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# FINANCIAL INFRASTRUCTURE REPORT

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2023

# FINANCIAL INFRASTRUCTURE REPORT

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

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## **Updated on 10 October 2023.**

Some of the data presented in Graph 2.5, panel B are updated.

The period presented in the title of graph R6.5, panel A was updated.

This update contains some ortho-typographical corrections that do not alter the information presented in the previous version.

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FINANCIAL  
**INFRASTRUCTURE**  
**REPORT**

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



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# Glossary

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**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)

**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*

**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

**FIC:** Collective investment fund

**FINAGRO:** Agricultural Sector Financing Fund

**IBR:** Benchmark Reference Index

**BDBR:** *Banco de la República's* Board of Directors

**MEC:** Colombian Electronic Market, owned by the Colombian Stock Exchange

**MHCP:** Ministry of Finance and Public Credit

**NDF:** Non-deliverable forwards

**PIB:** Gross domestic product (GDP)

**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

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The *Financial Infrastructure Report* is a product of *Banco de la República's* (Banrep) continuous efforts to scrutinize financial market infrastructures (FMIs) in Colombia, besides being a contribution to analyzing and monitoring the country's financial stability. If FMIs are not managed properly, they can pose significant risks to the financial system and be a possible source of contagion, especially in periods of market stress.

The domestic financial infrastructure during 2022 was safe and efficient, allowing the payment system and financial markets to operate normally, which lent stability and confidence to its participants. This 2023 edition of the *Report* includes analysis on the mitigation of intraday liquidity risk in the large-value payment system (CUD), as well as credit and liquidity risk based on countercyclical practices for the management of initial and variation margins in the *Cámara de Riesgo Central de Contraparte S.A.* (CRCC).

In addition, the *Report* addresses two topics that are at the center of international debate. The first deals with cyber risk, an issue that cuts across the entire domestic financial infrastructure. It is considered one of the most relevant risks; therefore, its effective management has been the focus of recommendations by multilateral organizations. On this occasion, a section is included that outlines these recommendations and focuses on highlights in local progress towards achieving substantial levels of cyber resilience in the Colombian payment system. It is worth noting that *Banco de la República* is moving forward with a research agenda to quantify the impact instances of cyber risk could have on the payment system and on financial stability. The second topic addresses the need to analyze the adoption of special frameworks for orderly settlement on the part of central counterparties (CCPs), so as to mitigate systemic risk, recognizing the role these types of entities play in the development of markets and financial stability, as well as their essential contribution to mitigating counterparty and liquidity risks.

As for retail payments, the use of electronic payment instruments rose significantly in value during 2022 compared to 2021. Transactional data shows the increase in the use of electronic transfers, both intra- and interbank, was particularly important, having become an object of greater innovation, as evidenced, for example, by the use of mobile wallets. Although the adoption for electronic transfers and debit and credit cards has increased in Colombia over the last ten years, compared to other economies, the country still has low levels in this respect. According to the most recent survey on perception of the use of payment instruments conducted by Banrep (2022), cash continues to be the instrument most used by Colombians for regular payments involving small amounts. This points to an important area for increasing the adoption of digital payments, which would materialize with implementation of the different initiatives the industry and the financial authorities (Ministry of Finance-URF, the Office of the Financial Superintendent of Colombia and *Banco de la República*) are carrying out to develop the instant payments ecosystem. On the other hand, analyses of the risks associated with crypto assets, which are understood as alternatives to the regulated assets in the traditional financial system, but traded in an unregulated digital environment, are also rele-

vant. In this respect, the *Report* looks at the potential risks that could arise from the added adoption of stablecoins in economies, specifically in a global context where authorities are studying possibilities for using different mechanisms to contain the risks inherent in crypto assets.

The third section of the *Report* deals with aspects such as smart contracts and programmable money, which are innovations that could be considered in an eventual issue of digital currencies by central banks. In keeping with the previous editions of this *Report* on matters related to central bank digital currencies (CBDC), this edition explains how these two technological functionalities could accompany the design of a retail CBDC, as well as some of the risks that should be considered. Also addressed in this section is the topic of standardized messaging, which is a trend in the field of payments. Reference is made to the United Kingdom's experience with the adoption of standardized messaging, and its contributions to interoperability.

**Leonardo Villar**  
Governor

# Main Points: 2023

**Banco de la República monitored financial market infrastructures (FMIs) in Colombia continuously throughout the year.**

The central bank monitored their performance continuously, using risk assessment methods and putting the findings of applied research into practice to detect possible challenges to financial stability that could arise from problems or disruptions in FMIs.

Colombian FMIs were extremely resilient in the face of economic and financial challenges, both domestic and international. Thanks to efficient management, the payment system and financial markets were able to operate normally, providing stability and confidence to their participants. As proof of this, the financial infrastructure maintained its services on a continuous basis, showing general evidence of its safe and adequate operation.

**The domestic financial infrastructure in 2022 was safe and efficient.**

**During the year, the FMIs reflected the movement in domestic financial markets.**

Primarily, the fixed-income market showed positive developments in traded volumes, despite experiencing devaluations (in a context of increased inflationary pressures, tighter financial conditions and added global and local uncertainty). The foreign exchange market, which experienced important levels of volatility during the year, registered significant momentum in TRM-indexed products cleared and settled through the CRCC.

*Banco de la República's* large-value payments system (CUD) saw an increase in activity compared to the previous year, thanks to more momentum the market for public debt (purchases and sales and sell/buy-back agreements), repos to expand money supply, and retail-value payments (electronic funds transfers, checks and cards). This dynamic was offset partially by lower balances for government interest-bearing deposits.

**There was more activity in the large-value payments system.**

**Added force was observed in financial market infrastructures..**

As a result of CUD activity, the amounts cleared and settled through the Central Securities Depository (DCV) were larger because of an increase in money market operations involving public debt. There was an increase in operations managed by the Central Counterparty Clearing House (CRCC), due to the addition of temporary transfers of sovereign-debt securities (TTS) in the fixed income segment and positive developments in underlying TRM products (futures, NDF forwards and options).

The evolution in several intraday liquidity indicators proposed by the Bank for International Settlements (BIS) showed the CUD maintained enough liquidity to make payments. As for the DCV, its simulated netting cycles have proven to be an effective option for generating liquidity savings in the system. A change in the cycles would imply an exhaustive evaluation of all the available simulated netting options, invariably seeking an adequate balance between efficiency and risk, with the objective of achieving an optimal and safe netting process.

**The initial balance in the CUD and the simulated netting cycles in the DCV made a positive contribution toward mitigating intraday liquidity risk in the large-value payment system.**

**A review of the margin management practices used by central counterparties (CCP) in stressed market incidents showed the CRCC was resilient to market turbulence during the first half of 2020. The measures used to mitigate procyclicality avoided high margin requirements for members during times of increased volatility.**

The higher initial and variation margin requirements caused by extreme market volatility during 2020 were mitigated by mechanisms the CRCC put in place (such as large position management and a buffer in the margin model) to reduce the impact on its clearing members. This counter-cyclical response made it possible to adequately manage the liquidity of market participants during a period of high volatility and risk aversion.

The functions and business models of financial institutions and CCPs are different, as are the risks inherent in one and the other. Consequently, the resolution strategies, powers and capabilities of financial authorities should be specific for the CCPs. In this respect, further analysis to create a special resolution regime for the CCPs in Colombia would be important, considering that the CRCC's contribution to mitigating counterparty and liquidity risks is essential for developing markets and financial stability in the country.

**Several recommendations and developments in international regulations recognize the importance of having special regimes for CCP.**

**Adequate cyber resilience in financial infrastructures is a relevant factor for maintaining financial stability in Colombia.**

Internationally, cyber risk is regarded as one of the most relevant risks. Therefore, its effective management has been the focus of recommendations from multilateral organizations. In Colombia, the SFC has established guidelines, protocols, and standards in light of these recommendations. Together with the policies and practices implemented by *Banco de la República* (Banrep), they have facilitated joint efforts on the part of authorities, financial infrastructures, and their participants to address cyber risks in a coordinated manner and to help strengthen cyber resilience in the Colombian financial sector.

**Electronic retail payments increased in 2022.**

The added use of payment channels, such as the Internet and mobile telephones, contributed to the growth in electronic payments. The increase in electronic transfers (both inter- and intra-bank), and their use in mobile wallets, recognized as closed payment schemes, is worth noting.

The latest measurement of the survey on perception of the use of payment instruments conducted by Banrep (2022) showed the instrument most used by Colombians for routine payments continues to be cash. Additionally, the value of banknotes in circulation, as a proportion of GDP over the last ten years (a proxy indicator of cash payments), showed an upward trend, consistent with the behavior of the same indicator in different countries.

**Cash is still the payment instrument most used by Colombians for routine payments.**

**Technological advances in payments have led to the possibility of including additional services, such as programmable money and smart contracts.**

These innovations eventually could be considered in the design of a central bank digital currency for use by the general population and businesses (a retail CBDC). A deeper understanding of how they work is helpful in recognizing their potential scope, as well as their benefits and risks.




ISO 20022 is a standard for messaging in the financial industry. It offers a common language with more complete data that allows for efficiency in processing different types of payment, harmonization between financial infrastructures, fraud detection and improved user experience. Internationally, the case of England is particularly relevant for outlining a long-term plan to incorporate standardized messaging. Locally, the new DCV has adopted standard messaging and plans to include it in instant payment systems.

**There is an international trend in the use of standardized messaging to facilitate interoperability in payments.**




# Key Figures for 2023

(Daily Average for 2022 and Annual Percentage Change)

## By Infrastructure

	Value	Change		Number	Change	
		Nominal	Real			
 <b>Transactions Settled in CUD</b>	<b>COP 61.3 b</b>	<b>15%</b>	<b>2%</b>	<b>6,765</b>	<b>9%</b>	
 <b>Payments in Financial Markets</b>	DCV	COP 43.0 b	25%	10%	2,425	13%
	CRCC	COP 31.5 b	18%	4%	8,503	18%
	Deceval	COP 3.0 b	15%	1%	6,540	45%
		<b>COP 77.5 b</b>	<b>21%</b>	<b>7%</b>	<b>17,468</b>	<b>26%</b>
 <b>Retail Payments</b>	ACH Colombia	COP 6.8 b	21%	7%	1,3 m	10%
	ACH Cenit	COP 1.3 b	13%	0%	91,315	37%
	Card networks	COP 0.7 b	55%	37%	5,1 m	54%
	Cedec	COP 0.6 b	-2%	-13%	19,256	-16%
		<b>COP 9.4 b</b>	<b>20%</b>	<b>6%</b>	<b>6,6 m</b>	<b>42%</b>

## By Instrument

	Value	Change		Number	Change	
		Nominal	Real			
 <b>Electronic Transfers</b>	Intra	COP 12,9 b	-5%	-16%	6,2 m	88%
	Inter	COP 8,1 b	20%	6%	1,4 m	11%
		<b>COP 20,9 b</b>	<b>3%</b>	<b>-9%</b>	<b>7,7 m</b>	<b>67%</b>
 <b>Card Transactions</b>	Debit	COP 997 mm	18%	4%	3,8 m	21%
	Credit	COP 261 mm	32%	17%	1,1 m	28%
		<b>COP 1,3 b</b>	<b>21%</b>	<b>7%</b>	<b>4,9 m</b>	<b>22%</b>
 <b>Check Transactions</b>	Intra	COP 221 mm	-4%	-15%	11.272	-14%
	Inter	COP 610 mm	-2%	-13%	19.256	-16%
		<b>COP 851 mm</b>	<b>-2%</b>	<b>-4%</b>	<b>30.528</b>	<b>-15%</b>

# 1. General Overview of the Financial Infrastructure in Colombia

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

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 local financial assets and bank payment instruments are settled.

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

There is the Derivex system, which manages the market for standardized derivatives where the underlying assets are energy-related commodities, and other trading and recording systems<sup>3</sup> that allow for trading and recording transactions between participants using hybrid mechanisms (voice and data).

With respect to foreign currency, the Forex Market Electronic Transaction and Information System (SET-FX), managed by SET-ICAP FX S.A.,<sup>4</sup> and the platforms for several trading and recording systems,<sup>5</sup> provide trading and recording infrastructure.

- 
- 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](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.
  - 3 These are ICAP Securities Colombia, GFI Securities Colombia and Tradition Securities Colombia.
  - 4 In 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 SAS, ICAP Latin America Holdings B.V. and the BVC. The intention is to jointly supply Colombia's capital markets with mixed system management services for forex and securities trading and recording.
  - 5 GFI Exchange Colombia and Tradition Colombia.

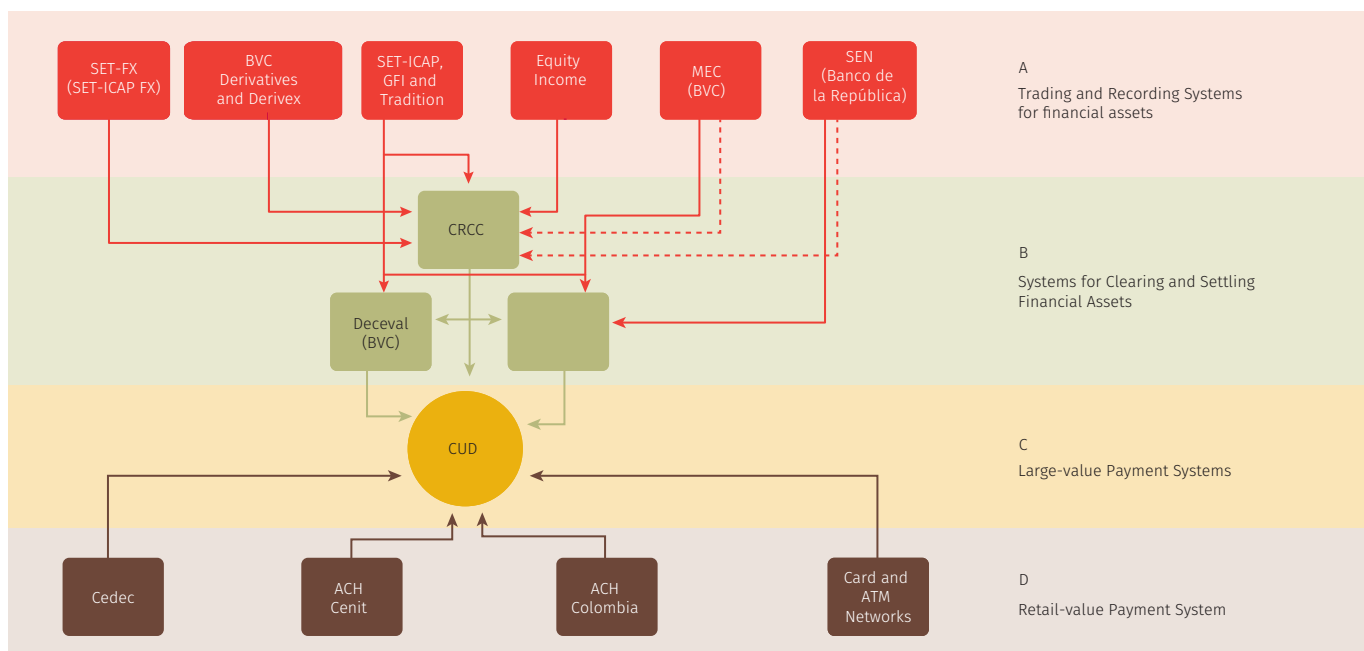
Band B in Diagram 1.1 shows the systems for clearing and settling operations. Businesses use these infrastructures to settle securities, foreign currency, and derivative legs resulting from the obligations they contract on those markets. The systems concerned with securities, as indicated in Diagram 1.1, include the Central Securities Depository (DCV), which is managed by *Banco de la República* and used solely for sovereign debt securities; the Centralized Securities Depository of Colombia (Deceval), which is for all types of securities, both government and private; and the Central Counterparty Clearing House of Colombia (CRCC), 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 CRCC clears and settles both spot transactions and standardized derivatives at the representative market rate of exchange (TRM) 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 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 systems.

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 con-

Diagram 1.1  
Overview of Financial Market Infrastructures (FMI) and Other Participants <sup>a/</sup> (2022)



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

**Table 1.1**  
**Financial Market Infrastructures in Colombia**  
**(Main operations in number and value)**

	Daily Averages <sup>a/</sup>						Main Operations
	Number of Operations		Value				
	2021	2022	2021 Nominal (billions of pesos)	Percentage of GDP	2022 Nominal (billions of pesos)	Percentage of GDP	
<b>Large-value Payment System</b>							
<b>Large Value</b>							
CUD	6,188	6,765	53,253	4.47	61,335	4.19	<ul style="list-style-type: none"> <li>- Settlement of the cash leg of operations cleared by the DCV, Deceval, the BVC, the CRCC, and retail-value payment systems.</li> <li>- Payment of the cash leg of monetary operations; monetary policy operations: repos and interest-bearing deposits</li> <li>- Funds transfers ordered directly by the participants.</li> <li>- Debit to accounts for items such as interbank clearing, VAT, GMF and commissions, among others</li> </ul>
<b>Systems for Clearing and Settling Financial Assets</b>							
<b>Securities Depositories</b>							
DCV <sup>b/</sup>	2,150	2,425	34,403	2.88	42,965	2.93	<ul style="list-style-type: none"> <li>- Pertains to transactions with government securities on the primary market (trusteeship), the secondary market, and monetary operations by <i>Banco de la República</i>.</li> <li>- Comprised of transactions with government securities, corporate debt and shares of equities on the primary and secondary markets. Includes cash collateral.</li> </ul>
Deceval <sup>c/</sup>	4,514	6,678	2,577	0.22	3,127	0.20	
<b>Central Counterparty Clearing Houses</b>							
CRCC S.A.	7,205	8,503	26,740	2.24	31,487	2.15	<ul style="list-style-type: none"> <li>- Clearing and settlement of standardized financial and energy derivatives.</li> <li>- Clearing and settlement of non-standardized foreign exchange and interest rate derivatives.</li> <li>- Clearing and settlement of repos, cash, and temporary transfer of securities (TTS).</li> <li>- Purchase and sale transactions in dollars between exchange market intermediaries in the spot market (t + 0, t + 1, t + 2 and t + 3).</li> <li>- Term operations (TES sell/buy-backs) are sent by the SEN and MEC systems to the <i>Cámara de Riesgo Central de Contraparte S.A.</i> (CRCC) for respective risk management, while gross clearing and settlement are done in the DCV-CUD. An average of 715 transactions were handled daily in 2022 for COP 11.75 trillion.</li> </ul>
<b>Retail-value payment systems</b>							
ACH Colombia	1,201,214	1,318,505	5,616	0.47	6,823	0.47	<ul style="list-style-type: none"> <li>- 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.</li> </ul>
ACH: Cenit	66,225	91,315	1,130	0.09	1,273	0.09	<ul style="list-style-type: none"> <li>- Mainly drafts and payments from the National Treasury to territorial entities.</li> </ul>
Cedec	22,819	19,256	621	0.05	610	0.04	<ul style="list-style-type: none"> <li>- Checks for the purchase and sale of goods and services, and to discharge obligations, among others.</li> </ul>
Cards Networks	3,343,067	5,141,523	467	0.04	725	0.05	<ul style="list-style-type: none"> <li>- Transactions using debit and credit cards.</li> </ul>

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. 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 the 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, Redeban, Visa and Visionamos.

ducted over the last two years. These figures reflect the extent of the resources 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.

As mentioned earlier, the settlement of obligations from the other external systems<sup>6</sup> 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 2022 came to COP 61.3 trillion (t), which is equivalent to 4.19 % of the country's annual gross domestic product (GDP) and represents a downturn compared to the historic trend. The largest portion of this amount pertains to operations in the securities market (COP 46.1 b); namely, the DCV with COP 43 t and Deceval with COP 3.1 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 CRCC (COP 31.5 t); the sum of the two ACHs (Cenit and Colombia) (COP 8.1 t); operations for clearing cards and ATMs (COP 1.4 t) and, finally, the interbank clearing of checks settled through the Cedec system (COP 0.6 t).

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6 External Resolution 5, issued in 2009 by the Board of Directors of *Banco de la República* (BDBR), defines an "external system" as any payment system other than a 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 infrastructures (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) managed by *Banco de la República*, as the backbone of the infrastructure, settles the cash leg of operations 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 100% of the time; Deceval, 99.9%, and the CRCC services for participants were available 99.8% 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.,<sup>7</sup> which indicates the risk of operations being left unsettled after the systems close was mitigated to a large extent.** During 2022, the degree of timeliness in the CUD went from 84.4% to 82.8% of operations settled before 5:00 in the afternoon (Graph 2.1). The CSD and Deceval settled 96% and 92%, respectively, before that time.<sup>8</sup>

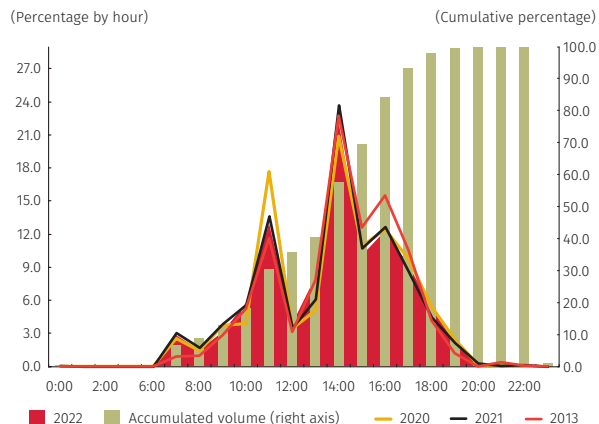
As in previous years, there are sharp transaction settlement peaks in the CUD at certain times of the day (Graph 2.1). This is due mainly to automatic activation of the CUD's netting mechanisms that aim to settle as many pending transactions as possible with the liquidity at hand.<sup>9</sup> In particular, the 21%, 24% and 22% peaks in payments observed at around 14:00 hours in 2020, 2021 and 2022, respectively, were generated because of the liquidity saving mechanisms (simulated netting) in the securities and cash legs offered by the DCV and the retrocession of BanRep repos to increase money supply. Although there was a 2% decline in transactions settled at that time compared to the previous year, it is due to the increase in transactions

7 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 3,170 to COP 40,000.

8 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.

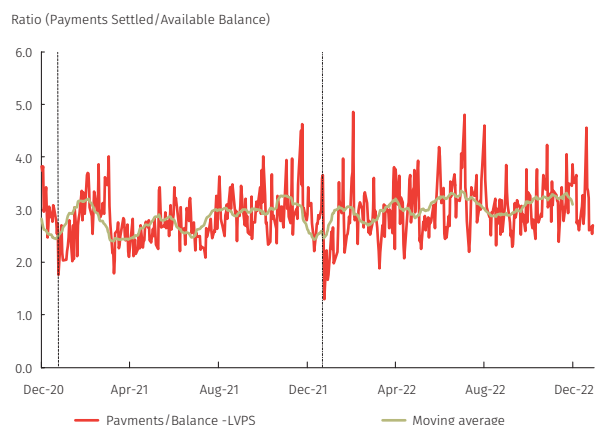
9 Currently, the DCV activates its simulated netting mechanisms at 11:50 a.m., 2:20 p.m., 3:30 p.m., 4:15 p.m., 4:50 p.m. and 5:45 p.m.

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



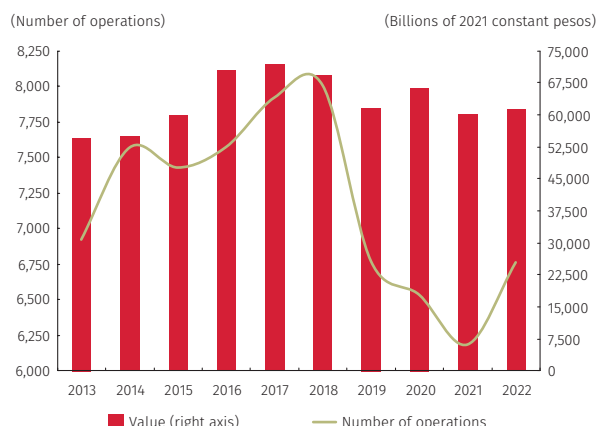
Source: Banco de la República (CUD).

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



Source: Banco de la República (DSIF)

**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)

settled in the bands (time slots) before and after this settlement peak.

**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, remained at similar levels with respect to the previous year (Graph 2.2).** For every COP 2.8 settled in 2021 there was COP 1 in the daily average available balance; in 2022, this ratio increased slightly to COP 3 for every COP 1. Considering the increase in system activity mentioned earlier, the similarity of the indicator could show that participants employ strategies to actively manage their intraday liquidity in function of the payments to be made.

However, this indicator could also be influenced by 1) the liquidity saving mechanisms available in the large-value payment system, and 2) the availability of resources (i.e., account balances) institutions must maintain to comply with regulatory requirements (i.e., reserve requirements, Liquidity Coverage Ratio (ILR)).

## 2.1 Payments in Financial Markets

**There was more momentum in the large-value payment system.<sup>10</sup>**

*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 in retail-value payments (electronic funds transfers, checks and cards). This expansion was offset partially by lower balances for interest-bearing government deposits.*

**The value and number of CUD operations increased** (Graph 2.3 and Table 2.1). The daily average number of operations (6,765) was up by 9.32% in 2022 compared to the previous year; likewise, the nominal value (COP 61.3 t) increased 15.18% with respect to that same year (1.8% in real terms). In the annual total, the value of the amount paid represented 10.3 times Colombia's gross domestic product (GDP) in 2022; i.e., a daily average of 4.19% of GDP, which is slightly less than in 2021, when it accounted for 4.47% 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 securities, by monetary**

10 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/publicaciones-investigaciones/reportes-mercados-financieros/cuarto-trimestre-2022>

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	(Billions of pesos)	Annual Value (Billions of 2022 constant pesos)	(Number of times GDP)
		(Billions of pesos)	(Billions of 2022 constant pesos)	(Billions of pesos)	(Billions of 2022 constant pesos)				
2013	6,925	34,543	54,720	5.0	7.9	1,689,588	8,428,598	13,351,695	11.8
2014	7,570	35,925	54,900	4.7	7.3	1,847,039	8,765,618	13,395,599	11.5
2015	7,430	41,767	59,782	5.6	8.0	1,805,454	10,149,449	14,527,019	12.6
2016	7,574	52,083	70,495	6.9	9.3	1,863,090	12,812,358	17,341,768	14.8
2017	7,921	55,305	71,916	7.0	9.1	1,932,687	13,494,365	17,547,429	14.7
2018	8,007	54,977	69,288	6.9	8.7	1,969,837	13,524,386	17,044,784	13.7
2019	6,774	50,752	61,621	7.5	9.1	1,652,880	12,383,453	15,035,516	11.7
2020	6,537	55,527	66,345	8.5	10.1	1,589,352	13,516,504	16,149,839	13.5
2021	6,188	53,253	60,241	8.6	9.7	1,516,294	13,047,093	14,759,224	10.9
2022	6,765	61,335	61,335	9.1	9.1	1,657,332	15,027,133	15,027,133	10.3

Source: Banco de la República (CUD).

**operations on the part of Banco de la República and by the evolution in retail payments.** The high points were BanRep repos to expand the money supply (with an increase of COP 1.9 t), intraday repos for the payment system (up by COP 0.8 t), trading and sell/buy-back activity with sovereign debt (COP 0.49 t more), and retail-value payments associated with the settlement of interbank clearing for electronic transfers, checks and automated-teller-machine networks (an additional COP 0.8 t). This expansion was offset, mainly, by a reduction of COP 1.45 t in interest-bearing government deposits with *Banco de la República*.

**The increase in the number of operations is explained by a generalized rise in activity within the system, where the transactionality of other FMIs such as DCV and Deceval, which finalize settlement of the cash leg of their operations in the CUD, was a prominent factor.** On average, 2,124 operations were conducted daily through these infrastructures in 2021 (DCV, 2,508; Deceval, 616), followed by an increase of 9.8% in 2022, closing at 2,333 (DCV, 1,671; Deceval, 662).

**Out of all operations in the CUD, 44% were conducted with sovereign debt securities held in custody at the DCV.** Settlement of the cash leg of sell/buy-backs, repos and TTSs by agents at the DCV (excluding Banrep) accounted for 26.4% of the total value of the CUD in 2022 (Table 2.2). BanRep repos to expand the money supply accounted for 17.7%, of which 4.2% correspond to intraday repos for payment systems. Interest-bearing deposits with BanRep represented 5.6%, with 4.1% constituted by the Ministry of Finance and Public Credit (MHCP).

**Direct funds transfers in the CUD accounted for 49.9% of the operations.** Prominent were transfers from credit institutions to other depositor-account entities (“money uploads”), with 12.7 %, so as to provide them with the necessary liquidity to meet the cash leg of their securities transactions; 5.82 % for net multilate-

**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 <sup>a/</sup>	Year 2021		Year 2022		Year 2021		Year 2022	
	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value
	(Percentage)							
Primary market <sup>b/, c/</sup>	44	469,81	55	425,28	0.7	0.9	0.8	0.7
Secondary market <sup>d/</sup>	746	3,409,77	835	3,516,40	12.0	6.4	12.3	5.7
Money market <sup>d/</sup>	690	11,703,18	752	12,075,03	11.2	22.0	11.1	19.7
Others DCV <sup>e/</sup> (2)	27	160,91	28	159,42	0.4	0.3	0.4	0.3
<b>Total sovereign debt operations in the DCV (1)</b>	<b>1,508</b>	<b>15,744</b>	<b>1,671</b>	<b>16,176</b>	<b>24</b>	<b>30</b>	<b>25</b>	<b>26.4</b>
Monetary policy <sup>f/, g/, h/</sup>	103	11,270	107	11,793	1.7	21.2	1.6	19.23
Provision of liquidity in the payment system ( <i>Banco de la República</i> ) <sup>i/</sup>	62	1,721	81	2,598	1.0	3.23	1.2	4.24
<b>Direct transfers of funds in the CUD<sup>j/, k/, l/</sup></b>	<b>3,066</b>	<b>19,378,30</b>	<b>3,355</b>	<b>24,363,86</b>	<b>49.5</b>	<b>36.4</b>	<b>49.6</b>	<b>39.7</b>
Deceval <sup>m/</sup>	616	1,036,15	662	1,308,10	10.0	1.9	9.8	2.1
Colombian Stock Exchange (BVC) <sup>n/</sup>	0	0,00	0	0,00	0.0	0.0	0.0	0.0
<i>Cámara de Riesgo Central de Contraparte</i> (CRCC) <sup>o/</sup>	20	42,09	19	144,29	0.3	0.08	0.3	0.24
<i>Cámara de Riesgo Central de Contraparte</i> (CRCC) <sup>p/</sup>	17	1,128,30	16	1,222,66	0.3	2.12	0.2	1.99
Retail-value payment systems <sup>l/</sup>	245	2,744,63	266	3,568,93	4.0	5.15	3.9	5.82
<b>Total direct transfers of funds in the CUD</b>	<b>3,964</b>	<b>24,329</b>	<b>4,318</b>	<b>30,608</b>	<b>64.1</b>	<b>45.69</b>	<b>63.8</b>	<b>49.90</b>
Other transactions <sup>l/</sup>	552	188,44	588	160,39	8.9	0.35	8.7	0.3
<b>Total operations debited in the CUD</b>	<b>6,188</b>	<b>53,253</b>	<b>6,765</b>	<b>61,335</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

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 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 the net value and interest.

g/ Establishment of reverse repos.

h/ Establishment of interest-bearing deposits. This includes the DGCPTN.

i/ Pertains to reverse intraday repos. In the case of repo chains, it includes only the 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 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 – Section No. 10 in Article 879 of the tax law; transfers between accounts belonging to the same institution; transfers of funds from the Foreign Exchange Clearing House account to foreign exchange market intermediaries with a multilateral creditor position in pesos (payment-versus-payment mode); initial transfers from foreign exchange market intermediaries 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 *Cámara de Riesgo Central de Contraparte* to institutions with a multilateral creditor position in pesos; initial transfers from institutions having a debtor position with the CRCC 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 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 *Cámara de Riesgo Central de Contraparte*, 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 foreign exchange market intermediaries with a debtor position in pesos to the Foreign Exchange Clearing House of Colombia (CCDC), 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, Redeban, Servibanca and ATH networks, so they can guarantee the settlement of clearing for electronic transfers and operations with debit, credit, and ATM cards. 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 collection.

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

ral clearing in the retail-value payment systems (4.53 % ACH, 0.95 % card and ATM networks, and 0.33 % checks) and 4.6 % for transfers of resources from collective investment fund (CIF) managers to the custodians of those funds, so the latter can settle purchase and/or sell/buy-back transactions involving securities. Table A1.2 in Annex 1 of this report provides this information in greater detail.

**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 intraday liquidity pressure and helps the system to operate safely.** Graph 2.4 shows the system's aggregate balance averaged COP 16.9 t daily and was up by 13 % with respect to the previous year (-0.2 % in real terms). When compared to the liquidity required by the system,<sup>11</sup> for every COP 1 required in 2021 and 2022, COP 1.7 were available. *In Focus 1* presents a complementary analysis suggesting these surpluses are related to the fact that credit institutions account for 95% of the system's balance, since they maintain certain levels of liquidity in the CUD to comply with the regulation on reserve requirements.

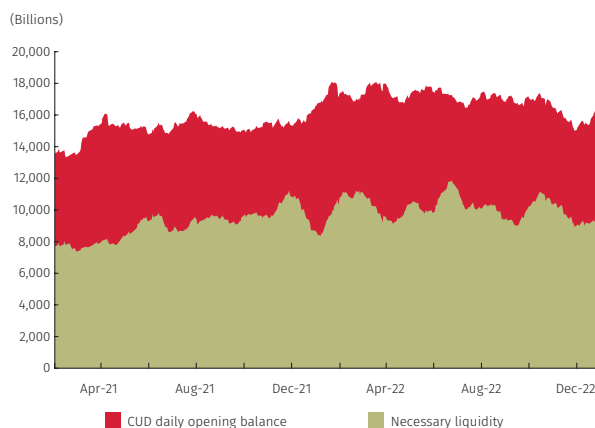
The central securities depositories (DCV and Deceval) and the CRCC are components of the financial infrastructure that oversee the clearing and settling of transactions with financial assets (securities, derivatives and foreign exchange). They interact with the CUD to settle the cash leg of their operations.

**The financial market infrastructures registered added momentum.**

*Larger amounts were cleared and settled through the Central Securities Depository (DCV) because of an increase in BanRep repos to expand the money supply (excluding intraday repos). Operations managed by Cámara de Riesgo Central de Contraparte (CRCC) increased due to a build-up in underlying TRM products and the positive evolution in peso/dollar non-delivery forward (NDF) contracts.*

**The average daily value of transactions settled in the DCV rose by 25% (10% in real terms), having gone from COP 34 t to COP 43 t (Graph 2.5, Panel A), mainly because of added momentum (42%) in the services the DCV provides to Banco de la República (OMA and the provision of liquidity to the large-value payment system).<sup>12</sup> Similarly, sell/buy-back operations increased by 3 % (-9 % in real terms), and trading rose**

Graph 2.4  
Evolution in the Beginning Day Balance - CUD  
(20 day moving average)



Source: Banco de la República (CUD).

11 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>.

12 In 2022, Banco de la República purchased definitive TES (the main source of monetary base expansion) to guarantee the supply of primary liquidity to avoid money market pressures. For more information, see the Board of Directors' Report to the Congress of the Republic of Colombia (March 2023): <https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/10611/informe-congreso-marzo-2023.pdf>

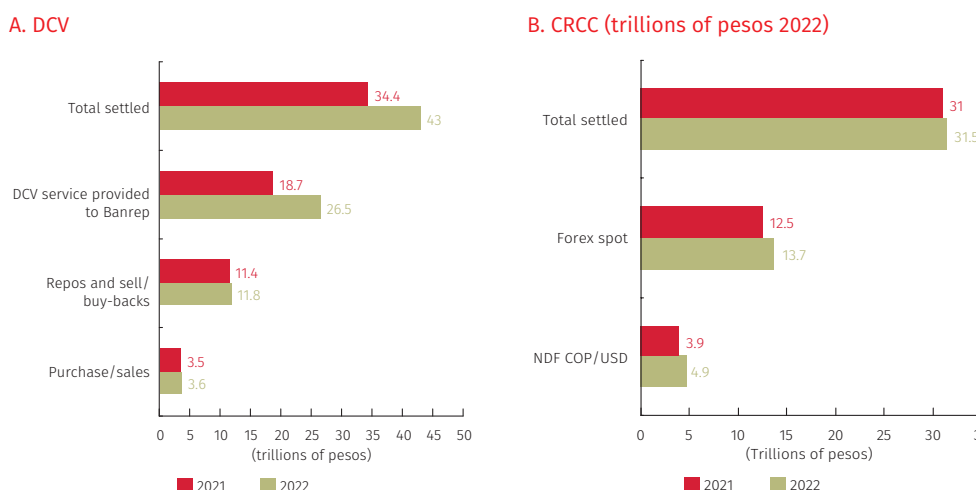
by 4 % (-8 % in real terms). The number of average daily transactions increased 13 %, from 2,150 in 2021 to 2,425 in 2022. The balance in custody was up 13% in current pesos, from COP 424 t to COP 480 t at the end of the year (94 % TES).

Since the liquidity savings facility in the simulated netting cycles that operate in the DCV is the mechanism that contributes most to the settlement of operations, and because this depository is implementing a new system, *In Focus 2* contains an analysis of how the change in the number of daily liquidity-saving cycles has implications in terms of the monetary savings they provide to the system.

**At Deceval, the average daily value of cleared and settled transactions increased by 15% (1% in real terms), having gone from COP 2.6 t to COP 3.0 t.** Regarding its function as a depository, the balance in custody in current pesos rose by 6 % (-7 % in real terms): from COP 536 t to COP 565 t. Out of this last amount, 48 % pertained to equities; 28%, to CDTs; 14%, to bonds; and the remaining 10%, to other securities.

**The CRCC exhibited more momentum, having experienced an increase of 17.5 % (6.7 % in real terms) in the value of transactions cleared and settled, mainly those with underlying TRM.<sup>13</sup>** On average, it cleared and settled COP 31.5 t daily, COP 13 t of which pertained to peso/dollar spot operations (Graph 2.5 panel b), COP 4.7 t, to peso/dollar NDF forwards and COP 1.05 t, to TRM futures. Respective growth, compared to the previous year, was 20% (9.2% in real terms), 39% (26.7% in real terms) and 115% (95% in real terms). Additionally, the CRCC began to serve as a central counterparty for sovereign debt TTS operations in the fixed income segment between the Ministry of Finance and the market makers of TES sovereign

Graph 2.5  
Daily Average for Transactions Carried Out through  
Financial Market Infrastructures  
(Values in trillions of pesos)

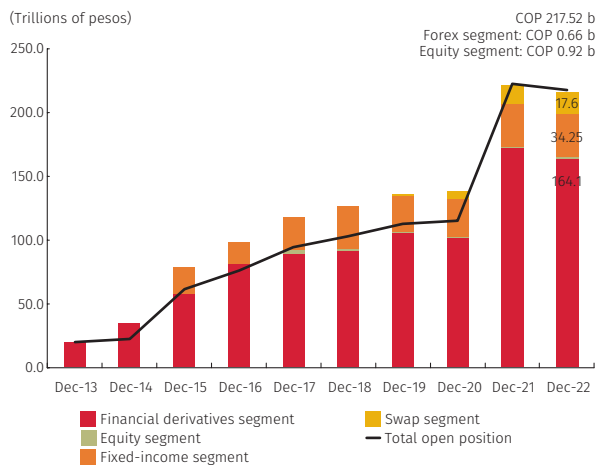


Sources: Banco de la República (DCV) and the Cámara de Riesgo Central de Contraparte (CRCC).

debt securities in the DCV, as of the trading day. Acceptance of the transactions will involve the initial transaction or outflow and the return transaction or return flow. The CRCC cleared and settled COP 896.6 b in operations, on a daily average, as of August 2022.

13 The high degree of volatility in the foreign exchange market during 2022 explains, on the one hand, the increase in the peso value of transactions cleared and settled by the CRCC and, on the other hand, the incentive for market participants to hedge and seek better returns.

**Graph 2.6**  
Evolution in the Open Position, by Segment and at the Close of Each Year (Gross open position, both ends) (Trillions of 2022 constant pesos)



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

The added momentum in operations was reflected in a higher value for the open positions with which the CRCC closed out 2022 (COP 218 t), which meant an increase of 11 % (-2 % in real terms) with respect to 2021. This was due to growth in positions in TRM futures, in long-term interest rate swaps, in peso/dollar NDF forwards and in sovereign debt sell/buy-back operations, with respective increases of 207 % (172 % in real terms), 35 % (20 % in real terms), 30 % (15 % in real terms) and 6.3 % (-3.8 % 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 164.3 t (75.3 %), the fixed income segment, COP 34 t (16 %), the interest rate swaps segment, COP 17 b (8 %), the equity income segment, COP 1 b (0.4 %) and the foreign exchange segment, COP 0.7 b (0.3 %) (Graph 2.6).

The impetus in transaction clearing and settlement and what it means in terms of an eventual increase in the CRCC'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 (for example, 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 2022 for the main products were: 63 % for futures contracts on TRM and on peso/dollar NDF forwards; 60 % for interest rate futures and swaps, and 24 % for positions in sovereign debt sell/buy-backs.

**In addition, multilateral clearing of peso/dollar spot transactions generated liquidity savings of 83% for CRCC members.** The average daily gross value traded was USD 1,398 million and the average daily net value settled was USD 238 million.<sup>14</sup>

**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 larger open positions of its clearing members), and to the lack of a substitute entity in event CRCC service is interrupted. There-

<sup>14</sup> Information on variations and details concerning operations, open positions and changes introduced by the CRCC in 2022 can be found in Annex 1.

fore, 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. *In Focus 3* expands on this topic by outlining the progress that has been made toward defining frameworks for CCP recovery and resolution, and the main objectives and elements to consider in the resolution of a CCP. Several recommendations are presented as well.

The market turbulence observed during the recent pandemic was the first event that tested the capacity of the tools and the efficiency of the CRCC risk model. *In Focus 1* contains a review of central counterparties' practices in managing initial and variation margins during times of extreme market volatility, highlighting the resilience and effectiveness of the tools established by the CRCC to mitigate the pro-cyclical effects of price changes for the underlying assets cleared during that period.

Another sign of adequate risk management by the CRCC was the fact that none of the thirteen 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<sup>15</sup> for the foreign exchange segment, going to the market, for the first time, to obtain the asset that was lacking, and closing the hedging operation. 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. It also set up a collective guarantee fund for the foreign exchange segment, in compliance with Banrep regulations. Consequently, this segment now has a more robust security ring to manage default by the two main clearing members.

This section of the current edition of the Report ends with a look at a key cross-cutting issue for FMIs: cyber resilience. *In Focus 5* explains how cyber resilience is critical to ensuring the stability and integrity of infrastructures in an increasingly interconnected and digitalized world. Cyber risks and threats are evolving constantly, requiring continuous adaptation and improvement in strategies for cyber security and cyber resilience.

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15 The tools to mitigate liquidity risk in dollars involve the use of pre-approved lines of credit with liquidity providers through an overnight COP-USD swap. 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 (EMI). To this end, the CRCC is authorized to operate as an EMI and to request the necessary dollars directly in the foreign exchange market.

## Box 1: Importance of the Initial Balance in the Large-Value Payment System (LVPS) as a Source of Liquidity that Helps to Mitigate Intraday Liquidity Risk

### Introduction

The large-value payment system (LVPS) managed by *Banco de la República* (Banrep), better known as the Single Deposit Accounts System (CUD), is the financial market infrastructure (FMI) where settlement of the cash leg of operations comes together for financial asset clearing and settlement systems, as well as retail-value payment systems. It is also the scenario where transactions associated with the payment of dividends, coupons, and tax transfers to the nation, among other operations, are settled.

Financial institutions participating in the LVPS resort to both their own and alternative sources of liquidity to settle these transactions. The first source includes opening balances at the start of the day; guarantees pledged with Banrep or other financial infrastructures (e.g., central counterparty clearing houses); assets not committed in the entity's balance sheet (e.g., tradable investments); available intraday credit lines, and balances maintained in other financial institutions. Alternative sources are understood as liquidity received through payments from other participants or support systems.

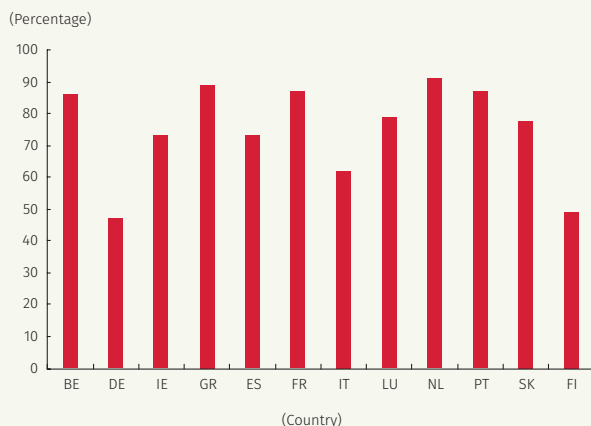
The balance at the start of the day plays an important role as a payment source in different jurisdictions. In the United States, for example, it accounts for 77% of all available sources (Garratt *et al.*, 2014). The situation in most European Union countries is similar, where the share ranges from 73% to 91%, except in Finland, Italy, and Denmark, where it accounts for 47% to 62% (Graph B1.1).

Considering the foregoing, an analysis of the beginning-of-day balance as a payment source in the LVPS is presented in this section and is divided as follows. The first part shows the current balance levels in the system and offers some comparisons regarding its use as a source of liquidity. The second part outlines several considerations on the management of risks that are mitigated, thanks to the beginning-of-day balance and have recently become quite relevant internationally. The third part analyzes several considerations of a structural nature that result in the current levels of liquidity in the LVPS, while the last part contains the conclusions.

