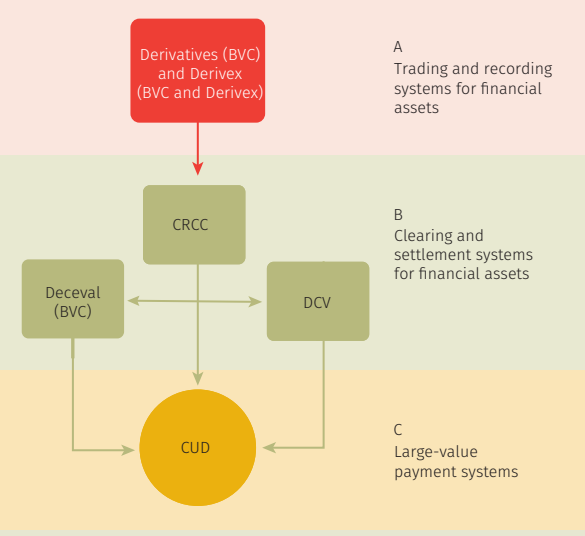


Source: *Banco de la República* (DSIF).

1 See Decree 2219 of 27 December 2017 by the Ministry of Finance and Public Credit. It amends Decree 2555 of 2010, in relation to several provisions applicable to transactions cleared and settled in a central counterparty clearing house and with the creation of a protocol for crisis or contingency situations in the stock market.

2 According to External Resolution 1 of 2018, the periods covered by the forex spot market are from t + 0 to t + 3

Diagram A3.4
Flow of Operations in the Market for Standardized Derivatives



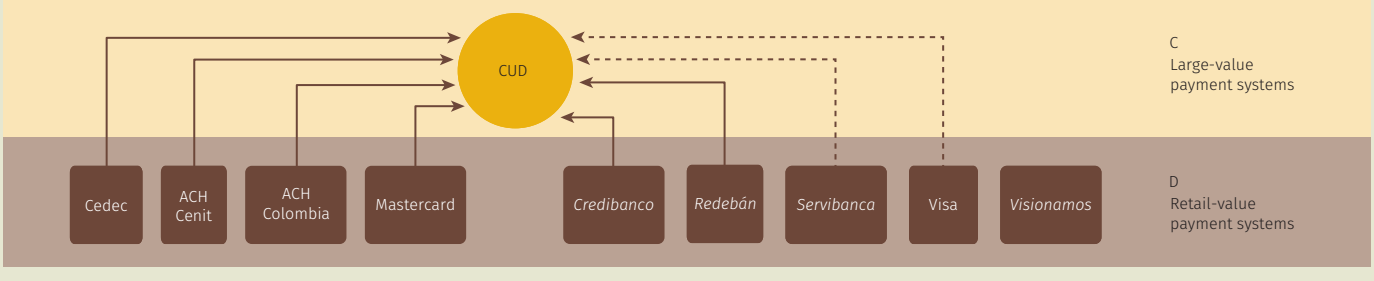
Source: *Banco de la República* (DSIF).

5. Retail-Value Payment Systems

Retail-value payment systems are illustrated in Diagram A3.5. The Electronic Check Clearing House (Cedec), managed by *Banco de la República*, clears checks and other payment instruments nationwide. The automated clearing houses for electronic payments (ACH), ACH-Cenit (also managed by *Banco de la República*) and ACH-Colombia, process electronic payment orders and retail-value funds transfers or collections initiated by associated institutions on behalf of their clients, whether individuals or legal entities, with checking or savings accounts. Credibanco, Mastercard Colombia, *Servibanca*, Visa Support Services, and *Redebán* networks process, among others, debit and credit card transactions made at ATMs and/or commercial establishments.

Credibanco, Mastercard Colombia, and *Redebán* maintain their own deposit accounts in the large-value payments system; therefore, they clear and settle their transactions directly, using the resources from these accounts. The other networks do not have deposit accounts in the central bank system;[3] thus, they only clear their transactions, while a bank carries out the settlement using a deposit account opened in its name at *Banco de la República*. Additionally, the *Visionamos* network, which belongs to the solidarity sector of the economy, processes credit card transactions covered by participating cooperatives or international franchises.

Diagram A3.5
Flow of Operations in Retail-value Payment Systems



Source: *Banco de la República* (DSIF).

3 The dotted lines in Diagram A3.5 suggest that these ATM and card networks do not have their own deposit account in the central bank's CUD system. *Visionamos* is a retail-value payment system, but it does not settle multilateral clearing in the CUD. It does so through *Banco Coopcentral*.