### 1. Beginning-of-Day Balance in the LVPS

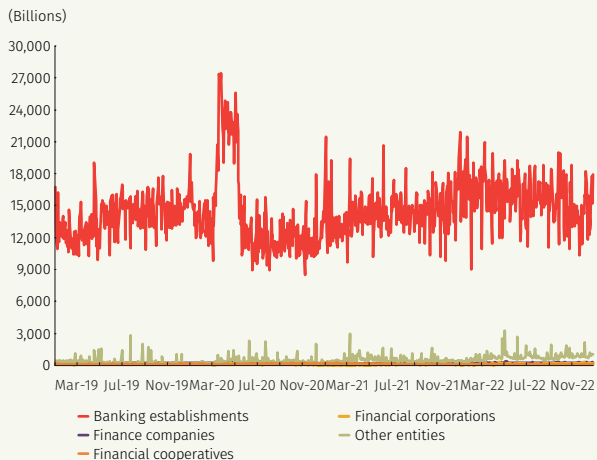
Graph B1.2 illustrates how the beginning-of-day balance in the LVPS has evolved. The total balance in the system averaged approximately COP 16.9 t per day in 2022. Credit institutions (CI) contributed 95% (COP 16.06 t), with banks accounting for 98% of the aggregate CI balance. It is important to note that the peak in the balance observed between March and May 2020 is consistent with an increase in banks' available funds and in high-quality investments. This occurred in an environment marked by uncertainty in financial markets, greater risk

**Graph B1.1**  
Share of the Beginning Day Balance as a Source of Payment  
(Daily averages: 2008-2020)



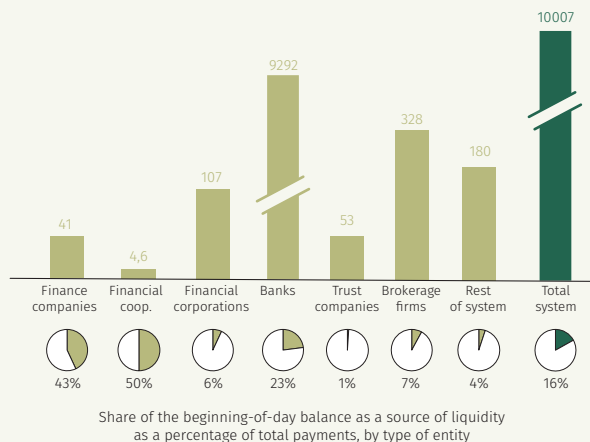
Source: ECB (2021); calculations by Banco de la República

**Graph B1.2**  
Evolution in the Beginning Day Balance in the Retail-value Payment System (2019-2022)



Source: Banco de la República (DSIF)

**Graph B1.3**  
Payments Made with the Beginning Day Balance, 2022  
(Billions, daily averages)



Source: Banco de la República (DSIF)

aversion, and the implementation of measures on the part of financial authorities to provide liquidity to the economy (REF, 2020).<sup>1</sup>

Based on the work of Ortega *et al.* (2021), Graph B1.3 illustrates the contribution of the beginning-of-day balance as a source of liquidity in Colombia. In 2022, approximately 16% of the COP 61.3 t in average daily payments in the system were made using the beginning-of-day balance. As illustrated in the graph, use of the beginning-of-day balance differs widely, depending on the type of financial institution. This is related to the nature of the institution,<sup>2</sup> its involvement in buying and selling financial assets (e.g., government bonds), and whether it is subject to reserve requirements. The latter are considered because the LVPS balance is part of the available CI reserve.

## 2. Beginning-of-Day Balance and Intraday Liquidity Risk

The previous section highlights the importance of the beginning-of-day balance as a source of liquidity for payments in the Colombian case. This balance also helps to mitigate intraday liquidity risk, which occurs when an entity is unable to manage its intraday payments effectively. This can result in incomplete payments that affect not only its liquidity position but also that of other participants in the LVPS.

The potential inability of an entity to meet its payments is rooted in a lack of synchronization between the entity's inflows and outflows of funds. This mismatch is associated with uncertainty about the amounts and timing of incoming and outgoing payments, which can lead to intraday liquidity shortfalls. Depending on the severity of these shortfalls, the entity may be forced to prioritize payments to guarantee those with critical timing (e.g., daily margin adjustments in a central counterparty clearing house that must be made before the market opens), or to seek sources of financing with other banks or the Central Bank, to use liquid assets, to delay payments, or even to refrain from making payments.

Inasmuch as real-time gross settlement (RTGS) is the modus operandi of the LVPS in Colombia, transactions are settled one by one and immediately, subject to the availability of sufficient balances to pay them. Accordingly, the dynamics of the interaction between participants in sending and receiving payments, along with the availability of alternative sources of liquidity, determine the minimum balances with which participants must start the day if they hope to settle their obligations promptly. For a given sequence of payments, a reduction in the alternative sources of liquidity that are available means more liquidity will be needed at the start of the day.

While the Basel III recommendations for adequate risk management and liquidity control were designed to address liquidity risk over periods longer than a single day (BCBS, 2010; IFS, 2017), the Basel Committee on Banking Supervision, together with the Committee on Payments and Market Infrastructures of the Bank for International Settlements (BCBS-CPMI, 2013), developed a set of tools in 2013 to monitor and control intraday liquidity risk. These are useful not only

1 In the case of Banco de la República, the definitive purchase of TES and private debt, the increase in quotas in transactions to increase the supply of money (repo) and access to new agents are especially relevant. For more information see: <https://www.banrep.gov.co/es/medidas-banrep-covid-19-0>

2 For example, a trust company's job is to manage third party resources; for this reason, maintaining high balances at the beginning of the day represents a high opportunity cost insofar as those resources could be earning interest in sight deposits or savings accounts with a lender.

to financial institutions but also for supervising and monitoring the work of financial authorities.

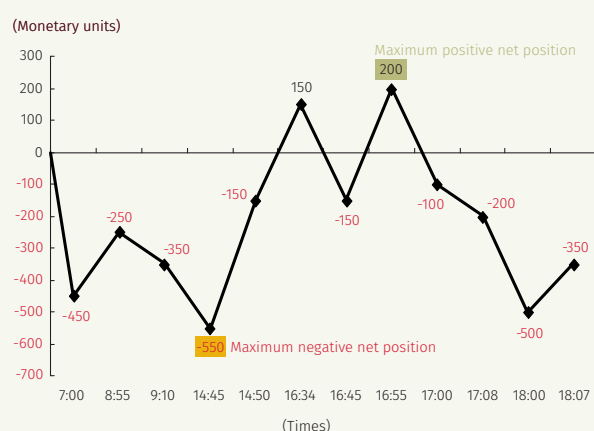
One of these tools involves calculating an indicator of maximum daily liquidity use. To put together this indicator, entities are required, in principle, to record the cumulative net value of payments they send and receive throughout the day. As shown in Graph B1.4 and Table B1.1, this is equivalent 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 Graph B1.4 and Table B1.1) is reached at a point in the day when the entity 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 Graph B1.4 and Table B1.1). It represents 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 entity needed to have on hand, at the start of the day, to ensure its daily payments could be made on time.

Graph B1.5 illustrates the changes in the total beginning day balance in the LVPS and the calculated maximum cumulative net negative position. The latter is the sum of the negative net positions (i.e., minimum initial balances required) of the financial entities that are linked to the system. According to the indicator, the levels of liquidity invariably exceed the minimum initial requirements. In 2022, the minimum level was COP 10.1 t, on average, and the actual level averaged COP 16.9 t. This is a positive sign. By having liquidity levels that exceed the necessary minimum, participants are less dependent on the timing of payments from their counterparts and, consequently, are less exposed to the risk of improperly managing their liquidity during the day.

It is important to point out that when comparing the necessary minimum levels of liquidity (i.e., COP 10.1 t) to the average amount moved daily by the system (i.e., COP 61.3 t), there is a ratio of 17%. This proportion is similar to what Kabadjova *et al.* (2023) found in a study on the use of intraday liquidity and its determinants in the large-value payment systems of nine countries. The same study notes this ratio is equivalent to a daily average of 15%.

**Graph B1.4**  
Evolution in the Cumulative Net Position



Source: Banco de la República (DSIF)

**Table B1.1**  
Summary of Actual 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

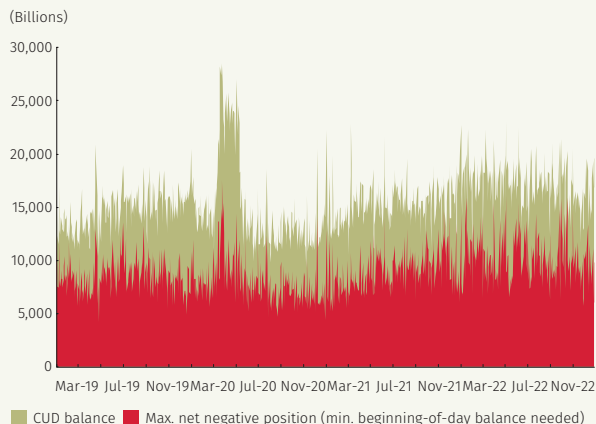
Source: Banco de la República (DSIF)

### 3. Bank Reserve Requirements and How they Relate to Intraday Liquidity

Financial institutions participating in the LVPS are allowed to maintain surplus reserves in their deposit accounts. This is for various reasons; namely, as a precaution, to facilitate transactions, as an investment strategy, because of economic uncertainty, or for regulatory compliance. Regarding the latter, entities may be subject to regulations that require them to maintain certain amounts of liquidity to ensure their strength and stability. Some requirements, such as the liquidity coverage ratio (equivalent to the liquidity risk indicator, LRI) and the net stable funding ratio (NSFR) established under the Basel III framework, can induce entities to maintain surplus liquidity to comply with regulations.

Aside from the current orientation of reserve requirements as a tool for monetary control (Betancourt and Vargas, 2008) and as a tax on financial intermediation (Montoro and Moreno, 2011), this regulation also gives entities an incentive to maintain surplus liquidity in the

**Graph B1.5**  
Evolution in the RVPS Beginning-of-day Balance and  
Maximum Negative Net Position



Source: Banco de la República (DSIF)

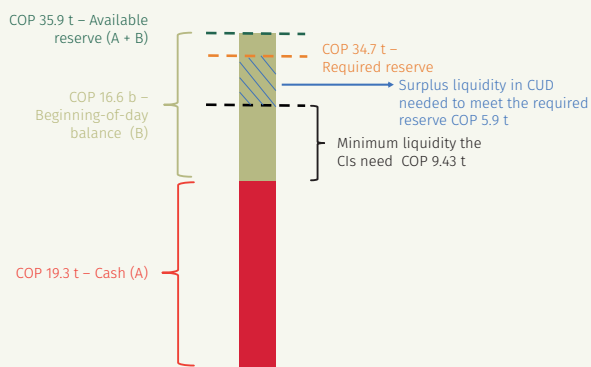
LVPS. According to current regulations, there are three percentages for required reserves: 8% for the most liquid current liabilities, 3.5% for some current liabilities maturing in under eighteen months, and 0% for certain current liabilities maturing in more than eighteen months and for transfer commitments made with the Directorate General of Public Credit and National Treasury (DGCPTN). Ordinary reserves are not interest-bearing and are held in the form of deposits with the Central Bank (i.e., balance in CUD) and/or in cash.

The reserve requirement has helped the LVPS to operate smoothly by facilitating and providing greater security for the fulfillment of its many operations. This is because the balances credit institutions (CIs) maintain in deposit accounts with the central bank (Banrep), which count towards meeting their reserve requirements, also represent spare liquidity they can use during the day to meet their obligations in the system. Among others, these obligations include fulfilling their transactions in the securities, foreign exchange, and monetary markets, as well as retail-value transactions ordered by their clients. In this way, the reserve requirements help to mitigate the intraday liquidity risk to which these entities are exposed.

Graphs B1.6 and B1.7 show the recent tendency in the components of reserve requirements. According to bi-weekly averages for 2022, CIs maintained COP 35.9 t in available reserves in the LVPS; that is, COP 19.3 t in cash (53%) and COP 16.6 t (47%) in the beginning-of-day balance. Deducting the minimum amount of liquidity needed for the system to function properly (i.e., the maximum use of intraday liquidity calculated in the previous section applied to CIs) from the beginning-of-day balance shows a liquidity surplus, which is necessary, in any case, to meet the required reserve. This surplus is approximately COP 5.9 trillion (blue shading, Graphs B1.6 and B1.7). In other words, if CIs had no more in their deposit accounts than the minimum amount of liquidity needed to make their payments, the reserve requirement would not be met.

Moreover, by providing resources to their counterparts from the time the daily trading session opens, the considerable quantity of available resources the CIs maintain in the LVPS at the beginning of the day, especially banks,<sup>3</sup> makes them suppliers and catalysts of the liquidity flow. This helps the payment process to function as it should (Graph B1.8). In fact, Kabadjova *et al.* (2023) found that higher reserve balances seem to induce early payments and reduce the habit of a few participants in the system providing liquidity to the rest.

**Graph B1.6**  
CUD Balance and Surplus Liquidity in the RVPS  
(Bi-weekly average, 2022)



Source: Banco de la República (DSIF)

#### 4. Closing Comments

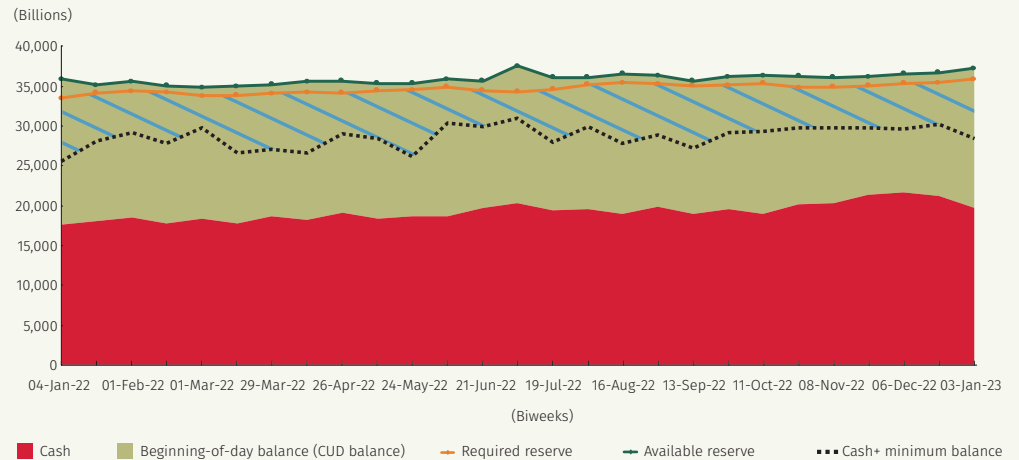
The beginning-of-day balance is an important source of liquidity that entities use to make their payments in the LVPS. Currently, it accounts for nearly 17% of all available sources of liquidity. In other words, COP 17 out of every COP 100 paid were funded using the available balance.

Furthermore, maintaining a reserve equivalent to the beginning-of-day balance would help to mitigate intraday liquidity risk, since having a balance of this sort would make entities less dependent on the synchronization and timing of expected payments. So, instead of waiting for flows of incoming payment to be able to make payments of their own, they could make payments and receive their anticipate payments at any time throughout the day.

Thanks to the tools for measuring and quantifying intraday liquidity, which are part of the Basel III comprehensive supervisory fra-

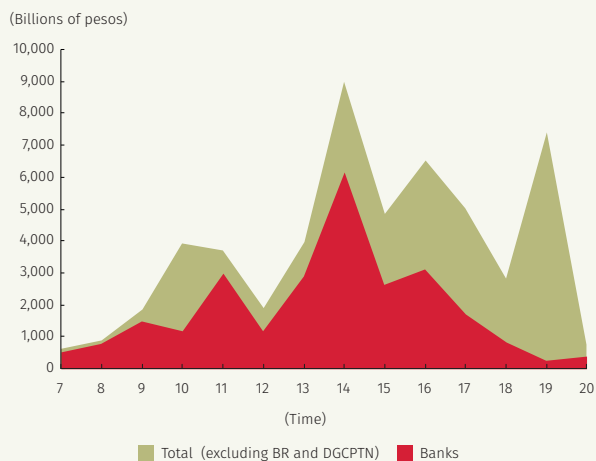
3 It is mainly banks, given the high reserve requirement they must meet due to the large volume of their deposits.

**Graph B1.7**  
Evolution in the CUD Balance and Surplus Liquidity in the RVPS (2022)



Source: Banco de la República (DSIF)

**Graph B1.8**  
Payments in the RVPS, by Time Slots  
(Daily average: Jan/21-Mar/23)



Source: Banco de la República (DSIF)

mework, it is possible to determine the adequate amount of initial liquidity the LVPS should have on hand for the day. The conclusion, in the Colombian case, is that the system, overall, has levels above that benchmark, and these levels are also related to conditions associated with the required capital reserve. While there is divergency in the use of liquidity by different participants in the system, the resulting liquidity surplus benefits the entire system in terms of mitigating intraday liquidity risk.

Finally, it is important to note that this analysis of liquidity needs in the LVPS and how they relate to reserve requirements is an element of the process to update the framework for action on the use of policy instruments that contribute to financial stability. It is all part of Banco de la República's strategic plan for 2022-2025.

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## Box 2: Benefits for the Market from Liquidity Savings through the Simulated Netting Cycles in the Central Securities Depository (DCV)

### 1. Securities Settlement in the DCV

The Central Securities Depository (DCV), operated by *Banco de la República*, uses real-time gross settlement (RTGS) as the modus operandi for trading securities and transferring funds. As a result, transactions are settled one by one, with securities transferred simultaneously from the seller to the buyer (delivery) and funds from the buyer to the seller (payment). In this way, assets are exchanged only if both the securities and money are available to be delivered to the respective counterparties.

Although this method eliminates counterparty risk by guaranteeing the simultaneous transfer of funds and securities in each transaction (delivery versus payment, DvP), it requires that participants have enough funds and securities to settle each of their transactions. In this case, the demand for intraday liquidity could place a significant burden on the daily operations of the participating parties.

For this reason, the DCV has offered simulated multilateral netting cycles since January 2006. Known as liquidity saving facilities (LSF), they help to reduce the demand for liquidity in securities and cash from market participants. In its LSF, the DCV settles instructions for the transfer of securities on a gross basis but settles funds transfers through simulated netting at the end of each cycle.<sup>1</sup> In this way, the central bank manages to reduce the risk of witnessing transaction defaults that can arise when participating entities need liquidity.

The choice between gross settlement and settlement with simulated netting raises important considerations with respect to counterparty risk, as well as the efficient use of liquidity in netting cycles. In this context, it is appropriate to analyze the current (original) netting cycles in the DCV.

An analysis of this sort implies evaluating the impact an increase or reduction in the number of daily netting cycles has on liquidity savings in the system.<sup>2</sup> Accordingly, a simulation exercise is used to assess the effect on liquidity savings by increasing in the number of original netting cycles, on the one hand, and moving closer to gross settlement as a result, and, on the other, by reducing the number of cycles towards a fully netted approach.

The aim of this exercise is to take the first step toward assessing the impact that can be achieved with different approaches to daily netting, thereby enabling informed decisions to optimize the system.

### 2. The Liquidity Saving Facility in the DCV

Liquidity saving facilities (LSF) operate by grouping transactions (spot purchases and sovereign debt sell/buy-backs) and by multilateral netting among counterparts. One of the main advantages of a LSF is its ability to minimize participants' use of liquidity in terms of both securities and cash, which translates into a more efficient use of available resources.

Through an optimization algorithm, the LSF allows transactions to be fulfilled by settling securities and cash using a simulated multilateral clearing process. The algorithm aims to maximize liquidity savings by settling as many transactions as possible, subject to the balances that are on hand in the CUD.

1 BIS (1992). "Delivery versus Payment in Securities Settlement Systems," Model 1, September.

2 Although the exercise focuses on measuring the results in terms of settling transactions in cash, it is important to note that the savings in securities are also significant.

Currently, this daily process is conducted in six cycles between 11:50 a.m. and 5:45 p.m. During each cycle, the system compares the total amount of incoming and outgoing transfer orders from a depositor's account that could not be settled and calculates the value offset against the balance available in that account.

The system selects the transactions that are part of the LSF, calculates the nominal value of the trade and its total value, and verifies if the balance of securities on hand is sufficient to fulfill the agreed-upon transactions. If it is not, the LSF initiates an exclusion process to select the transactions that can be fulfilled.

Subsequently, an additional check is done to determine if the transactions that were excluded can be reintroduced into this operational expediting process. As many reiterations are performed as necessary to ensure as many transactions are fulfilled as possible, until all the liquidity requirements are met.

### 3. Simulation Exercise

With implementation of the new system in the DCV, it is important to validate the efficiency of the original six cycles in terms of the maximum liquidity savings they provide to the system. In this respect, it is necessary to determine whether including or excluding cycles would improve the level of savings for market participants. As mentioned, striking a balance between counterparty risk and resource savings is important. It is what makes the exercise relevant. Accordingly, an analysis is proposed in this section that examines the implications of both increasing and decreasing the number of original cycles.

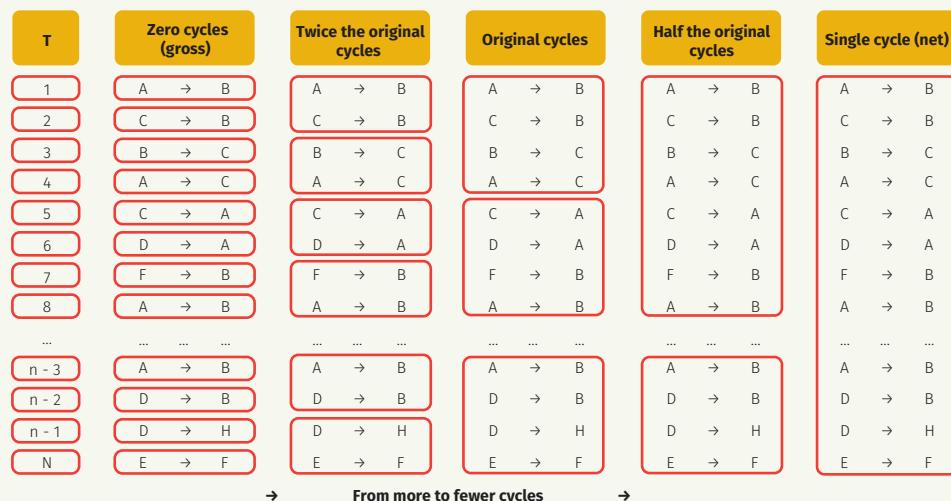
Data from *Banco de la República's* large-value payment system (CUD) were used in the analysis to identify the transactions involved in each of the daily netting cycles.

Diagram B2.1 illustrates the possible netting cycles. It shows the moment (T) when a transaction from a buyer to a seller (e.g., from A to B) takes place. The number of transactions included in each of the different netting cycles is highlighted with a red border.

The complete range of possible cycles is depicted, from gross settlement on the left, where each transaction is settled individually, to fully net-based settlement on the right, where all transactions are accumulated for multilateral netting in a single daily cycle at the end of the day.

Although both gross settlement and fully net-based settlement – shown at opposite ends of the diagram - are possible, they are inefficient due to the excessive liquidity requirement with the former and the major liquidity risk associated with the latter. For this reason, the

Diagram B2.1  
Range of Daily Netting Cycles



Source: Banco de la República (DSIF)

analysis starts with an illustration of the original netting cycles at the center of the diagram, where a divide in the actual six cycles is shown. Three original netting cycles are assumed as the basis for the exercise.

Starting with these three base cycles for the exercise, two simulated ones are proposed to assess the implications of a change in the number of netting cycles.<sup>3</sup> One simulated cycle is established with twice the number of settlement cycles (six), closer to gross settlement, and another with half of the original cycles (two<sup>4</sup>), closer to fully net-based settlement.

Liquidity savings were used as the metric in the analysis to determine the impact of this change in the number of netting cycles. Liquidity savings are defined as the difference in money between each cycle and gross settlement. In other words, how much an entity and the system in general save by having the option of multilateral netting was assessed.

Liquidity savings were determined by settling each of the simulated nettings compared to the liquidity required to settle the transactions individually (gross settlement), where the savings are zero.

#### 4. Results

Graph B2.1 illustrates the patterns in the percentage of liquidity savings, together with the respective gross and net values, which would be obtained by doubling or reducing the number of original netting cycles. As the exercise involves the same set of transactions settled in the original cycle, the simulation scenario panels (double, half, and single cycle) show they share the same area that reflects the gross value but differ in the net aggregate payer position.<sup>5</sup>

Between January 2013 and February 2023, the substantial flow of transactions related to the purchase/sale and sell/buy-back of sovereign debt securities<sup>6</sup> made it possible for the DCV's liquidity savings facilities to settle COP 2.96 t net, per day, on average, in the original cycles out of COP 10.98 b in transaction value. This represents a reduction of COP 8.02 t in the necessary liquidity and a saving of 72.5% (Graph B2.1 panel A). During the period under consideration, the minimum daily saving with this mechanism (original) was 64.5% and the maximum, 82.6%.

The percentage of liquidity savings compared to the number of cycles is illustrated in Graph B2.2. For the same set of transactions, one sees there is a negative connection between the number of cycles and the percentage of liquidity savings. In other words, the larger (smaller) the number of netting cycles, the smaller (larger) the liquidity savings.

This outcome may indicate a clear preference for fewer cycles, since including a larger number of transactions in netting cycles of this type results in greater liquidity savings. For example, a single daily cycle at the end of the day offers the greatest potential for savings. However, it is important to bear in mind two considerations:

1. The new number of cycles can prompt changes in the positions held by the participating entities. This means that savings can be achieved owing to the composition of the trading network. There could be a scenario where a group of entities with changes in position (debtor/creditor) in a new netting cycle benefit from the operability and improve aggregate savings.
2. Counterparty risk should also be considered as a criterion in defining the number of cycles, as well as the time of day when they occur.

<sup>3</sup> The exercise, starting from the moment when each of the original cycles is activated, divides the number of transactions in each cycle, assigning the original time to half of the transactions and one hour earlier to the rest. It also adds two or more cycles, assigning them the time of the last cycle that was added.

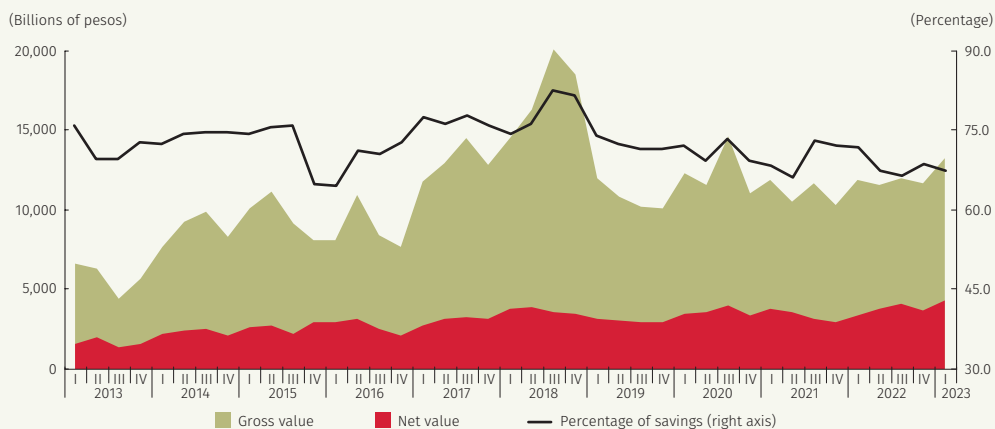
<sup>4</sup> While the database covers a period that shows changes in the number of netting cycles, odd-numbered netting days were found. The upper integer closest to their division was used to establish half the cycles on these days.

<sup>5</sup> The change in the number of transactions that can be considered in a netting cycle can alter an entity's debit/credit position and affect aggregate liquidity savings in the market as a result.

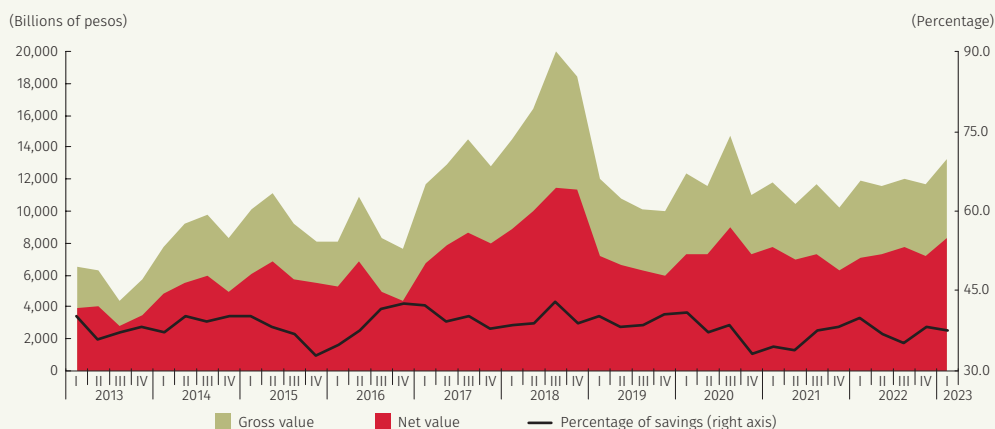
<sup>6</sup> In the year to date (Apr-2022 and Mar-2023), 1,150 transactions were settled per day, on average, using the LSF.

**Graph B.2.1**  
**DCV Liquidity Saving Mechanisms**  
**Gross, Net and Savings (quarterly average)**

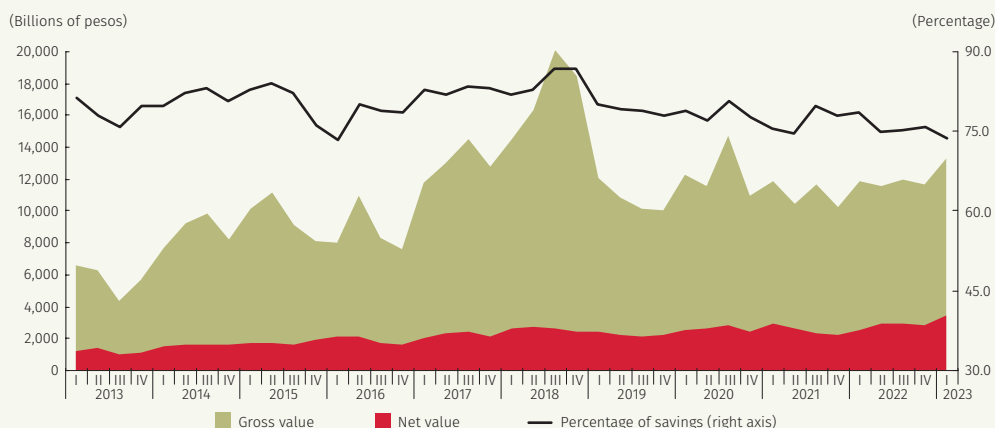
**A. Original netting cycles**



**B. Twice the original cycles**



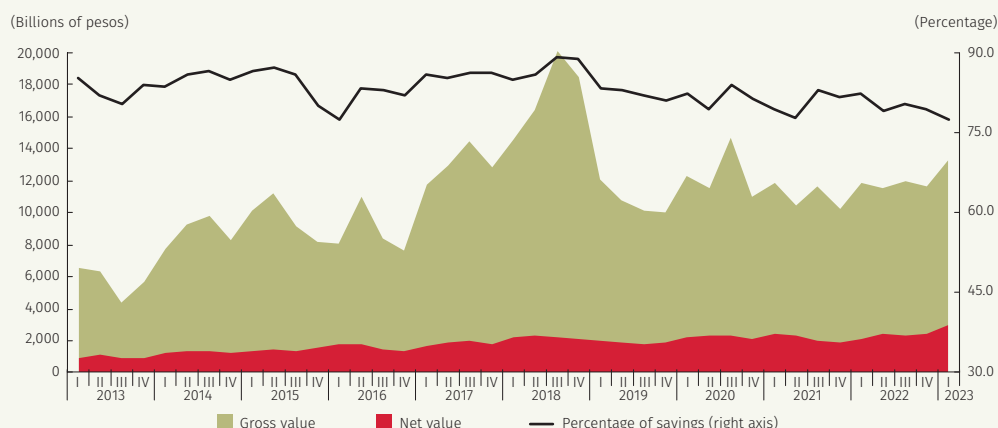
**C. Half the original cycles**



Source: DCV, DSIF calculations.

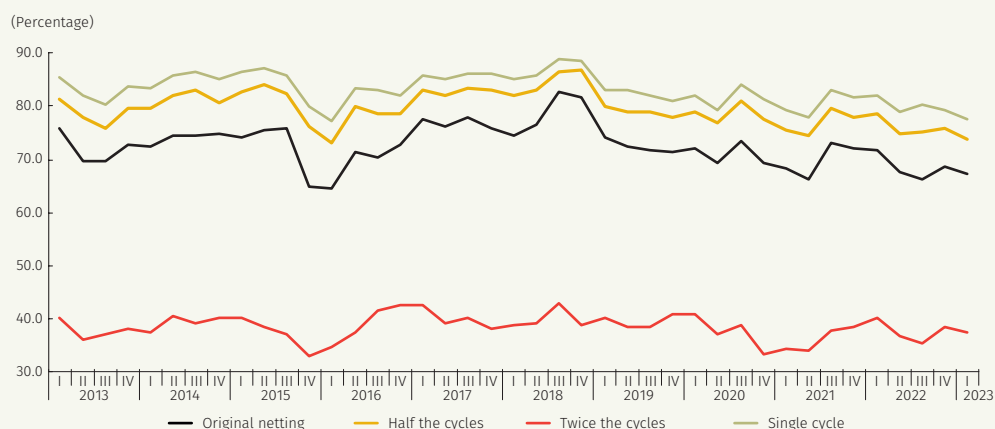
Graph B2.1 (Continued)  
DCV Liquidity Saving Mechanisms  
Gross, Net and Savings (quarterly average)

D. Single daily cycle



Source: DCV, DSIF calculations.

Graph B2.2  
DCV Liquidity Saving Mechanisms  
Percentage of savings, by number of cycles



Source: DCV, DSIF calculations.

In this sense, it is important to bear in mind that the largest number of transactions are concentrated in the 11:00 a.m. and 2:00 p.m. cycles (around 12% and 24% of daily settlement in 2022). The change in the number of cycles and, consequently, in the number of transactions considered will be fundamental in determining the extent of liquidity savings.

In fact, while the percentage of savings in the original netting scenario is 72.5%, redistributing the original transactions by doubling the number of netting cycles significantly reduces that percentage to an average of 38.3% (with a minimum of 32.8% and a maximum of 42.8%).

On the other hand, it was noted that reducing the netting cycles, by allowing more transactions to converge and increasing the possibilities for multilateral netting, boosts the percentage of savings with the DCV's optimization mechanism to 79.6% (with a minimum of 73.2% and a maximum of 86.8%) when half of the original netting cycles are performed, or to 83.1% (with a minimum of 77.3% and a maximum of 89.0%) when all the transactions are concentrated in a single cycle held at the time of the last original daily cycle.

Since settlement in the domestic market for sovereign debt is at t+0, determining the optimal number of netting cycles in terms of greater intraday liquidity savings is fundamental

in a market where the demand for liquidity is so considerable. With same-day settlement, participants have less time to obtain the funds they need to fulfill their obligations.

## 5. Final Points

These being optimization algorithms (heuristic algorithms) that resolve a set of transactions at a given time (instances), determining the number of cycles and the LSF execution times should be the result of an analysis that considers, among other factors, the changing behavior and closing times of the markets, as well as the payment patterns of the participants.

Although the results of the simulations indicate all the scenarios, both the current one and the simulated scenarios, are efficient in terms of liquidity savings compared to gross settlement, the scenario with a single daily cycle at the end of the day is the most efficient, since it brings together a larger number of transactions, but it is also the riskiest. If a net payer entity does not have a sufficient balance at the close of the cycle to cover its negative position, some of the transactions resolved in the netting cycles may go uncleared and unsettled. Furthermore, because the single daily cycle is near closing time, the response time to address liquidity shortfalls could be insufficient.

Therefore, when defining the number of netting cycles and the time they occur, it is necessary to consider both efficiency and risk. Consequently, determining the optimal cycle will depend on the period evaluated, with reference to the liquidity context in which the market finds itself, and will be based on a detailed analysis of all netting possibilities.

The cycles established in the current context (number and time of implementation) have proven to be an effective option for generating liquidity savings in the system, by helping to mitigate intraday liquidity risk, and are a viable alternative for minimizing credit risk. It will be up to the infrastructure to carefully evaluate the simulated netting options that are available to find the right balance between efficiency and risk, with the goal being to achieve an optimal and secure netting process.

## In Focus 1: Review of How Central Counterparties (CCPs) Handle Initial and Variation Margins during Periods of High Price Volatility

Central Counterparties (CCPs) use initial and variation margins to manage credit risk in the event of default by their clearing members. Initial margins cover a CCP's possible exposure to participants,<sup>1</sup> while variation margins collect, daily, the amounts owed, at current market prices for the current positions of clearing participants, so they can then be paid to creditor participants.

It is important for a CCP to establish a margin system that considers appropriate levels consistent with the risks and specific characteristics of each product it clears. Low margin requirements: that is, when scenarios of extreme price volatility, with appropriate time horizons and confidence levels, are omitted, can jeopardize a CCP's ability to manage default by its key clearing members during times of stress in financial markets. In contrast, high margin requirements can increase liquidity pressure on members during times of considerable market volatility and create challenging situations for CCPs to manage. Moreover, to avoid pro-cyclical scenarios, CCPs must have tools to mitigate the probability of exacerbating the impact of potential market turbulence. According to the *Cámara de Riesgo Central de Contraparte*, "pro-cyclicality in margin requirements is related to low requirements when financial market conditions are stable and high requirements when financial markets become more volatile, which can lead to excessively optimistic or pessimistic spirals, with undesirable effects on market participants and markets."<sup>2</sup>

Several international organizations and financial authorities have published documents to guide and recommend the construction of frameworks for determining appropriate margin levels. *Principles for Financial Market Infrastructures* (PFMI), published by the Committee on Payments and Market Infrastructures (CPMI) and the Board of the International Organization of Securities Commissions (IOSCO) in 2012, is one example.

Among these principles, a specific one was established for managing and defining the best practices for CCPs regarding margin management (Principle 6).<sup>3</sup> In 2017, this work was supplemented with an additional guide to strengthen the resilience of CCPs.<sup>4</sup> It provides advice and outlines several considerations on monitoring intra-

1 Initial margins cover the period required to settle a clearing member's open positions.

2 "Medidas para mitigar la prociclicidad en las garantías exigidas," (Measures to Mitigate Pro-cyclicality in Required Collateral), published by the *Cámara de Riesgo Central de Contraparte S.A.*, describes the tools established to manage pro-cyclicality. See: <https://camaraderiesgo.com/politicas-para-mitigar-la-prociclicidad>.

3 PRMI-Principle 6 points out what CCPs should do regarding margin requirements, the methodology to determine initial and variation margins, tests to validate margins, and payment terms, among other aspects.

4 "Resilience of Central Counterparties (CCPs): Further Guidance on the PFMI," was published in 2017 by CPMI-Iosco.

day exposure, the maximum period for closing positions, stress testing, sensitivity analysis and tools to avoid procyclicality.<sup>5</sup>

The turbulence in the financial markets at the onset of COVID-19 (February to April 2020) tested the effectiveness of margin management practices. As a result, the Basel Committee on Banking Supervision (BCBS), the CPMI and IOSCO conducted a study to examine and evaluate the regulations on these practices, the existing models for determining appropriate levels, and to identify current and structural challenges in this respect.

The results of these studies are summarized in this section, which also looks at some of the exercises developed for the Colombian case. The main findings of the studies in the international context were documented in *Review of Margining Practice* (October 2021),<sup>6</sup> a report based, in part, on a thematic summary of feedback obtained through a survey of several interest groups with a stake in the value chain in financial markets; namely CCPs, clearing members, industry associations representing certain customer segments, and financial authorities.

Overall, the report shows positive performance in initial and variation margin management practices on the part of CCPs. Due to market turbulence, CCPs had to require higher margins from their participants. However, this did not have significant negative consequences when it came to normal operation of the markets or the financial health of its participants. This is explained by the existence of appropriate margin models and efficient measures to prevent pro-cyclicality.

On the other hand, the report emphasizes the value of effective regulations and proper risk management in setting margins and underscores the need to continue to improve this practice in financial markets. It also highlights the importance of harmonizing international regulations and examines how regulations on margining have evolved in different jurisdictions. Moreover, it discusses the relevance of cooperation between regulators and market participants in supervising this practice.

As for the challenges that lie ahead, the report looks at margining practices in centrally cleared markets on five fronts and concludes with several recommendations to improve those practices, particularly by : 1) optimizing the tools CCPs offer participants for calculating possible initial and variation margins to anticipate major changes in requirements; 2) identifying gaps and standardizing the data available to financial authorities to define policies or preventive mechanisms; and 3) improving timeliness in the way CCPs collect and distribute variation margins. The main findings and challenges are summarized in Table A.

A highlight of the quantitative exercises conducted in the study is the evaluation of aggregate initial and variation margin flows, by type of asset and type of account (proprietary or client position). To assess and compare margin behavior with the Colombian case, the same period of the report by the committees and IOSCO was used, and the results selected were aggregated according to the type of account.

Regarding the behavior of initial margins (IM), the report shows that when price volatility increased, IM levels adjusted upward because the IM is designed to cover potential future risks in the event of default by the two main participants (cover 2). As to the CCPs that were evaluated, it was found they increased the total volume of required IMs by 40%, on average. Both members' proprietary accounts and client

<sup>5</sup> In the financial context, pro-cyclicality can be seen as the way the performance of market participants, including CCPs, banks and regulators, can exacerbate pressure on the markets in times of crisis. For example, a spontaneous requirement for high margin volumes from members can accentuate potential financial problems and increase the likelihood of default or payment delays.

<sup>6</sup> Committee on Payments and Market Infrastructures (CPMI); Board of the International Organization of Securities Commissions (IOSCO), and the Basel Committee on Banking Supervision (2021). "Review of Margining Practices," BIS, October.

**Table A**  
**Summary of the Main Challenges and Findings in Margin Practices between February and April 2022 and 2021**

Challenges	Findings
Increase transparency in centralized clearing markets through a CCP.	Differences were found in the tools used and offered by CCPs to their members for calculating and, to the extent possible, anticipating additional margin requirements. In March, these tools were considered to be useful; however, some clearing members and clients suggested a number of possible improvements concerning the transparency, disclosure, and functionality of these tools, which they felt would help them to overcome the challenges in anticipating margin changes.
Improve market participants' preparedness in terms of liquidity and respective information.	<p>It was found that most members or intermediaries experienced no substantial changes in their procedures. Central bank liquidity facilities and sovereign debt securities were the main sources of liquidity used by the intermediaries to cover additional margin requirements. Also, fire sale risk a/ was avoided, in part, thanks to central bank intervention to support the financial markets.</p> <p>However, it was unclear how clearing members encourage and facilitate greater readiness to access liquidity on the part of clients.</p>
Identify the gaps in regulatory requirements for information.	Gaps in information requirements were identified. For example, it was not possible to identify the main common providers of liquidity and how they are interconnected. Therefore, it is felt that gaps in regulatory information requirements need to be identified on an ongoing basis to have a more complete picture of to what extent market participants are adequately prepared to meet margin requirements. This effort could guide future policies and facilitate collaboration and the sharing of information among authorities.
Streamline the collection and distribution of variation margins (VM) in centrally cleared markets.	It was found that most members experienced no inconvenience in paying VMs. However, an international effort is recommended to promote participants' readiness to pay out mass VM calls and to identify best practices for the collection and distribution of VMs on the part of CCPs.
Assess the responsiveness of the initial margin (IM) models of centralized settlement to market stresses, focusing on the impacts and implications for the resources of CCPs and the financial system in general.	<p>Evaluate the capacity of initial margin (IM) models for centralized clearing to respond to market stress, with a focus on the impact and implications for CCP resources and those of the financial system in general.</p> <p>It was found that multiple models exist to determine IMs in normal periods and during times of market stress. These models require parameters and mechanisms for calibration that differ from one other. Therefore, the size and speed of increases in IMs change not only from one asset class to another but also within each asset class.</p> <p>Consequently, it was recommended additional work be done to understand the extent and nature of how CCP margin models respond to volatilities and other types of stress in the market. Appropriate ways to analyze, compare and establish benchmark expectations on procyclicality in different environments should be explored as well. This can be useful to authorities in identifying adjustments in the requirements of anti-procyclicality measures, in a margin period of risk (MPOR), and other parameters.</p> <p>It is also necessary to review the role of clearing members in passing on margin calls from the CCPs to clients, and to determine if this process helps to cushion or amplify margin procyclicality.</p>

a/ Fire sale risk is the possibility of negatively affecting the prices of assets received as collateral by selling those assets *en masse* in the markets, due to temporary liquidity needs. Collateral balances will lose value as a result and additional margin calls would be necessary, creating a possible vicious circle.  
Source: Bank of International Settlements, prepared by Banco de la República.

accounts experienced similar percentage increases in IM, but the extent of the disruption varied, depending on the type of asset.

In the Colombian case, the *Cámara de Riesgo Central de Contraparte S.A. (CRCC)* increased IM requirements by 30% between the start of the period and the point where the margin requirement was the highest. The reduced impact on margin requirements was due to less significant price volatilities in local markets and the mechanisms established to mitigate pro-cyclicality. To this end, the CRCC has tools to manage the large open positions of its members and a 25% buffer to cushion market stress scenarios.

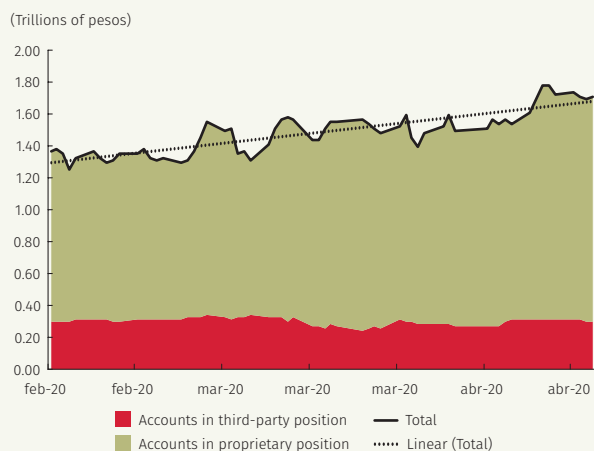
Graph A shows how the initial margins changed during the period under evaluation, when financial market volatility was at a peak (February to April 2020). The tendency in the sum of all collateral required by the CRCC from its clearing members is illustrated in the panel on the left, for both proprietary and third-party positions. The proprietary position accounts of clearing members grew steadily, while those of third parties remained stable. On the other hand, the right panel, shows the behavior of initial margins in around fifty CCPs worldwide that were studied by the committees and IOSCO. There is evidence of moderate growth in initial margins during February and part of March, followed by a peak at the end of March and the beginning of April, for both types of accounts. Overall, the slope of the trendline for initial margins is lower in the case of the CRCC compared to the CCPs in the global study.

Regarding the variation margin (VM), Graph B shows how the flows calculated at the end of the day and subsequently paid to the CCPs evolved. Daily VM requests rose from around USD 25,000 million in February 2020 to a maximum of USD 140,000 million on March 9 of the same year, which amounts to an increase of approximately 460%. This period of high volatility affected different jurisdictions and markets, with VM requests from CCPs showing a succession of peaks, each above USD 100 billion. The increases in VM began in mid-February and peaked in mid-March.

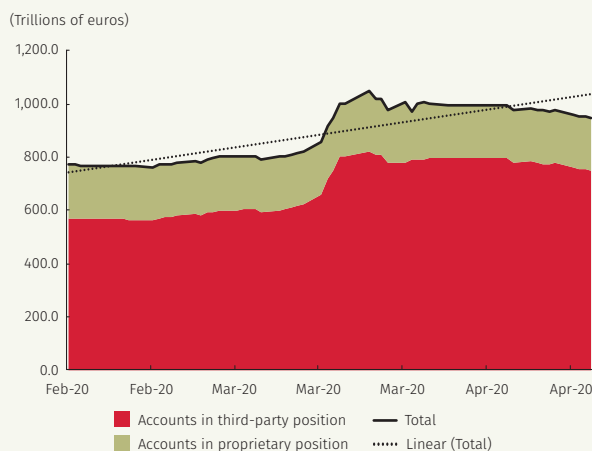
In the Colombian case, VMs were evaluated through the payments made by clearing members to the *Cámara de Riesgo Central de Contraparte S.A. (CRCC)* after daily settlement by the CRCC. The value of these payments increased during the first half of March but adjusted quickly during the second half of the month. On average, VMs

**Graph A**  
Initial Margin Requirements in Colombia and Other Jurisdictions

**1. CRCC: Initial margin requirement, by type of account**



**2. IM requirement, by type of account**



Sources: BIS, CRCC and Banco de la República.

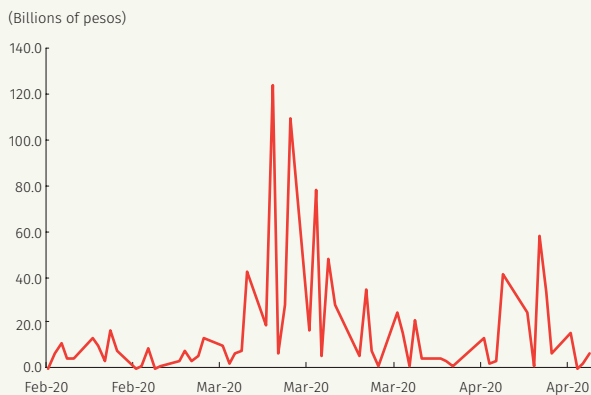
were COP6 b day in February and COP 30 b per day in March, having increased 400%, with peaks of up to COP 123 billion. It is important to clarify that some products cleared and settled by the CRCC do not require the adjustments resulting from end-of-day market price valuation to be settled daily. Instead, this payment is due only when the product matures. So, it is possible these payments coincide with the peaks in March.

Despite the significant increases in VM requirements, the CRCC experienced no delays or defaults in payments by clearing members between February and April 2020.

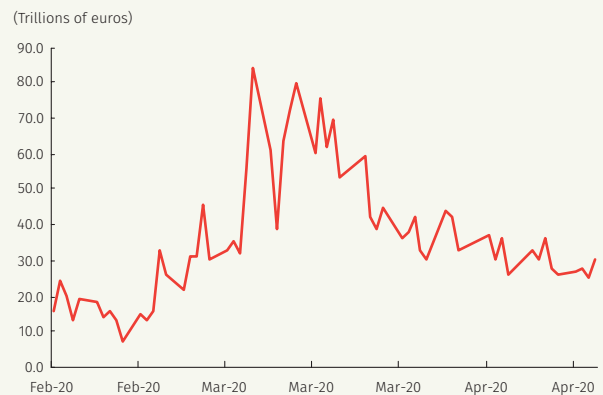
In summary, the study conducted by the international committees of the CPMI and Iosco shows positive results for good practices in managing initial and variation margins in times of high price volatility, especially during the health crisis. In Colombia, the CRCC’s margin management model proved to be resilient to financial market turbulence.

**Graph B**  
**Variation Margin Requirements in Colombia and Other Jurisdictions**

**1. CRCC: VM requirements**



**2. VM requirements, by CCPs in other jurisdictions**



Sources: BIS, CRCC and Banco de la República.

## Box 3: Special Frameworks for Orderly Settlement by Central Counterparties (CCPs): An Important Step in Systemic Risk Mitigation

Central counterparties (CCPs) play an important role in mitigating counterparty and liquidity risks in financial markets. As of the global financial crisis that began around 2007-2008, centralized clearing and settlement of derivative transactions through a CCP, especially for those traded over the counter (OTC), have been encouraged to increase transparency in the markets and to offset the effects of the manifestation of credit risk on the part of participants. As a result, CCPs have experienced steady growth in transaction clearing and settlement, and in the variety of products they manage.

Given this situation, CCPs have become players of systemic importance in most of the jurisdictions where they operate, especially in those where there is no substitute. The *Cámara de Riesgo Central de Contraparte S.A.* is a case in point.<sup>1</sup>

Disruption of the services provided by central counterparties (CCPs) could have significant systemic implications and impact financial stability, both locally and globally. This is due to several crucial factors; namely, 1) the complexity of interconnections with other CCPs and with other infrastructures in the financial market; 2) business relationships with service providers and common clearing members; and 3) market participants' reliance on CCPs to manage counterparty risks. Consequently, it is imperative for financial authorities to ensure the continuity of CCP services or, as the case may be, they should have tools and plans in place to restore a CCP's viability or to facilitate a timely and orderly settlement of member positions, while minimizing any adverse impact on the financial markets and their participants (Wenqian and Takáts (2020), Wilkes (2020), BIS (2014), Wendt (2015), and Mariño *et al.* (2020)).

A CCP may be resolved or liquidated due to member defaults or a manifestation of business risks, as highlighted by the BIS (Bank for International Settlements) in 2012.<sup>2</sup> Because the business models and risks associated with CCPs differ from those of financial institutions, it is essential to establish special or complementary procedures for CCP resolution or liquidation, as pointed out by Rodríguez and Portero in 2015.

Clear recognition of the need for differentiation within the financial industry is evident in the recommendations issued by the Financial Stability Board (FSB). Specifically, the document entitled *Key Attributes of Effective Resolution Regimes for Financial Institutions* (2014) includes an annex that outlines guidelines applicable to financial market infrastructures. This underscores the importance placed on regulating the various market participants to ensure financial stability and the protection of users within the financial system.

There is a distinct difference between credit institutions, such as banks and financial corporations, and CCPs in terms of their functions and business models. Consequently, the inherent risks associated with each of them are also different, and the strategies, powers, and capabilities of financial authorities to resolve them must address the challenges particular to each process.

<sup>1</sup> The *Cámara de Riesgo Central de Contraparte S.A.* is the only CCP operating in Colombia. It intervenes in transactions in five segments (financial derivatives, equities, fixed income, swaps, and foreign exchange). The transactions cleared and settled during 2022 were eight times GDP, while open positions at the close of 2022 represented 22% of GDP.

<sup>2</sup> General business risk refers to the potential risks and losses derived from management and operation of an FMI as a business. They are not related to default by a participant and are not covered separately by financial resources in accordance with the principles relative to credit or liquidity risk.

For example, credit institutions are involved primarily in mobilizing resources and lending, while CCPs focus on clearing and settling transactions in the financial market.<sup>3</sup> From the standpoint of the value chain in the financial market, financial institutions or financial service providers are involved in the process of negotiating transactions, either on their own behalf or on behalf of their clients, while a CCP handles post-trade processes, primarily by acting as an intermediary between the parties to the transaction, by providing central clearing, and by facilitating the final settlement of transactions or the transfer of traded assets (the principle of finality).

The focus in this section is on describing what has been achieved globally in terms of defining recovery and resolution frameworks for CCPs. The main objectives and elements to consider in CCP resolution are summarized, the regulations in the Colombian case are described and recommendations are made.

## **1. Regulatory Measures and Recommendations on Establishing Frameworks or Regimes for CCP Resolution**

### *1.1 Key Attributes of Effective Resolution Regimes for Financial Institutions (FSB 2011, 2014)*

When the FSB first adopted the Key Attributes (KAs) in 2011, it was agreed new guidance on their application would be developed to promote effective and consistent implementation across all jurisdictions, given the need for adaptation to different national legal systems and market environments, as well as specific sector considerations (e.g., insurance, financial market infrastructures, etc.). The aim of the document is to assist countries in fostering robust resolution frameworks that can address financial crisis and minimize its impact on the overall economy.

In October 2014, the FSB adopted additional guidance that elaborates on specific KAs with respect to an exchange of information for resolution purposes and sector-specific guidance outlining how the KAs should be applied to insurers, financial market infrastructures (FMIs), and the protection of client assets immersed in resolution.

The newly adopted guidance documents have been included in the new version as attachments (supplements). The KAs are still the general standard for resolution regimes that cover financial institutions of all types, which could be of systemic importance in the event they fail. However, FMIs should be subject to resolution regimes that apply the objectives and provisions of the KAs appropriately to each FMI and to its critical role in the financial markets.

The supplement on the resolution of FMIs<sup>4</sup> defines them as infrastructures that facilitate the transfer of funds or securities among participants in the financial market. These include payment systems, CCPs, central securities depositories, and other infrastructures of a similar nature. The resolution of an FMI is linked to its ability to maintain its operations in the event of a financial crisis or failure in the system. The supplement also confirms the principles and practices FMIs and their participants should follow to ensure the stability and resilience of the financial system and provides recommendations to guarantee that FMIs have effective resolution plans and are prepared to address any contingency.

In general terms, the document is intended to supplement the considerations defined in the Principles for Financial Market Infrastructures (PFMI) (BIS 2012) and the interpretation of certain elements established in the Key Attributes (KAs) for the resolution of financial market infrastructures (FMIs), depending on what services they provide to the markets. The assumption is that all FMIs are systemically important or critical, at least within the jurisdictions where they are located.

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3 CCPs support trade clearing and settlement processes with models for managing and mitigating credit and liquidity risks, optimizing collateral, and managing default through a robust scheme with lines of defense and cascade or security rings.

4 The key attributes and guidance in the annex do not apply to FMIs that are owned, managed, and operated by central banks.

## 1.2 Framework for the Recovery and Resolution of Central Counterparties in the European Union

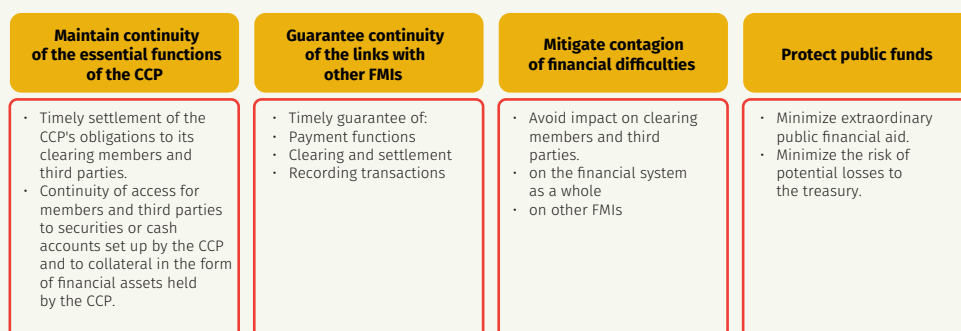
The European regulation is a reference point in regulatory progress towards strengthening financial market infrastructures (FMIs) and, specifically, the rules on plans for CCP recovery and resolution. In this sense, the European Parliament and the Council of the European Union, in coordination with the financial authorities of EU jurisdictions, have established regulations on the operation of CCPs, their required capital, risk management frameworks, and default management, among other aspects. To that end, they have published regulations regarding over-the-counter derivatives, central counterparties, and trade registers (EU-No 648/2012), as well as technical standards on the requirements for central counterparties (EU-152/2013 and EU-153/2013).

These regulations express their interest in enhancing the resilience of CCPs, and financial markets in general, to the wide range of risks managed and concentrated in CCPs. However, they also indicate that no system of rules and practices can prevent existing resources from being inadequate to manage the risks a CCP faces, including one or more instances of default by its clearing members. In the event of severe financial difficulties or imminent insolvency, financial institutions should, in principle, be subject to ordinary insolvency procedures. However, as revealed by the 2008 financial crisis, and especially during a prolonged period of economic instability and uncertainty, such procedures can disrupt functions that are vital to the economy and jeopardize financial stability as a result.

Ordinary corporate insolvency procedures might not always ensure a sufficiently fast intervention or appropriately prioritize continuity of the essential functions of financial infrastructures to preserve financial stability. Therefore, it is necessary to establish a special framework for CCP resolution to prevent these negative consequences when ordinary insolvency procedures are applied.

This being the case, the previous regulation was reinforced in 2020 through the issue of a new one on recovery and resolution frameworks for central counterparties (EU 2021/23 of 16 December 2020). The purpose of a framework for recovery and resolution is to ensure, to the extent possible, that CCPs establish measures to recover from financial difficulties, to ensure the essential functions of CCPs that are unviable or likely to be unviable are maintained, to preserve financial stability and to prevent a major adverse impact on markets and payment systems or events with systemic implications (Diagram 3.1).

Diagram B3.1  
Main Objectives of Recovery and Resolution Plans in the European Union



Source: European Securities and Markets Authority (ESMA); prepared by Banco de la República.

The framework for recovery and resolution strengthens the extent to which authorities and CCPs are prepared to mitigate financial difficulties and enables the authorities to better understand the measures adopted by CCPs to address stressful situations. It also grants them special powers to prepare for the possible resolution of a CCP and to address its deterioration in a coordinated way, thereby contributing to the smooth functioning of financial markets and avoiding or minimizing the need to use public resources.

Table B3.1 describes the key points in the regulation on the recovery and resolution framework for CCPs in Europe. The importance of enhancing strategies to ensure the continuity of CCP services through recovery mechanisms<sup>5</sup> or by transferring services to another CCP is emphasized, as is the need to establish competent collegial bodies for transparent and timely CCP resolution, and the search for tools to prevent a systemic event that could lead to the use of public resources.

### 1.3 Framework for the Recovery and Resolution of Central Counterparties in the United States

The Code of Federal Regulations (CFR) and the Commodity Futures Trading Commission (CFTC) set the rules applicable to CCPs in terms of compliance with the Principles for Financial Market Infrastructures (PFMI) and the establishment of recovery and resolution plans for infrastructures of this type.<sup>6</sup> These plans are regarded as fundamental elements of risk management and planning for contingencies that could threaten the viability and financial soundness of a CCP. A recovery plan helps a CCP to better understand, in advance, the scenarios that would lead to unhedged credit losses or liquidity shortfalls and how to manage the challenges it would face. On the other hand, a resolution plan establishes strategies for orderly liquidation and would be used in a situation where recovery is not possible.

The Federal Deposit Insurance Corporation (FDIC) is the authority empowered<sup>7</sup> to draw up the resolution plan. Resolution must be conducted in accordance with applicable state or federal law, including the United States Bankruptcy Code, without causing severe adverse effects on the financial stability of the United States.

In addition, the Clearing and Risk Division of the CFTC issued a memorandum with instructions and considerations for CCPs on how to define procedures or plans for their recovery and resolution. Importantly, the memorandum contemplates involving various stakeholders (such as clearing members, interconnected infrastructures, etc.) in reviewing, adjusting, and updating these procedures.

As a starting point for local debate, Table B3.2 outlines the main considerations for processes to liquidate a financial institution and a CCP. There is no standard in this respect because each jurisdiction establishes its own processes, depending on the structure of its financial systems and its institutional arrangements. When comparing these processes, it becomes evident that CCP resolution can be more challenging. On the one hand, this is because a larger number of actors (clearing members, various financial authorities, clients, third countries, etc.) are involved in post-trade processes. On the other hand, there is the complexity of settling transactions for some of the financial products that CCPs clear and settle (such as financial derivatives).

The progress in regulations for the recovery or liquidation of a CCP reflects the importance of these infrastructures for financial stability and, therefore, the relevance of preserving the continuity of the services they provide. While the complexity of interconnections between multiple CCPs and possibly the presence of common clearing members and clients requires greater oversight and monitoring to mitigate contagion, the impact on CCPs that have no substitutes in the jurisdictions where they operate is also significant. The following is a summary of the Colombian regulations in this regard.

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5 Mechanisms for restoring a CCP's viability include requirements for resources from non-defaulting clearing members and shareholder recapitalization (bail-in).

6 See Title 17, Part 39: *Recovery and Wind-down for Systemically Important Derivatives Clearing Organizations and subpart C: Derivatives Clearing Organizations*.

7 Title II of the Dodd-Frank Act gives it the faculties of a settlement authority.

Table B3.1  
Key Considerations for CCP Recovery and Resolution Frameworks in Europe

Challenges	Findings
Resolution authorities	<p>Each member state shall designate one or more resolution authorities who are permitted to apply the tools for resolution and exercise resolatory powers. These authorities shall have the necessary expertise, resources, and operational capacity to implement the measures for resolution and shall exercise their powers with the speed and flexibility necessary to achieve the objectives of resolution.</p> <p>Resolution authorities shall be national central banks, competent ministries, public administrative authorities, or other agencies that are given government administrative powers.</p> <p>When it is necessary to assign more than one authority, it is important to limit the scope of each authority, and to define mechanisms for coordination and mechanisms to avoid conflicts of interest.</p>
Collegiate bodies of resolution authorities	<p>The CCP's resolution authority shall establish, manage, and chair a collegiate body of resolution authorities charged with creating and designing the resolution plan and ensuring cooperation and coordination with the authorities who are members of that body and, where appropriate, cooperation with the competent authorities and the resolution authorities of third countries.</p> <p>Its functions also include assessing the possible dissolution of CCPs and coordinating measures for communication with the public. It establishes rules to operate smoothly. This includes convening and chairing meetings and coordinating information and communication among the members. Powers are delegated to supplement the regulations by adopting technical regulatory standards for the coherent functioning of collegiate bodies of resolution authorities across the EU.</p>
Recovery plans	<p>It will always be in the best interest of the system for a CCP to recover rather than to be liquidated. Therefore, these rules stipulate, in detail, the considerations for developing and maintaining a recovery plan that defines the measures to be adopted, whether in the event of default or non-default or a combination of both, to restore a CCP's financial soundness without involving any extraordinary financial support from the public sector.</p>
Resolution plans	<p>Among other aspects, the regulations outline, in detail, the features of the resolution plan, the decision-making processes, and how resolution is to be done. Importantly, the resolution plan is structured to feature an assessment of:</p> <ul style="list-style-type: none"> <li>- The CCP's lack of feasibility, including situations involving general financial instability or factors that affect the entire system, due to default by its members or for reasons of corporate unviability.</li> <li>- How execution of the resolution plan would affect the clearing members and their clients, other related financial infrastructures, the financial markets and the financial system of any member state or the EU on the whole.</li> <li>- The manner and circumstances in which a CCP may request to take advantage of the facilities offered by the Central Bank on conventional terms with respect to collateral, maturity, and interest rates, and determination of the assets that could serve as collateral.</li> <li>- The possible instruments for resolution; for example, the allocation of losses and positions, amortization and conversion of assets, sale of the business and creation of a bridge CCP.</li> </ul>

Source: European Securities and Markets Authority (ESMA); prepared by Banco de la República.

Table B3.2  
Key Considerations in the Resolution Processes of a Financial Institution and a CCP

	Financial entity	CCP
Recovery plan	There are instances prior to the ultimate liquidation of an entity. A government takeover is one example.	CCPs have tools to recover losses not covered by the safety rings, including the power to call for additional resources from their members, to set haircuts on positive variation margins and, ultimately, to use the CCP's equity.
Announcement of resolution	The supervisor of the financial system is often the authority charged with announcing the liquidation of a CCP.	The supervisor of the financial system is often the authority charged with announcing the liquidation of a CCP.
Assignment of the liquidation authority	The supervisor assigns the appropriate authority to carry out the liquidation. It is common for institutions responsible for securing savers' deposits to fulfill this function.	Each jurisdiction assigns the liquidation authority and establishes a collegiate body that comprises representatives of liquidating members, clients, interconnected financial infrastructures, and other financial authorities, to advise decision-making.
Design and implementation of the liquidation plan	The liquidation authority defines the guidelines for liquidating a CCP, and the supervisor oversees the liquidation processes.	<p>"The settlement authority defines the guidelines for executing the liquidation. However, the collegiate body reviews, proposes adjustments, and approves the resolution plan.</p> <p>The plan includes the following elements:</p> <ul style="list-style-type: none"> <li>- Corporate restructuring of the CCP</li> <li>- The possibility of transferring the open positions to another CCP</li> <li>- Coordinating liquidation processes with other interconnected infrastructures and ensuring that operations are finalized.</li> <li>- Coordinating with third countries, if the CCPs provide services in other jurisdictions.</li> <li>- Early close-out of open positions in an orderly manner and at appropriate times so as not to affect the markets (particularly those that require a transfer of securities) or jeopardize financial stability.</li> <li>- Cooperation with other authorities to facilitate or eliminate obstacles in the liquidation process."</li> </ul>
Determining the property to be liquidated	The liquidation authority calculates the assets to be liquidated and implements a plan to prioritize the creditors.	How the losses incurred in liquidation are managed will depend on whether the reason for liquidation was non-compliance by the clearing members or if it was due to other reasons, including poor corporate management.

Source: Prepared by Banco de la República.

## 2. Regulatory Measures in Colombia on CCP Liquidation

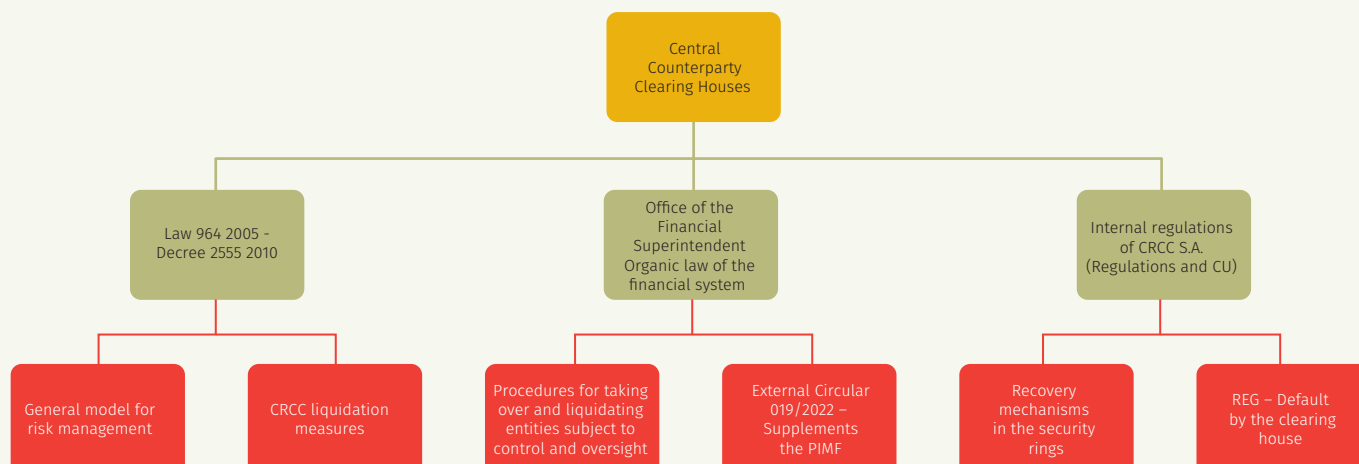
The regulations governing CCPs in Colombia are shown in Diagram B3.2. They are known locally as central counterparty clearing houses (CRCC). In the event of potential liquidation or resolution, these CCPs are regulated in three ways:

On the one hand, the National Government issues regulations, through laws and decrees, on the operation and requirements for establishing and operating CRCCs.

The Office of the Financial Superintendent of Colombia (SFC) has the authority to supervise procedures for taking over and liquidating the entities under its control and supervision, when necessary.

In its internal regulations, the *Cámara de Riesgo Central de Contraparte S.A.* has provisions for an eventual corporate liquidation.

Diagram B3.2  
Colombian Regulations on CCPs



Source: SFC and CRCC; prepared by Banco de la República.

The first set of norms corresponds to Law 964 of 2005, which gives life to these types of entities, and to Decree 2555 of 2010, through which regulations on the financial, insurance, and securities sectors, among others, are compiled and reissued. These regulations include rules applicable to CRCCs and provide several recommendations for measures in the event of their liquidation. Specifically, they indicate that surplus resources owned by third parties shall not be part of the assets subject to liquidation and are to be returned to the respective counterparties once all the open positions are settled.

The second set of regulations refers to Decree 663 of 1993, known as the Organic Statute of the Financial System (EOSF). It sets the rules for entities that are under the control and supervision of the Office of the Financial Superintendent of Colombia (SFC) and determines the procedure for their takeover and liquidation.<sup>8</sup> The primary objective is to protect the financial system and depositors and savers, to ensure they are able to receive payment for their claims from the assets of the entity and, if necessary, from the deposit insurance. In addition, it assigns the Financial Institutions Guarantee Fund (Fogafin) the task of appointing a special agent, who may be a person or a legal entity, and may act during the initial stage, management, or liquidation. The agent may also have an advisory board with creditor representation, as determined by the government. In any case, the SFC will oversee the liquidation process for these entities.

On the other hand, External Circular 019 of 2022 issued by the SFC requires infrastructure providers, including CRCCs, to comply with the PIMF that apply to them, based on their corporate purpose and the activities they carry out. They must undergo review and self-assessment processes regarding their compliance with these principles. If deemed necessary, they will have to decide on action plans to follow. These self-assessments must be conducted at least every three years and published on each entity's website.

Last but not least, the internal regulations<sup>9</sup> of the only CCP operating in Colombia; that is, the *Cámara de Riesgo Central de Contraparte S.A. (CRCC)*, contain a specific chapter on episodes of clearing house default that outlines the procedure for early settlement of all the open positions of clearing members and their clients if the clearing house is unable to meet its obligations to its members or in the event of a takeover announcement by the SFC aimed at liquidating the clearing house.

In summary, there are various regulations in Colombia that guide the resolution of a CRCC on different fronts, with the EOSF serving as the general framework for the resolution or liquidation of all entities that are under the SFC's authority. However, there is no specific framework for infrastructure providers and, specifically, for the CRCC. Given the differences

<sup>8</sup> CRCCs are regarded as infrastructure providers that are subject to SFC control and oversight.

<sup>9</sup> The regulations on the operation of CCPs in Colombia must be authorized by the SFC.

between the business models of financial institutions and those of CCPs, and their inherent risks, as outlined in this section, the appropriateness of creating a specific model within the EOSF for resolution and recovery of the CRCC in Colombia needs to be evaluated.

### 3. Conclusions and Recommendations

The business models and inherent risks associated with the activities carried out by financial institutions and central counterparties (CCPs) are different. Consequently, the impact of a disruption in their services varies, depending on the substitutability of the institution and the potential negative impact on market stability and, eventually, on the economy. Therefore, it is necessary to have recovery and resolution frameworks that consider the complexity of resolution for each type of entity.

Regulatory headway in some jurisdictions and recommendations from international organizations recognize the importance of developing a special recovery and resolution framework for CCPs. These directives are aimed at maintaining the stability and normal functioning of the financial market and, therefore, on preventing events with systemic implications when resolving a CCP.

In Colombia, despite clear progress towards analyzing and regulating these entities, there is still no specific recovery and resolution framework for CCPs. On one hand, the CRCC has tools for the early settlement of open positions, according to the terms approved by the SFC in its operating regulations. On the other, the EOSF stipulates the rules and procedures for taking control and liquidating entities that are under the SFC's authority, including financial service providers and infrastructure providers (i.e., CCPs).

It is recommended the convenience of harmonizing the current rules on CCP resolution in Colombia be assessed by creating a framework for recovery and resolution or liquidation of the CRCC. This is because of the complexity of coordinating an orderly process for settling open positions in CCPs. It also is suggested the feasibility of creating an advisory body comprised of the various financial authorities, representatives from other interconnected infrastructure providers, and representatives of the clearing members be considered. These matters could be discussed with all the other financial authorities within the framework of the Financial System Coordination and Monitoring Committee.

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## Box 4: High Levels of Cyber Resilience as a Key Factor for the Stability of Financial Infrastructures

### 1. Introduction

In view of the growing dependence on information and communication technology (ICT), cyber security and cyber resilience are now a priority in all sectors, particularly in the financial industry.<sup>1</sup> Cyber threats are becoming more frequent and sophisticated,<sup>2</sup> and affect the various actors within the financial system, such as financial market infrastructures (FMI), jeopardizing their stability and integrity. Due to their potential impact on financial stability, these cyber threats have become a major concern for economic authorities (Doerr et al., 2022).

Given the crucial role FMIs play in financial stability by facilitating the settlement and clearing of financial market transactions, ensuring their normal and secure operation is of utmost priority to financial authorities. FMIs must mitigate their exposure to numerous risks, including cyber risks, and enhance their resilience as a result, if they are to guarantee their continuous and stable functioning.

This section outlines a conceptual framework for cyber-risk analysis, focused specifically on FMIs. It describes the concerns of financial authorities and the action they likely will take to strengthen cyber resilience in FMIs and the in financial sector in general. There are five parts to this section, in addition to the introduction. The second part looks at the international standards established for cyber-management and resilience in FMIs. The third outlines the most common types of cyberattacks financial institutions face, especially FMIs. The ways in which cyber risk has the potential to impact financial stability are explained in the fourth part, while the fifth contains a compilation of actions taken globally and in Colombia, by both financial authorities and the private sector, as well as multilateral organizations. The sixth part contains conclusions and recommendations.

### 2. International Standards on Cyber-risk Management and Cyber Resilience in FMIs

The safe and efficient operation of financial market infrastructures (FMIs) is essential to maintaining and promoting financial stability and economic growth. If FMIs do not manage their risks properly, including cyber risks, they can become sources of financial shocks such as liquidity mismatches and credit losses, or channels through which these shocks are transmitted in national and international financial markets. In this context, the level of cyber resilience of FMIs contributes to the continuity of their services and can be a decisive factor in the overall resilience of the financial system and the general economy.

1 Although the terms “cyber security” and “cyber resilience” may seem synonymous, since they both are related to protection against cyberattacks, their actions, tools and objectives differ. Simply put, while “cyber security” refers to the collection of technologies and actions undertaken to mitigate security risks, the concept of “cyber resilience” is understood as an organization’s ability to recover data, avoid service interruption, mitigate overall damage and, at the same time, ensure successful recovery from adverse cyber events.

2 In the reports on future risks published by AXA for the last five years (2018-2022), cyber security has been among the top three risks, according to the results of a survey of experts and the general public. The high dependence on technology in our lives makes cyber-security risks, like health, an enduring concern. Also, current geopolitical tensions directly fuel worries about cyber risks. In the 2022 report, the main concerns voiced by experts with respect to cyber risk were: shutdown of essential services and critical infrastructure, identity theft (personal and corporate), and cyber extortion and ransomware (data hijacking). The members of the public who were surveyed shared the experts’ first two concerns and included privacy breaches as an additional one. See: [https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com/15c65a87-4d11-49a4-b88e-be5953965b37\\_axa\\_futurerisksreport\\_2022\\_va.pdf](https://www-axa-com.cdn.axa-contento-118412.eu/www-axa-com/15c65a87-4d11-49a4-b88e-be5953965b37_axa_futurerisksreport_2022_va.pdf).

The Principles for Financial Market Infrastructures (PFMI), published in April 2012 by the Committee on Payments and Market Infrastructures (CPMI) and the Technical Committee of the International Organization of Securities Commissions (IOSCO) (CPMI-IOSCO 2012), defined the primary policy objective as “enhancing the safety and efficiency of payment, clearing, settlement, and recording arrangements, and, in so doing, limiting systemic risk and fostering transparency and financial stability.” As for cyber risk, the PFMI recognized that it falls within the category of operational risks and determined that an FMI must have governance arrangements and objectives to deal with cyber risks through a comprehensive framework for risk management.

In June 2016, CPMI-IOSCO (Committee on Payments and Market Infrastructures - International Organization of Securities Commissions) published “Guidance on Cyber Resilience for Financial Market Infrastructures” (hereinafter referred to as the guide). It specifically addresses cyber risk and provides recommendations on how financial market infrastructures (FMIs) can enhance their cyber resilience in an effort to mitigate the growing hazard cyber risks pose to financial stability. Cyber resilience is defined in the guide as “the ability of an FMI to anticipate, withstand, contain, and rapidly recover from a cyberattack.”

Specifically, the CPMI-IOSCO guide (2016) offers orientation and advice to supplement the PFMI but does not pretend to impose further standards on FMIs, beyond those established in the PFMI. Instead, it provides additional details concerning the measures FMIs must take to improve their cyber-resilience capabilities. This supplementary orientation focuses primarily on the PFMI in the context of governance (Principle 2), the framework for comprehensive risk management (Principle 3), finalizing settlement (Principle 8), operational risk (Principle 17), and FMI links (Principle 20).<sup>3</sup>

The guide defines<sup>4</sup> cyber risk as: “the combination of the probability of an event occurring within the domain of an organization’s information assets, computer and communications resources, and the consequences of that event for an organization.” It identifies several unique characteristics of cyber risk, such as: 1) the persistent nature of a campaign conducted by a motivated attacker (malicious attack); 2) the existence of a wide range of entry points through which an FMI could be compromised (FMI participants, associated FMIs, service providers, vendors, vendor products, and careless and/or dishonest employees); 3) cyberattacks that can render some risk management and business continuity arrangements ineffective (automated systems and arrangements for replicating contaminated data); and 4) furtive cyberattacks that spread rapidly within a network of systems (exploiting unknown vulnerabilities and weak links in systems and protocols to cause disruptions and/or infiltrate an FMI’s internal network).

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3 Principle 2. Corporate Governance: An FMI should have governance arrangements that are clear and transparent, promote the safety and efficiency of the FMI, and support the stability of the broader financial system, other relevant to public interest considerations, and the objectives of relevant stakeholders.

Principle 3: Comprehensive Risk Management Framework: An FMI should have a sound risk management framework for comprehensively managing legal, credit, liquidity, operational and other risks.

Principle 8: Finality of settlement: An FMI should provide clear and certain final settlement, at a minimum by the end of the value date. Where necessary or preferable, an FMI should provide intraday or real-time final settlement.

Principle 17. Operational Risk: An FMI should identify the plausible sources of operational risk, both internal and external, and mitigate their impact through the use of appropriate systems, policies, procedures, and controls. Systems should be designed to ensure a high degree of security and operational reliability and should have adequate scalable capacity. Business continuity management should aim for timely recovery of operations and fulfillment of the FMI’s obligations, including in the event of a wide-scale or major disruption.

Principle 20. FMI links: An FMI that establishes a link with one or more other FMIs should identify, monitor, and manage link-related risks.

4 An alternative definition is the one in the Cyber Lexicon of the Financial Stability Board (FSB), where cyber risk refers to “the combination of the probability of occurrence of cyber incidents and their impact,” and where a “cyber incident” is understood as “any observable occurrence in an information system [...] that: (i) compromises the cyber security of an information system or the information that the system processes, stores, or transmits; or (ii) violates security policies, security procedures, or policies on acceptable use, whether or not as a result of malicious activity.”

The guide recommends financial institutions implement a cyber-resilience framework that aligns with the dynamic nature of cyber risks and promotes a culture of cyber-risk awareness. Financial institutions should implement the guide, through a risk-based approach, and develop specific plans to enhance their capabilities, including achieving the objective of a two-hour recovery time.

Understanding the financial stability vulnerabilities that derived from cyber incidents is essential, as Brando *et al.* (2022) argue. While capital and liquidity may be enough to address episodes of financial loss, they are inadequate to accelerate the process of recovery in systems or data in the event of a cyber incident.

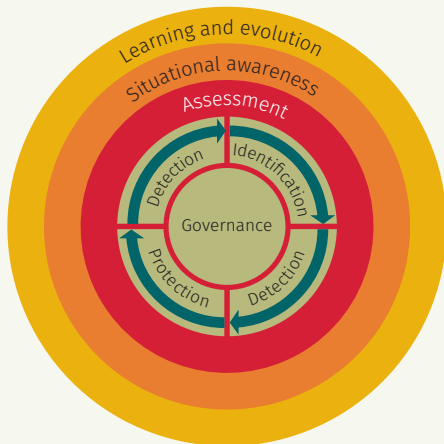
The systemic ramifications when cyber risk materializes can surpass those of operational risk because, as acknowledged by Brando *et al.* (2022), reactions such as forced sales, liquidity freezes, potential solvency issues, and the restoration of normal payment flows can evolve differently after a cyber shock. A cyber incident in a financial institution can compromise its data and its ability to serve creditors, causing customers to move to other institutions out of fear of losing access to their accounts.

For its part, the CPMI-Iosco (2016) guide provides FMIs with orientation (Diagram B4.1) on cyber resilience, and recommends they include, as categories within their risk management: strong governance, identification of critical functions and assets to be protected, confidentiality protection, integrity, and availability of an FMI’s assets and services, cyber incident detection, and the safe resumption of critical operations within two hours.

Additionally, the CPMI-IOSCO guide (2016) advises FMIs to incorporate the following general components when defining their cyber-resilience framework:

- a. Tests: The elements of an FMI’s cyber- resilience framework must be tested rigorously to determine their overall effectiveness.
- b. Situational awareness: FMIs must monitor the cyber-threat landscape proactively and use threat information to validate risk assessments and mitigation strategies.
- c. Learning and evolving: FMIs must implement an adaptable cyber-resilience framework that evolves with the dynamic nature of cyber risks.

Diagram B4.1  
Component of the Cyber-resilience Guide



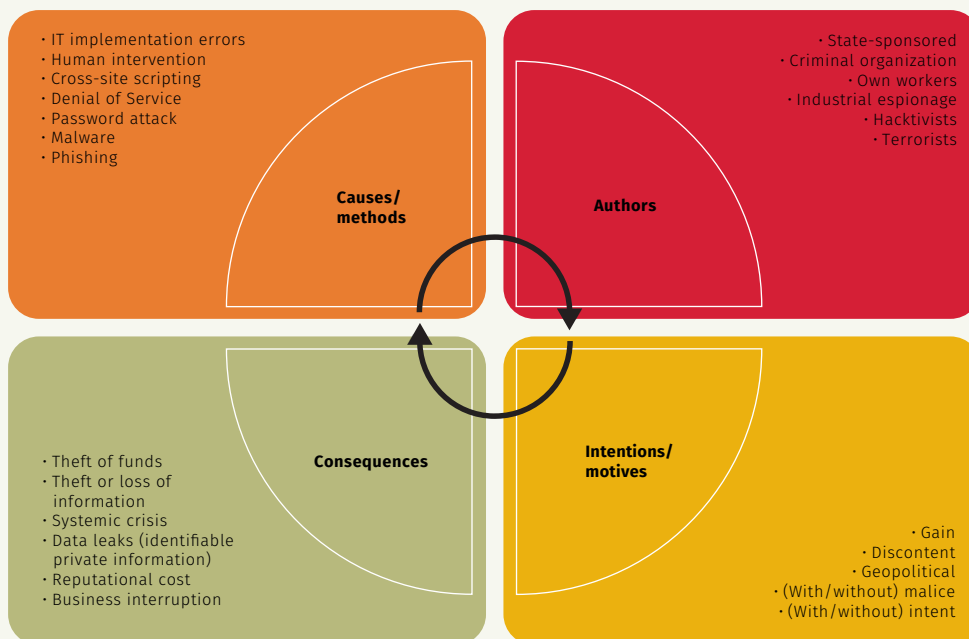
Source: CPMI-Iosco (2016).

### 3. Taxonomy of Cyber Risk in the Financial System

The cyber risk faced by financial institutions and FMIs can be classified according to the simple taxonomy proposed by Aldasoro *et al.* (2022), which considers four categories: causes/methods, actors, motives/intentions, and consequences (Diagram B4.2).

Causes include both unintended incidents and intentional attacks. For example, in the financial sector, this category includes the accidental disclosure of data and errors in the implementation, configuration, and processing of ICT. The most common methods used for cyberattacks on the financial system are ransomware, data theft, malware, cross-site scripting, identity theft (phishing), password decryption, and denial-of-service attacks.

Diagram B4.2  
Simple Taxonomy of Cyber Risk



Source: Aldasoro et al. (2022).

The players involved in cyber risks include those sponsored by the state,<sup>5</sup> criminal and terrorist organizations, industrial spies, and hacktivist groups (such as Anonymous). As for intent, according to Aldasoro et al. (2020), approximately 40% of cyber incidents are intentional and malicious rather than accidental. They may be driven by profit motives (e.g., ransomware, industrial espionage), geopolitical aims (state-sponsored attacks on critical infrastructure), or a general expression of discord.

According to Doerr et al. (2022), based on a survey of members of the Global Cyber Resilience Group (GCRG) in 2021,<sup>6</sup> central banks consider phishing and social engineering to be the most common methods of attack, and believe that potential losses from a cyberattack can become systemically significant when directed to technology companies that provide digital services to critical cloud infrastructures, more than traditional financial services.

5 A state-sponsored cyberattack is a form of defense strategy adopted by nations to attack the governments, critical infrastructure, and civil society of hostile states. The governments of North Korea, Russia and Ukraine are famous for attacks of this type.

The U.S. Treasury Department acknowledges that, in the case of North Korea, the Lazarus, Bluenoroff and Andariel groups operate as government-controlled agencies. The Lazarus group specializes in attacks on government, military, financial, manufacturing, publishing, media, entertainment, and international shipping companies, as well as critical infrastructure, using tactics such as cyber espionage, data theft, monetary heists, and destructive malware operations. This group was involved in the ransomware known as Wannacry 2.0 in 2017, which affected 150 countries and shut down approximately three hundred thousand computers. The Bluenoroff group was formed by the North Korean government to illicit revenue in response to increased global sanctions. Together with Lazarus, it stole USD 80 million from the Bank of Bangladesh using credentials heisted from the Swift system. Andariel focuses on malicious cyber operations against foreign companies, government agencies, financial services infrastructure, corporations and private businesses, as well as the defense industry. This group was identified in the attempt to rob bank card information by hacking ATMs to withdraw cash or steal customer information and then sell it on the black market, it has also been responsible for developing and creating unique malware to hack online gambling and poker sites to steal cash. Retrieved from <https://home.treasury.gov/news/press-releases/sm774>

State-sponsored attacks of this type have increased during the Russia-Ukraine war and have also gained prominence in the wake of the Covid19 pandemic. Russian cyberattacks in 2022 targeting NATO countries and Ukraine were four and three times, respectively, those recorded in 2020.

6 Comprised of 19 central banks from nine advanced economies and twelve emerging market economies.

In the same survey, Doerr *et al.* (2022) found that central banks in advanced economies are more concerned about supply chain attacks<sup>7</sup> than their counterparts in emerging market economies. When it comes to the costs resulting from an attack, central banks agree that persistent advanced malware and ransomware attacks rank at the top of the list. In attributing attacks, central banks in advanced economies view organized crime and state-sponsored malicious groups as the main culprits, while those in emerging market economies consider organized crime and individual hackers to be the primary perpetrators.

Cyber incidents can have both monetary and reputational consequences for FMIs, which can result in a loss of funds, confidentiality breaches, and service unavailability. Malicious attacks designed as fraud and theft can lead to the loss of funds or data. Cyberattacks on FMIs can be particularly concerning due to the pivotal role these infrastructures play in the financial system and the broader economy. These attacks have the potential to trigger systemic impacts and cause important economic consequences, ultimately affecting financial stability.

#### 4. Cyber Risk as a Source of Financial Vulnerability

Cyber risk is a cause for growing concern in relation to FMIs and its impact on financial stability. The central role FMIs play in the financial system makes them a pivotal and highly interconnected component. The fact that they rely heavily on information and communication technology exposes them to major cyber risks that can trigger systemic effects on participants, other FMIs, and financial markets. Cyber risk in FMIs and financial institutions has the potential to significantly impact financial stability due to factors such as the following:

1. Propagation throughout the financial system: Cyberattacks can spread through complex and often unrecognized links between companies. These connections stem from the use of shared technology, third-party service providers, and the networks formed between financial institutions through payments and through counterparty risk exposure (Brando *et al.*, 2022). According to Adelman *et al.* (2020), successful cyberattacks on FMIs in the financial system occur because these infrastructures, by facilitating clearing and settlement functions, establish links to participants that are responsible for large volumes of daily transactions in different markets, and are highly dependent on technology. Such attacks can have ripple effects on other direct participants, other FMIs, their clients, and the markets.
2. Market concentration: The increase in market concentration, driven by digital economies of scale or other market forces, can create critical failure points and greater vulnerability to cyber crises in the financial system. This is evident in key services such as clearing and settlement, as well as in the provision of cloud service. Furthermore, the rise in transactions cleared through central counterparties (CCPs) represents an increased cyber vulnerability risk due to the concentration of this activity within a single entity and its dependence on investment in cyber resilience.
3. Nature of the intent behind cyberattacks: There can be different reasons for cyberattacks. Some are financially motivated, while others, backed by nation-states with cyberattack capabilities, are intended to cause maximum damage. In the case of state-sponsored attacks, the goal may be to disrupt or suspend the operations of the target system for extended periods. If there are fewer redundancies or if suitable substitutes for FMIs or financial institutions are lacking, this situation can make the financial system more vulnerable, even with a substantial investment in resilience, and can lead to greater contagion.

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<sup>7</sup> When a cyberattack targets the supply chain, the perpetrator infiltrates a legitimate software vendor's network and, through malicious code, compromises the software before the vendor distributes it to its customers. These attacks take advantage of the trust and machine-to-machine communications involved in critical software updates. Because they are difficult to mitigate, they target both service providers (e.g., the 2020 attack on the software and network infrastructure company SolarWinds) and key technology (e.g., Microsoft Exchange servers in 2021). Supply chain attacks are less frequent but can have serious and potentially systemic consequences (Doerr *et al.* 2022).

4. **Correlated risk exposure:** Correlated risk exposure can impact financial stability. For example, if multiple companies use the same infected third-party software update containing malware, they can incur losses simultaneously across multiple firms. Due to interconnections in the financial system, this can have a domino effect and systemically impact other companies.
5. **Cascading effects:** Like operational or liquidity issues, a cyber event at one bank can disrupt its ability to send payments, which can have cascading effects on the liquidity and operations of other financial institutions. Moreover, if they do not adequately invest in cyber resilience and do not internalize the impact of their actions on system stability, individual companies in the supply chain that provide services (such as energy, telecommunications, hardware, and software) to the financial system, expose the financial system to higher than optimal risk.

In conclusion, cyber risk poses a major threat to financial stability due to its potential to spread throughout the financial system and to market concentration, the intent of cyberattacks, correlated risk exposure, and cascading effects.

### 5. Action Undertaken to Mitigate Cyber Risk and Strengthen Cyber Resilience

Mitigation of cyber risk and its systemic vulnerabilities requires a comprehensive approach involving regulators, supervisors, and the private sector (financial institutions and FMIs) to enhance operational resilience, promote cyber resilience through financial oversight, collaborate on privately led initiatives, and develop cyber insurance markets.

Aldasoro *et al.* (2022) categorize the actions taken by various types of organizations to mitigate the risk of cyberattacks and enhance cyber resilience into four main areas:

1. **Strengthening Operational Resilience:** Organizations in both public and private sectors are working to enhance their ability to withstand and recover from cyber incidents. This involves aligning security activities with business objectives and prioritizing investments in cyber security. Moreover, maintaining a distrustful or skeptical mindset at operational and governance levels at all times is encouraged as a way to reinforce resilience. Organizations can also learn from each other by sharing their expertise. In keeping with this line of action, the Cyber Resilience Coordination Center, established by the BIS, aims to facilitate information exchange and collaboration among central banks.
2. **Promoting Cyber Resilience through Financial Oversight:** Financial supervisors and regulators use national or international standards and guidelines to promote cyber resilience in financial institutions. Many authorities use current regulatory and supervisory tools to set expectations for managing, assessing, and responding to cyber risks. Some even engage in real cyber-incident tests or simulations in cooperation with the financial sector.
3. **Initiatives led by the private sector:** The private sector is spearheading a number of initiatives to support cooperation and coordination concerning prevention, response, and recovery from cyber incidents, in addition to an exchange of information. To help mitigate cyber risks stemming from reliance on third-party cloud service providers, financial institutions are collaborating on frameworks for data portability and interoperability among these service providers.
4. **Development of cyber insurance markets:** This market is growing and could assist companies in covering losses and fostering improvements in cyber resilience. However, insurance coverage may be insufficient to prevent extreme high risks and could contribute to the spread of losses through systemic impacts.

In response to the growing dependence on ICT and the outsourcing of services to third parties, the Basel Committee on Banking Supervision (BCBS) and the Bank for International Settlements (BIS) assessed cyber resilience practices among banks, regulators, and super-

visors in 2018, across different jurisdictions. The objective of the subsequent report was to identify, describe, and compare cyber-resilience practices in different jurisdictions, using information from surveys conducted by the Financial Stability Board (FSB) and the direct experience of the members of the Operational Resilience Group (ORG) (Table B4.1).

Based on the results of that report, international initiatives were designed to enhance cyber resilience, such as the G7 Fundamental Elements of Cyber Security (Group of Seven, 2016) and the guide developed by CPMI and Iosco for financial market infrastructures (FMIs). In the case of the European Union, the Fintech Action Plan of the European Commission (European Systemic Risk Board, 2020) urged European supervisory authorities to consider issuing guidelines to achieve convergence on ICT risk.

In this context, Basel Committee on Banking Supervision (BCBS) recognized the merits of addressing operational resilience beyond the scope of operational risk management and minimum capital requirements. It established the Operational Resilience Group (ORG) to contribute, among other things, to the international effort on cyber risk, in close coordination with other international bodies. For this reason, the BCBS requested the ORG to provide an initial assessment of cyber resilience practices observed among authorities and regulated financial institutions, including financial market infrastructures (FMIs).

In Colombia, cyber security and cyber resilience are extremely important, given the growth of the financial sector and the increased digitization of financial services. The Colombian government has implemented national strategies and policies to enhance cyber security and cyber resilience in the country. This effort included creation of the National Cyber Security and Cyber Defense Strategy in 2011 and the Intersectoral Commission on Cyber Security in 2016.

The Office of the Financial Superintendent of Colombia (SFC) has established specific regulations and guidelines for cyber security and cyber resilience in the financial sector. They include minimum requirements for cyber-security risk management, such as having appro-

**Table B4.1**  
**Cyber Resilience: Range of Practices**

1. General overview: Most supervisors use national or international standards, such as the NIST framework, the ISO 27000 series, and the CPMI-Iosco guide. Although there is convergence in certain areas, technical specifications and practices vary among jurisdictions.	2. Strategies: Regulators do not require a specific cyber-security strategy, but they do expect institutions to maintain an adequate capability as part of their overall strategies.
3. Cyber-risk management: Despite a certain amount of maturity in ICT and operational risk management, banks lack a cyber-security strategy that defines clear levels of tolerance and risk appetite.	4. Governance/organization: Although models are adopted, such as the three lines of defense (3LD), cyber resilience is not always articulated clearly in the different areas.
5. Workforce: The shortage of cyber-security skills generates challenges in recruiting specialized personnel.	6. Assessment: Protection and detection tests are prevalent, but response and recovery testing are less common.
7. Incident response capability: Banks are expected to have incident response plans, although an incident management framework is not required.	8. Cyber resilience metrics: There is no standard set of metrics for cyber resilience, and this hinders communication between supervisors and banks.
9. Information exchange: Most of the mechanisms for exchanging information are between banks, and between banks and regulators. However, the content and use of information varies widely among jurisdictions.	10. Risk of outsourced service providers: Although there are common regulatory frameworks for outsourcing, there is no common approach to third-party risk management beyond the outside services.

Source: BCSB-BIS (2018); prepared by *Banco de la República*.

appropriate policies, procedures, and technical and human resources. The SFC recommends international standards<sup>8</sup> be applied in the development of cyber-security management systems.

In 2020, the SFC issued Resolution 0674, which establishes a crisis or contingency protocol for the securities and foreign exchange market in Colombia. This protocol was the result of collaboration and agreements among various players in the financial industry. It focuses on the management of operational and technological risks, including cyber security, operational disruption, and data recovery. The goal is to ensure the continuity of operations in the financial market through identification, prevention, monitoring, and proper management of operational and technological risks.

*Banco de la República* (Banrep) has conducted a self-assessment of its cyber-security capabilities, based on the NIST Cyber Security Framework. Banrep prioritizes data integrity and reserves the right to interrupt operations to investigate and ensure the integrity and quality of information in critical systems and platforms. It also is working on a cyber-disaster management protocol for its critical services.

Knowing the potential systemic impact cyber risk can have on financial stability, Banrep recently began to monitor the measures taken by credit institutions to protect themselves against this type of risk. To this end, it tracks the overall rating of the cyber-risk indicator (CRI) provided by Security Scorecard, as well as the factors that comprise it.<sup>9</sup>

In the private sector, Asobancaria, in its capacity as the association representing the Colombian financial sector, has established a sectoral incident response squad called “CSIRT Financiero.” This cooperative team strengthens the capacity to anticipate, contain, and mitigate cyber-security risks in financial institutions and payment systems.

In summary, strategies and regulations have been implemented in Colombia to enhance cyber security and cyber resilience in the domestic financial sector. The government, regulatory authorities, and the private sector are working together to combat cybercrime and to promote an ecosystem for collaboration on matters of cyber security.

## 6. Conclusions and Recommendations

Cyber resilience is critical to ensuring the stability and integrity of financial institutions in an increasingly interconnected and digitized world. Cyber risks and threats are evolving continually, necessitating constant adaptation and improvement in strategies for cyber security and cyber resilience.

Cyber risk poses a considerable threat to financial stability for several reasons, such as the complex network of connections through which it spreads within the financial system, market concentration, the intent behind cyberattacks, correlated risk exposure, and cascading effects.

The analysis of cyber threats and approaches to addressing the risks and challenges associated with cyber security in financial institutions demonstrates the need for a holistic and collaborative approach to managing the matter. Financial institutions and banks must work together, in conjunction with authorities, regulators, and central banks, to adopt and maintain robust cyber-security and cyber resilience practices as a way to safeguard financial stability. This includes adopting recognized cyber-security frameworks and standards, pro-

<sup>8</sup> These include ISO 27032, NIST, ISF, CIS Crystal Security Controls or Cobit 5 for Information Security.

<sup>9</sup> A more detailed description of the methodology for calculating the cyber risk indicator (CRI) and the analysis of recent results for the institutions in the Colombian financial system is available in Box 2: The Cyber Risk Indicator, in the Financial Stability Report for the First Half of 2023. <https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/10638/reporte-estabilidad-financiera-primer-semester-2023.pdf>

moting cyber-security awareness and training, and engaging in information sharing and collaboration with other relevant stakeholders.

Multilateral organizations such as the BIS, the World Bank, and the IMF also play an important role in promoting cyber resilience in financial institutions by developing specific guidelines and principles and providing advice and technical assistance in this area.

Therefore, it is important for financial institutions and their local participants to continue to work on and strengthening action such as: 1) improving cyber resilience, 2) enhancing collaboration and information sharing, 3) evaluating and managing risks associated with outsourced IT services, 4) promoting cyber-security training, 5) strengthening contingency measures and recovery plans, and 5) conducting contingency tests and cyberattack simulations.

As part of this effort, Banrep is moving ahead with a research agenda aimed at quantifying the systemic impact manifestations of cyber risk in FMIs and/or their participants would have on clearing and settlement processes, and formulating mechanisms and policy recommendations to mitigate it.

By addressing these challenges and adopting a proactive approach to cyber-risk management, financial institutions and FMIs can reduce the likelihood of a significant impact on financial stability. Collaboration between the public and private sectors, coupled with increased awareness and preparedness, is crucial to protecting the financial infrastructure from continuously evolving cyber threats.

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## 2.2 Retail Payments

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.

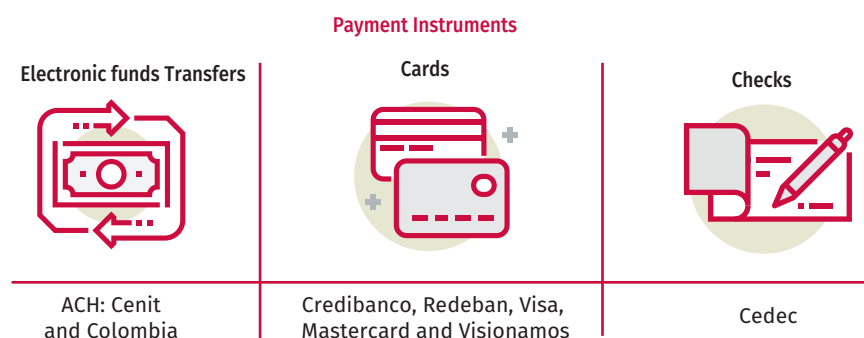
Retail payments are often used for different types of transactions between persons, companies and national or local governments (legal entities). They are also involved, daily, in trade and business activity in general, in the distribution and collection of payments made by government entities, and in payments between individuals, among others (BIS, 2016).

### Electronic payments increased in 2022.

*According to the data on transactions, all electronic payment instruments increased in nominal value versus 2021 (electronic funds transfers and debit and credit cards). The use of checks continued to decline, continuing the trend observed in years past. With respect to transfers, the growing participation of closed schemes is an aspect that stands out, driven by the use of mobile wallets (38% of the number of intrabank transfers).*

Some of the country's financial infrastructures are associated with a particular retail payment instrument used in the economy,<sup>16</sup> such as the automated clearing houses for electronic payments (ACH): ACH-Cenit (managed by the central bank) and ACH Colombia, which receive electronic payment orders for the transfer of funds; the Credibanco, Redeban, Mastercard, Visa and Visionamos networks, which process debit and credit card transactions made at commercial establishments and ATMs; and the Electronic Check Clearing House (Cedec) (Diagram 2.1).

Diagram 2.1  
Retail-value Infrastructure Operating in Colombia, by Use of Payment Instruments



### Infrastructure for retail-value clearing and settlement

Source: Banco de la República (DSIF).

16 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 (checks are an example).

In Colombia, the infrastructure for electronic payments was regulated recently through Decree 1692 of 2020. This norm has been supplemented (as described, in detail, in Box 5), primarily through a change in the regulations on these systems and the application of new practices to achieve several objectives, namely, transparency, integrity, stability, efficiency, innovation and interoperability.

Wire transfers and checks are both characterized by the fact they originate mostly with legal entities. The use of debit and credit cards originates largely with individuals (Table 2.3).

**Table 2.3**  
Principal Payment Instruments in the Colombian Economy, 2022

Market	Instrument	Use in Value by Originator (Percentage)	
		Person	Legal Entity
Goods and services	Debit card	86.0	14.0
	Credit card	90.0	10.0
	Check	13.0	87.0
	Electronic Funds Transfers <sup>a/</sup>	15.0	85.0

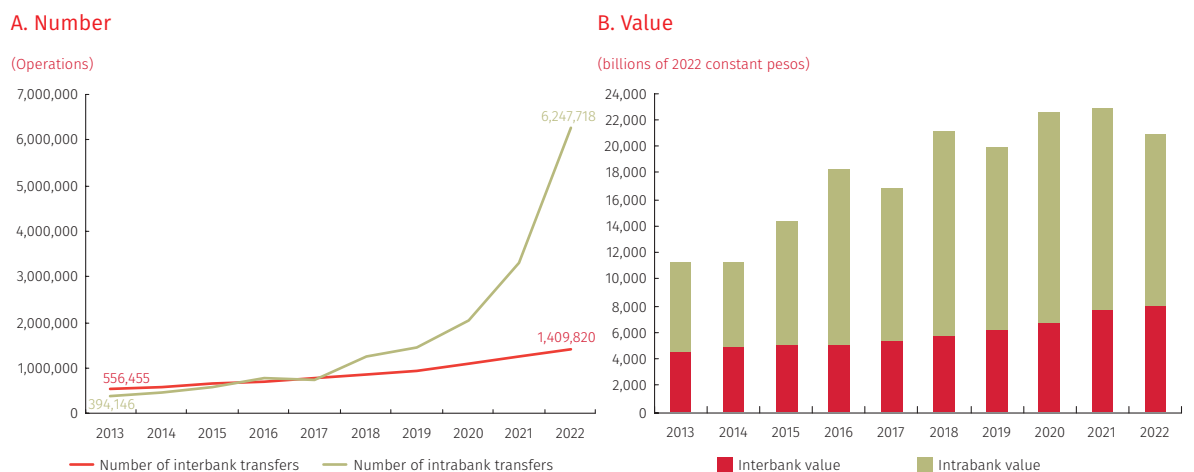
a/ Pertains to the percentages of interbank transfers.  
Sources: Banco de la República, Office of the Financial Superintendent of Colombia, commercial banks and ACH Colombia.

The general pattern in each of the electronic payment instruments is outlined below. A more detailed description is provided in Annex 2, which compares the use of these payment instruments in Colombia to that in other countries.

### 2.2.1 Electronic Funds Transfers

**The use of electronic funds transfers has increased in recent years, and they continue to be the most widely employed electronic instrument of payment in the market for goods and services in Colombia (Graph 2.7).** In 2022, transfers of this type (inter and intrabank) came to COP 20.9 t in average daily gross payouts and

**Graph 2.7**  
Electronic Transfers  
(Daily average)

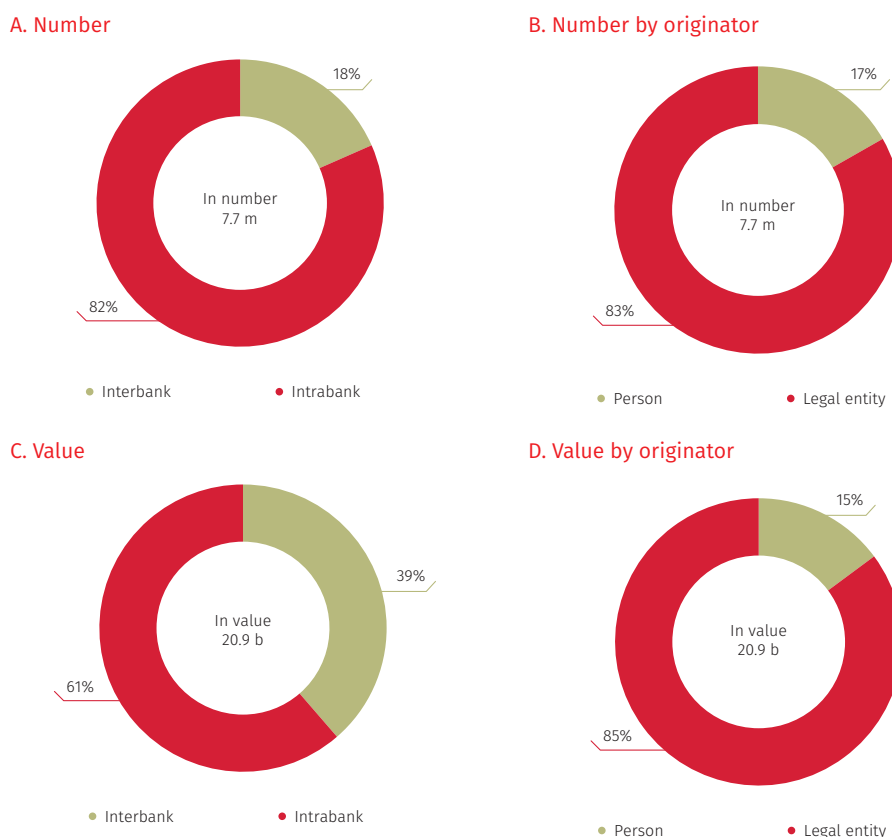


Sources: Banco de la República, ACH Colombia and commercial banks.

7.7 m transactions. The increase in value between 2022 and 2023 was 3% (-8.7% in real terms). Intrabank transfers accounted for a large percentage of all electronic funds transfers in 2022: 82% in terms of value and 61%, in number, and continue to register high growth rates, with an average variation of 49%<sup>17</sup> in number during the 2013-2022 period. As for interbank loans, the average variation during the same period was 11%.

**As to who uses these transfers, 83%, in number, originated with individuals and 85%, in terms of value, were generated by legal entities (Graph 2.8).**

Graph 2.8  
Electronic Funds Transfers, 2022  
(daily average)



Sources: Banco de la República, ACH Colombia and commercial banks.

The rate of adoption of electronic funds transfers has trended upward in the last few years: in 2014, it was five transfers per person and, in 2022, the number was 36. In Annex 2, in the section with an international comparison of payment instruments, this performance can be seen in Graph A2.19, in addition to the per capita value and the value in relation to GDP.

**Electronic funds transfers have been the instrument most widely used in the development of new payment schemes, such as the payment button (initiator), instant payments and mobile wallets.**

<sup>17</sup> In average transaction terms, intrabank transfers by legal entities are similar in amount to checks. This indicates transfers have been a substitute instrument, given the downward trend in the use of checks (see section A2.4).

**The payment button and Transfiya (a system for immediate person-to-person payments), which are part of ACH Colombia, increased 33% and 495% in value during 2022, in that order.**

The value of SOP transactions in 2022 accounted for 21% of interbank transfers, while the value of *Transfiya* transactions represented 0.18%.

**On the other hand, the transactionality of mobile wallets rose 101% in value;** and that of intrabank transfers accounted for 1.5% in value and 38% in number. Use was mainly by individuals (97%).

The situation with mobile wallets is summarized in more detail in the section entitled *In Focus 2*. The conclusion is that electronic deposits in Colombia are used on the basis of 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.

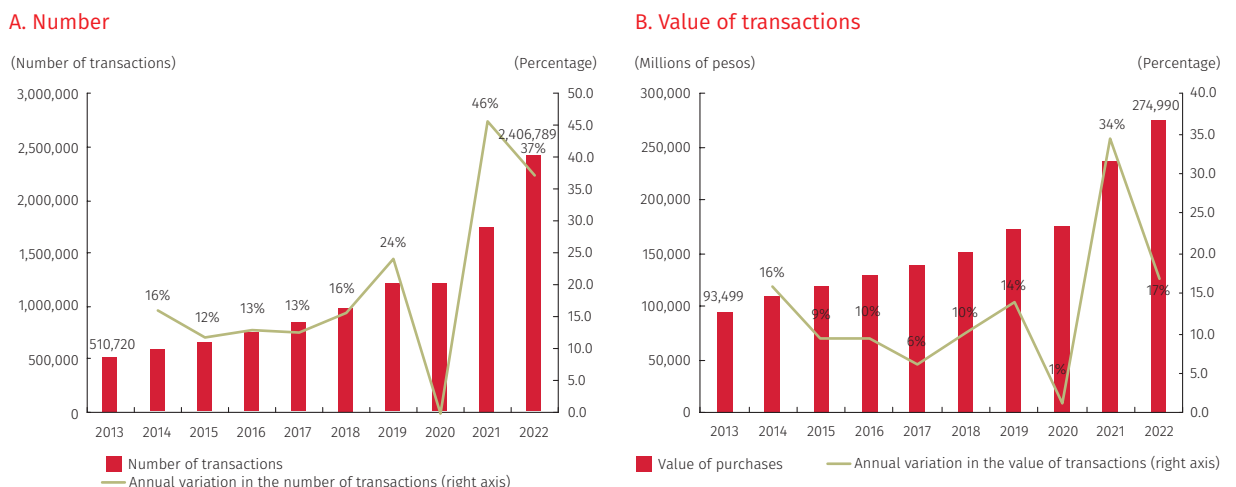
### 2.2.2 Cards

**Debit and credit card purchases trended upward in the last few years, and the value and number of transactions increased in 2022.** The average daily value of debit card transactions in 2022 was COP 275 b and the number of transactions came to 2.4 m, with positive variations over the previous year of 32% (17% in real terms) and 37%, respectively (Graph 2.9). For credit card purchases, the average daily value in 2022 was COP 200.4 b and the number of transactions came to 968,190, with positive variations of 31% (16% real) and 27%, respectively, compared to the year before (Graph 2.10).

**As for the value of purchases, 86% of those made with debit cards and 90% of those made with credit cards originate with individuals.** Most transactions by individuals are for amounts up to COP 1 m (79% of purchases with debit cards and 56% of those with credit cards).

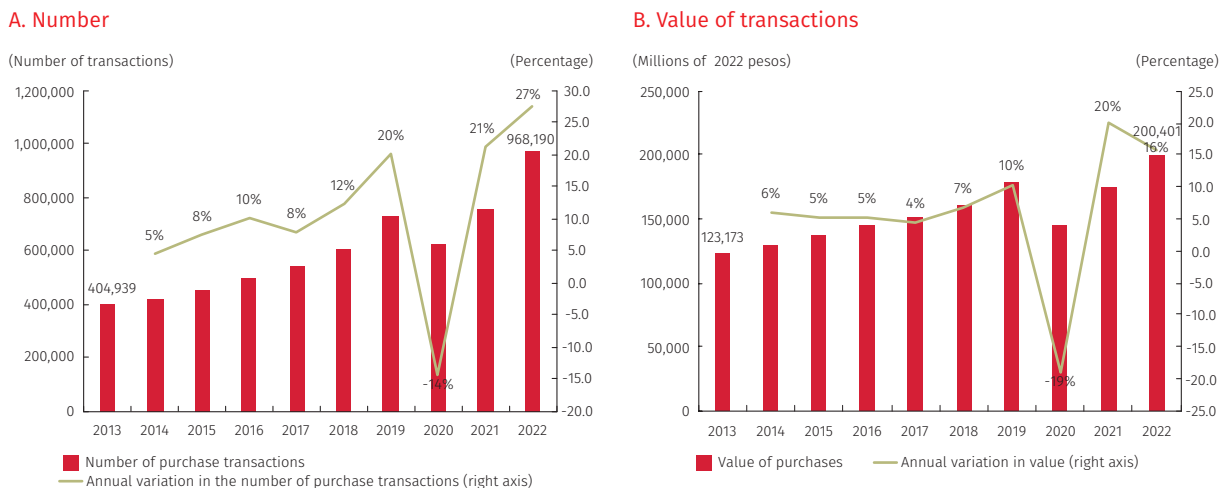
In general, the use of electronic retail payment instruments increased in 2022. This added use is reflected in the rise in transactionality through digital payment chan-

**Graph 2.9**  
**Debit Cards**  
**(Purchase transactions, daily average)**



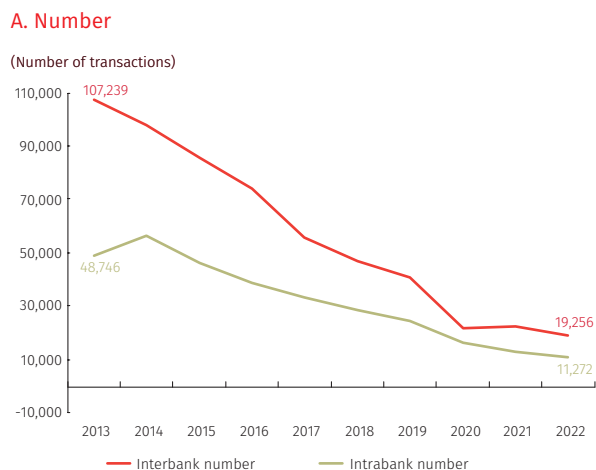
Source: Office of the Financial Superintendent of Colombia; calculations by Banco de la República.

**Graph 2.10**  
Credit Cards  
(Purchase transactions, daily average)



Source: Office of the Financial Superintendent of Colombia; calculations by Banco de la República.

**Graph 2.11**  
Checks  
(Daily average)



Sources: Banco de la República, ACH Colombia and commercial banks.

nels, such as the Internet and mobile telephones. Box 6 contains an analysis of the behavior of payment channels, which clearly shows the increase in the use of digital payment channels.

### 2.2.3 Checks

**There has been a downward trend in the use of checks (inter and intrabank) during the last ten years.** The decline in value was 2% (-14% in real terms) between 2021 and 2022, when the gross daily average went from COP 851 b to COP 831 b. The number declined by 15%, going from 35,900 (2021) to 30,500 daily transactions, on average, (2022) (Graph 2.11).

**Eighty-seven percent (87%) of the value of checks cleared in 2021 originated with legal entities and the rest, with individuals.** Most of the checks drawn by companies (40%) are for amounts above COP 200 m.

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

**According to the survey on the first half of 2022, most usual payments for food, beverages, clothing, transportation, housing, and public utilities, among other items, are made in cash (78.4% in cash, according to the number of transactions, and 74.6% in terms of value).** In the same sense, commerce ratifies the public's response and indicates that cash is the preferred instrument for customer payments.

Additionally, the value of banknotes in circulation as a proportion of GDP during the last ten years (proxy indicator of cash payments) showed an upward trend, consistent with the behavior of the same indicator in different countries. However, the variation between 2021 and 2022 was a negative.

## Box 5: How Regulations on Retail-value Payment Systems Have Evolved\*

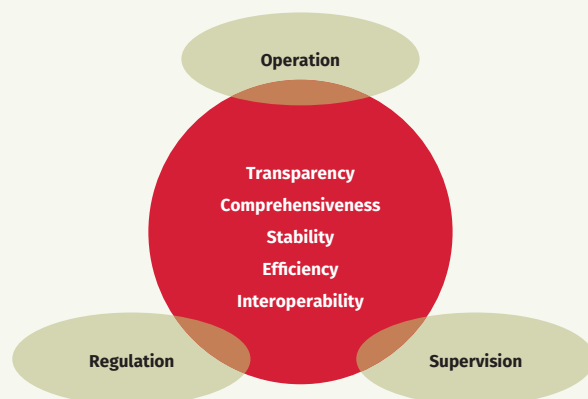
Colombia has had a new regulatory framework since 2020. Designed to build a better ecosystem for retail-value payment systems (RVPS), it started with Decree 1692, which was supplemented with regulations established by the Office of the Financial Superintendent of Colombia (SFC).<sup>1</sup> Decree 1297 on payment initiation was introduced later, in 2022. The idea behind this framework is to separate clearing and settlement activities from those involving acquisition and issue, to identify activities related to the payment process in the interest of encouraging different agents to participate, and to expand potential participants in the RVPS (including a new category: non-supervised acquiring companies). In addition, rules on corporate governance and conflict-of-interest management within the RVPS were strengthened, and the mandatory publication of relevant information on the system, such as fees, among other aspects, was encouraged. Some of the progress resulting from the application of these new regulations is described below.

Bearing in mind that RVPSs are essential to the proper functioning of the financial sector and to increasing the efficiency and formality of the economy, the new regulations incorporated principles on transparency, integrity, stability, efficiency, innovation, and interoperability in activities related to operation, regulation, and supervision of these systems (Diagram 5.1).

One of the first points to address is the definition of retail-value payment system administrators (RVPSA). Ever since Decree 1692 took effect, they have been responsible for clearing and settlement in RVPSs. In other words, they “[...] calculate each participant’s balance, at the end of an established period, based on the payment orders or the funds transfer orders processed in the retail-value payment system, and settles what the participant owes to others in the system, as per current regulations.” Settlement will occur through *Banco de la República* deposit accounts, “via debits and credits to deposit accounts with *Banco de la República*, in checking accounts or in savings accounts the participants in a payment system have with a credit institution.”<sup>2</sup>

This concept separates the functions of a clearing and settlement system from the activities of acquiring companies<sup>3</sup> and issuers,<sup>4</sup> which also can be performed by the administrators of retail-value

Diagram B5.1  
Principles on Operational, Regulatory and Supervisory Activities in Retail-value Payment Systems



Source: Decree 1692 of 2020; adapted by DSIF.

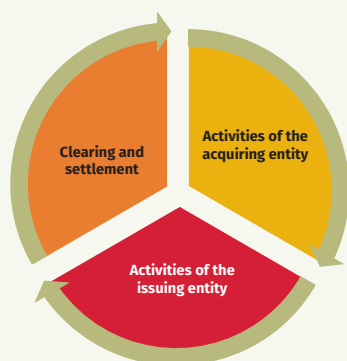
\* The SFC Financial Intermediary Delegation provided comments and suggestions on the development of this section.

- 1 Instructions imparted by the SFC through external circulars 005 and 020 of 2021.
- 2 Ministry of Finance, Decree 1692, December 2020.
- 3 These link the merchant to retail-value payment systems; provide the merchant with access technology that allows for the use of payment instruments; and process payment orders or funds transfer orders initiated through access technology.
- 4 They transmit authorization for a payment order or a funds transfer order to the retail-value payment system administrator.

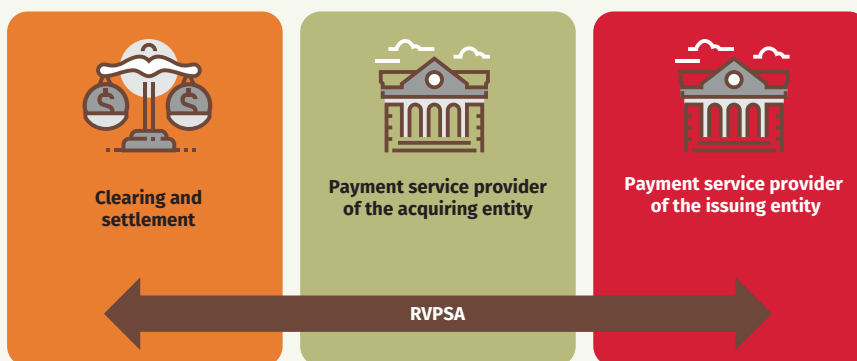
payment systems (RVPSA) in their capacity as payment service providers (agents in the payment system that are delegated by the acquiring or issuing entity to perform one or more of their functions) (Diagram B5.2). Separating the three functions (clearing and settlement) from other services, such as acquisition and issue, encourages more participation in each activity on the part of different agents. It also ensures the provision of clearing and settlement services does not influence or determine the contracting of other services (and vice versa), thereby creating conditions for transparency in determining the costs of each of the processes required to complete an electronic payment.<sup>5</sup>

Diagram B5.2  
Retail-Value Payment System Administrator, Before and After the Recent Regulation

A. RVPSA before the regulation



B. RVPSA after the regulation



Source: Decree 1692 of 2020; adaptation by DSIF.

In compliance with the new regulations, RVPSAs have modified their own rules, explicitly addressing matters concerning their participants, conflict-of-interest management, risk management, operational, technical and security standards, as well as criteria on fees (e.g., trading, access, clearing, and settlement), among other aspects. The main changes occasioned by the regulations on each of these topics are described below.

**Participants in the system** are those authorized by RVPSAs to process payment orders or funds transfers within the system. They may or may not be entities that are under the SFC’s authority. The latter include non-supervised acquiring companies.<sup>6</sup> These are limited liability companies that must register with the SFC (RANV: Register of Non-supervised Acquiring Companies). The SFC issued instructions<sup>7</sup> on the purpose and scope of RANV, the requirements, effects and procedures for registration, as well as the specific rules on how this

5 Financial Regulatory Unit (2019). “Actualización normativa de los sistemas de pago de bajo valor” (Regulatory Update on Retail-value Payment Systems), December.

6 Decree 1692 of 2020 dictates the SFC will authorize RANV registration for companies that meet the following general requirements:

1. They must be a corporation or company with limited liability.
2. Have subscribed and paid-in capital equal to or greater than one thousand seven hundred times the legal monthly minimum wage currently in effect.
3. Have a mechanism to keep the funds received from the settlement of payment orders or funds transfers separate from the funds that represent its own resources or the resources of persons apart from its users. For this purpose, these companies may, among other things, enter alliances with credit institutions or constitute independent equity.
4. From the first year of operation, and each year thereafter, the company must demonstrate that it has subscribed and paid-in capital equal to at least 2% of the value of the funds received from the settlement of payment orders or funds transfers in the last twelve months.

7 As per External Circular 005 of 18 March 2021 amending SFC Basic Legal Circular, Bulletin 575, which defines the purpose and scope of the RANV, the requirements, effects and procedures for registration, as well as particular rules on how the registry is to operate

registry is to operate. The purpose of RANV is to assess the solvency of the company that will engage in acquisition before it is accepted as a participant in the RVPS. Being included in RANV is separate from meeting the requirements stipulated by RVPSAs for acquiring companies to access their payment system as participants. On their part, acquiring companies that are not under SFC's authority must separate the funds resulting from payment orders or fund transfers in favor of the acquired businesses. They may do so through partnerships with credit institutions and other mechanisms. At the time this report was written, two non-supervised acquiring companies were listed on the SFC's website as being active.

The current regulation, generally speaking, is based on principles that ensure potential participants have access to the system, with non-discriminatory, transparent, and competitive treatment (to prevent the abuse from dominant positions) and with objective fees.

In modifying their regulations, which can be found on their websites, the RVPSAs have outlined the access requirements for participants, the characteristics of the system, and the items and definition of fees and commissions charged for the activities involved in clearing and settlement. The new rules also propose not restricting participants from joining other RVPSAs the same capacity.

Likewise, participants are required to have rules and high operational, technical, and security standards that enable their operations and their participation in the retail-value payment system to develop under secure, transparent and efficient conditions. They must maintain suitable systems to manage the risks inherent in their activities and those associated with their participation in the retail-value payment system, such as counterparty risk, operational risk, credit risk and liquidity risk, among others, as well as policies on handling and protecting personal data, policies and procedures to prevent and control the risk of money laundering and terrorist financing, and duties to inform beneficiaries about their fees, commissions, and payment procedures.

Recently, the SFC requested a new form from RVPSAs to collect monthly data in order to measure, supervise, and monitor retail-value payment systems, their participants, and costs.<sup>8</sup>

The latest information from this form, as of March 2023, made it possible to identify the number of participants in each RVPS (Table 5.1) and the number of entities for which RVPSAs act as payment service providers (Table B2), indicating their interest in providing these services to acquiring companies and issuers.<sup>9</sup> To do so, RVPSAs: 1) are required to offer their services and products separately and charge individual fees for each of them; 2) may not condition the provision of clearing and settlement activities to the contracting of other services, nor vice versa; 3) may not restrict the contracting of services with their competitors; 4) may use the information they access to develop any of the activities that are authorized for performing another activity;<sup>10</sup> and 5) must have ways of solving conflicts of interest.

Comparing Tables B5.1 and B5.2 with the information in March 2023 shows the retail-value payment systems have as many participating entities as the number of those they serve in their capacity as payment service providers. This highlights the important role they play for buyers and issuers by offering services such as issuer processing, buyer processing, aggregation, and supplying access technology.

**Measures to manage conflict of interest.** Decree 1692 of 2020 stipulates the regulations of a RVPSA must specifically include policies and procedures to identify, prevent, manage and disclose any conflicts of interest that could possibly derive from the following cases: 1) RVPSAs acting simultaneously in clearing and settlement and as providers of payment services to buyers or issuers; and 2) when RVPS participants are also subsidiaries, affiliates,

8 External Circular 024 of 28 October 2022, Bulletin 647.

9 Form 418 requests information on three types of a RVPSA's income; namely, the importance of revenue from the provision of payment services (first place), accounting for slightly more than twice the revenue from clearing and settlement (second place), and revenue from access fees (in third place).

10 Decree 1297 of 2022, Article 2.

**Table B5.1**  
**Number of Participants with access to the Retail-Value Payment System**

Retail-value payment system	Number of entities
ACH Colombia	38
Cedec	25
Cenit	44
Credibanco	23
Mastercard	35
Redeban	23
Servibanca	25
Visa	15
Visionamos	146

Source: Office of the Financial Superintendent of Colombia, Form 418; calculations by Banco de la República.

**Table B5.2**  
**Number of Entities for which the RVPSA acts as a Payment Service Provider**

Retail-value payment system	Number of entities
ACH Colombia	38
Credibanco	23
Redeban	23
Servibanca	25
Visionamos	146

Source: Office of the Financial Superintendent of Colombia, Form 418; calculations by Banco de la República.

controlling entities or shareholders of RVPSAs.<sup>11</sup> On the other hand, according to Decree 1297 of 2022, in the event an entity managing a retail-value payment system, or any of its affiliates, subsidiaries, controlling entities, or shareholders, engages in payment initiation, its regulations must include a specific chapter on policies and procedures to identify, prevent, manage, and disclose conflicts of interest that could arise from that relationship.

To complement this directive,<sup>12</sup> the SFC ruled the board of directors of a RVPSA may not appoint, as non-independent members, those employees who are involved in areas of the business that are related to payments and to the banking operations of the RVPSA's subsidiaries, affiliates, controlling entities, or shareholders. It defines business areas related to banking operations as those directly linked to financial intermediation by banks. Furthermore, it determined the composition of the board must adhere to the principles of retail-value payment systems and adopt good corporate governance practices, such as: 1) ensuring that members who are appointed to the board represent an adequate balance of skills, diversity, and knowledge in line with the entity's size, complexity, and risk profile; 2) making sure that all members are kept informed about the entity's affairs, attend all meetings, and share equal responsibility for the decisions that are made; 3) having policies on disclosing information and procedures for generating reports and managing customer relationships; and 4) guaranteeing the selection, approval, renewal, and replacement of board members is a strategic process within the company, one that should include internal regulations specifying the qualifications and qualities required to be a member, the nomination and removal procedures, and the arrangements for leadership succession.

Consequently, RVPSAs have made changes to their board members. If any of their participants or payment service providers are invested in their capital or in the capital of their participants or payment service providers, the regulation requires the board of directors to comply with the requirement of having an odd number of members; that is, not less than five nor more than eleven, at least 25% of whom must be independents. The SFC oversees and accompanies this process by screening candidates for board membership through the procedure to verify qualifications for occupying the position.

**Risk management systems:** The new regulation emphasizes the continuity of RVPS operations and the management and mitigation of credit, legal, liquidity, operational, and systemic risks. Therefore, RVPSAs must have appropriate risk management systems in place, including contingency plans and data-security measures. The SFC ruled that RVPSAs must define operational, technical, and security requirements that are proportional to the role and inherent risks associated with the activity each of their participants performs within the sys-

11 Financial services companies, capitalization companies and companies specialized in electronic deposits and payments (Sedpe) are authorized to hold shares in a RVPSA. Its own institutions may do so as well. Together, they may own any percentage of the shares of stock.

12 External Circular 020 of 08 October 2021, Bulletin 600.

tem. To do so, they must conduct a prior technical analysis that justifies and supports the criteria used to define these requirements.<sup>13</sup>

**Rates.** According to Decree 1692 of 2020, information on what a RVPSA charges for clearing and settlement activities, as well as exchange rates and other fees, must be made available to participants and the general public on its website or via any other widely accessible means of communication.

For its part, the SFC issued instructions on the publication of rates by RVPSAs,<sup>14</sup> stipulating information on access, clearing and settlement, and exchange rates must be displayed prominently on their websites, in a clear and explicit manner, with a breakdown of the items listed and an indication of the methods used to calculate them. For this purpose, their boards of directors must define and approve a procedure that stipulates, at the very least: 1) how and when franchises, buyers, and other participants must provide the information to be published; 2) the mechanisms for receiving, processing, and validating the information that is submitted; and 3) the frequency with which the information is updated, which shall be at least quarterly ending in March, June, September, and December. This procedure must be documented and made available to the SFC.

With regard to services for access and clearing and settlement, Decree 1692 of 2020 indicates the respective rates are to be determined by the board of directors of the RVPS, provided its members do not have a capital investment in the system nor in its participants and service providers.

Fees for access and clearing and settlement are to be established by the RVPSA in the event any of its participants or payment service providers are invested in its capital or in the capital of its participants or payment service providers. Neither the board of directors of the RVPSA nor the participants or payment service providers that hold investments in its capital may influence the decision in any way whatsoever.

Likewise, the SFC determined that the commission on acquisition and the cost of linking the seller to the buyer must be disclosed to the financial consumer clearly and explicitly, with a breakdown of the items that are included, the currency in which they are charged, and an indication of the methods and the classification, by categories or commercial sectors, used to determine them.<sup>15, 16, 17</sup>

The transaction fees between participants will be established, at all times, by the franchises for funds transfers initiated with franchised payment instruments. The franchises may not set different transaction fees depending on the RVPSA where the transaction is processed.

In the case of RVPSAs that act as payment service providers, the financial consumer to whom they provide this service must be informed of the acquiring or issuing entity to whom they provide services, the scope of their activities, and the fee they charge for providing their

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13 External Circular 020 of 08 October 2021, Bulletin 600.

14 External Circular 020 of 08 October 2021, Bulletin 600.

15 The categories must be clear for the financial consumer to be able to identify the type of commercial establishments or sector to which each specific category refers.

16 If a payment service provider is contracted, it must be specific in providing information on the fee it charges for providing its services and whether that fee is included in the acquisition commission.

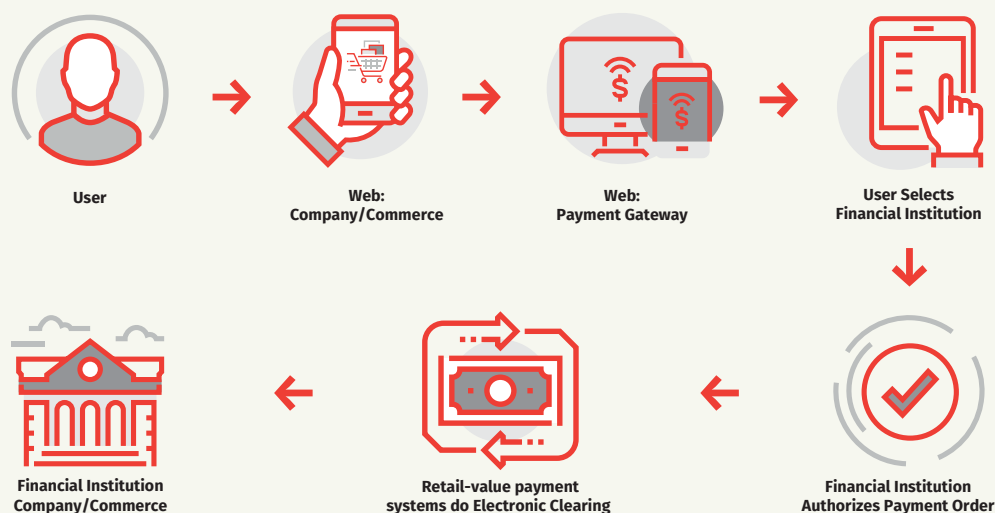
17 Acquirers and payment service providers that are under the authority of the SFC must provide financial consumers with information on commissions, fees and costs. This must be done on their websites, free of charge, and in a comparable manner.

products or services. This information must be conveyed by the RVPSA through verifiable means.<sup>18</sup>

**Payment initiation.** The rules on payment initiation corresponding to Article 4 in Decree 1297 of 2022 take effect twelve months after publication of the decree. Payment initiation is defined as the activity of sending a payment order through a third party to the entity that will issue the means of payment, with prior authorization from the user and with the requirement that the payment be processed through a RVPSA.

For a better understanding of this newly regulated activity, Diagram B5.3 shows a possible general flow in a process with a payment initiator, where the user has previously authorized the initiator.

Diagram B5.3  
Flow of the Payment Process with Third Parties as Initiators



Source: Decree 1297 of 2022. Design by Banco de la República.

The same user selects the payment instrument to be used from a website, and the user’s entity is identified through the initiator to obtain authorization for the payment order. Then, the RVPS settles the transaction, assigning the specified amount to the merchant’s or recipient’s financial institution.

Payment initiation can be done by credit institutions, Sedpes, RVPSAs, and by entities that are not under the SFC’s authority.

There are rules established for RVPSAs to ensure open access and to promote competition among payment initiators. For example, they may not make arbitrary decisions on restricting access for payment initiators or blocking their payment orders. RVPSAs are required to inform payment initiators about the system’s characteristics, access requirements, and costs. On the other hand, payment initiators must comply with the operational, technical, and security rules and standards set by the RVPSA.

Since the regulations specify payment initiation should be done only through RVPSAs, there is room in the future to explore other ways to develop payment initiation activities, taking

18 In addition, the RVPSA must specify that the contractual relationship being formalized is directly with the acquirer or issuer, providing the information necessary to identify it fully. The information must be disclosed individually for each of the products or services. It must be clear and explicit, with a breakdown of the items included, and an indication of the methods used to determine it. The procedures, reception channels, persons in charge and deadlines for handling complaints and claims must be disclosed as well.

international experience into account. For instance, one option might be to not limit this activity to the retail-value payment system.

In general, the new regulation is consistent with the roadmap outlined in Decree 1692 of 2020 and Decree 1297 of 2023, as well as the supplementary rulings by the SFC. With the changes in regulations for RVPSAs and the implementation of new practices, the country is working to achieve the objectives of transparency, integrity, stability, efficiency, innovation, and interoperability in retail-value payment systems. Moreover, the National Development Plan for 2022-2026 indicates *Banco de la República* is approved to regulate the interoperability of fast payments. The Financial Regulation Unit will conduct an ex-post evaluation of the aforementioned regulations, following best practices for an assessment of this type, which will be done within a reasonable time frame to consolidate the changes. With these efforts, progress will continue to be made in the medium-term towards projecting a strategic plan to develop the local ecosystem of retail-value electronic payments.

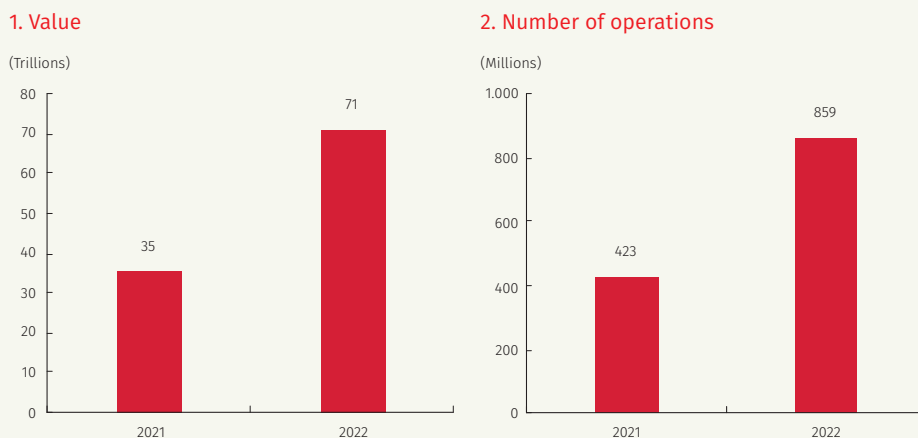
## In Focus 2: Mobile Wallets: Transactional Use of Electronic Deposits

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.<sup>1</sup> These are different from current and savings accounts. The objective was to promote electronic payments, transactions, and collections. Later, in 2014, to strengthen access to transactional financial services, specialized electronic deposit and payment entities (Sedpes)<sup>2</sup> were regarded, by law, 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 commercial banks and Sedpes, payments (purchases) made in 2022 through electronic deposits, using the payment instruments noted above, amounted to COP 71.2 t in value and 858.7 million transactions (on average, this comes to COP 195.1 billion and 2.4 million transactions per day). The variation with respect to 2021, both in value and the number of transactions, was around 100% (Graph A).<sup>3</sup>

**Graph A**  
Share by Type of Payment Instrument, Electronic Deposit



Sources: Commercial Banks and Sedpes.

1 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 on the use of channels, means of handling and risk management.

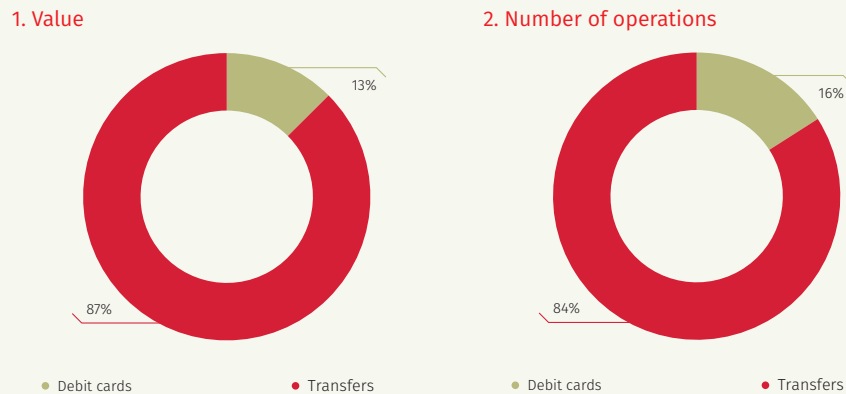
2 Decree 4687 of 2011 and Law 1375 of 2014.

3 At the end of December 2022, the balance for the electronic deposit payment method accounted for 1.24% of the balance for the savings account payment method.

Approximately 98% of the value and number of transactions originated with individuals and 2% with legal entities. This suggests a wide range of potential use in the corporate sector.

On the other hand, transfer transactions represented approximately 87% in value, while those with debit cards (debit or prepaid) accounted for 13%. In terms of the number of transactions, transfer represented 84%, and card transactions, 16% (Graph B).

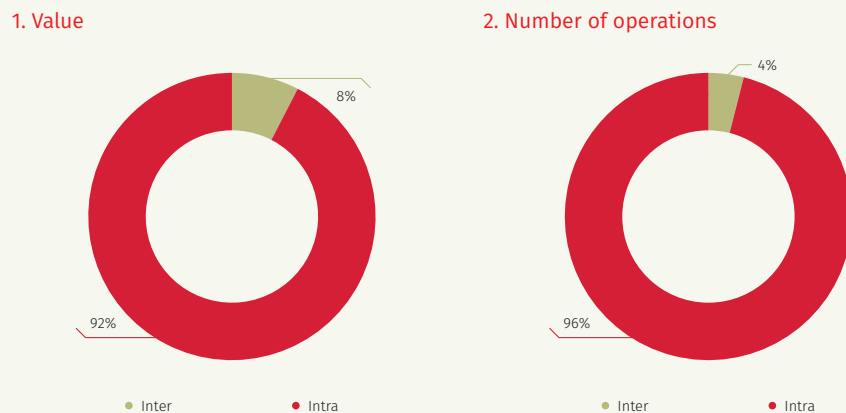
**Graph B**  
Share by Type of Payment Instrument, Electronic Deposit



Sources: Commercial Banks and Sedpes.

In general, electronic funds transfers are the instrument used the most. However, their use has evolved primarily within closed schemes. According to the intra and inter classification, the former accounted for 92% of the value, and the latter, 8%. In number, intrabank transfers represented 96%, and interbank transfers, the remaining 4%. This higher share for intrabank transfers, both in value and number, indicates the transactional use of mobile wallets has developed in closed schemes, i.e., in operations where the payer and the beneficiary have electronic deposits with the same financial institution. Mobile wallets in Colombia have the potential for use in interoperable operations (between different entities) (Graph C).

**Graph C**  
Share by Type of Electronic Transfer, Electronic Deposit



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 72% in value, followed by the range of COP 500,001 to COP 1,000,000, with 17%. In terms of the number of operations, 98% were in the range up to COP 500,000 (Graph D).

**Graph D**  
**Payments, by Ranges in Pesos, Electronic Deposit**

**1. Value**



**2. Number of operations**



Sources: Commercial Banks and Sedpes.

Despite significant developments in the use of mobile wallets, it is possible to conclude that electronic deposits in Colombia remain focused on personal 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 immediate payments for different types of use, by involving individuals, businesses, and the government.

## Box 6: Performance of Access Channels in the Payment Process: Changes in the Use of Digital and In-person Channels

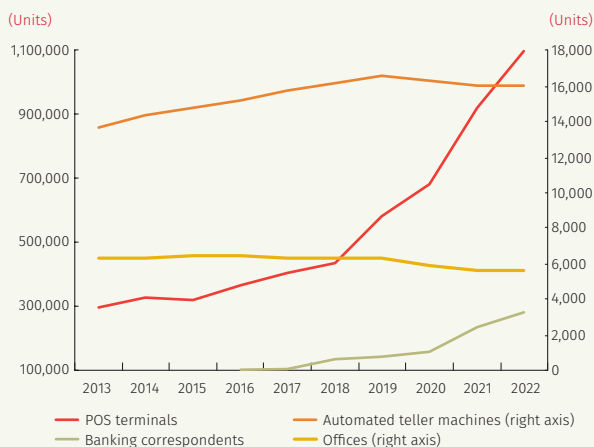
Retail payment transactions require the use of access channels. Their function is to connect the payer to their financial institution to be able to initiate the payment.<sup>1</sup> Currently, these channels include the Internet, the offices of financial institutions, banking correspondents, POS terminals, mobile phone networks, ATMs, and interactive voice response (IVR) systems.<sup>2</sup>

Retail commerce has embraced non-face-to-face sales through payment innovations propelled by the progress in technology. From the standpoint of payment channels, this corresponds, for example, to use of the Internet, which enables communication and agreements between sellers and buyers of goods and services. In general, use of the Internet and mobile phone-based payments in the economy has been on the rise. In Colombia, 73.0% of people used the Internet in 2021, with 83.7% doing so from home. However, the mobile phone was the most widely used device for Internet access (93.9%).<sup>3,4</sup>

In fact, digital channels such as the Internet and mobile phones play an important role in supporting e-commerce<sup>5</sup> in Colombia. The following data provides an overview of the use of access channels in 2022 and analyzes how both digital and in-person channels have evolved over the past ten years.

At the end of 2022, there were 1,096,503 POS terminals installed at commercial establishments in Colombia, 277,591 banking correspondents, 16,019 ATMs (automated teller machines) and 5,616 bank offices (Graph B6.1). Over the past ten years, banking correspondents have increased in number at an average annual rate of 26%. On the other

Graph B6.1  
Number of Payment Channels



Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2012-2022); calculations by Banco de la República (DSIF).

- 1 They also connect with the beneficiary to receive the payment.
- 2 In general, payment transactions and balance queries are made through payment channels. Mobile telephony allows for payments that can be defined as those initiated and transmitted via cellular communication networks. Through this access channel, it is possible to use voice technology, mobile applications, text messages (e.g. SMS), or near field communication (NFC). Access devices for mobile payments include traditional mobile phones, tablets and computers. A payment made by these means is considered an Internet payment if it uses that network (and is made directly through the entity's portal), and a mobile payment, if it uses the mobile network -Banco de la República (2015, Payment Systems Report); SFC (2016, Format 444)-.
- 3 In 2021, 16.4% (6,029,805) of persons over 18 years of age made purchases through the Internet (Colombian Chamber of Electronic Commerce. 2023. "E-commerce in 2022 and Perspectives, 2023," February).
- 4 DANE (2021). *Boletín Técnico: Encuesta de tecnologías de la información y las comunicaciones en hogares*.
- 5 According to *National Electronic Commerce Policy (Draft 1, 12/06/2020)*, Conpes defines electronic commerce as the sale or purchase of goods or services carried out through computer networks via methods specifically designed for the purpose of receiving or processing orders, regardless of whether payment and delivery of the goods or services occur online. E-commerce refers to physical goods, intangible (digital) products and services that can be provided digitally. It also anticipates that products or services can be offered individually or packaged, and can be purchased using personal computers, laptops, tablets, and cell phones with varying degrees of complexity.

hand, POS terminals were up by 18% and ATMs, 3%, while the number of bank offices declined by 1%.

### 1. Number of Transactions

In 2022, the number of transactions overall averaged around 38 million per day (37,834,126), with 58% being non-monetary transactions (21,956,342)<sup>6</sup> and 42%, monetary transactions (15,877,784) (Graph B6.2).

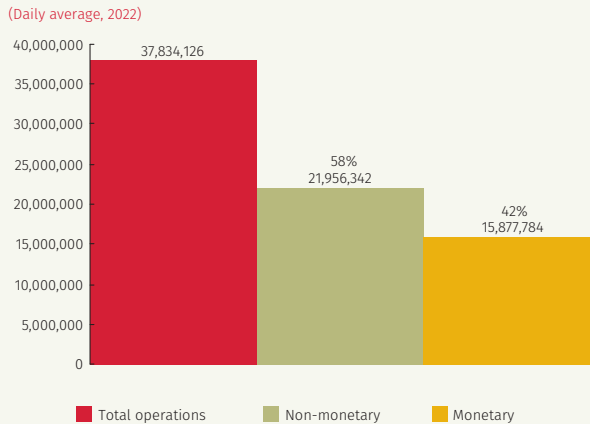
The most widely used channel in 2022 was the mobile phone network (23,419,666 transactions), followed by the Internet (5,286,121). In a smaller range of transactions, there are ATMs (2,393,401), POS terminals (3,345,795), banking correspondents (2,123,880), bank offices (1,184,516), and interactive voice response (IVR) systems (80,746) (Graph B6.3).

Non-monetary transactions are concentrated primarily in digital channels, such as mobile phone networks (80%) and the Internet (57%) (Graph 3.C). Similarly, in terms of monetary transactions (those involving the movement of money), the mobile phone network is the most widely used channel (4,791,435 transactions), followed by POS terminals (3,312,533), the Internet (2,284,349), ATMs (2,252,846), banking correspondents (2,123,880), bank offices (1,111,323), and interactive voice response (IVR) systems (1,418).

Over the past ten years (2013-2022), the number of transactions across all channels increased at an average annual rate of 18%. Notably, mobile phone networks, the Internet, ATMs, POS terminals, and banking correspondents saw significant growth in transaction volumes during that period. Conversely, there was a downward trend for bank offices and IVR channels, which is consistent with greater digitalization of the economy (Graph B6.4).

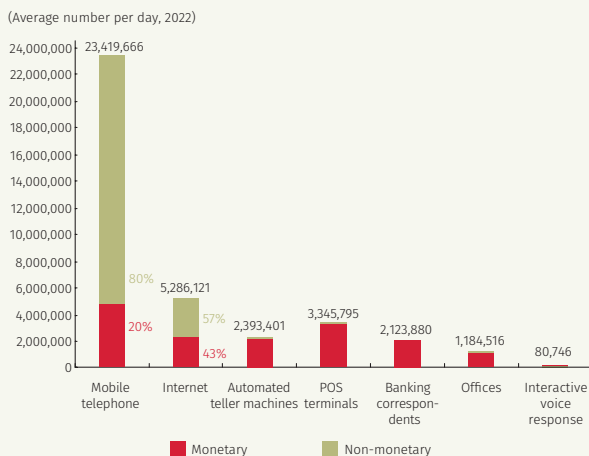
A comparison between the number of transactions conducted in 2022 and those in 2021 shows the channels, in general, experienced growth (29%). Mobile phone networks led the way, with an increase of 41%,

**Graph B6.2**  
Total Monetary and Non-monetary Operations (Daily average, 2022)



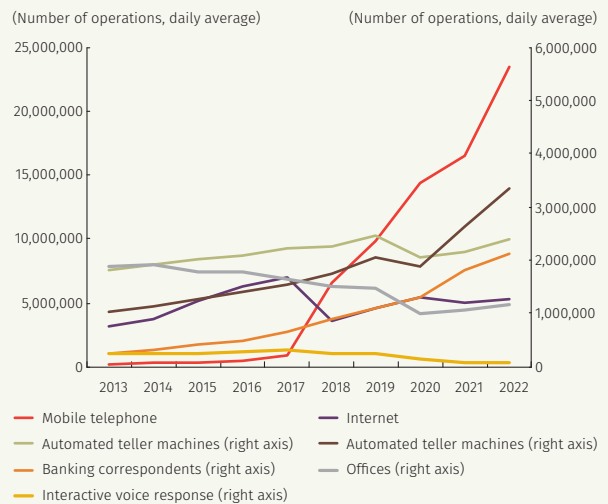
Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2012-2022); calculations by Banco de la República (DSIF).

**Graph B6.3**  
Operations by Channel, Average Number per Day, 2022



Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2022); calculations by Banco de la República (DSIF).

**Graph B6.4**  
Number of Operations (Daily average)

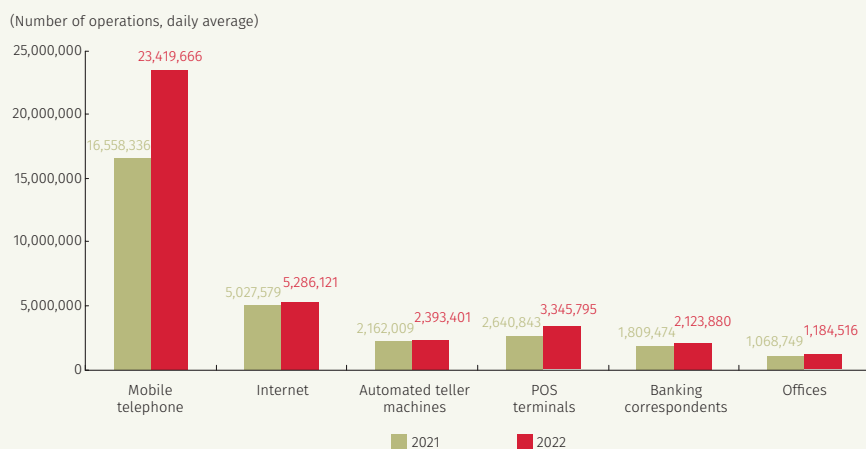


Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2012-2022); calculations by Banco de la República (DSIF).

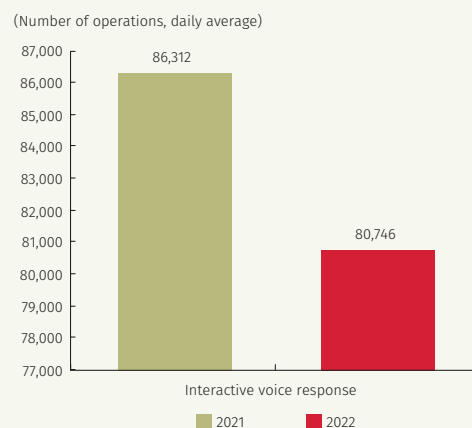
6 These are balance queries made by customers.

**Graph B6.5**  
Payment Channels, Behavior in the Number of Operations between 2021 and 2022

**A. Growth in Channels between 2021 and 2022**



**B. Decline in Channels between 2021 and 2022**



Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2022); calculations by Banco de la República (DSIF).

followed by POS terminals (27%), banking correspondents (17%), ATMs (11%), bank offices (11%), and the Internet (5%) (Graph R6.5, panel A). On the other hand, the interactive voice response (IVR) channel experienced a decline of -6% (Graph B6.5, panel B).

The performance of the mobile phone network in terms of transaction volume is worth noting. Its average annual growth was 106% during the period from 2013 to 2022.

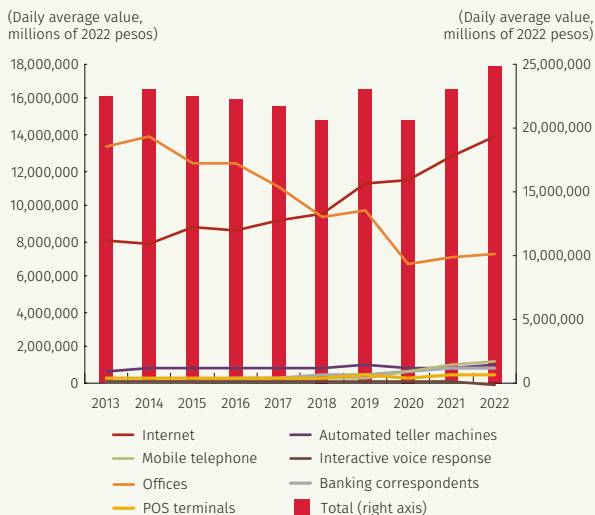
## 2. Transaction Value

In 2022, the total value of transactions averaged COP 24.8 trillion (t) per day (Graph B.6.6). The Internet and bank offices were the most representative, with Internet transactions averaging COP 14.0 t per day, and bank offices, COP 7.3 t. The following channels were below COP 1.5 t (Graph B6.7): mobile phone networks (COP 1,262,322 million), ATMs (COP 929,577 million), banking correspondents (COP 842,114 million), POS terminals (COP 493,905 million), and the interactive voice response (IVR) channel (COP 1,811 million). The value of transactions across all channels grew at an average annual rate of 1% during the past ten years (2013-2022).

The value of transactions, by channels, increased 8% in 2022 compared to the year before. Nearly all the channels showed a positive change. Mobile phone networks lead the way with 35% growth, followed by the Internet and POS terminals, each with an increase of 9%, ATMs and banking correspondents with 6% each, and bank offices with 3 (Graph B6.8, panel A). The interactive voice response (IVR) channel was the only one that declined (-13%) (Graph B6.8, panel B).

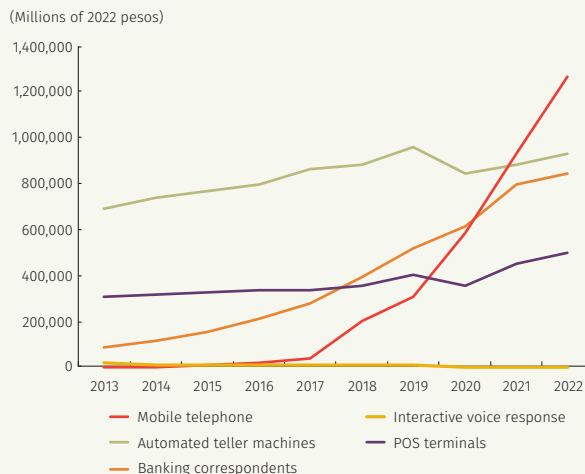
In conclusion, the number of transactions made through payment channels has increased at an average annual rate of 18% over the past ten years, representing approximately 38 million transactions daily, on average, in 2022, with 58% being non-monetary. Notably, digital channels such as mobile phone networks and the Internet played a significant role in this growth. As for the value of transactions, the total across all channels increased by 1% during the same period, reaching approximately COP 24.8 t in 2022. Internet and bank offices were the major contributors in terms of value. This highlights the importance of digital channels; however, traditional channels, such as bank offices, are still relevant.

**Graph B6.6**  
Value of Payment Channel Operations (Daily average)



Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2012-2022); calculations by Banco de la República (DSIF).

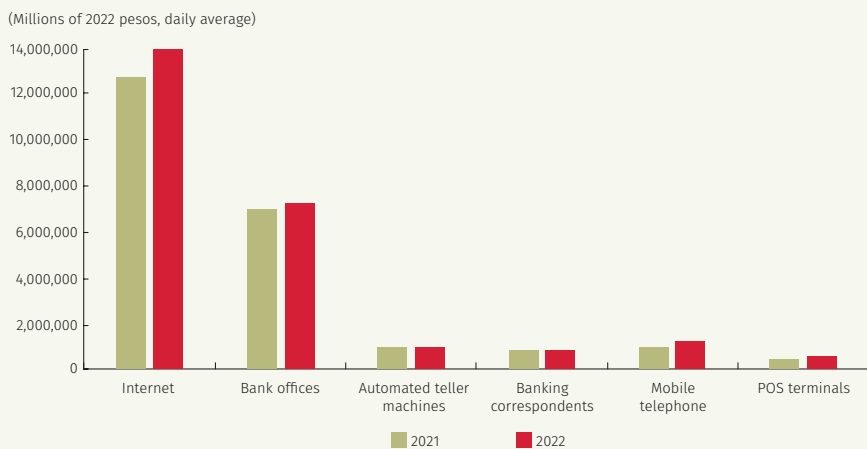
**Graph B6.7**  
Average Daily Value Below COP 1.5 Trillion



Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2012-2022); calculations by Banco de la República (DSIF).

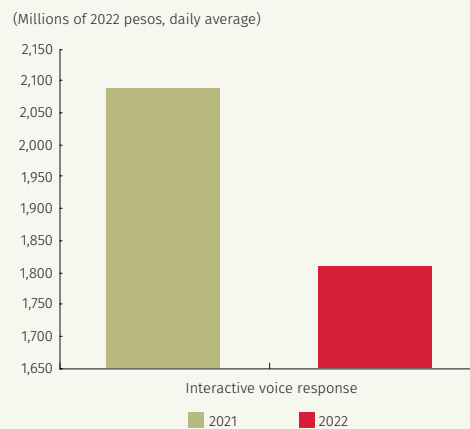
**Graph B6.8**  
Payment Channels, Behavior in the Value of Operations between 2022 and 2021

**A. Channels that Grew between 2022 and 2021**



Source: Office of the Financial Superintendent of Colombia (Report on Operations: 2012-2022); calculations by Banco de la República (DSIF).

**B. Channels that Declined between 2022 and 2021**



## Box 7: Stablecoins and Their Possible Risks

### 1. General Overview

Stablecoins are crypto assets <sup>1</sup> whose price is pegged to the market value of a basket of (ideally) liquid assets to ensure their stability (FSB, 2020). This reference basket may be comprised entirely (100%) of fiat money <sup>2</sup> of advanced economies (although the US dollar is often preferred), or other liquid market assets such as sovereign bonds, high-grade corporate bonds, commercial paper, and precious metals (Eichengreen and Viswanath-Natraj, 2022).

A stablecoin unit of account attempts to peg its value to its reference basket, theoretically following the 1:1 rule, meaning the price of this crypto asset and that of its underlying basket are traded in equivalency or at par. Accordingly, for each crypto asset in circulation, there is an equivalent amount of underlying assets to which it is pegged. In general, most stablecoins trade at par. However, when this is not the case, exchange rates between payment instruments change, and the singleness of the currency is disrupted (Carstens, 2023), which can lead to over-collateralized or under-collateralized schemes (as described later).

Another type of stablecoin has a value pegged to commodities (e.g., gold, oil), to other assets (which can include other cryptocurrencies) or is defined by instructions programmed through algorithms. Unlike the stablecoins summarized in the first group (i.e., those referenced by fiat currencies or other stable assets), the ones included in the third group are those whose issuers perform various operations (e.g., supply-side transactions) to pursue stability for the cryptocurrency in question.

Stablecoins are used in various cases, but mostly for retail payments in unregulated digital spaces where they serve as an alternative form of payment for individuals and/or businesses. These situations come about when cash cannot be used and when the parties in question do not have access to the traditional financial system. Some stablecoins are used to settle payment obligations on e-commerce platforms, for peer-to-peer payments (i.e., person-to-person, person-to-merchant, and person-to-government), and for micropayments. Stablecoins can also be used by multinational firms to pay salaries in different countries and for cross-border money transfers (remittances). <sup>3</sup> In this case, they are issued by private companies and agents and began to be traded in 2014. Dai, HUSD, Paxos Standard, Tether, TrueUSD, and USD Coin are some of the more well-known stablecoins (Arner, Auer, and Frost, 2020).

As with first-generation crypto assets, stablecoins involve an agent who serves as a transaction intermediary, converting orders into money to be then used for payments. These agents are known as exchanges. The operation of these exchanges could pose a risk since they process changes in the ownership of cryptocurrencies and are not necessarily regulated or supervised by financial and monetary authorities.

Stablecoins are different in some ways from first-generation crypto assets (cryptos) (e.g., Bitcoin and Ethereum), which have fluctuating prices due to the absence of a central entity to stabilize them or a reserve of high-quality assets to serve as a reference for their value. Therefore, first-generation cryptos are often sought after for speculative purposes and not

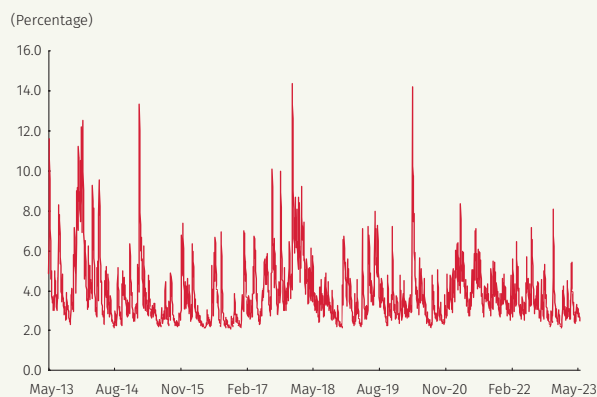
1 They are understood as private digital assets that rely primarily on cryptocurrency and distributed ledger or similar technology. Crypto assets can be divided into two groups: unbacked (i.e., crypto assets that are neither traditional tokenized assets nor stablecoins) or those backed by a basket of underlying assets (i.e., stablecoins).

2 Fiat money is understood to be synonymous with “lawful money” or “legal tender” and is a medium prescribed as “money” according to law and regulations (i.e., imposed by a government, generally by the central bank). The most tangible criterion for legal tender is if it can be used as a medium to pay taxes. It may have no intrinsic value of its own, for example, when it exists on paper or in electronic form (Gross and Siebenbrunner, 2019).

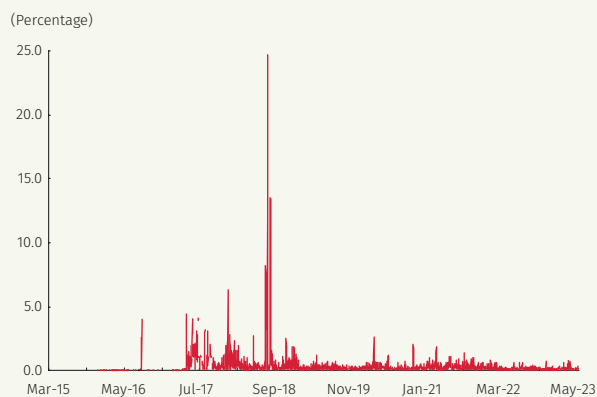
3 See: “What to Know if You Want to Pay Employees with Cryptocurrencies,” available at: [https://www.ey.com/en\\_us/tmt/blockchain-solutions-promote-digital-ecosystems/what-to-know-if-you-want-to-pay-employees-with-cryptocurrencies](https://www.ey.com/en_us/tmt/blockchain-solutions-promote-digital-ecosystems/what-to-know-if-you-want-to-pay-employees-with-cryptocurrencies); “Salary Payments in USDT Stablecoin Ruled as Illegal in the Chinese Court,” available at: <https://cointelegraph.com/public/index.php/news/salary-payments-in-usdt-stablecoin-ruled-as-illegal-in-the-chinese-court/amp> (cointelegraph.com).

Graph B7.1  
Volatility

A. Bitcoin



B. Tether



Source: "Reporte sobre la situación de los cryptoactivos," Banco de la República.

necessarily as a payment instrument.<sup>4</sup> The differences in volatility between first-generation cryptos and stablecoins are shown in Graph B7.1, panels A and B. As expected, Bitcoin (panel A) exhibits far more peaks in the conditional volatility of its price compared to what is observed for Tether (panel B).

Stablecoins, on the other hand, may be more attractive for making payments. In an extreme scenario where their use becomes widespread, stablecoins could potentially serve as an imperfect substitute for central bank money, originating with the private sector to pay for goods and services or as a vehicle for constituting and settling remittances through the infrastructure offered by the crypto world. While this scenario still seems highly unlikely, some emerging jurisdictions have begun to see more use of these instruments, particularly in cross-border transactions using peer-to-peer mechanisms and as substitutes for vehicles offered by the traditional financial system, which require an intermediary for these operations.<sup>5</sup>

The present section focuses on the consequences and potential risks that could arise from the popularization of stablecoins in an economy,<sup>6</sup> which have been identified in the relevant literature. The references cited here come from both the private sector and multilateral organizations (e.g., BIS, IMF, FSB, ESMA, among others) and highlight the important task of expediently identifying and monitoring the risks posed by crypto assets. The pertinent risks described here are market, liquidity, credit, operational, and cyber risks, which can pose considerable challenges for users (businesses and individuals) and for the overall economy. As an example, a recent document published by the BIS (2023)<sup>7</sup> identifies the main risks to financial stability from a broader perspective that includes both first and second-generation crypto assets. It proposes several guidelines for regulating and managing the restrictions on access to information about these activities. *Banco de la República* actively participated in the network that produced the report.

Starting with this introduction, the focus of this section is on stablecoins or second-generation cryptocurrencies, whose supposed price peg is defined by a basket of reference (or underlying) assets, given that they accounted for more than 92% of the market capitalization of all stablecoins in 2022. Other types of stablecoins, such as algorithmically generated ones or those whose price depends on the market value of other cryptocurrencies, represent sources of risk beyond the scope of what is described here.

## 2. The Potential Risks of Stablecoins

Like traditional payment systems, stablecoins could involve market, liquidity, and credit risks. These risks are inherent in cryptocurrencies, due to their nature, although manifestation of these risks can differ from that of traditional assets or those defined in financial regulations, as they are traded in an unregulated space. The origin and manifestation of financial risks related to stablecoins are explained by distortions in their price stabilization mechanisms (i.e., when the peg cannot be maintained) or in their redemption mechanisms

4 See: "Regulating the Crypto Ecosystem: The Case of Unbacked Crypto Assets," available at: <https://www.imf.org/en/Publications/fintech-notes/Issues/2022/09/26/Regulating-the-Crypto-Ecosystem-The-Case-of-Unbacked-Crypto-Assets-523715>

5 See: "Stablecoins' Role in Crypto and Beyond: Functions, Risks and Policy," available at: [https://www.ecb.europa.eu/pub/financial-stability/macprudential-bulletin/html/ecb.mpbu202207\\_2-836f682ed7.en.html](https://www.ecb.europa.eu/pub/financial-stability/macprudential-bulletin/html/ecb.mpbu202207_2-836f682ed7.en.html)

6 Because they are based on decentralized technology (DLT), stablecoins have the potential to be used in certain applications, such as programmable money and smart contracts (see Arner et al., 2020).

7 Available at: BIS (2023). "Financial Stability Risks from Cryptoassets in Emerging Market Economies," BIS Paper, no. 138

(i.e., when there are not enough reserves to support the issue or when the issuer refuses to redeem the currency (see FSB 2020)). As mentioned, exchanges play a significant role in transactions with this type of asset, and the potential risks identified below could manifest to a greater extent.

### Market Risk

Generally, stablecoin pegs tend to reflect minimal or tolerable variations in prices for their holders. This reflects low volatility in the market value of their reference basket. In other words, exposure to market risk is low. However, in times of stress, maintaining the peg can be quite challenging in the face of massive and unanticipated redemption by stablecoin holders, which could lead to a greater manifestation of market risk (ESMA, 2022).

### Liquidity Risk

Liquidity risk is inherent in stablecoins. These digital currencies are usually traded in an unregulated space, which means it is difficult to audit the composition of the reference (or underlying) basket of assets, making it impossible to quantify the issuer's ability to honor the holder's requests for withdrawals. In panic situations, the market risk described here can lead to liquidity risk when it becomes impossible to comply fully and promptly with all redemption orders, either because the assets in the basket backing the stablecoin are insufficient or due to delays caused by technological or operational limitations (FSB, 2022).<sup>8</sup>

### Credit Risk

In an unregulated environment, stablecoin issuers are not obligated to calculate or report their exposure to credit risk, and there is no supervisor or regulator in place to perform this task. Therefore, it is important to understand the potential for loss if an issuer defaults since solvency on the part of the issuer would provide the public with more credibility in terms of the performance of these crypto assets. In this context, a sudden default by an issuer could trigger a cascade effect among those who hold its stablecoins, as these cryptos would quickly lose their value (Arner *et al.*, 2020).

When stablecoins are over-collateralized with other crypto currencies, especially first-generation crypto currencies (rather than low-risk financial assets), one would expect to see more exposure to credit risk due to the high degree of volatility in the prices of the underlying assets. In the event of a correction in the cryptocurrency market, these collaterals could rapidly lose their value, thereby compromising the issuer's ability to fulfill its contractual obligations.<sup>9</sup>

Other potential risks to the economy with the widespread use of stablecoins are operational risks, cyber risks, redemption risks, and data loss risks. Threats of this type are related to the robustness of the infrastructure and the technology used to record transactions. These risks also are related to accessing, transferring, and exchanging stablecoins, as well as to the reference basket of assets used to peg the issue (FSB, 2020).

### Operational Risks

Operational risks arise from the vulnerabilities inherent in blockchain technology and decentralized finance.<sup>10</sup> On the technological front, neither issuers nor those who provide services to stablecoin holders are required to follow standards that promote operational resilience. Consequently, their operation could be compromised in various scenarios, such as power outages, hacking, and data breaches. As for decentralized finance, some government agencies, such as the European Securities and Markets Authority (ESMA), have stressed

8 For details on the Terra case, see: <https://ledger.pitt.edu/ojs/ledger/article/view/283/244>; also: "Built to Fail: The Inherent Fragility of Algorithmic Stablecoins," available at: <https://heinonline.org/HOL/LandingPage?handle=hein.journals/wflron11&div=9&id=&page=>

9 See: <https://coinmarketcap.com/alexandria/glossary/over-collateralization>

10 The term decentralized finance (DeFi) refers to trading, lending and investment services that are based on distributed ledger technology (DLT) and, therefore, do not require a centralized intermediary (see Auer *et al.*, 2023).

that existing risks could be exacerbated by the growing complexity of this type of financial technology and the potential increase in the rate at which it is adopted (ESMA, 2022).

Stablecoins are issued privately, making it difficult to ensure interoperability among different kinds of these cryptocurrencies. This characteristic gives rise to isolated or unconnected systems, where each issuer determines the rules and conditions of operation, as well as how stablecoins are issued, traded, and redeemed. Known in the literature as a *walled garden*, this occurs when stablecoins are imperfect substitutes for each other, and results in fragmented systems where there would be uncertainty about the value of money (see Cunliffe, 2023). In such situations, the issuer, at its own discretion, defines how technological and operational risks are managed, thus avoiding universality or uniformity in the stablecoin space with respect to this aspect.

### Cyber Risks

Cyber risk is a special class of operational risk. Generally, it tends to materialize in two ways: on user access mechanisms (e.g., digital wallets) or in the infrastructures that provide services (i.e., cryptocurrency trading platforms—exchanges). Most exchanges are global and, as mentioned, they are not regulated. Many have experienced service interruptions or hacks that have halted or limited the ability of buyers and sellers to transact or have led to large-scale theft from their customers (FSB, 2018). While quantifying cyber risks is complex at this point in time, their potential effects may motivate stablecoin issuers to update their cyber-security systems continually in an effort to limit likely losses.

### Redemption Risk

The entire value of stablecoins is pegged to the market value of the basket of underlying assets. A stablecoin is overcollateralized or exactly collateralized if it can be exchanged for the reference currency at par (1:1). If, on the other hand, it is undercollateralized, its redemption at par will not be possible. This last case can lead to redemption risk, which arises when the underlying assets are insufficient to allow the stablecoin to be redeemable at its reference value. Accordingly, the peg cannot be maintained (see BIS, 2022), and both the investor and the financial system are exposed to redemption risk.

### Capital Flow Risk

More interest among the population of a country in transacting with stablecoins, especially those with global and cross-border reach (i.e., global stablecoins), could lead to unanticipated and untraceable capital outflows from the economy to foreign jurisdictions. While these crypto assets allow residents to engage in transactions with non-residents, without using the traditional means offered by the financial system, it is currently difficult to determine whether these transactions can be conducted smoothly and without the risk of stablecoin holders facing unanticipated and unrecoverable losses of wealth, especially in an unregulated environment and in the absence of capital controls. This risk could be exacerbated in times of stress and global risk aversion. In this sense, the economy indirectly increases its exposure and vulnerability to global conditions.<sup>11</sup>

## 3. Case Study: Terra

A recent episode involving all the risks mentioned above is that of UST/Luna. In March 2020, Terraform Labs began to issue a set of stablecoins through its Terra platform and payment infrastructure. They were linked to various fiat currencies, and the most prominent was UST/Luna, which was pegged to the US dollar. UST was pegged to Luna through a pegging mechanism aimed at encouraging traders to engage in arbitrage whenever the stablecoin deviated from the peg.

Each token of this algorithmic stablecoin was worth one unit of Luna (i.e., another stablecoin) and Luna and UST tokens could be swapped freely. Smart contracts automatically adjusted the token supply when exchanging UST for Luna, and vice versa. If the price of UST

<sup>11</sup> See: “G7 Working Group on Stablecoins: Investigating the Impact of Global Stablecoins,” available at: <https://www.bis.org/cpmi/publ/d187.pdf>

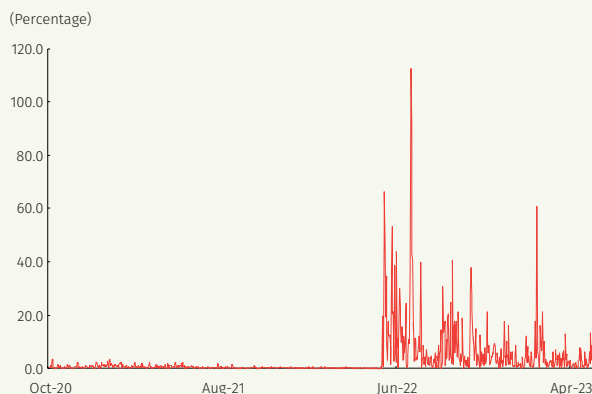
fell below USD 1, traders could buy UST at a discount, exchange it for Luna, and sell Luna to make a profit.<sup>12</sup>

UST/Luna is a particular case because it was an algorithmic stablecoin. This made it a risky investment since it was not pegged to a reference basket of assets comprised of cash, U.S. Treasury bonds, or other traditional and low-risk assets (as is the case with a fiat-referenced stablecoin). Additionally, UST/Luna's stability was derived from algorithms that pegged it to the value of Luna. This created uncertainty among investors about whether an algorithm could keep two tokens stable.

Although it is not clear what triggered the massive sell-off of UST/Luna prior to its collapse, it occurred in an environment of considerable uncertainty in the crypto currency market, and where the Fed's policy of interest rate hikes made holdings in risky assets less attractive to financial market investors. In any case, the collapse on 09 May 2022 was caused by massive sales of UST that could not maintain the peg to Luna. The result was rapid depreciation of this stablecoin and significant losses in the crypto market. As illustrated in Graph B7.2, the increase in the conditional volatility of UST/Luna that began with this collapse persisted for a year afterwards.

The Terra case highlights the hazards posed by stablecoins, especially algorithmic ones. That said, other types of stablecoins are not immune to the risks described here. USDC is known as a fiat-referenced stablecoin, which means the value of this virtual currency is tied to a strong currency issued by a central bank. USDC is designed to trade at USD 1 (1:1), but on Saturday, April 15, it fell below 87 cents, according to CoinDesk data, indicating the stablecoin's peg was broken. This situation occurred after it was revealed that the reserves backing this stablecoin were highly exposed to Silicon Valley Bank assets, which demonstrates how vulnerable stablecoins can be to stress situations in financial markets.

Graph B7.2  
USD Terra Classic (USTC)



Source: "Reporte sobre la situación de los cryptoactivos," Banco de la República.

#### 4. Conclusions

Stablecoins are cryptoassets whose value depends on a basket of reference or underlying assets. An eventual popularization of stablecoins could generate various types of risks, some derived from their stabilization and redemption mechanisms (market, liquidity, and credit risks), and others from the infrastructure and technology required to issue and operate these cryptocurrencies (operational risks and cyber risks). Manifestation of the risks outlined in this section could be greater in the case of global stablecoins (i.e., stablecoins with global scope), as these would involve agents from different jurisdictions with difficult-to-quantify contagion or second-order effects. A deeper understanding of the potential effects of stablecoins on the economy is considered essential.

This task becomes more challenging in jurisdictions with no financial regulation of cryptocurrencies, such as the Colombian case, where collecting traceable and timely data on residents' cryptocurrency transactions is not possible. For that reason, regulating cryptocurrencies and periodic measurements of their risks have become increasingly important for financial authorities.

According to the BIS (2023), a robust and interoperable fast payment system that ensures local settlement of payments in real-time

<sup>12</sup> This process continued until enough USTs were removed from circulation, bringing their price back up to one unit of Luna. Conversely, if the price of UST rose above one unit of Luna, traders could take advantage of the difference by buying Luna, exchanging it for UST, and selling UST for a profit. Smart contracts adjusted the supply of tokens to bring the price of UST back to USD 1.

(24/7/365) with other compatible systems could reduce the population's interest in using cryptocurrencies as payment instruments (especially stablecoins), particularly if they operate in unregulated schemes without the security and confidence of preserving participants' wealth and payment integrity. In this respect, *Banco de la República* is committed to designing and implementing its own fast payment system, which will be available as of 2025 and will complement the fast payment system currently managed by the private sector by offering real-time payment services.

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## 3. Payment Trends and Innovations

There have been important developments in the financial sector during the last five years. These have led to an expanded offer of payment services, particularly those oriented towards individuals and companies. The private sector has contributed a large part of these innovations, many of which are aimed at offering real-time (24/7/365) transactional services, an aspect that, until a few years ago, seemed out of the question for users. New technological solutions have redefined the payment services landscape through the inclusion of fast payment systems. However, several challenges remain, many of which require a deep understanding of financial infrastructures, payment instruments and the technologies on which these new solutions are based.

One of the mandates of central banks is to promote the safety and efficiency of retail payment services. This implies, among other things, being at the frontier of knowledge concerning technological innovations. The local payment ecosystem in Colombia currently includes, among other players, the fast payment system offered and managed by the private sector (e.g., *Transfiya*, operational since February 2020). The payment ecosystem in the future also will include a fast payment system provided and managed by *Banco de la República*, which is expected to be launched in 2025. Other potential innovations in retail payment services are being discussed internationally, such as the use of a central bank digital currency for general purpose (or retail CBDC), which was examined previous editions of this Report.

This edition of the Report aims to contribute to an understanding of some of these innovations, more specifically, two technological functionalities that could accompany digital payment services, and standardized messaging in retail-value payment services.

Regarding the first topic, which is related to technological innovation in retail payment services, Box 3.1 in this Report looks at two technological functionalities that could accompany the eventual issue of a retail central bank digital currency: programmable money and smart contracts. These functionalities would allow their users to carry out much more specialized transactional activities than they usually do.

The second topic on payment innovations relates to standardized messaging in retail-value payments, with special emphasis on England's experience and on interoperability issues.

### 3.1 Programmable Money and Smart Contracts in a Payment Context

The unregulated private sector has developed programmable money and smart contracts, which are understood as technological functionalities that could facilitate payments in the context of decentralized finance (DeFi). Outlined below are some thoughts on these developments that could be considered in the use of tools to facilitate payments in the economy and in the design of an eventual retail central bank digital currency (rCBDC).

### 3.1.1 Retail Central Bank Digital Currency

Retail CBDC (rCBDC) is a form of money that would be issued and backed by the central bank, like cash. This new type of currency would allow the general public, as well as merchants and businesses, to make retail payments in real time, face-to-face, directly (peer-to-peer) or online (e. g.: e-commerce).

*Banco de la República* has concentrated on designing and implementing its own fast payment system, which is expected to be available as of 2025. It will interconnect and complement the one currently managed by private agents, by offering real-time payment services. In this context, the Bank has not decided on the possibility of issuing currency in a digital format for use by the general public and companies, nor does it consider this to be a priority in its plans for the short or medium-term. However, it continues to closely monitor developments, discussions, and innovations in this field.

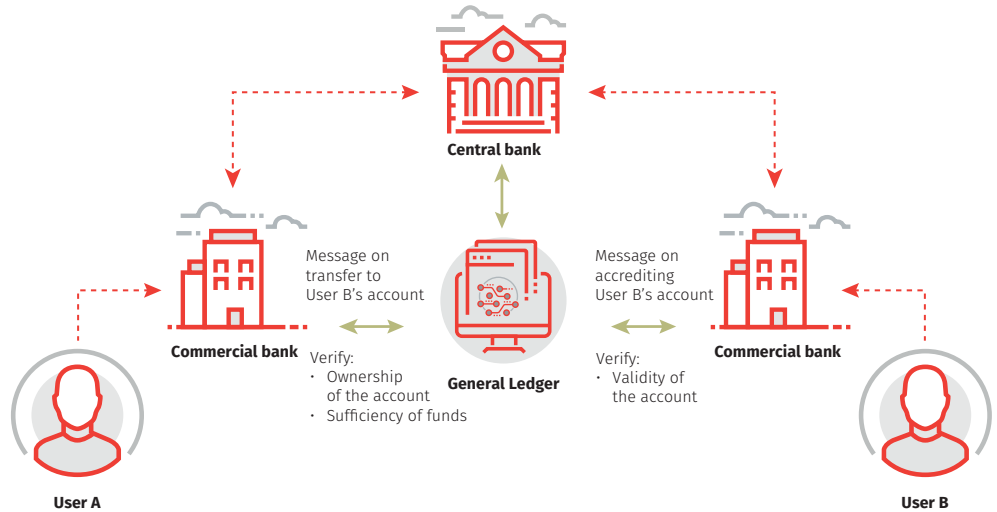
At this point, it is relevant to describe some of the aspects highlighted in recent literature on the architecture, issue, distribution, and redemption of a rCBDC. With respect to management of the general ledger (that is, the platform where the details of operations are recorded), and the distribution of a rCBDC among the population, there are two variants. In one case, everything would be done by the central bank; in the other, distribution and/or management of the general ledger could be done by the regulated financial sector. Depending on the country and the design and use of a rCBDC, this public-private synergy can vary, but it is understood that the experience of the financial sector in payments infrastructure, operations management, customer transactions and related considerations, makes it necessary to support the central bank in the operation and distribution of legal tender in digital format.

As illustrated in Diagram 3.1, in a transaction between two people, call them A and B, where the former wishes to pay the latter, the account-based transfer mechanism suggests that commercial banks (and other payment service providers) act as intermediaries between the central bank and the population, allowing different agents to be connected in transactions and payments when using rCBDC. For security and technological reasons, the recording of transactions in the general ledger (i.e., a detailed record of transactions, including information on participants, the amount transferred, the time, etc.) can be the responsibility of the central bank or one or more financial intermediaries. Whether this task is handled by the central bank or by a third party depends on the country and context, as mentioned earlier.

The other transfer mechanism is token-based, which, in turn, contemplates the public-private synergy referred to earlier, but distribution of the central bank's digital currency would occur in the DeFi space,<sup>18</sup> through some type of distributed ledger technology (DLT) (see Diagram 3.2). There, the concept of the programmability of currency is key, since the instructions on how to transport the money (from the digital wallet of customer A to customer B) and various security protocols would be the faculty of the central bank, but a third party could execute them. Again, the characteristics of the operations and distribution, and how relevant the third party becomes, depend on the jurisdiction in question.

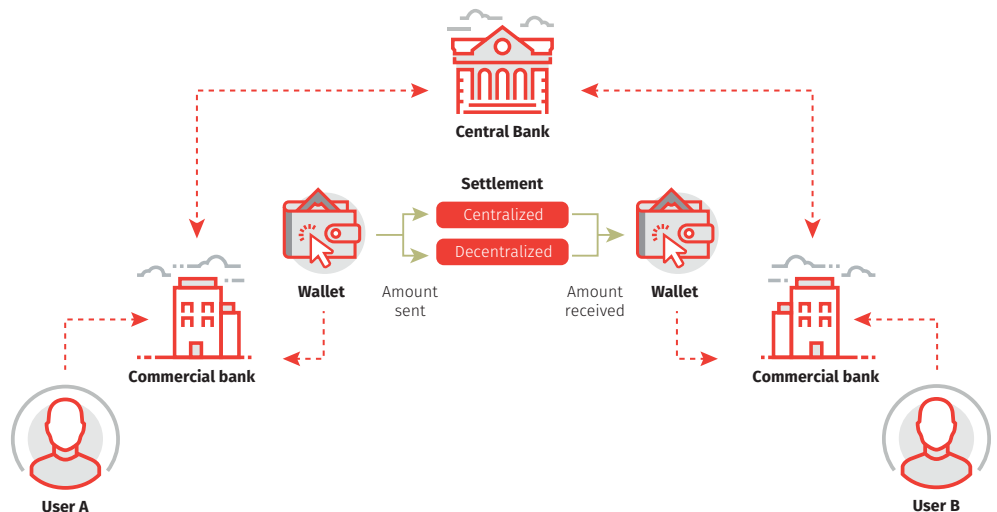
18 DeFis can be understood as the set of markets, products and alternative financial systems that operate through crypto assets and "smart contracts" (software) constructed with distributed ledger or similar technology. (IMF, 2023). See: [https://www.imf.org/en/Publications/fandd/issues/2022/09/Digital-Money-101-explainer#:~:text=DECENTRALIZED%20FINANCE%20\(DeFi\),distributed%20ledger%20or%20similar%20technology](https://www.imf.org/en/Publications/fandd/issues/2022/09/Digital-Money-101-explainer#:~:text=DECENTRALIZED%20FINANCE%20(DeFi),distributed%20ledger%20or%20similar%20technology)

Diagram 3.1  
Account-based Transfer Mechanism



Source: Prepared by Banco de la República.

Diagram 3.2  
Token-based Transfer Mechanism



Source: Prepared by Banco de la República.

At this point, it is important to recognize that the public-private synergy outlined above assumes the regulated financial sector would have the necessary and sufficient experience to carry out the described activities, especially with respect to management of the general ledger. In addition, to always guarantee the security of rCBDC and its support, its activities must be regulated and framed in a context where risk management is efficient and mitigates relevant vulnerabilities. This is especially important in a scenario where the distribution of legal tender, in digital form, could be carried out in a DLT or similar space, since these infrastructures, as noted in the section on the risks of stablecoins, are novel and disruptive. In this sense, an adequate understanding of the information protocols in the realm of DeFi, of the way the assets there are traded, and of the assessment of relevant

risks is key to defining participation by the financial system that guarantees proper functioning of a rCBDC and, in turn, maintains the credibility of the central bank and the reliability of the country's legal tender.

A retail CBDC could offer the functionalities of smart contracts and programmable money as further technological developments in addition to the basic digital payment services. Whether or not these technological functionalities are implemented in the central bank's digital currency would be part of the aspects of its technological design. These elements would not be required in a strict sense, as would other aspects of economic and technological design -e.g., the architecture that defines its operation, data governance, interoperability, scalability and resilience (see Martínez *et al.*, 2023)- which must be established before a currency of this type is issued.

One possible use that could be anticipated by including programmable money and smart contracts in a retail CBDC would be the purchase of equities directly on the stock market with central bank currency (i.e., but without the involvement of a brokerage firm or another type of intermediary). This would be done in a decentralized way and on the condition that the terms set forth in the respective smart contract are met. These two technological functionalities are described in this section in the context of central bank digital currency.<sup>19</sup>

### 3.1.2 Programmable Money

Programmable money is a form of digital money that is conditioned by the user to compliance with circumstances in terms of time, mode and value that have been established in advance of the payment process (Deutsche Bundesbank, 2020).<sup>20</sup> In other words, programmable money is defined on the basis of a set of rules or codes stipulated in a smart contract. This technological functionality allows transfers to be done automatically, provided that a pre-established objective is met (Panetta, 2023).<sup>21</sup> Payment agreements are fulfilled through programmable money by blocking funds between the time they are promised by the originator to the time they are delivered to the recipient, with the understanding that they will be released when the service agreed on is delivered.

Programmable money differs from direct payments in that the latter settle the respective obligation without having to block the funds in question. Therefore, they allow for greater liquidity savings (Kahn and van Oordt, 2022).

Individuals, companies, and other agents in the economy could use programmable money to resolve single-payment arrangements as well as payment chains. As the name suggests, single-payment arrangements occur when a buyer needs to purchase a good or service from a seller on a one-time basis. For this reason, using pro-

<sup>19</sup> Micropayments (i.e., very low-value payments) are another technological aspect that could be included in the design of a retail CBDC. The cost of processing micropayments through existing payment solutions usually exceeds their value. A retail CBDC that allows for extremely low-cost micropayments could contribute to the development of applications such as the Internet of Things (which would connect networks of devices like smartphones and computers to online payments). Individuals and merchants, as well as other businesses, will want to use it (offer their services) much more frequently in their online transactions (Bank of England, 2020).

<sup>20</sup> Programmable money differs from automatic payments in that the latter originate with payment instructions - usually pre-established - for the direct debit of fees for public utilities (i.e., pre-authorized charges debited from your deposit account at commercial banks).

<sup>21</sup> Another class of conditional payments includes payments upon delivery, automatic refunds, and pay-as-you-go payment services.

programmable payments in such cases would not be efficient, due to the opportunity cost of blocking the funds until the condition for their release becomes effective. One-time payment arrangements are generally resolved through direct payments.<sup>22</sup>

Programmable payments can be used to settle payment chains (i.e., periodic disbursements in amounts that may change in value from one point in time to another), since this functionality would delay the release of funds until the trade relationship or payment arrangement terminates. Typically, payment chains arise out of recurring transactions, such as payments for services and invoices. The demand for programmable payments and direct payments will depend, to a large extent, on the cost of the transaction. Programmable payments that cost less than direct payments could eventually replace direct payments altogether. If, on the other hand, these costs exceed those of direct payments, the demand for programmable payments will depend on how burdensome they are for digital currency users (see Kahn and van Oordt, 2022).

### 3.1.3 Smart Contracts

The technological solutions offered by programmable money necessitate integrating smart contracts into the payment process. These contracts use computer programs to encode the terms set by users of digital currency and execute them automatically. Most smart contracts are implemented in decentralized applications (DLT), where funds are released without the need for third-party intervention (Bakos and Halaburda, 2019; Kiff *et al.*, 2020). However, they can also be implemented in centralized systems (see Bank of England, 2020).

Machine-to-machine payments, payments made on the Internet of Things, automated payments, and pay-as-you-go payments are some of the cases where smart contracts are required to settle the cash leg of the operation.<sup>23</sup> Currently, none of these payments can be executed through conventional payment systems. Therefore, innovative solutions in payment services must be promoted to address the future demand for smart contracts. One alternative would be to incorporate (adapt) technological solutions into conventional payment systems;<sup>24</sup> however, their potential use would be limited by the inability to have payment services available on a permanent basis. The second solution to offering payment services for smart contracts involves the use of rCBDC. This would be entirely applicable only if there is a secure and interoperable standard (Deutsche Bundesbank, 2020). Further details on this solution are discussed in the following section.

### 3.1.4 Programmable Money and Smart Contracts in rCBDC

Programmability is a technological aspect that could be a part of retail CBDC. As per the theoretical model developed by Kahn and van Oordt (2022), including program-

22 Direct payments are all those we make at present; in other words, payments that do not have a smart contract that makes them programmable.

23 Although there is no standardized definition for the Internet of Things, this concept refers to an Internet application that includes virtual or physical things, and where a pair of these things have a form of interconnection or interaction. Devices such as cameras and sensors are needed to operate the Internet of Things. A common assertion regarding this application is that it will change the way individuals interact with machines and, consequently, transform a wide range of activities such as asset tracking, property energy consumption control, health monitoring, and efficiency in education, among others (Sorri *et al.*, 2022).

24 Currently, conventional payment systems (specifically, large-value systems with real-time gross settlement) can be used only in cases that are not complex, either by establishing orders or direct debits (Deutsche Bundesbank, 2020).

mable payments in the central bank's digital currency would be feasible only if the transaction cost is low enough. According to these authors, the lower the transaction cost, the greater the potential for various relationships between buyers and sellers. A greater number of relationships in the economy could lead to positive network externalities in rCBDC, which would be essential for achieving the widespread adoption of a digital currency on the part of the population (see Martínez *et al.*, 2023).<sup>25</sup>

A programmable retail CBDC would need to have the capacity to store a program that runs computerized protocols, which execute the terms of a contract and can depend on events, identities, and natural or time-based states (see Usher *et al.*, 2021).

Incorporating features such as programmable money and smart contract into a rCBDC could have both advantages and risks for users. Added efficiency and reduced transaction costs in financial markets are the advantages to be expected. The anticipated risks of these features are those arising from the reliance of smart contracts on external sources for their execution and those related to cyberattacks. The latter could have a far greater negative impact on payment services, as they could result in data breaches as well as significant financial losses for users (Usher *et al.*, 2021).

At this point, it could be assumed that widespread use of these features (programmable money and smart contracts) would allow the financial industry to benefit from multiple opportunities for payment innovation, which could represent important benefits for investors, especially in segments of the financial industry where intermediation costs are high, and efficiency is low.<sup>26</sup> Other cases where programmable money could be used include automatic routing of tax payments from point-of-sale and dividend payments to shareholders (see Bank of England, 2020). This would reduce the number of intermediaries through which funds must pass, allowing for faster access to these resources.

All of this is possible if the rCBDC infrastructure allows for programmable payments. According to the Bank of England, rCBDC could offer programmable payments through smart contracts in three ways. The first would involve building the "programmable money" functionality within the core ledger. In this case, processing programmable money would be much more complex than a simple payment button, as it would depend on conditions and contingencies set by the contract participants. This complexity could slow down the system, limit scalability, and compromise overall system security (Bank of England, 2020).<sup>27</sup>

The second way to offer programmable money in rCBDC would imply developing a separate module of the ledger to manage and process smart contracts (i.e., run the code) and indicate when action is needed to address operational issues. This approach would reduce the limitations generated by the first alternative in terms of system performance. The third way to offer programmable money in rCBDC

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25 Positive network externalities arise when an increase in the number of users of payment instruments makes the instrument much more attractive to those who are not using it. Boissay *et al.* (2022) explain network externalities in the case of cash.

26 A retail CBDC that provides far more efficient digital services than those offered by private solutions, such as stablecoins and other crypto assets, could limit the potential threats the latter could pose to financial stability.

27 Scalability refers to the capacity of the CBDC (Central Bank Digital Currency) system to expand to meet large volumes of future transactions (Bank of Canada *et al.*, 2020).

would mean allowing third parties, such as payment interface providers, to handle this functionality. In this case, the central bank would need to set standards for the security and interoperability of smart contracts among providers (see Kiff *et al.*, 2020).

According to Panetta (2023), the digital euro is not expected to be programmable money because the European Central Bank does not foresee imposing any restrictions on when, where, and to whom payment can be made using legal digital tender. This suggests there are central banking cases where programmable money and smart contracts have been studied in the design of rCBDC.

### 3.1.5 Conclusions

Services such as programmable money and smart contracts could enhance the adoption of digital currencies. Programmable money, for instance, would allow for automatic payments if the conditions established in advance by the user are triggered in the smart contract. The conditions under which value units would be transferred to the recipients of these payments would be stipulated in such contracts (Deutsche Bundesbank, 2020). These two technological functionalities are closely related, as programmable money would be used to automatically execute payment orders defined by the digital currency user in a smart contract, facilitating the functioning of programmability. However, although the adoption of programmable money and smart contracts offers potential gains in efficiency and innovation in the payment system, it entails major risks associated with, for example, potential cyberattacks and the mishandling of private information.

A review of several international references showed that programmable money and smart contracts could be implemented in a rCBDC system in three ways. The first would involve building the programmable money functionality within the ledger, the second would require developing a separate module of the ledger to manage and process smart contracts, and the third would imply allowing third parties to offer programmable money services.

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### 3.2 Standard in Payment Messaging: A Key Aspect for Interoperability

ISO 20022 is a financial standard created for the universal language of payments. It enables an exchange of electronic messages between financial institutions and between these institutions and payment systems, within the same country or across countries.<sup>28</sup>

This messaging standard requires common rules for identifying senders, recipients, currency, amount, date, and, if additional information is needed, there is a format that is allowed. As to its characteristics, ISO 20022: <sup>29</sup> 1) is an open standard in which the specifications are available for free, development is open, and the standard can evolve to meet users' needs; 2) the language can be read by a wide range of operating systems; and 3) there is more data capacity and better structuring. This allows for efficient identification of the originators and ultimate beneficiaries of payment instructions, a better understanding of the purpose of a payment, and prevents data truncation when sending messages.

The use of ISO 20022 messaging is becoming increasingly prevalent worldwide, and several jurisdictions plan to implement it by the end of 2025. Therefore, in the medium term, it is possible the payment industry will have this international standard with a common language for most payments around the globe.

**The Colombian Case:** On the domestic front, *Banco de la República* has been working to apply ISO 20022 in the large-value payment system (CUD) and is also in the process of implementing it in the new technological platform of the Central Securities Depository (DCV). The CUD uses ISO 20022 messaging for funds transfer services<sup>30</sup> and account statements (thereby allowing participants to standardize reconciliation processes in their own systems).

28 Accespay (2022). "¿Qué es ISO 20022? Explicación de la norma de mensajería financiera de Swift," at: <https://accesspay.com/es/knowledge-hub/pagos/que-es-iso-20022/>

29 Bank of England (2018). "ISO 20022," Consultation Paper: A Global Standard to Modernise UK Payments.

30 The entities with ISO 20022 for funds transfers in the CUD are: Banco de Bogotá, Bancolombia, Bancolombia Cumplimiento, Citibank, Banco Davivienda for external systems, the National Treasury Department (DTN), the General System of Royalties, Cititrust, Fiduciaria Bancolombia S. A., Sistema BNP Paribas Securities Services, Positiva Compañía de Seguros S. A., Cámara de Riesgo Central de Contraparte, Bolsa de Valores de Colombia S. A., and Deceval.

The DCV has successfully conducted an initial simulation of its use, which is mandatory for financial market infrastructures that are connected to the DCV and optional for depositors. Also, the central bank envisions the possibility of including migration in the fast payment systems it will operate. Both Deceval and the Colombian central counterparty (*Cámara de Riesgo Central de Contraparte, CRCC*) have implemented ISO 20022. Deceval, in interoperability with *Banco de la República*, processes payments for fee collections and delivery-versus-payment transactions through the CUD. The CRCC has interoperability with *Banco de la República* for its peso payment operations.

Consequently, ISO 20022 has been implemented in Colombia by the financial asset infrastructures around the CUD, with certain services.

**The Case of England:** Implementing this global standard for financial messaging in England has facilitated the execution of a long-term strategic plan. A multi-year program was initiated to enhance resilience and promote competition and innovation in payments. The transition to ISO 20022 began in June 2023, initially with two of the country's payment systems: the Real-Time Gross Settlement (RTGS) service and the Chaps electronic transfer system.<sup>31</sup> One of the main reasons for the change in the Bank of England's RTGS system is to expand interoperability, which is understood as the ability of different information systems to communicate with each other, exchange data, and use the data that has been exchanged.<sup>32</sup> It is precisely by implementing a common messaging standard, through ISO 20022 in the UK, that broader interoperability among types of payment is expected to be achieved. This will facilitate the exchange of data among payment systems, whose global standardization will enable greater interoperability, leading to more efficient fraud detection and improved processing efficiency.<sup>33</sup> In June 2018, the Bank of England, in conjunction with the payment systems operator known as Pay.UK and its regulator, the Payment Systems Regulator (PSR) (see Graph 3.1), announced the introduction of ISO 20022-compatible messaging in retail payments within the New Payments Architecture (NPA),<sup>34</sup> so as to organize payments between financial entities with interoperability by replacing each payment system characterized by peculiarities in information, methodology, formats, standards and rules that generated inefficiency, including the difficulty and high cost of payments between different payment systems. The purpose was to migrate to a new infrastructure for clearing and settlement based on the ISO 20022 messaging standard.<sup>35</sup> As part of the plan, other retail interbank payments in England must also migrate to ISO 20022 in the next few years.<sup>36</sup>

31 The Clearing House Automated Payment System (Chaps) has around thirty direct participants and more than five thousand financial institutions that make Chaps payments through one of its direct participants.

32 Bank of England (2018). "ISO 20022," Consultation Paper: A Global Standard to Modernise UK Payments.

33 See: <https://www.bankofengland.co.uk/paper/2022/roadmap-for-real-time-gross-settlement-service-beyond-2024>.

34 NPA stands for the new way proposed in the UK payments industry to organize the clearing and settlement of payments made from one payment account to another, known as interbank payments.

35 Minsait Payments (2021). *Informe*, XI edition, in collaboration with Tendencias en Medios de Pago (Trends in Payment Methods).

36 Bank of England (2022). "ISO 20022: implementación del estándar de mensajería de pagos globales dentro de Chaps y RTGS," in: <https://www.bankofengland.co.uk/payment-and-settlement/rtps-renewal-programme/iso-20022>

**Table 3.1**  
**England: Institutional Arrangements for Payments Subject to ISO 20022**

	Function	Independent Entity	Bank of England
	Transfers – BACs	PAY.UK <sup>a/</sup>	
	Faster transfers FPS	PAY.UK	
Operation	Checks – Image Clearing System	PAY.UK	X
	Chaps		X
	RTGS		
Regulation		Payment system Regulator (PSR) <sup>b/</sup>	
Oversight and Monitoring			X

a/ Payment system operator with three national retail payment schemes; namely, Bacs, the faster payments system, and the check clearing company (Image Clearing System).

b/ The payment systems regulator is a subsidiary of the Financial Conduct Authority (FCA) and the independent economic regulator for the payment systems industry in the UK. The FCA regulates electronic money institutions and payment institutions.

Source: FCA (“Access to UK Payment Schemes for Non-Bank Payment Service Providers,” December 2019; available at: <https://www.fca.org.uk/about/uk-regulators-government-other-bodies>).

It has been around five years from the time the plan was announced up to its gradual implementation. Overall, the entire ISO 20022 proposal in England has been built through debate and consultation with numerous stakeholders. The Bank of England, together with the retail systems, has engaged with over fifty payment organizations, participating in various working groups, primarily in three areas: data and interoperability, RTGS renewal, and technology. In terms of interoperability, the group’s main purpose was to provide relevant information on the innovative design and on implementation of the new standard.

### 3.2.1 Benefits Expected in England with Implementation of the ISO 20022 Messaging Standard

Messaging in a universal language, with richer and structured data, that involves the clients of financial institutions,<sup>37</sup> those institutions themselves, and the payment systems will lead to benefits in terms of flexibility, compliance and regulation, resilience, enriched data and analytics, competition and innovation, direct processing, and harmonization, among other advantages<sup>38</sup> (Diagram 3.3).

One of the greatest benefits anticipated with standardized messaging is the harmonization that comes with facilitating interoperability in payments, understood

37 ISO 20022 has become a common term in business-to-bank interactions, derived from the common global implementation (CGI) initiative. This standard enables new services, regulatory compliance, and maintains service levels by ensuring that all data sent when initiating corporate payments is end-to-end encrypted. A company may use the same message structure for all its payments with all its transaction banks, reaching any payment system worldwide (See <https://www.swift.com/standards/market-practice/common-global-implementation>).

Currently, payment methods have been incorporated into customers’ ERP systems through application programming interfaces (APIs), enabling companies to connect and exchange data with third parties. In addition, e-commerce platforms are leveraging wallets to create seamless online shopping experiences. See: J. P. Morgan (2022). *White Paper, ISO 20022: el lenguaje universal para el futuro de pagos.*

38 Bank of England (2021). “Victoria Cleland: A New Dawn for Payments,” a speech by Ms. Victoria Cleland, Executive Director for Banking, Payments and Innovation at the Bank of England.

Diagram 3.3  
Benefits of ISO 2022



Source: Bank of England (2021). "Victoria Cleland: A New Dawn for Payments," speech by Ms. Victoria Cleland, Executive Director for Banking, Payments, and Innovation of the Bank of England; prepared by Banco de la República.

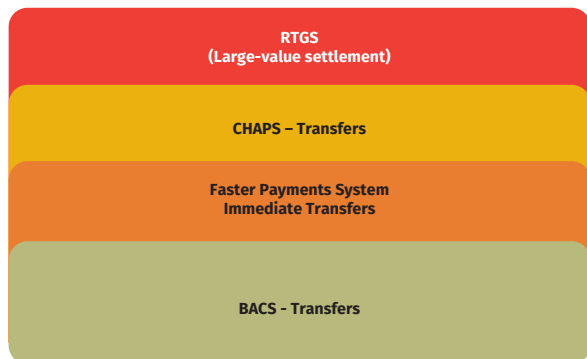
as communication between payment systems,<sup>39, 40</sup> which enables industry cooperation in developing operational standards. An example of interoperability is the acceptance of card payments in commerce, for which standards are imposed on physical cards, terminals, and data security. There is also the interoperable scheme of the Automated Clearing House network (ACH) in Europe, where various national payment systems, regulated by the pan-European scheme, have interoperability for credit transfer, debit, and direct debit services. Additionally, adoption of the standard can be seen as an initial step in connecting process chains by facilitating automatic (direct) processing of operations.

With the implementation of ISO 2022, the goal is to provide a common set of definitions, structures, and rules for entering data into a payment message for all payment service providers and users. The adoption of this standard in England will ensure the content of transaction information between a retail payment and a large-value payment is aligned. In Chaps, Bacs, and Faster Payments, there will be an overlap in format, and the message structure and content will ensure national interoperability (see Diagram 3.4). In addition to domestic harmonization, ISO 2022 is being adopted abroad. In other words, the expectation is that a cross-currency payment from a UK organization to a European-based company will require data organized in a similar structure at each stage of the process, thereby improving the efficiency and accuracy of cross-border payments.

39 World Bank (2021). "Interoperability in Fast Payment Systems," Part of the World Bank Fast Payments Toolkit.

40 These are composed of infrastructure, regulatory frameworks and applications. Infrastructure refers to the systems that clear and settle payments, which require the joint operation of hardware and software, such as servers and routing. Regulation corresponds to the operating rules for payment systems in terms of payment messaging standards, settlement, and participant access, among other aspects, and applications are the payment services used by consumers and businesses, which can be developed by the entities participating in the systems.

Diagram 3.4  
Information Content Alignment: Overlapping Format  
between Systems



Source: Bank of England (2018). "ISO 20022," Consultation Paper: A Global Standard to Modernize UK Payments; prepared by Banco de la República.

In “Developments in Retail Fast Payments and Implications for RTGS Systems” (December 2021), the BIS states that an increasing number of real-time payment systems have adopted or are moving toward adopting the ISO 20022 messaging format.<sup>41</sup> The implementation of ISO 20022 and the subsequent increase in its use by real-time payment systems are expected to result in richer and more structured data being transmitted with transactions in a standardized manner, in addition to consistency, flexibility and greater resilience, and security in transactions. The same document mentions two countries in Latin America with fast payment systems: Brazil and Mexico. The first, with the PIX system, has an ISO 20022 communication interface for its messages with participants. The second is part of the SPEI large-value payment system, which does not report the use of this type of messaging.

The applicability of the standard in countries like England, where ISO 20022 is universal across large and retail-value systems, and the operation of fast payment systems in different countries that have incorporated the same messaging standard, invite us to consider the need for strategic planning so the payment industry in Colombia can have a standardized messaging system, especially in the case of those responsible for retail payment operations.

This requires coordination among the various entities involved in the payment process - such as payment system operators, payment service providers, regulators, and supervisors - to diagnose the standard that has been implemented already and to determine the steps to be taken in the local financial infrastructure. The purpose of implementing ISO 20022 is to achieve interoperability, flexibility, compliance and regulation, resilience, enriched data and analytics, competition and innovation, and direct processing, all intended to foster further development in local and cross-border digital payments.

41 Out of 27 countries (including the Euro area as a country), 20 implemented or are implementing ISO 20022.

# Annex 1: Payments in Financial Markets

## 1. Large-value Payment System

### 1.1 General Aspects and Development

As of December 2022, 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 low-value payment infrastructures (7) and others (10).

Table A1.2 offers details on the origin and items pertaining to the operations that debit deposit accounts in the CUD system.

### 1.2 Indicators of Concentration, Operational Efficiency and Others

Estimates of the concentration of payments among the direct participants in the large-value payment system (excluding some payments) are shown in Table A1.3. Using 70% of total payments as a point of reference, it was determined how many entities and what percentage of all participants are covered by this reference. The concentration increased between 2021 and 2022, having gone from fifteen to fourteen participants. Consequently, the total percentage of participants generating this concentration declined slightly, from 10.9% in 2021 to 9.9% in 2022.

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

Type of Institution	Number of Participants
Trust companies	26
Banks	29
Brokerage firms	16
Insurance companies	13
Finance companies	11
Public financial entities	8
Social security information operators	8
Financial cooperatives	5
Retail-value payment system (ACH Colombia and networks)	4
Pension and severance funds	4
Finance corporations	3
Companies specialized in electronic deposits and payments – SEDPE	4
Capitalization companies	1
<i>Banco de la República</i>	1
General Directorate of Public Credit and the National Treasury	1
The Nation –Ministry of Finance and Public Credit – general system of royalties	1
Stock exchange	1
Centralized securities depository	1
Central counterparty clearing houses	1
Securitization firms	1
Employee funds	2
<b>Total</b>	<b>141</b>

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 <sup>a/</sup>	Year 2021		Year 2022		Year 2021		Year 2022	
	Number of operations	Value	Number of operations	Value	Number of operations	Value	Number of operations	Value
					(Percentage)			
Primary market								
Placements <sup>b/</sup>	20	270.09	17	212.93	0.3	0.5	0.3	0.3
Payment of principal and yield <sup>c/</sup>	24	199.72	38	212.35	0.4	0.4	0.6	0.3
Secondary market <sup>d/</sup>								
Purchase/sales	746	3,409.77	835	3,516.40	12.0	6.4	12.3	5.7
Money market <sup>d/</sup>								
Sell/buy-backs	341	5,676.27	372	5,852.98	5.5	10.7	5.5	9.5
Reverse sell/buy-backs	340	5,647.12	371	5,854.89	5.5	10.6	5.5	9.5
TTS MHCP	5	189.79	4	183.73	0.1	0.4	0.1	0.3
Reverse TTS MHCP	5	190.00	4	183.43	0.1	0.4	0.1	0.3
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)	1,480	15,583	1,642	16,017	23.9	29.3	24.3	26.11
Others – DCV <sup>e/</sup> (2)	27	160.91	28	159.42	0.4	0.3	0.4	0.3
Total (1) + (2)	1,508	15,744	1,671	16,176	24	30	25	26.4
Monetary Policy	Number of operations	Value	Number of operations	Value	Number of operations	Value	Number of operations	Value
					(Percentage)			
Repos to increase money supply <sup>f/</sup>	58	6,325.38	59	8,274.23	0.93	11.9	0.9	13.5
Reverse repos <sup>g/</sup>	0	0.00	0	0.00	0.00	0.0	0.0	0.0
Definitive TES purchase	7	44.90	10	49.52	0.12	0.1	0.1	0.1
Definitive private debt purchase	0	0.00	0	0.00	0.00	0.0	0.0	0.0
Repos with private debt	0	0.00	1,67	8.34	0.00	0.0	0.0	0.0
Repos with promissory notes	0.1	3.11	0,2	10.78	0.00	0.0	0.0	0.0
Non-delivery forwards	0.1	0.14	0,0	0.00	0.00	0.0	0.0	0.0
Interest-bearing deposits <sup>h/</sup>	38	4,896.61	36	3,450.40	0.61	9.2	0.5	5.6
Total monetary policy operations	103	11,270	107	11,793	1.7	21.2	1.6	19.23
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 <sup>i/</sup>	62	1,721.27	81	2,597.65	1.01	3.2	1.2	4.2
Total operations to provide liquidity	62	1,721.27	81	2,597.65	1.01	3.23	1.19	4.24

Table A1.2 (Continued)  
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 <sup>i/</sup>	Number of operations	Value	Number of operations	Value	Number of operations			
					Value		Number of operations	
					(Percentage)			
Securities (money uploads/downloads) <sup>k/</sup>	638	6,187.45	689	7,811.20	10.3	11.6	10.2	12.7
Intraday interbank loans	24	276.85	28	365.17	0.4	0.5	0.4	0.6
Reverse intraday interbank loans	15	143.02	17	173.55	0.2	0.3	0.2	0.3
Interbank loans at one or more days	16	489.15	20	602.91	0.3	0.9	0.3	1.0
Reverse interbank loans at one or more days	17	468.12	19	593.92	0.3	0.9	0.3	1.0
Interbank loans: IBR	16	320.00	16	320.00	0.3	0.6	0.2	0.5
Reverse interbank loans: IBR	16	320.02	16	320.09	0.3	0.6	0.2	0.5
Foreign currencies settled outside the clearing house	41	265.95	54	336.10	0.7	0.5	0.8	0.55
Taxes	143	687.17	145	886.64	2.3	1.3	2.1	1.45
Transfers from managers to custodians: CIF operations	123	2,422.27	154	2,804.73	2.0	4.5	2.3	4.6
Transfers from custodians to managers: CIF operations	143	1,408.94	190	1,913.78	2.3	2.6	2.8	3.1
Other transfers <sup>l/</sup>	1873	6,389.35	2008	8,235.76	30.3	12.0	29.7	13.4
<b>Deceval<sup>m/</sup></b>								
Placements	42	171.08	86	355.24	0.7	0.3	1.3	0.6
Payment of principal and yield	192	275.92	213	338.65	3.1	0.5	3.1	0.6
Purchase/sales	93	299.93	84	256.40	1.5	0.6	1.2	0.4
Sell/buy-backs	44	56.59	57	78.08	0.7	0.1	0.8	0.1
Reverse sell/buy-backs	44	56.55	57	77.77	0.7	0.1	0.8	0.1
Repos	4	2.77	4	2.15	0.1	0.0	0.1	0.0
Reverse repos	4	2.77	5	2.30	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	176	143.77	133	159.26	2.8	0.3	2.0	0.3
Term transactions	5	0.59	6	0.60	0.1	0.0	0.1	0.0
CRCC-Deceval spot operations	13	26.18	18	37.67	0.2	0.0	0.3	0.1
<b>Total Deceval operations</b>	<b>616</b>	<b>1,036.15</b>	<b>662</b>	<b>1,308.10</b>	<b>10.0</b>	<b>1.95</b>	<b>9.8</b>	<b>2.13</b>
Colombian Stock Exchange (BVC) <sup>n/</sup>	0	0.00	0	0.00	0.0	0.0	0.0	0.0
Cámara de Riesgo Central de Contraparte (CRCC) <sup>o/</sup>	20	42.09	19	144.29	0.3	0.08	0.3	0.24
Cámara de Riesgo Central de Contraparte (CRCC) <sup>p/</sup>	17	1,128.30	16	1,222.66	0.3	2.12	0.2	1.99

**Table A1.2 (Continued)**  
**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 <sup>i/</sup>	Number of operations	Value	Number of operations	Value	Number of operations	(Percentage)		
						Value	Number of operations	Value
Retail-value payment systems <sup>a/</sup>								
ACH	155	2,230.58	174	2,780.92	2.5	4.19	2.6	4.53
Card and ATM networks	53	321.82	56	584.65	0.9	0.60	0.8	0.95
Checks (Cedec and delegated clearing houses)	37	192.23	35	203.35	0.6	0.36	0.5	0.33
Total retail-value payment systems	245	2,744.63	266	3,568.93	4.0	5.15	3.9	5.82
Total direct funds transfers in the CUD	3,964	24,329	4,318	30,608	64.1	45.69	63.8	49.90
Other transactions	Number of operations	Value	Number of operations	Value	Number of operations	Value	Number of operations	Value
(Percentage)								
Total other transactions <sup>j/</sup>	552	188.44	588	160.39	8.9	0.35	8.7	0.3
Total debit transactions in the CUD	6,188	53,253	6,765	61,335	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's* investments.

d/ Does not include cross trades; that is, operations where a financial entity is both the originator and recipient of the cash leg. It is the same financial institution.

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 the net value and interest.

g/ Reverse repos.

h/ Interest-bearing deposits. This includes the DGCPTN.

i/ Pertains to reverse intraday repos. In the case of repo chains, it includes only the 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 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 – Section No. 10 in Article 879 of the tax law; transfers between accounts belonging to the same institution; transfers of funds from the Foreign Exchange Clearing House account to foreign exchange market intermediaries with a multilateral creditor position in pesos (payment-versus-payment mode); initial transfers from foreign exchange market intermediaries 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 with a debtor position to the CRCC 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 *Cámara de Riesgo Central de Contraparte S.A.*, 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 foreign exchange market intermediaries 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, Redeban, Servibanca, and ATH networks, so they can guarantee the settlement of clearing for electronic fund transfers and operations 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 collection by the government.

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

Specifically, in the case of 2022, while the top 9.9% of the most active participants (fourteen entities) accounted for 71.9% of CUD payments (twelve banks: 65.9%; one trust company: 2.7%; and one brokerage firm: 3.3%), the remaining 90.1% sent only 28.1% of all payments.

The timeline in the CUD system is illustrated in Table A1.4. In hourly timeframes from the start of the transfer service to closing time, it shows the accumulated settlement percentages of operations for the most relevant items affecting deposit account balances. For example, 64.85% of secondary market transactions and 68.12% of intraday repos during the year 2022 had already been settled by 14:59 hours, on average. In terms of the aggregate value for the entire system, one can see, for example, that 34.85% of the operations had already been settled by 13:59 hours.

It is important to note that the long-term trend in concentration has remained stable, with around 10% of the participants accounting for approximately 70% of the system's activity.

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

Year	Number of Participants	Percentage of Participants
2013	15	9.4
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

Source: Banco de la República (DSIF)

The total value settled (average daily) for each item is shown on the far-right side of Table A1.4, allowing for each cumulative percentage of compliance to be translated into its respective value. Continuing with the example of secondary market transactions, the 65% mentioned earlier corresponds to COP 2.3 trillion out of COP 3.5 trillion.

Considering that Section 1 of the Report provides an analysis of timeliness in the settlement of operations, according to different timeframes, an additional objective in presenting Table A1.4 is to detail the effects the diversity of operations has on intraday liquidity in the system. This information is relevant for monitoring the system, from an operational standpoint, and for decision-making when contingency scenario certification activities must be scheduled with the system in production.

To make tracking easier, the different effects on liquidity are detailed using colors. Specifically, 1) yellow denotes operations 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 operations that drain or withdraw liquidity from the aggregate in the payment system, as funds debited from a participant are transferred to outside agents, such as the Central Bank or the Ministry of Finance, or they remain frozen in another external system (e.g., Deceval) for a certain period and are subsequently restored, and 3) green signals operations that inject or add liquidity to the aggregate in the payment system, precisely for reasons opposite to those mentioned above.

At the end of the timeline, the percentage of the number of operations processed (not accumulated) is broken down for each hour, making it possible to identify the intraday periods when the CUD system experiences low or high processing loads, regardless of the amounts involved.

## 2. Clearing and Settlement of Securities and Financial Derivatives

Additional information about the components of financial asset clearing and settlement in the Colombian financial infrastructure is presented in this part of the annex.

### 2.1 Central Securities Depository (DCV)

Graph A1.1 shows how transactions settled in the DCV have evolved during the last ten years (2013-2022) in terms of nominal value, settled value (cash value), and the number of operations. It highlights the increase in the average daily value of operations, with a compound annual growth rate (CAGR) of 9.3% in nominal terms and 2.4% in settled value. There has been a negative variation in the number of operations over the last ten years, with a CAGR of -3.3%.

Table A1.5 contains a breakdown of the operations processed by the DCV, according to their origin. Prominent in the secondary market is the growth in the average daily value of monetary operations (OMA and liquidity provision) in the last ten years, with a CAGR of 11.4% (6.4% in real terms), as are sell/buy-back transactions, with a CAGR of 6.3% (1.5% in real terms).

As for the primary market, which includes the placement of securities through different means (forced, agreed, and auctioned), as well as payment of yield and repayment of principal by the National Government, significant growth has been observed in the past year, resulting in a CAGR of 10.9% (5.9% in real terms) over the last ten years.

**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						
<b>Primary market</b>	Percentage of accumulated settlement in each time range					
Placements	0.00	0.00	0.00	1.43	2.82	8.73
Payment of principal and yield	23.94	23.94	31.70	32.14	33.49	34.06
<b>Secondary market</b>						
Purchase/sales	0.00	0.00	0.00	0.10	0.61	19.21
<b>Money market</b>						
Sell/buy-backs, repos, third-party repos and TTS	0.00	0.00	0.00	0.19	1.25	27.28
Reverse sell/buy-backs, third-party repos and TTS MHCP	0.10	0.47	1.34	2.78	5.67	57.34
Monetary policy						
Repos to increase money supply	0.00	0.00	0.00	0.00	0.03	0.17
Reverse repos to increase money supply	0.00	0.11	0.58	1.27	3.26	6.66
Provision of liquidity in the payment system ( <i>Banco de la República</i> )						
Intraday repos	0.00	2.07	7.32	17.77	31.72	41.66
Reverse intraday repos	0.02	0.02	0.81	1.42	2.36	4.16
Direct funds transfers in the CUD						
Securities (money uploads/downloads)	0.58	4.11	8.07	10.98	14.83	18.92
Intraday interbank loans	8.50	10.65	18.96	40.61	44.33	46.00
Reverse intraday interbank loans	0.04	0.04	0.04	0.16	0.25	1.43
Interbank loans at one or more days	0.00	0.00	0.00	0.08	0.12	0.20
Reverse interbank loans at one or more days	0.00	0.00	0.05	0.45	1.54	5.36
Interbank loans: IBR	0.00	0.00	0.00	0.00	0.00	97.90
Reverse interbank loans: IBR	0.00	0.00	0.12	1.19	3.77	5.63
Taxes	0.00	0.69	21.04	68.34	97.48	99.89
Custodians	0.09	0.33	0.73	4.93	14.45	20.10
Foreign currencies settled outside the clearing house	0.00	0.00	0.00	0.46	1.66	6.40
Deceval						
<b>Primary market</b>						
Placements	0.40	0.40	0.40	0.40	0.69	1.56
Payment of principal and yields	0.00	0.00	0.00	0.32	0.58	2.22
<b>Secondary market</b>						
Purchase/sales	0.22	0.22	0.23	0.29	0.77	1.73
<b>Money market</b>						
Sell/buy-backs	0.09	0.09	0.09	0.23	3.17	13.64
Reverse sell/buy-backs	0.00	0.00	8.56	33.83	60.77	73.32
Repos	0.00	0.00	0.00	0.54	4.82	18.88
Reverse repos	0.00	0.00	88.93	89.62	90.70	92.98
<b>Others</b>						
Change of depositor	2.69	2.69	2.69	5.15	18.07	27.34

Neutral liquidity effect  
 Neutral effect of operations settled with liquidity-saving mechanisms  
 Liquidity drainage effect  
 Liquidity injection effect

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

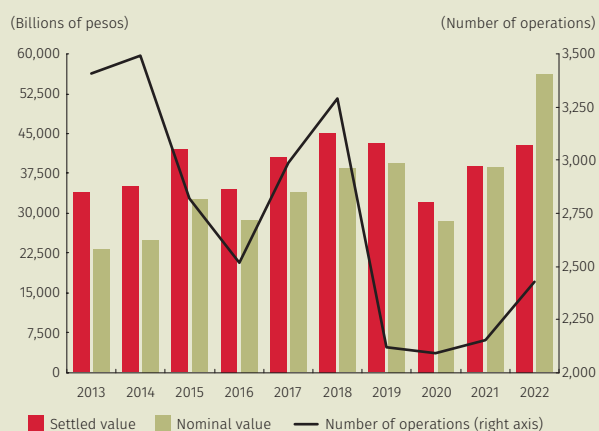
	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	Total value settled daily on average (billions)
Percentage of accumulated settlement in each time range											
	29.72	48.87	67.07	83.40	92.93	98.21	99.78	100.00			212.93
	35.42	35.58	36.23	38.16	38.16	38.16	38.16	38.16	49.39	100.00	212.35
	21.10	23.91	64.85	77.19	91.75	97.88	99.64	99.95	99.99	100.00	3.516.40
	30.42	33.73	77.75	88.17	96.28	98.82	99.66	99.95	99.96	100.00	6.036.71
	58.51	59.22	85.05	91.11	97.76	99.14	99.73	99.97	99.99	100.00	6.038.32
	1.36	30.83	53.70	77.67	93.85	98.76	99.56	99.99	99.99	100.00	8.273.58
	8.63	37.12	84.11	91.69	98.14	99.35	99.92	100.00			8.274.23
	52.00	59.76	68.12	77.83	86.50	94.37	98.34	99.98	99.99	100.00	2.597.62
	5.65	10.68	16.33	25.56	43.97	74.29	95.75	99.78	99.99	100.00	2.647.78
	22.11	25.33	29.39	42.37	62.31	78.50	89.33	97.27	99.13	100.00	7.811.20
	52.02	53.78	56.21	60.72	63.10	63.86	63.96	64.02	87.99	100.00	365.17
	17.27	30.87	34.18	37.86	38.42	38.50	74.48	98.52	99.61	100.00	173.55
	0.43	0.80	3.48	23.74	61.50	89.55	99.36	99.99	99.99	100.00	602.91
	9.22	13.46	21.78	39.13	66.05	93.43	99.73	99.97	100.00		593.92
	97.90	97.90	99.97	99.97	100.00						320.00
	6.09	6.78	97.01	97.65	99.79	100.00					320.09
	99.97	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	100.00	886.64
	24.72	29.45	35.27	44.76	62.94	83.09	97.21	99.84	99.99	100.00	4.718.51
	12.93	20.19	33.46	58.19	80.50	94.74	99.17	99.96	99.99	100.00	336.10
	2.71	3.65	7.04	23.42	57.88	86.91	97.25	98.73	99.96	100.00	355.24
	6.57	8.16	14.54	30.68	94.17	97.51	99.54	99.72	99.98	100.00	338.65
	4.13	8.20	20.77	43.50	71.83	93.22	98.90	99.59	99.93	100.00	256.40
	21.25	27.77	52.98	76.06	89.76	97.70	99.60	99.85	99.97	100.00	78.08
	81.91	87.65	93.16	96.88	99.49	99.91	99.98	99.98	100.00		77.77
	37.85	59.87	75.28	86.77	94.61	97.97	99.65	99.70	99.82	100.00	2.15
	94.54	95.37	96.85	97.11	99.77	99.99	99.99	100.00			2.30
	40.34	43.24	48.06	56.50	71.66	88.48	96.76	98.90	99.28	100.00	159.26

**Table A1.4 (Continued)**  
**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
<b>Cámara de Riesgo Central de Contraparte (CRCC)</b>						
Institutions pay debit positions to the CRCC	0.00	0.00	53.64	53.64	53.64	53.64
CRCC pays credit positions to institutions	13.22	13.22	32.29	32.47	32.48	44.79
<b>Cámara de Riesgo Central de Contraparte (CRCC)-Forex segment</b>						
Institutions pay debit positions to the CRCC	2.25	7.61	12.93	17.74	27.54	34.80
CRCC pays credit positions to institutions	0.00	0.01	0.01	0.01	0.01	0.01
<b>Retail-value payment systems</b>						
ACHs	0.00	0.01	0.06	7.07	37.14	40.10
Card and ATM networks	0.00	0.00	0.00	0.22	2.54	12.02
Checks (Cedec and delegated clearing houses)	0.00	0.00	0.00	0.01	0.08	92.10
<b>Aggregate timeline for the entire CUD system</b>	<b>2.01</b>	<b>2.81</b>	<b>4.24</b>	<b>7.29</b>	<b>13.22</b>	<b>22.63</b>
<b>Percentage of the number of operations processed per hour (not cumulative)</b>	<b>0.07</b>	<b>1.54</b>	<b>2.42</b>	<b>4.66</b>	<b>6.29</b>	<b>10.77</b>

■ Neutral liquidity effect  
■ Neutral effect of operations settled with liquidity-saving mechanisms  
■ Liquidity drainage effect  
■ Liquidity injection effect  
 Source: Banco de la República (DSIF).

**Graph A1.1**  
**Central Securities Depository (DCV), Operations Performed (Daily averages)<sup>a/</sup>**



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

Regarding its function as a depository, all nominal sums held in custody at the end of each year since 2013, in current and constant prices, are shown in Table A1.6.

During the past ten years, the balance in custody accounted for a CAGR of 10.1% in current pesos and 5.1% at constant prices. Of this balance, 97% pertains to securities issued by the national government, and the remaining 3%, to those 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 93.9% of the total balance and 97.1% with respect to domestic sovereign debt issued by the national government. Solidarity bonds (TDS) were the second most important category in terms of debt issued by the national government, with approximately COP 9.74 trillion (Table A1.7).

Graph A1.2 contains a breakdown of the activation mechanisms used to settle the operations received by the DCV during the past year. It shows all participants activated their operations manually between 8:00 and 11:00 a.m. Between 11:00 a.m. and 2:00 p.m., the liquidity savings facility was used as well and proved to be the mechanism that contributed the most to settlement. For the time slots thereafter, automatic matching was added. Thus, 82.3% of all the operations received by the DCV in 2022 were activated automatically (automa-

	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)
	53.64	53.64	53.64	66.81	66.81	66.81	66.81	66.81	75.43	100.00	144.29
	70.39	74.98	77.10	91.79	94.65	94.65	95.42	100.00			144.29
	38.80	87.96	89.91	89.92	90.04	90.04	90.04	90.04	96.61	100.00	1,222.66
	0.01	0.01	96.35	100.00							1,222.66
	48.05	51.46	58.71	68.50	77.83	89.44	94.99	99.73	99.88	100.00	2,780.92
	38.03	52.27	74.66	93.42	98.17	99.58	99.82	99.94	100.00		584.65
	97.96	98.01	98.48	98.70	99.19	99.53	99.86	99.99	100.00		203.35
	25.87	34.85	52.90	63.11	74.06	81.75	86.00	93.51	95.89	100.00	61,335.24
	5.60	5.06	16.07	12.14	13.61	9.10	4.57	2.00	0.80	1.01	6,764.62

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

Year	Quantity	Primary Market		
		Nominal Value	Settled Value	
			Current	Constant
2013	128	346	371	587
2014	113	440	412	630
2015	99	338	363	520
2016	82	399	407	551
2017	76	396	422	549
2018	77	446	453	571
2019	76	565	514	623
2020	143	733	511	610
2021	138	1,109	797.5	902
2022	158	1,675	1,045.0	1,045

Table A1.5 (Continued)  
Average Operations Performed 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	
2013	1,667	4,890	5,700	9,029	2	15	11	17	690	3,630	0	0
2014	2,006	5,936	6,575	10,048	2	7	7	11	439	3,603	0	0
2015	1,557	4,516	4,997	7,152	1	8	8	12	170	5,134	0	0
2016	1,451	3,873	4,141	5,605	9	61	63	85	136	4,388	0	0
2017	1,825	5,657	6,294	8,185	4	26	17	22	146	4,761	0	0
2018	2,107	8,424	9,220	11,620	1	26	27	33	147	4,705	0	0
2019	1,051	4,370	4,807	5,836	7	34	35	42	145	5,518	0	0
2020	875	3,308	3,675	4,391	4	19	20	24	200	3,258	0	0
2021	841	3,288	3,484	3,942	11	122	69	78	208	5,167	0	0
2022	931	4,113	3,631	3,631	10	68	50	50	254	8,287	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	
2013	3	11	0	0	686	5,607	6,409	10,153
2014	1	5	0	0	722	7,026	7,703	11,772
2015	1	2	0	0	787	9,242	10,008	14,324
2016	0	1	0	0	656	9,363	10,035	13,582
2017	0	1	0	0	763	10,537	11,643	15,140
2018	0	2	0	0	787	12,405	13,600	17,140
2019	1	2	0	0	622	9,428	10,363	12,582
2020	0	1	0	0	684	11,702	12,874	15,382
2021	1	2	0	0	691	10,634	11,402	12,899
2022	2	5	0	0	756	13,094	11,759	11,759

Year	Monetary Operations			
	Quantity	Nominal Value	Settled Value	
			Current	Constant
2013	229	8,549	8,963	14,198
2014	210	7,884	8,213	12,551
2015	207	13,292	13,943	19,956
2016	180	10,748	10,971	14,850
2017	175	12,632	12,931	16,815
2018	171	12,388	12,564	15,834
2019	220	19,526	19,807	24,048
2020	184	9,604	9,823	11,737
2021	260	18,390	18,650	21,097
2022	315	28,750	26,480	26,480

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
2013	183,580	290,808
2014	202,604	309,619
2015	207,943	297,631
2016	239,717	324,462
2017	265,680	345,477
2018	304,235	383,428
2019	323,440	392,709
2020	372,275	444,803
2021	424,035	479,680
2022	480,029	480,029

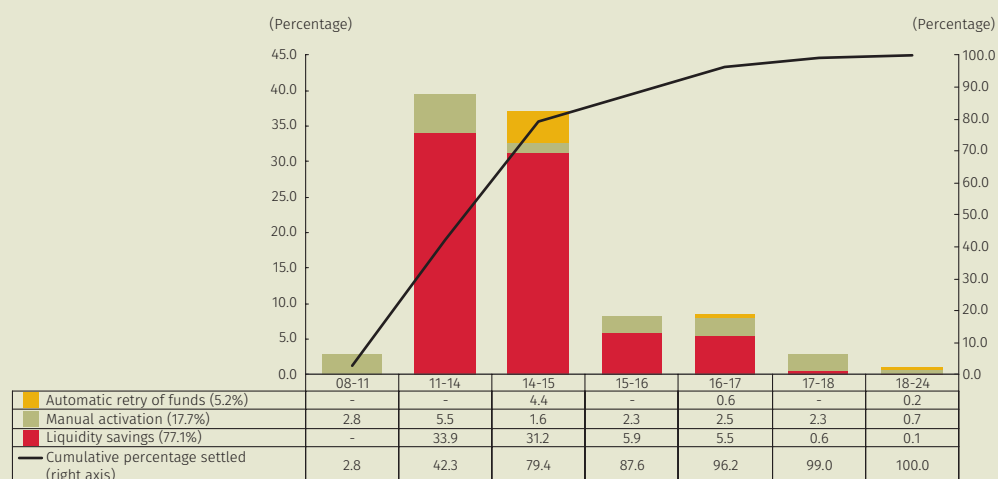
Source: Banco de la República (DCV).

**Table A1.7**  
**Details on the Balance Held in Custody by the DCV at the Close of 2022, by Issuer**  
**(Millions of pesos)**

Issuer	Balance	Percentage
National government		
TES, Class B	450,963,094	93.9
Solidarity Bonds (TDS)	9,741,703	2.03
TIDIS	2,536,183	0.53
Constant-value bonds – Series B	946,591	0.20
CERT	42,312	0.01
Constant value bonds – Series A	69,706	0.01
Solidarity Bonds for Peace	768	0.00
Security Bonds	0	0.00
National government total	464,300,357	96.7
Finagro		
Agricultural Development Bonds – Class A	11,192,418	2.33
Agricultural Development Bonds – Class B	4,535,935	0.94
Finagro total	15,728,353	3.3
General total	480,028,710	100

Source: Banco de la República (DCV).

Graph A1.2  
Distribution of the Operation Activation Mechanism, by Type (2022)



Source: Banco de la República (DCV).

tic matching and the liquidity savings facility), and 17.7%, by direct instruction from the participants.

## 2.1 Centralized Securities Depository (Deceval)

Table A1.8 and Graph A1.3 illustrate how the transactions carried out in Deceval have evolved. They include primary market operations (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 operations (repos, sell/buy-backs and temporary transfers of securities [TTS]), with their respective reversals and cash collateral.

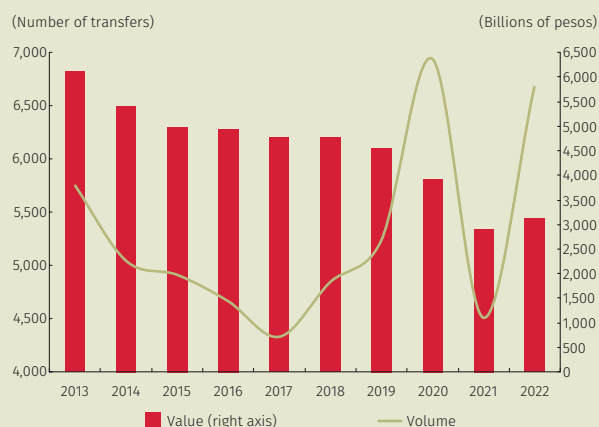
One sees the average daily volume of transactions, after declining between 2013 and 2017, grew steadily until 2020, when it averaged 6,941 transfers daily. Afterwards, there was a set-back in 2021, followed by a recovery in 2022. On the other hand, the average daily transaction

Table A1.8  
Deceval Statistics

Year	Transfers Processed								
	Volume (Number of operations)	Daily Average		Average Value Transferred		Annual Value			
		Value (Billions of pesos)	(Billions of 2022 constant pesos)	(Millions of pesos)	(Millions of constant 2022 constant pesos)	(Number of operations)	(Billions of pesos)	(Billions of 2022 constant pesos)	(Number of times GDP)
2013	5,752	3,867	6,126	672	1,065	1,403,374	943,534	1,494,647	1.32
2014	5,046	3,539	5,408	701	1,072	1,231,272	863,508	1,319,612	1.13
2015	4,915	3,478	4,979	708	1,013	1,199,378	848,744	1,214,817	1.05
2016	4,668	3,652	4,944	782	1,059	1,143,678	894,841	1,211,185	1.04
2017	4,335	3,662	4,761	845	1,098	1,049,081	886,131	1,152,282	0.96
2018	4,849	3,778	4,761	779	982	1,178,228	917,961	1,156,906	0.93
2019	5,239	3,752	4,555	716	869	1,283,659	919,146	1,115,992	0.87
2020	6,941	3,278	3,916	472	564	1,686,627	796,526	951,708	0.80
2021	4,514	2,577	2,916	571	646	1,105,892	631,438	714,300	0.53
2022	6,678	3,127	3,127	468	468	1,636,110	766,030	766,030	0.52

Source: Deceval.

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



Source: Deceval.

**Table A1.9**  
**Total Value Held in Custody by Deceval at Year's End<sup>a/</sup>**  
**(Billions of pesos)**

Year	Current	Constant
2012	362,513	585,383
2013	387,405	613,686
2014	421,697	644,436
2015	381,310	545,773
2016	440,282	595,930
2017	486,555	632,692
2018	470,519	592,995
2019	560,596	680,655
2020	545,372	651,623
2021	535,794	606,104
2022	565,187	565,187

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 equities held in custody.  
Source: Deceval.

value declined over the past ten years, with a CAGR of -2.9% (-7.4% in real terms).

As for Deceval's function as a depository, Table A1.9 shows the total amounts held in custody at the end of each year since 2013, in current and constant prices.

Over the last ten years, the balance in custody, in current pesos, showed a CAGR of 4.5%, and -0.4% at constant prices.

Table A1.10 shows common and preferred equities account for the largest portion of all current issues managed by Deceval, at 47.8%, followed by term deposit certificates (CDT) at 28.4%, and bonds at 14%. Other instruments such as commercial paper and acceptances, among others, account for 9.8%.

### 3. The Cámara de Riesgo Central de Contraparte S.A. (CRCC)

#### 3.1 Details of the Changes in Operations and Open Positions, by Product

The value of operations cleared and settled <sup>1</sup> by the CRCC in the financial derivatives segment during 2022 amounted to COP 1,569.31 t, which comes to an increase of 39.4% (26.6% in real terms) compared to the value of operations in 2021. A breakdown of these operations, by product, shows 20.17% (COP 316.47 t) for standardized financial derivatives and 79.83% (COP 1,252.84 t) for non-standardized derivatives, with 55.43% growth (40% in real terms) in standardized derivatives and 35.88% (24% in real terms) in non-standardized derivatives compared to the previous year.

The exchange rate volatilities in 2022 energized underlying TRM products, leading to important growth within the financial derivatives segment. Consequently, the sum of trading in TRM futures cleared and settled through the CRCC was up by 115.45% (95% in real terms), having gone from COP 119.58 trillion to COP 257.64 trillion; NDF forex forwards (pesos/dollars) increased 39.05% (27% in real terms), from COP 817.81 trillion to COP 1,137.17 trillion, and TRM options, by 32.6% (27% in real terms), from COP 0.45 trillion to COP 0.59 trillion. Additionally, OIS-IBR products rose 10.97% (4.3% in real terms), from COP 104.23 trillion to COP 115.67 trillion. On the other hand, OIS futures were down by 60.41% (-65% in real terms), from COP 1.94 trillion to COP 0.77 trillion; as were stock futures, by 53.89% (-56.8% in real terms), from COP 1.78 trillion to COP 0.82 trillion, and futures on specific reference TES, by 29% (-36% in real terms), from COP 79.83 trillion to COP 56.63 trillion.

The share of the sum of these products, according to the type of standardized futures contract, was as follows: TRM futures at 81.41% (COP 257.64 t), TES futures on specific references at 17.89% (COP 56.63 t), OIS futures at 0.24% (COP 0.77 t), and 0.45% (COP 1.44 t) for other products, including futures on stocks, indexes and electricity. In terms of the share of non-standardized products, NDF forex forwards (pesos/dollars) accounted for 90.77% (COP 1,137.17 t), and OIS IBR and OIS IBR overnight forwards, 9.23% (COP 115.67 t).

<sup>1</sup> As a result of novation by the CCRC, a negotiated transaction is registered as two transactions cleared and settled in the CCRC, since the original counterparty link disappears and, in its place, two links appear in which the clearing house becomes the buyer and the seller for the initial counterparties.

**Table A1.10**  
**Details on the Year-end Balance of Securities Held in Custody by Deceval in 2022, by Type**  
**(Millions of pesos)**

Type	Balance	Percentage
Common equities	259,866,072	45.98
Term certificates of deposit	160,272,862	28.36
Bonds	79,154,554	14.01
Participation securities	52,274,255	9.25
Preferred equities	10,098,796	1.79
Securitization	2,698,470	0.48
Treasury bonds (TES)	802,239	0.14
Tax refund securities (TIDI)	19,354	0.00
Bank acceptances	30	0.00
<b>General total</b>	<b>565,186,631</b>	

Source: Deceval.

In the fixed income segment, the total value of operations involving sell/buy-backs of sovereign debt securities managed by the clearing house, for subsequent gross settlement through the DCV, was up by 6.31%, having increased to COP 2,879.42 t in value.<sup>2</sup>

Regarding the equity segment, stock repo operations grew by 16% (5.8% in real terms), going from COP 6.24 t to COP 7.24 t, and spot equity transactions rose 12.1% (2.65% in real terms), from COP 50.63 t to COP 56.76 t, while temporary transfers of securities (TTS) declined by 73.44% (-75.3% in real terms), from COP 2.4 t to COP 0.65 t.

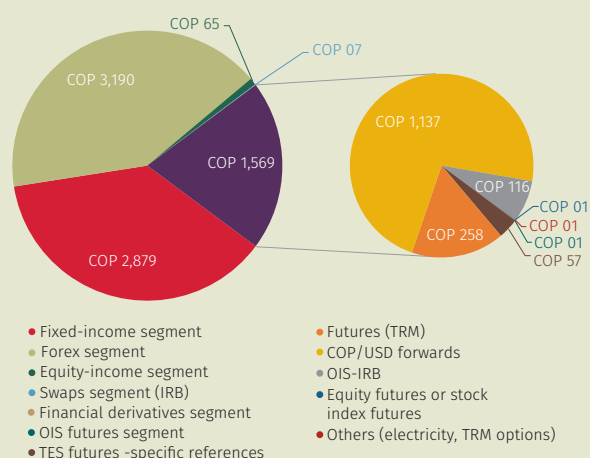
Last of all, the foreign exchange segment grew as a result of TRM volatilities and the rise in dollar-denominated securities. Total operations cleared and settled in the spot market (peso-dollar) amounted to COP 3,189.79 t: 88.09% (COP 2,809.79 t) with same-day settlement, 11.64% (COP 371.16 t) with one-day settlement, and 0.28% (COP 8.81 t) with two or three-day settlement (Graph A1.4). The increase in dollars was 6.75%, from USD 708.93 billion to USD 756.74 billion. In pesos, it was 20.01%, from COP 2,658.04 t to COP 3,189.79 t.

The number of futures contracts<sup>3</sup> cleared and settled in the CRCC mounted from 6,085 per day, on average, in 2021 to 7,382 in 2022. The total value of operations accepted for net clearing in the financial derivatives segment increased from COP 4.58 t per day, on average, in 2021 to COP 6.41 t in 2022.

On the other hand, the average daily value of transactions cleared on a gross basis in the fixed income segment (TES sell/buy-backs) went from COP 11.05 t in 2021 to COP 11.75 t in 2022.

The average daily value of transactions cleared on a gross basis in the equity segment (repo operations, spot, and TTS with shares) rose from COP 242.1 billion in 2021 to COP 263.88 billion in 2022. The daily average for operations in the foreign exchange segment went from COP 10.83 t in 2021 to COP 13.03 t in 2022 (Graph A1.5).

**Graph A1.4**  
**Cámara de Riesgo Central de Contraparte**  
**Share in trillions of pesos, by product**  
**(Total value of operations in 2022)**

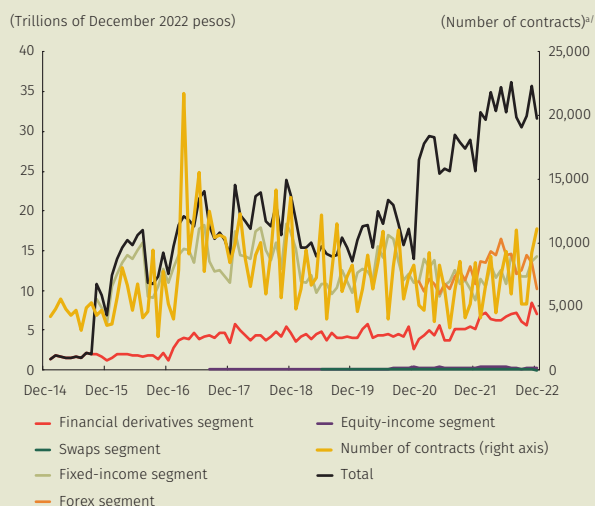


Sources: CRCC and Banco de la República (DSIF).

<sup>2</sup> This value takes into account the two operations resulting from novation on the date of constitution.

<sup>3</sup> It only includes standardized products; therefore, it does not include exchange rate forwards or operations in the equity or fixed-income segments.

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



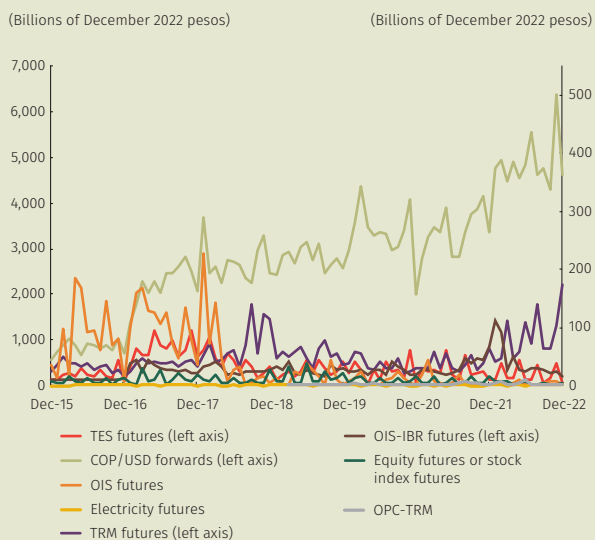
a/ The financial derivatives segment does not include exchange-rate or interest-rate forwards.  
Sources: CRCC and Banco de la República.

A detailed look at how each segment evolved during 2022, by product, shows the highest average daily value accepted for TES sell/buy-backs was in July, at COP 13.77 t, and in May for spot transactions, repos, and TTS with equities, at COP 386.02 b. On the other hand, the highest daily averages in the financial derivatives segment were obtained in May for futures on specific TES references, with COP 535.08 b; in December for TRM futures, with COP 2.2 t; in May for OIS futures, with COP 9.72 b; in March, for futures with stock with COP 7.33 b; in November for NDF currency forwards (pesos/dollars), with COP 6.29 t; and in January for OIS-IBR, when they came to COP 1.29 t (Graphs A1.5 and A1.6).

Open positions behaved differently, depending on the product. The most representative products with declining open positions were swaps (IRS and OIS) in the financial derivatives segment, with -46.5% (-52.7% in real terms), and OIS futures, with -65.3% (-69.3% in real terms). Meanwhile, the most representative products with higher open positions were: TRM futures, with 207% (171.4% in real terms), NDF currency forwards (pesos/dollars), with 29.6% (14.6% in real terms), and positions in the IBR swaps segment, with 35.4% (19.7% in real terms) (Graph A1.7).

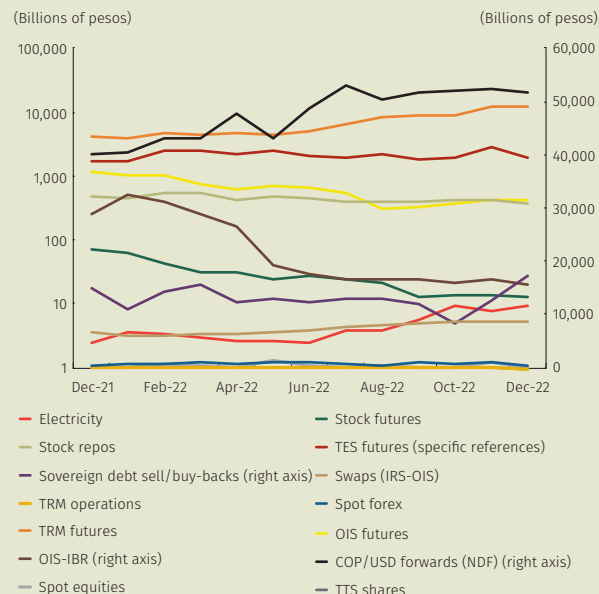
As for operational efficiency, the CRCC's services were available to participants 99.81% of the time in all segments, on average, as per the schedules established for 2022. The operational incidents that occurred did not disrupt the provision of CRCC services (Table A1.11)

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



Sources: CRCC and Banco de la República.

**Graph A1.7**  
Evolution in Open Positions during 2022, by Product Groups (One leg)



Sources: CRCC and Banco de la República.

**Table A1.11**  
**Operational Efficiency: Availability of the System during 2022, by Segment**

Segment	Percentage of System Availability	Number of Operational Incidents
Financial derivatives	99,83%	3
Fixed income	99,83%	3
Equity income: repos	99,83%	3
Equity income: spot	99,72%	5
Swaps	99,83%	3
Forex	99,83%	3

Source: CRCC S. A.

## Annex 2: Retail Payments

### 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.

#### 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 345.4 million transactions during 2022, 11.23% more than in 2021. On average, this amounts to 1,409,820 payment instructions per day (91,315 processed by ACH-Cenit and 1,318,505 by ACH-Colombia), for a total value of COP 8.0 t (COP 1.27 t in ACH-Cenit and COP 6.82 t in ACH-Colombia). In 2022, the total gross amount cleared by these ACH, together, came to COP 1,983.5 t; that is, 20% more than in 2021 (6.1% in real terms) and 1.6 times the nominal GDP in 2022. The net amount settled by these clearing houses in 2022 was COP 681.3 t in total (an average of COP 2.78 t per day). This is equivalent to 34.35% of the gross value and results in a liquidity savings of 65.65% (Table A2.1).

It is important to note the increase in the average daily value of the amount mobilized over the past ten years (2013 to 2022), with a nominal CAGR of 12.4%. As for the number of transactions, the variation during the same period has been positive, with a CAGR of 10.9%.

##### 1.1.1 ACH-Cenit

As shown in Graph A2.1 and Table A2.1, more than 22.3 million transactions (91,315 daily, on average) were processed through ACH-Cenit during 2022, including credit (credit of funds) and debit (discount of funds) operations. The respective gross amount was over COP 311.8 t (COP 1,273.8 b daily, on average). These figures, when compared to those for 2021, reflect an increase of 37.9 % in the number of operations and 12.6 % growth in value (-0.45 % in real terms). The low amount of liquidity savings (1.7 % in 2022) resulting from the net amounts cleared through ACH-Cenit is due to payments sent by the DGCPN and the General Royalties System, which accounted for the majority (85%).

Credit transactions represented the bulk of all transactions in 2022, both in number (97.09%) and value (99.65%) Debit transactions registered increases of 103 % in number and 46 % in the value, compared to 2021 (Table A2.1).

As for operational efficiency, ACH-Cenit's availability in 2022 was 99.8%. In other words, there were occasional interruptions that affected the provision of the service for a period equivalent to 0.2% of the time.

##### 1.1.2 ACH-Colombia

During 2022, ACH-Colombia processed 323.0 million transactions in total, including credit and debit operations, for more than COP 1,671 t gross. These figures represent a 9.76% increase in the number of transactions and a 21.49% rise (7.4% in real terms) in value compared to 2021 (Table A2.2 and Graph A2.2).

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 2022 was COP 374.6 t (an average of COP 1,529.0 b per day), which is equivalent to 22.4% of the gross value. This results in a liquidity savings of 77.59%.

Table A2.1  
Statistics on ACH Cenit<sup>a/</sup>

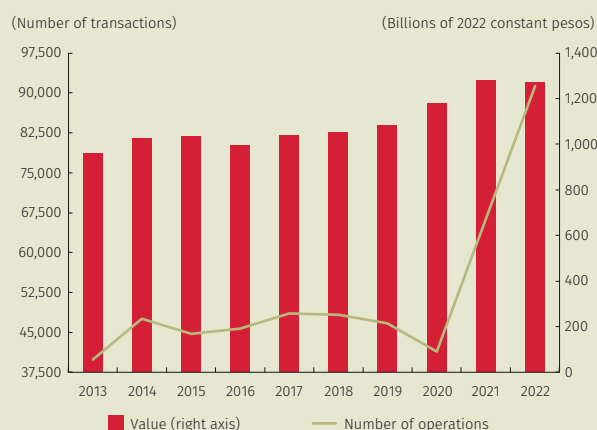
Year	(Number of transactions)	Daily Average			
		Value (Billions of pesos)	Value (Billions of 2022 constant pesos)	Average Transaction Value (Millions of pesos)	Average Transaction Value (Millions of 2022 constant pesos)
2013	39,852	607.0	961.6	15.2	24.1
2014	47,586	670.8	1,025.1	14.1	21.5
2015	44,743	722.8	1,034.5	16.2	23.1
2016	45,697	733.8	993.2	16.1	21.7
2017	48,572	797.7	1,037.3	16.4	21.4
2018	48,284	832.8	1,049.5	17.2	21.7
2019	46,741	890.0	1,080.6	19.0	23.1
2020	41,327	987.1	1,179.5	23.9	28.5
2021	66,225	1,130.2	1,278.5	17.1	19.3
2022	91,315	1,272.8	1,272.8	13.9	13.9

Year	Annual Total							
	Number of Transactions			Value of Transactions (Billions of pesos)			Annual Value (Billions of 2022 constant pesos)	Number of Times GDP
	Credit	Debit	Total	Credit	Debit	Total		
2013	9,522,192	201,586	9,723,778	147,926	188.5	148,114	234,627	0.21
2014	11,035,981	574,941	11,610,922	163,238	429.0	163,667	250,116	0.21
2015	10,410,511	417,239	10,827,750	174,408	505.5	174,914	250,356	0.22
2016	10,909,837	285,842	11,195,679	179,164	617.7	179,782	243,338	0.21
2017	11,549,242	205,292	11,754,534	192,463	574.9	193,038	251,017	0.21
2018	11,567,335	165,728	11,733,063	201,849	511.2	202,360	255,035	0.20
2019	11,249,571	201,856	11,451,427	217,549	493.9	218,043	264,739	0.21
2020	9,817,581	266,197	10,083,778	240,297	566.3	240,863	287,789	0.24
2021	15,905,326	319,814	16,225,140	276,150	743.8	276,894	313,230	0.23
2022	21,722,190	649,955	22,372,145	310,739	1,086.3	311,826	311,826	0.21

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

Graph A2.1  
Value and Number of Transactions in ACH Cenit  
(Daily averages)



Source: Banco de la República (Cedec).

Table A2.3 shows the CR5 concentration rate, which is constructed as the sum of the five largest portions of the transaction value, was 73.6% for credit transactions in 2022. This amounts to an increase of 1.4% from 2021. For debit transactions, the CR5 rate reflects an increase of 3.0 percentage points, having gone from 85.6% in 2021 to 88.6% in 2022.

Graph A2.3 shows how use of the SOP button has evolved. This service, which is provided by ACH Colombia, saw a 32.6% increase in the number of transactions and a 33% rise in monetary value (17.5% in real terms) compared to 2021.

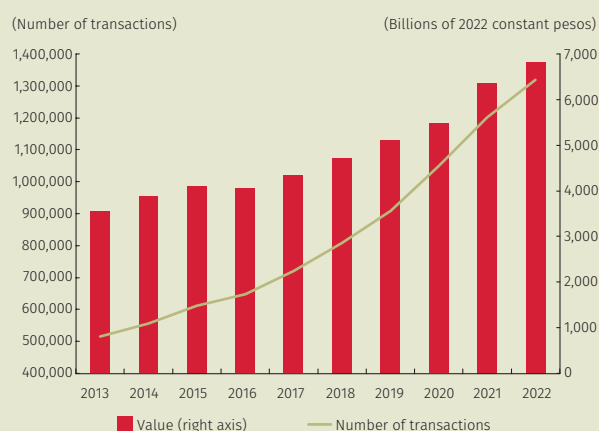
ACH Colombia inaugurated a fast payment service called “Transfya” at the beginning of 2020. It allows a person to transfer or receive money from another person in less than ten seconds, using each of their mobile phone numbers. Graph A2.4 shows how monthly use of this service has evolved in terms of the number and value of transactions. December 2022 was a highlight, having been the month with the largest number of transactions and the largest value. With respect to the previous year, the average number of transactions per day

Table A2.2  
Statistics on ACH Colombia

Year	Daily Average					Annual Value			
	(Number of transactions)	Value		Average transaction value		(Number of transactions)	(Billions of pesos)	(Billions of 2022 constant pesos)	Number of Times GDP
		(Billions of pesos)	(Billions of 2022 constant pesos)	(Millions of pesos)	(Millions of 2022 constant pesos)				
2013	516,603	2,238	3,545	4.3	6.9	126,051,206	546,108	865,086	0.8
2014	556,449	2,536	3,875	4.6	7.0	135,773,574	618,750	945,572	0.8
2015	611,228	2,877	4,117	4.7	6.7	147,917,150	696,124	996,370	0.9
2016	648,858	2,995	4,054	4.6	6.2	158,970,262	733,736	993,125	0.8
2017	721,067	3,340	4,343	4.6	6.0	174,498,262	808,298	1,051,073	0.9
2018	808,832	3,750	4,727	4.6	5.8	196,546,261	911,333	1,148,552	0.9
2019	909,622	4,215	5,118	4.6	5.6	221,947,874	1,028,475	1,248,735	1.0
2020	1,048,593	4,577	5,469	4.4	5.2	255,856,641	1,116,811	1,334,392	1.1
2021	1,201,214	5,616	6,354	4.7	5.3	294,297,520	1,376,035	1,556,608	1.2
2022	1,318,505	6,823	6,823	5.2	5.2	323,033,757	1,671,688	1,671,688	1.1

Source: ACH Colombia.

Graph A2.2  
Value and Number of Transactions in ACH Colombia  
(Daily averages)



Source: ACH Colombia.

Table A2.3  
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
2013	21	68.5	5	21	93.5	5
2014	20	70.2	5	20	92.1	5
2015	20	70.2	5	20	88.1	5
2016	20	73.5	5	20	85.3	5
2017	23	73.8	5	23	91.0	5
2018	25	74.3	5	25	92.9	5
2019	27	74.0	5	27	92.0	5
2020	27	74.3	5	27	89.3	5
2021	31	72.2	5	31	85.6	5
2022	32	73.6	5	32	88.6	4

Source: ACH Colombia.

rose from 22,140 to 96,526 (a 336% increase), while the transferred amount went from COP 2,440 million to COP 14,526 million (a nominal increase of 495% and a real increase of 426%).

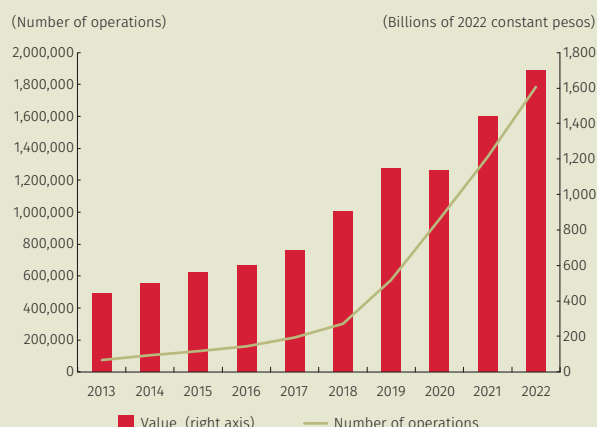
To complement the statistics on the use of electronic funds transfers as a payment instrument, Table A2.4 shows figures for intrabank transfers in which the drawer and the drawee of the funds share the same bank. For that reason, these transfers are not cleared through ACH.

Intrabank transfers during 2022, in terms of the number of transactions, accounted for 443.2% of all interbank transfers. In terms of value, they were 1.6 times more than intrabank transfers.

## 1.2. Debit and Credit Card Clearing and Settlement Systems

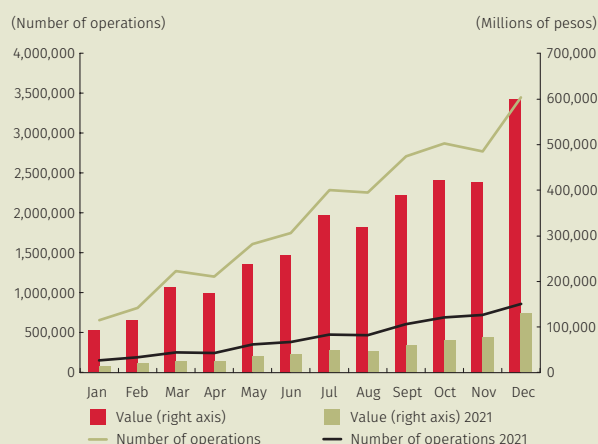
By 2022, Colombia had five retail-value payment systems (RVPS) dedicated to clearing and settling debit and credit card transactions conducted on site, at retail establishments, as well as through digital

**Graph A2.3**  
Value and Number of Transactions Using the SOP Service (ACH Colombia) (Daily averages)



Source: ACH Colombia.

**Graph A2.4**  
Value and Number of Monthly Transactions Using the Fast Payment Service: Transfiya (ACH Colombia)



Source: ACH Colombia.

channels.<sup>1</sup> According to information reported by the managers of these systems, there was an aggregate increase of 53.8% in the number of transactions and 55.3% in value compared to the previous year (Graph A2.5).

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

As shown in Graph A2.6 for 2022, approximately 83% of the amount resulting from debit and credit card payment obligations was processed through deposit accounts held by RVPS managers, while the remaining 17% was settled through accounts or ledger systems that support the RVPS settlement processes.

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

#### 1.3.1 The Cedec Check Clearing House

In 2022, 4.7 million checks were cleared (19,256 per day, on average) for a total of COP 149.4 t (an average of COP 0.61 t per day),<sup>2</sup> which represents 10% of GDP. These figures are below the 5.6 million checks and COP 152.2 t in value recorded for 2021 and signify respective reductions of 15.6% and 1.8% (-13.2% in real terms) (Graph A2.7 and Table A2.5).

As for liquidity requirements, Table A2.5 shows average gross clearing at COP 610 billion per day in 2022. However, due to multilateral netting, only COP 203.35 billion were required to settle the obligations between financial institutions (Table A1.2). Accordingly, this meant a liquidity savings of 66.7%.

The data provided by commercial banks indicates that intrabank checks (the drawer and the drawee share the same bank and the checks are not sent to Cedec or physical clearing houses) accounted for 36.2% of the value and 58.5% of the total number of interbank checks cleared in 2022. This amounts to a decline in the value and number of checks equal to 3.4% and 13.5%, respectively, compared to 2021 (Table A2.6).

In the last ten years (2013 to 2022), there has been a substantial decline in the average daily value of the amount mobilized, with a nominal CAGR of -7.5%. As for the number of transactions, the variation during that same period has been positive, with a CAGR of -17.4%.

#### 1.3.2 Concentration and Operational Efficiency Indicators

Compared to 2021, the number of entities involved in the check clearing process declined, ending up with 22 entities in 2022 (Table A2.7).

<sup>1</sup> Although there are six RVPSs operating in Colombia under the SFC's authority, those dedicated to clearing and settling obligations resulting from ATM transactions are not included for the purpose of this section.

<sup>2</sup> 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.

Table A2.4  
Value and Number of Operations in ACH and Financial Institutions

Year	Interbank Clearing <sup>a/</sup>		Intrabank Transfers <sup>b/</sup>			
	(Number of operations)	Value (Billions of pesos)	(Number of operations)	(As a percentage of interbank operations)	Value (Billions of pesos)	(Number of times interbank operations)
2013	135,774,984	694,22.8	96,171,547	70.8	1,050,129	1.5
2014	147,384,496	782,417.0	112,103,184	76.1	1,025,864	1.3
2015	158,744,900	871,037.4	145,895,871	91.9	1,581,650	1.8
2016	170,165,941	913,517.7	189,358,265	111.3	2,393,927	2.6
2017	186,252,796	1,001,336.4	179,104,744	96.2	2,138,592	2.1
2018	208,279,324	1,113,692.7	304,602,311	146.2	2,965,085	2.7
2019	233,399,301	1,246,518.2	353,430,214	151.4	2,773,874	2.2
2020	265,940,419	1,357,674.0	498,345,093	187.4	3,236,407	2.4
2021	310,522,660	1,652,928.7	815,131,209	262.5	3,315,448	2.0
2022	345,405,902	1,983,513.3	1,530,690,810	443.2	3,149,116	1.6

a/ Pertains to the number and value of operations cleared through ACH Cenit and ACH Colombia.

b/ These transfers are settled within each financial institution and do not go through an ACH.

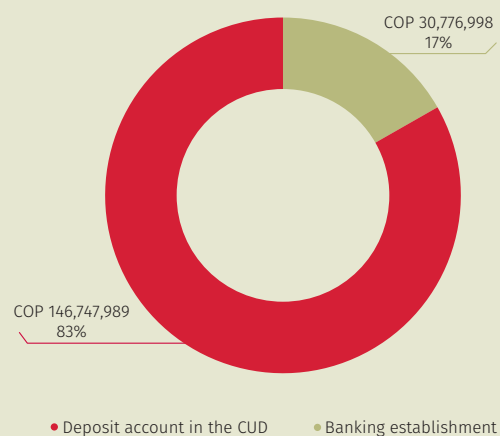
Sources: Financial institutions and ACH.

Graph A2.5  
Clearing and Settlement of Card Transactions through Retail-value Payment Systems (Daily averages)



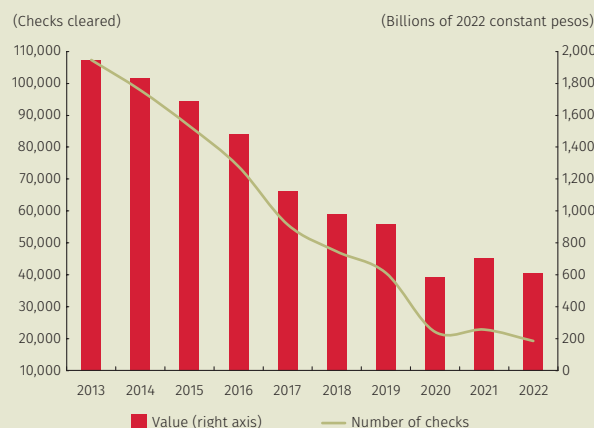
Source: Reporting institutions.

Graph A2.6  
Distribution of Settlement, by Operational Arrangement



Source: Banco de la República (DSIF).

Graph A2.7  
Statistics on Checks Cleared through Cedec



Source: Banco de la República (Cedec).

Table A2.5  
Statistics on Checks Cleared through Cedec

Year	Number of Checks (Number of Operations)	Daily Average				Annual Value			
		Value		Average Transaction Value		(Millions of checks)	(Billions of pesos)	(Billions of 2022 constant pesos)	Number of Times GDP
		(Billions of pesos)	(Billions of 2022 constant pesos)	(Millions of pesos)	(Billions of 2022 constant pesos)				
2013	107,239	1,226	1,943	11.4	18.1	26.2	299,225	474,001	0.42
2014	97,762	1,201	1,835	12.3	18.8	23.9	293,048	447,835	0.38
2015	86,537	1,179	1,688	13.6	19.5	20.9	285,374	408,459	0.35
2016	73,852	1,094	1,481	14.8	20.0	18.1	268,009	362,755	0.31
2017	55,674	863	1,123	15.5	20.2	13.5	208,944	271,701	0.23
2018	47,254	777	979	16.4	20.7	11.5	188,771	237,908	0.19
2019	40,553	757	920	18.7	22.7	9.9	185,567	225,309	0.18
2020	22,097	488	583	22.1	26.4	5.4	118,569	141,669	0.12
2021	22,819	621	703	27.2	30.8	5.6	152,214	172,188	0.13
2022	19,256	610	610	31.7	31.7	4.7	149,418	149,418	0.10

Source: Banco de la República (Cedec).

Moreover, the concentration of operations increased, as indicated by the CR5 metric, 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 2022, Cedec had an availability rate of 99.53%. In other words, there were occasional interruptions in service for a period equivalent to 0.47% of the entire time.

Table A2.6  
Value and Number of Operations Cleared through Cedec and Directly in Commercial Banks

Year	Interbank Checks Cleared <sup>a/</sup>		Intrabank Checks <sup>b/</sup>			
	Number	Value	Number		Value	
	(Number of checks)	(Billions of pesos)	(Number of checks)	(As a percentage of interbank checks)	(Billions of pesos)	(As a percentage of interbank checks)
2013	26,166,386	299,225	11,894,023	45.5	88,791	29.7
2014	23,853,920	293,048	13,745,083	57.6	109,282	37.3
2015	20,900,000	285,374	11,207,337	53.6	106,209	37.2
2016	18,093,721	268,009	9,530,565	52.7	88,672	33.1
2017	13,472,000	208,944	7,990,110	59.3	89,619	42.9
2018	11,482,000	188,771	7,004,212	61.0	72,738	38.5
2019	9,935,390	185,567	6,019,882	60.6	73,447	39.6
2020	5,369,615	118,569	4,039,429	75.2	47,238	39.8
2021	5,590,533	152,214	3,192,381	57.1	56,077	36.8
2022	4,717,777	149,418	2,761,681	58.5	54,157	36.2

a/ Corresponds to the number and value of checks cleared through Cedec.

b/ Checks that are cleared within each financial institution and do not go through the check clearing house.  
Sources: Commercial Banks and Banco de la República (Cedec).

## 2. Payment Instruments

### 2.1 Electronic funds transfers

There has been a growing trend in interbank transfers (those conducted through ACH Colombia and ACH Cenit), both in terms of value and the number of transactions. They averaged COP 8.1 t in value and 1.4 million transactions per day in 2022 (Graph A2.8).

Table A2.7  
Cedec  
(Participants and Concentration)

Year	Total Participants	CR5 (percentages)	Number of participants that clear 70% of the value
2013	25	69.7	5.0
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	80.1	4.0

Source: Banco de la República (DSIF).

With respect to transfers overall (interbank and intrabank),<sup>3</sup> 67% of those made by businesses are for more than COP 200 million, and 46% of those made by individuals are for less than COP 50 million (Graph A2.9).

### 2.2 Cards

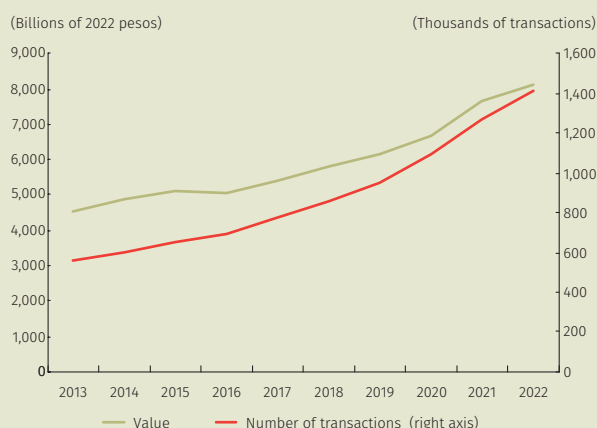
The use of debit and credit cards increased in 2022 with respect to 2021 (Graph A2.10).

The number of debit cards averaged 42.8 million per month in 2022, with use averaging COP 996 billion daily. Withdrawals accounted for 72% of that amount and purchases, the remaining 28%. The average number of credit cards per month in 2022 was 16 million, and daily use averaged COP 261.5 b, with purchase transactions accounting for around 77% and cash advances, 23%.

Debit and credit card purchases have trended upward in recent years. In 2022, the average daily value was COP 475.4 b, and the number of transactions came to 3.4 m, with real positive variations of 16.3% in value<sup>4</sup> and 34.2% in number compared to the year before (Graph A2.11).

Based on the information reported by commercial banks with respect to purchases, Graph A2.12 show individuals are responsible for 86% of debit card transactions and 90% of those with credit cards, in terms of value, and most transactions by individuals involve amounts of

Graph A2.8  
Interbank Transfers (Daily average)



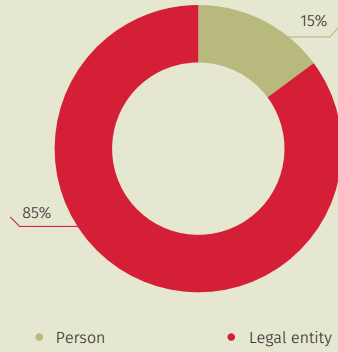
Sources: ACH Colombia and Banco de la República.

3 Specifically, 80% of intrabank transfers originate with legal entities and 20% with private individuals.

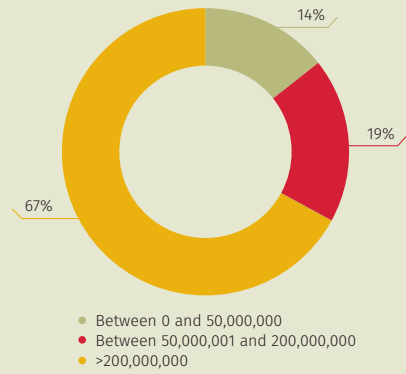
4 The variation in nominal value was 31.6%.

Graph A2.9  
Transfers, by Originator, 2022  
(Share of Value)

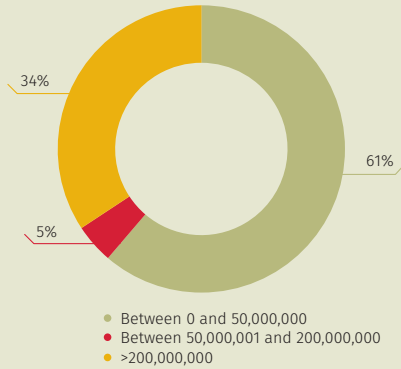
A. Total



B. Legal entity



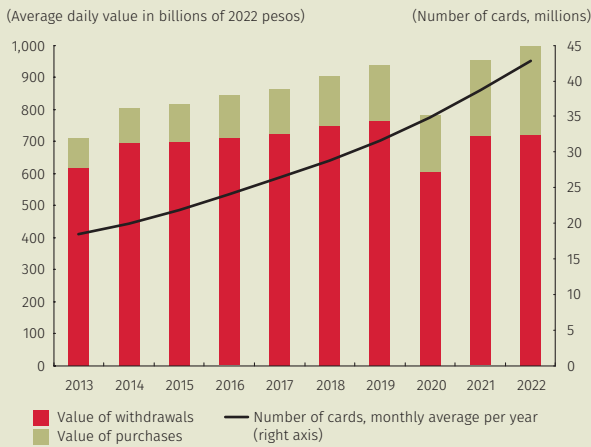
C. Person



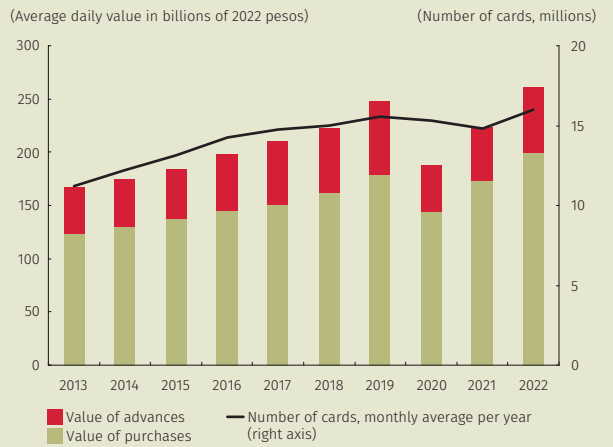
Source: ACH Colombia, commercial banks.

Graph A2.10  
Use of Cards

A. Debit cards

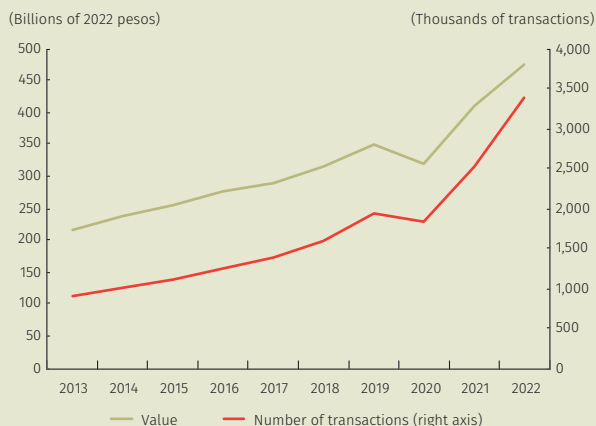


B. Credit cards



Sources: Office of the Financial Superintendent of Colombia and Banco de la República (DSIF).

**Graph A2.11**  
Debit and Credit Card Purchases  
(Daily average)



Source: Office of the Financial Superintendent of Colombia.

up to COP 1 million (79% of debit card transactions and 56% of credit card transactions).

### 2.3 Checks

There has been a decline in the value and number of transactions with interbank checks during the last ten years. Between 2021 and 2022, the average value went from COP 703 billion to COP 610 billion in real terms, and the number of transactions dropped from 22,819 to 19,256 (Graph A2.13).

Based on the data reported by commercial banks with respect to inter and intrabank checks, Graph A2.14 shows most of the checks drawn by businesses (40%) are separate checks for amounts over COP 200 million, followed by checks for up to COP 50 million (31%). At the same time, 42% of the checks drawn by individuals are for amounts up to COP 50 million.

### 2.4 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 means of payment (Table A2.8). Checks are the instrument with the largest average transaction value for both legal entities and individuals (between COP 28 million and COP 26 million). On the other hand, intrabank transfers by legal entities register an amount similar to that 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 24 million). The other instruments, in order of importance, are used for payments in amounts under COP 700,000; namely, interbank transfers, followed by intrabank transfers, credit cards, and debit cards (with payments averaging COP 109,293).

### 2.5 Comparative Use of Electronic Payment Instruments: Cards, Checks and Electronic Funds Transfers

The information on payment instruments presented in this section is divided between individuals and legal entities. This classification is based on who initiates the transaction. As mentioned earlier, individuals account for most debit and credit card use, while funds transfers and checks are used more often by legal entities.

#### 2.5.1 Number of Transactions

In terms of the number of transactions by individuals in 2022, Graph A2.15 shows debit cards accounted for 60%, and credit cards, 26%. This comes to an 86% share. Electronic funds transfers accounted for approximately 14% and checks, less than 1%. In the case of legal entities, electronic funds transfers accounted for the largest share, at 74%, followed by debit cards (21%) and, to a lesser extent, credit cards (3%) and checks (2%).

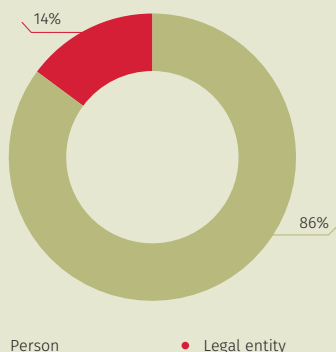
#### 2.5.2 Value of Transactions

As for the value of transactions initiated by individuals (Graph A2.16), debit cards accounted for 28%, and credit cards, 21%. Checks represented 9%, while electronic funds transfers accounted for 42%. With respect to legal entities, in terms of value, electronic funds transfers accounted for 94%, and check, 6% (the use of cards by legal entities is not substantial).

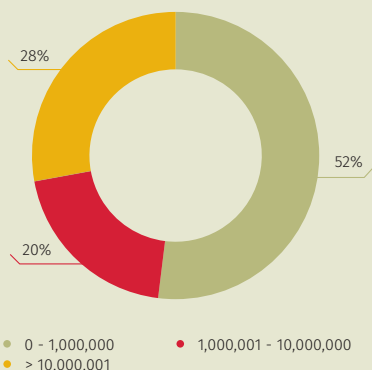
Graph A2.12  
Debit and Credit Cards, by Originator: 2022  
(Share of the value)

A. Debit cards

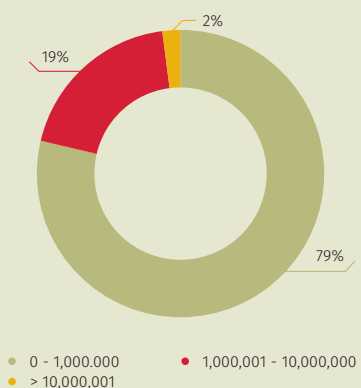
i. Total



ii. Person

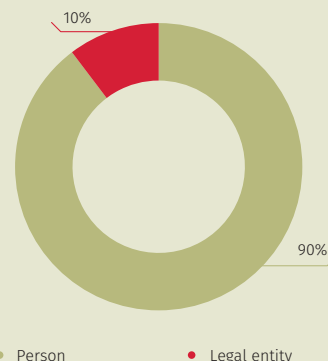


iii. Legal entity

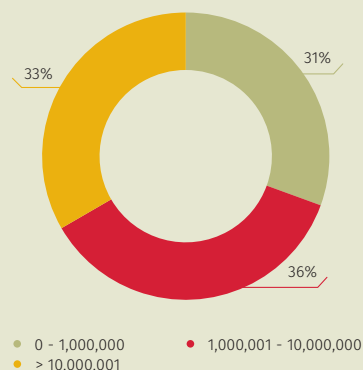


B. Credit cards

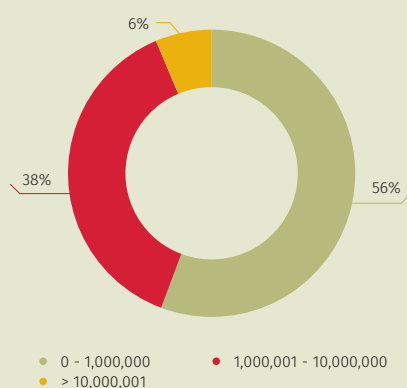
i. Total



ii. Person



iii. Legal entity



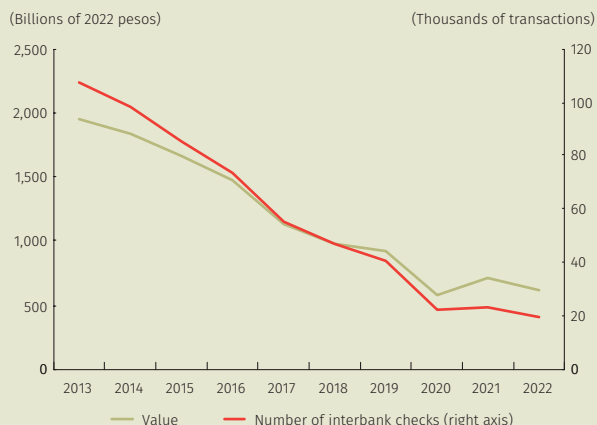
Source: Commercial banks.

2.6 Cash

*Banco de la República* conducts a survey to monitor the use of cash as a payment instrument.<sup>5</sup> Another way to track the use of cash is to analyze the amount of currency in circula-

5 The latest survey was done in the first half of 2022. It was found that most routine monthly payments for food, beverages, clothing, transportation, housing, and public utilities, among other items, are made with cash (78.4% in terms of the number of transactions and 74.6% in terms of value). Likewise, commerce ratifies the public's response and indicates that cash is the preferred instrument for customer payments. The main results of this survey can be found in *Resultados de la encuesta de percepción sobre el uso de los instrumentos, para los pagos habituales en Colombia, 2022*, available on *Banco de la República's* website: [https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/10486/encuesta\\_percepcion\\_de\\_usos\\_de\\_instrumentos\\_2022.pdf](https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/10486/encuesta_percepcion_de_usos_de_instrumentos_2022.pdf).

**Graph A2.13**  
Interbank Checks  
(Daily average)



Sources: ACH Colombia and Banco de la República.

tion. This is understood as an approximation to the potential use of this instrument in the economy, but not as a direct reference to cash payments.

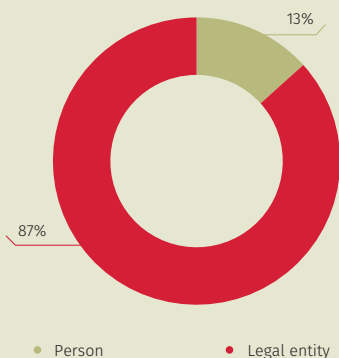
To identify how banknotes in circulation have evolved up to 2022,<sup>6</sup> Graph A2.17 shows an average annual increase of 5.9% in the number of units during the 2013-2022 period, with 3,916 million units in 2022.

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 70% in 2022, while the lower denominations (5,000 pesos and 2,000 pesos, along with coins) accounted for the remaining 30%.<sup>7</sup>

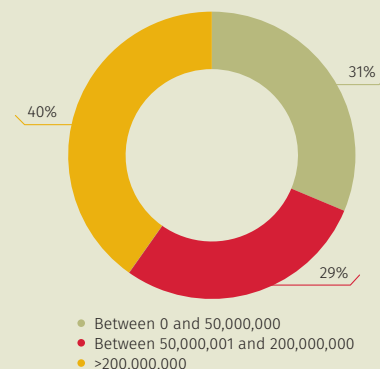
Graph A2.18 illustrates how the real value of all banknotes in circulation changed during 2013-2022. Average growth in real value during this period was around 6.5% and represented close to COP 131.9 t in value in 2022. However, there was a 4.8% decline in real terms between 2021 and 2022.

**Graph A2.14**  
Checks, by Drawer: 2022  
(Share in the value)

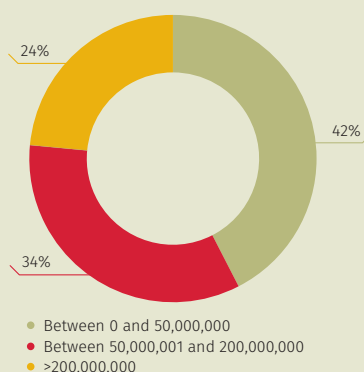
**A. Total**



**B. Legal entity**



**C. Person**



Sources: ACH Colombia and commercial banks.

6 Only the change in banknotes is included, since they accounted for 97% of the total value of currency in circulation during the 2013-2022 period, while coins accounted for the remaining 3%.

7 In the high denomination category, by quantity, the 50-thousand-peso banknote accounted for the largest share, with 44 %; in the low denomination category it was the 2-thousand-pesos banknote, with 16 %.

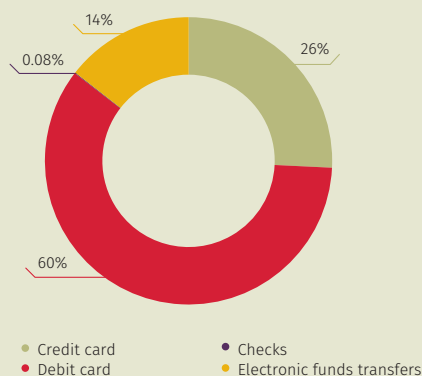
**Table A2.8**  
Transaction Value, Daily Average: 2022

Instruments	Person	Legal entity
Checks	24,012,705	27,788,445
Intrabank transfers	447,924	26,527,417
Interbank transfers	687,314	8,715,205
Credit card purchases	193,362	533,934
Debit card purchases	109,293	156,398

Sources: Banco de la República, ACH Colombia, Office of the Financial Superintendent of Colombia and financial institutions; calculations by Banco de la República.

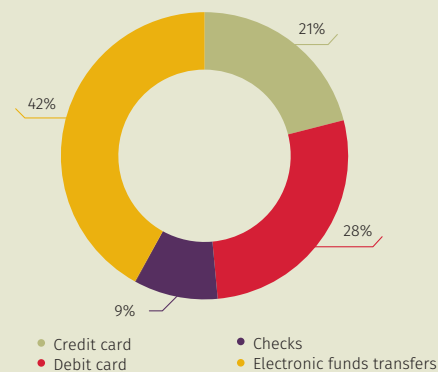
**Graph A2.15**  
Share in the Number of Transactions, 2022

**A. Person**

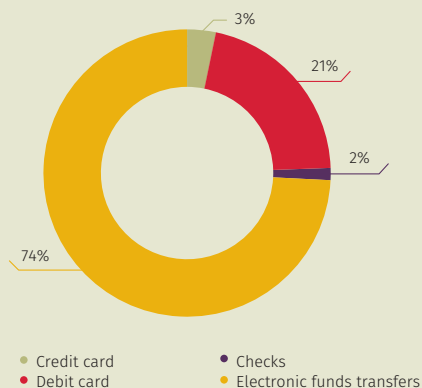


**Graph A2.16**  
Share in Value, 2022

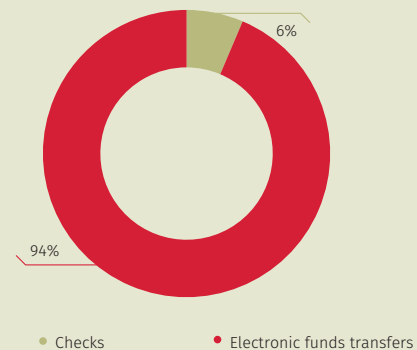
**A. Person**



**B. Legal entity**



**B. Legal entity**



Source: commercial banks.

Sources: Office of the Financial Superintendent of Colombia, ACH Colombia, Banco de la República and commercial banks; calculations by Banco de la República.

Regarding denomination in terms of value, the 50,000-peso banknote accounted for 65% of the total value of currency in circulation in 2022, while the 100,000-peso banknote accounted for 25%, and the 20,000-peso banknote, 6%. The other denominations each accounted for less than 2%.

On the other hand, the ratio of cash in circulation in the real sector to GDP averaged 7.1% between 2013 and 2022, with an upward trend in recent years. In 2022, this share was 7.9%, which is less than in 2021 and 2020 (around 9%), but higher than in 2019 (7%).

## 2.7 International Comparison of Payment Instruments

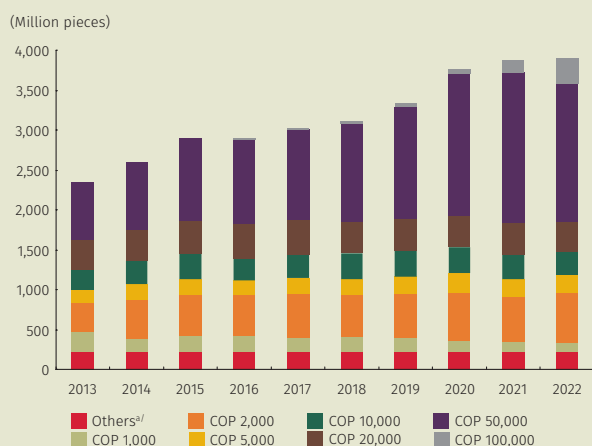
The following is a graphic comparison of the evolution in payment instruments; namely, electronic funds transfers, checks, debit cards, and credit cards for different indicators such as the number of transactions per capita, transaction value per capita in US dollars,<sup>8</sup> and transaction value as a percentage of GDP, with data up to 2021.<sup>9</sup> The per capita value in US dollars and the value relative to GDP with respect to cash in circulation are also shown (Graph A2.19).

The comparison includes twenty countries, in addition to Colombia, all with available data in BIS comparative statistics. As for the indicators of the number of transactions, Colombia is positioned in the lower quartile of the distribution, with ample room to improve its ranking compared to the countries in the sample.

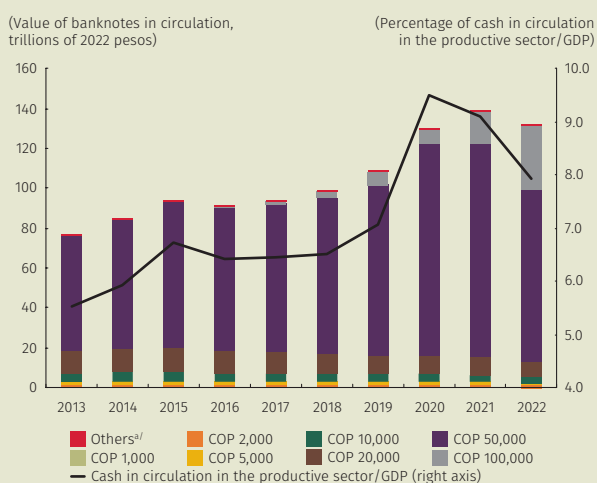
On the other hand, the indicators of value relative to GDP (excluding cash) represent an intermediate position for Colombia among the group of selected countries. By type of instrument, the value of transfers relative to GDP was 4.48 times GDP (for the group of countries, the range is between 1.5 to 42 times GDP). For checks, it was 19% (the country with the highest value was 2.3 times GDP). For debit cards, it was 7% (the country with the highest value was 31% of GDP). For credit cards, it was 6% (the country with the highest value was 38% of GDP); and for cash, it was 9.1% (the countries in the sample range from 1.1% to 23% of GDP).

When analyzing Colombia's performance over an eight-year period, one sees an upward trend in the indicators for all payment instruments, apart from checks.

**Graph A2.17**  
Banknotes in Circulation



**Graph A2.18**  
Value of Banknotes and Cash in Circulation/GDP



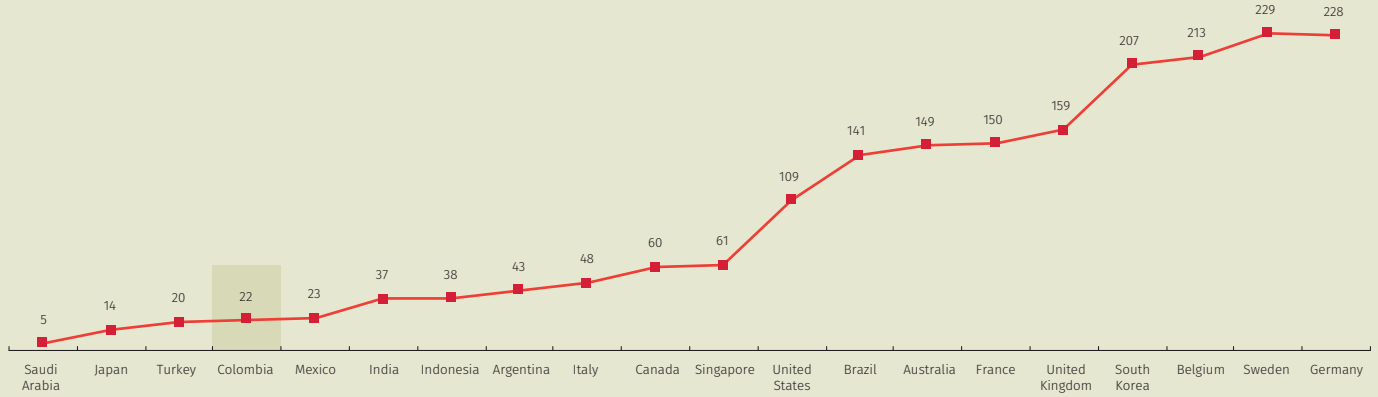
8 In general, the indicators that include value are presented in US dollars due to the impossibility of a comparative analysis in local currencies. To mitigate the effect of the exchange rate, the BIS uses the average annual exchange rate.

9 Most recent data as of June 2023.

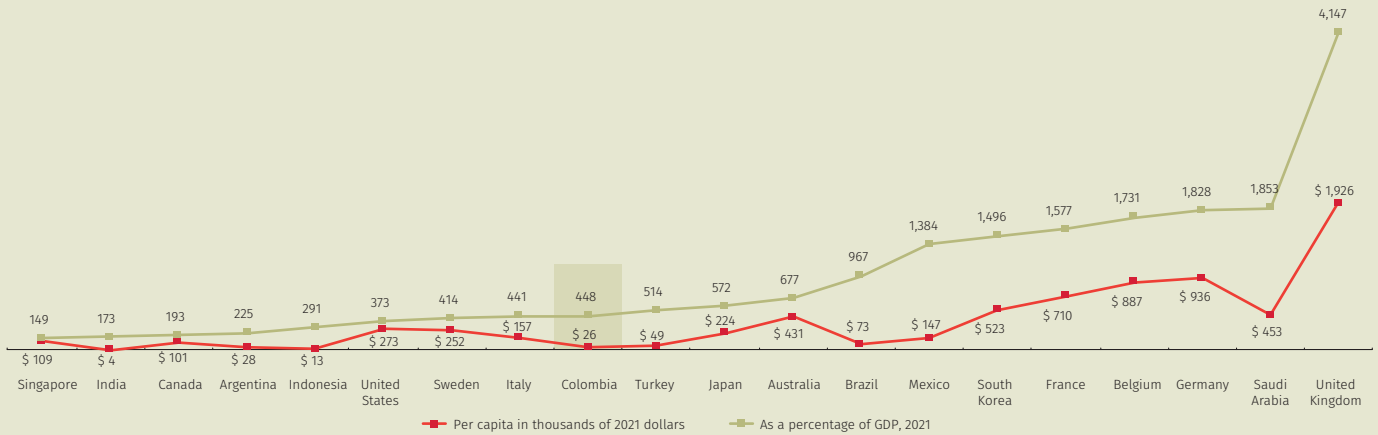
Graph A2.19  
Payment Instruments, International Comparison: 2021

A. Transfers

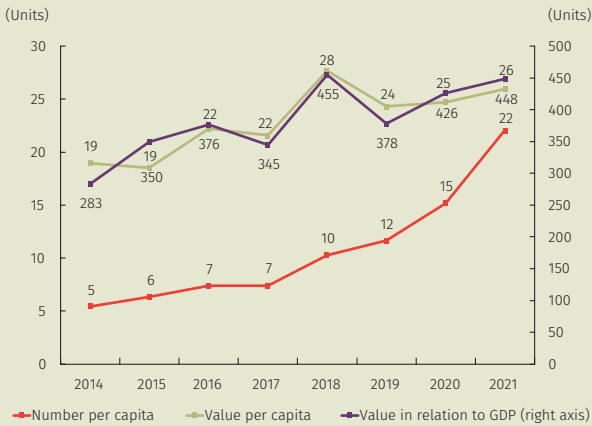
i. Number of transactions per capita



ii. Value per capita and in relation to GDP



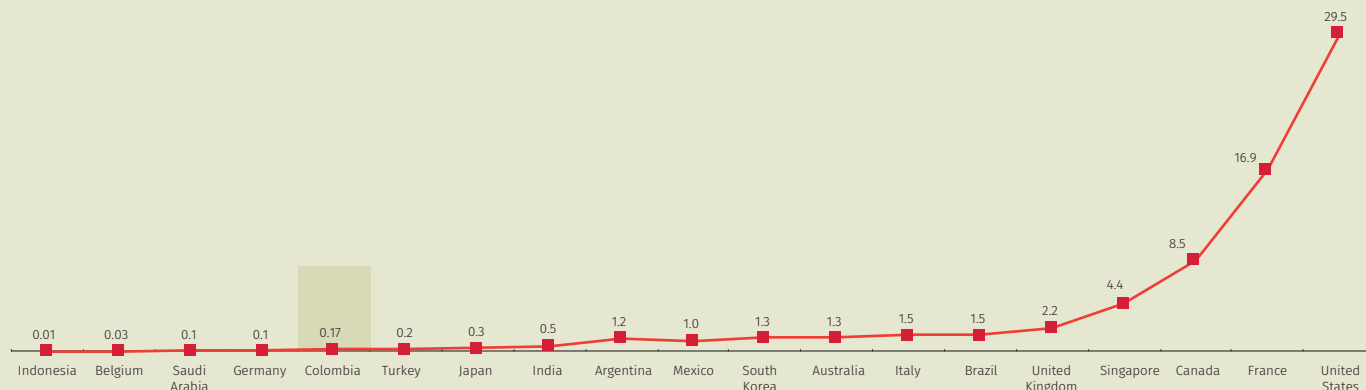
iii. Historical performance: Colombia



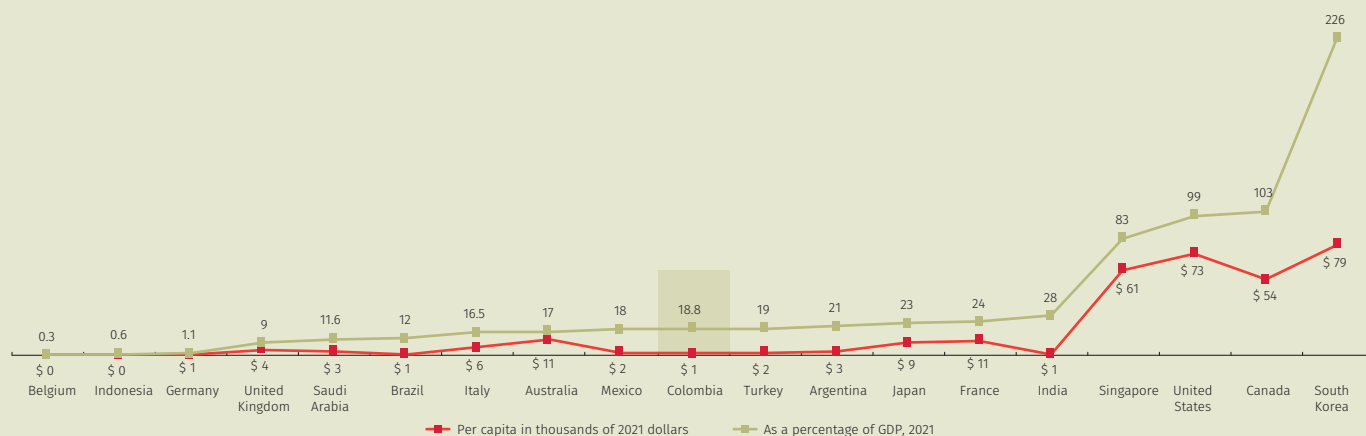
Graph 2.19 (Continued)  
Payment Instruments, International Comparison: 2021

B. Checks

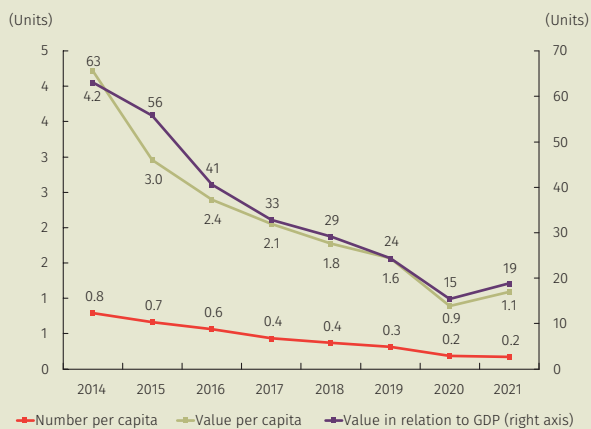
i. Number of transactions per capita



ii. Value per capita and in relation to GDP



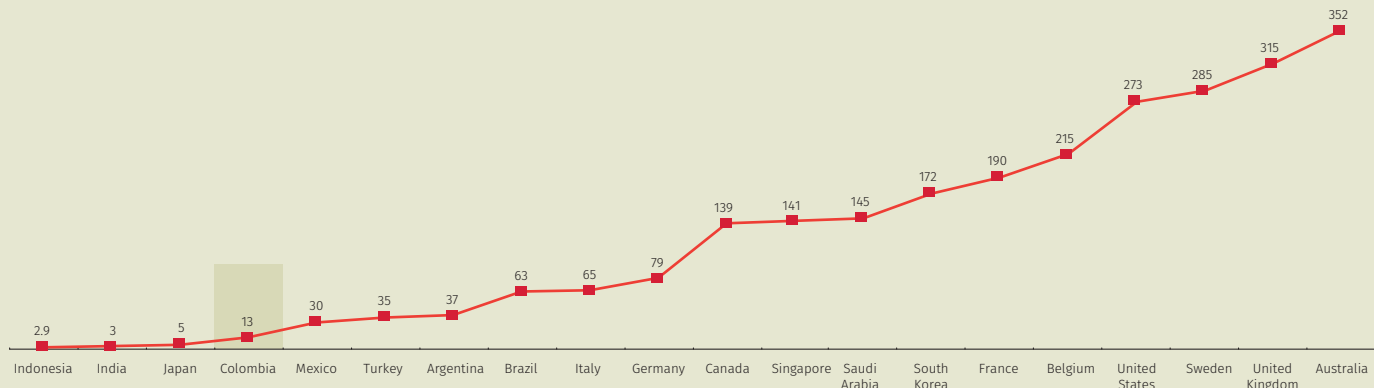
iii. Historical performance: Colombia



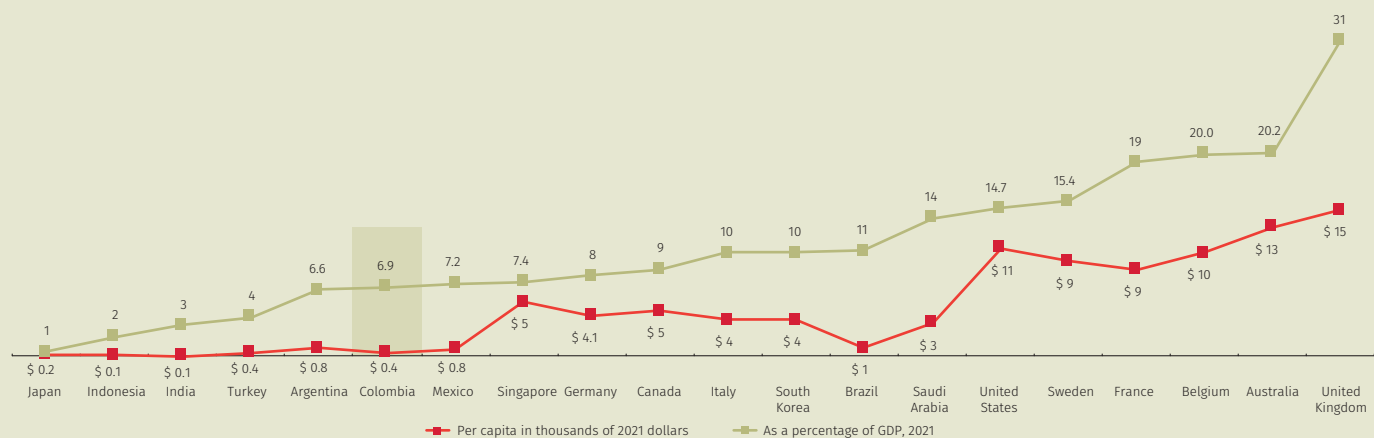
Graph 2.19 (Continued)  
Payment Instruments, International Comparison, 2021

C. Debit cards

i. Number of transactions per capita



ii. Value per capita and in relation to GDP



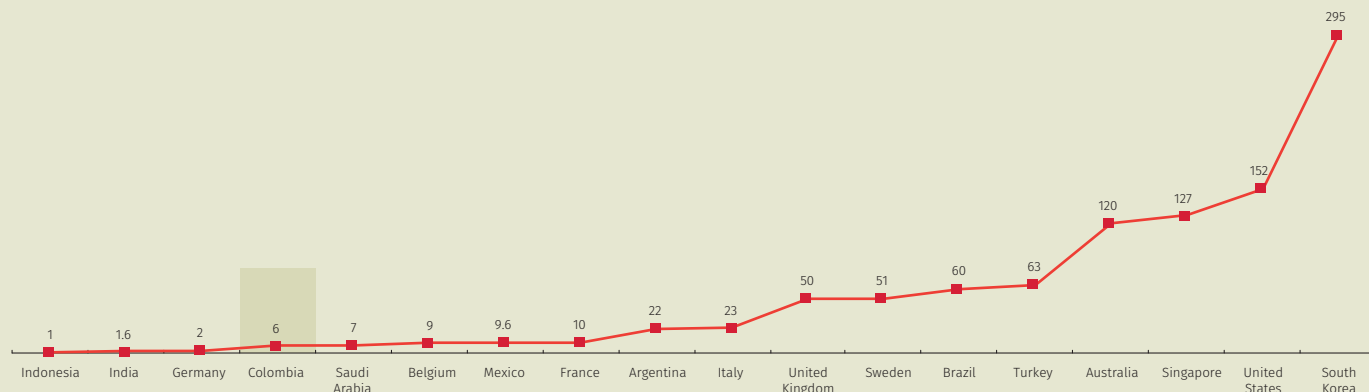
iii. Historical performance: Colombia



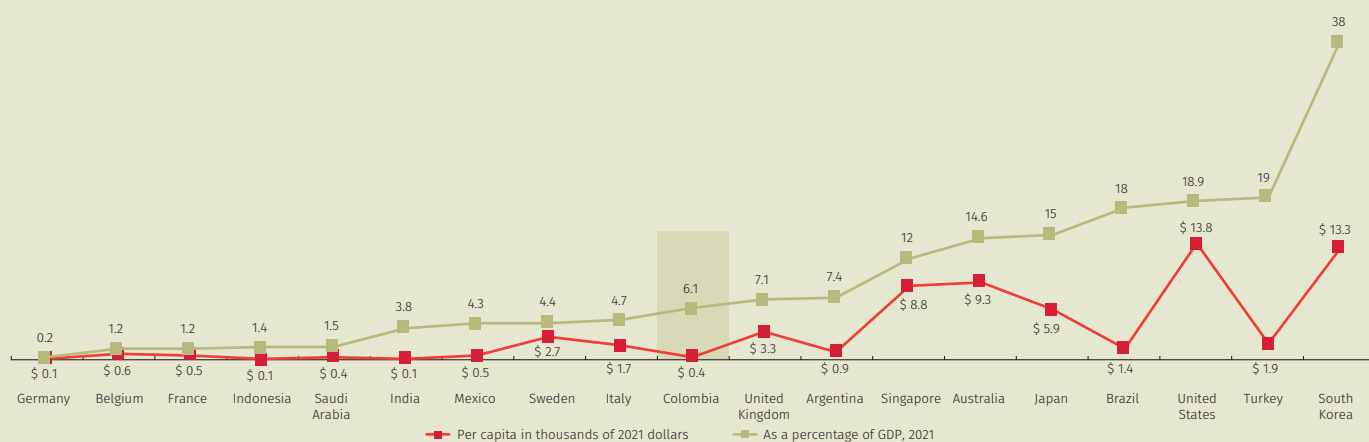
Graph A2.19 (Continued)  
Payment Instruments, International Comparison, 2021

D. Credit cards

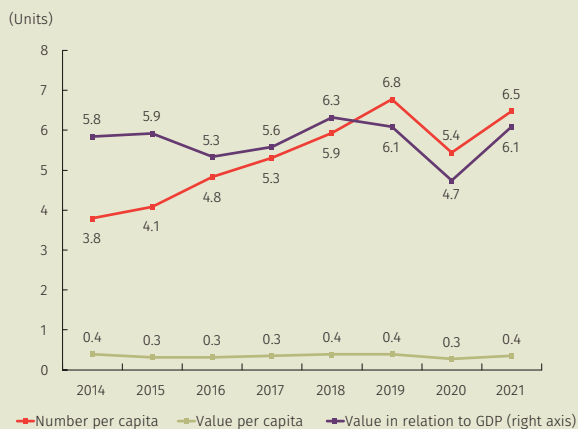
i. Number of transactions per capita



ii. Value per capita and in relation to GDP



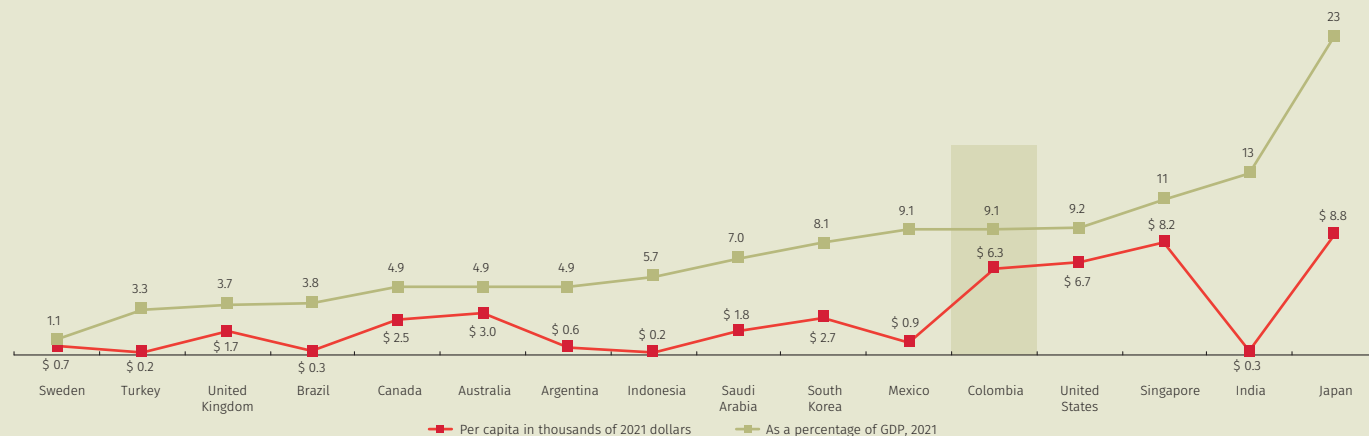
iii. Historical performance: Colombia



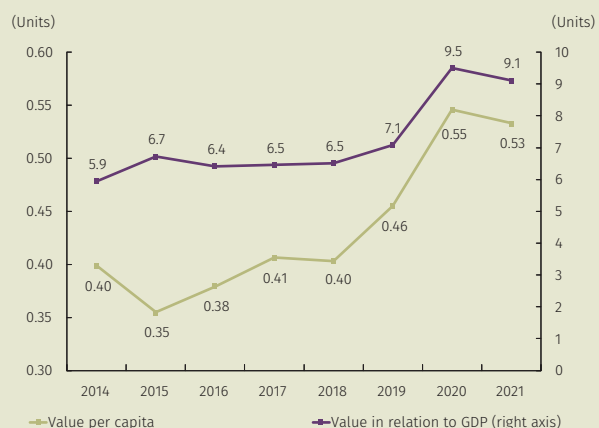
Graph A2.19 (Continued)  
Payment Instruments, International Comparison, 2021

E. Cash in circulation

i. Value per capita and in relation to GDP



ii. Historical performance: Colombia



Sources: BIS Red Book, BIS, ACH Colombia, Office of the Financial Superintendent of Colombia and Banco de la República (DSF).

Table A2.9  
Payment Instruments, International Comparison: 2020 – 2021

Country	Transfers						Checks					
	Operations per capita		Value per capita in USD thousands		Value as a percentage of GDP		Operations per capita		Value per capita in USD thousands		Value as a percentage of GDP	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Germany	219	228	834	936	1,787	1,828	0.1	0.1	0.7	0.5	1.5	1.1
Saudi Arabia	6	5	462	453	2,301	1,853	0.1	0.1	2.4	2.8	12.1	11.6
Argentina	24	43	22	28	218	225	1.2	1.2	2.0	2.6	19.6	20.5
Australia	133	149	351	431	663	677	1.6	1.3	10.9	10.8	20.7	17.1
Belgium	200	213	787	887	1,729	1,731	0.1	0.0	0.3	0.2	0.6	0.3
Brazil	98	141	60	73	878	967	1.8	1.5	1.0	0.9	14.8	12.1
Canada	67	60	88	101	204	193	8.8	8.5	45.1	53.6	103.8	102.6
Colombia	15	22	25	26	426	448	0.2	0.2	0.9	1.1	15.4	18.8
South Korea	173	207	423	523	1,333	1,496	1.5	1.3	74.0	79.0	233.0	226.1
United States	100	109	233	273	357	373	33.8	29.5	75.3	72.6	115.2	99.2
France	139	150	599	710	1,489	1,577	18.0	16.9	10.7	10.6	26.6	23.6
India	21	37	3	4	162	173	0.5	0.5	0.6	0.7	28.7	27.9
Indonesia	26	38	9	13	226	291	0.0	0.0	0.0	0.0	0.7	0.6
Italy	44	48	134	157	420	441	1.6	1.5	5.4	5.9	16.8	16.5
Japan	14	14	220	224	551	572	0.3	0.3	10.0	8.9	25.0	22.7
Mexico	17	23	126	147	1,359	1,384	1.2	1.0	1.9	1.9	20.9	18.3
United Kingdom	149	159	1,899	1,926	4,709	4,147	2.8	2.2	4.4	4.1	11.0	8.9
Singapore	45	61	85	109	139	149	5.5	4.4	55.0	60.5	90.5	83.2
Sweden	210	229	203	252	383	414	-	-	-	-	-	-
Turkey	12	20	44	49	510	514	0.2	0.2	1.7	1.8	19.3	19.0

Country	Debit cards						Credit Cards					
	Operations per capita		Value per capita in USD thousands		Value as a percentage of GDP		Operations per capita		Value per capita in USD thousands		Value as a percentage of GDP	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
Germany	71	79	3.7	4.1	7.9	8.0	1.7	2.0	0.1	0.1	0.2	0.2
Saudi Arabia	77	145	2.4	3.3	12.2	13.7	4.2	7.1	0.3	0.4	1.4	1.5
Argentina	27	37	0.6	0.8	5.9	6.6	18.9	22.1	0.8	0.9	7.6	7.4
Australia	315	352	10.4	12.8	19.7	20.2	112.0	120.0	8.0	9.3	15.1	14.6
Belgium	192	215	9.0	10.3	19.7	20.0	8.0	8.7	0.5	0.6	1.2	1.2
Brazil	54	63	0.7	0.8	10.9	10.5	44.9	59.5	1.0	1.4	15.3	18.1
Canada	127	139	3.9	4.5	8.9	8.6	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
Colombia	9	13	0.3	0.4	5.0	6.9	5.4	6.5	0.3	0.4	4.7	6.1
South Korea	165	172	3.3	3.6	10.2	10.3	275.6	295.4	11.7	13.3	37.0	38.1
United States	254	273	10.0	10.8	15.2	14.7	142.6	152.0	12.9	13.8	19.7	18.9
France	152	190	6.7	8.7	16.7	19.2	27.5	9.9	1.4	0.5	3.4	1.2
India	3	3	0.1	0.1	3.2	3.1	1.3	1.6	0.1	0.1	3.1	3.8
Indonesia	2	3	0.1	0.1	1.8	2.0	1.0	1.0	0.1	0.1	1.5	1.4
Italy	47	65	2.8	3.7	8.9	10.3	19.5	23.1	1.4	1.7	4.5	4.7
Japan	4	5	0.2	0.2	0.4	0.5	n. a.	n. a.	5.5	5.9	13.9	15.0
Mexico	25	30	0.6	0.8	6.4	7.2	8.2	9.6	0.4	0.5	4.1	4.3
United Kingdom	261	315	12.2	14.5	30.3	31.3	42.5	50.3	2.7	3.3	6.8	7.1
Singapore	108	141	4.4	5.4	7.3	7.4	105.4	127.1	7.2	8.8	11.9	12.1
Sweden	274	285	8.1	9.4	15.3	15.4	49.4	50.5	2.3	2.7	4.4	4.4
Turkey	27	35	0.3	0.4	3.6	3.9	51.8	63.3	1.6	1.9	19.0	19.4

Table A2.9 Payment Instruments, International Comparison: 2020-2021 (Continued)

Country	Cash			
	Value per capita in USD thousands		Value as a percentage of GDPe	
	2020	2021	2020	2021
Germany	n. a.	n. a.	n. a.	n. a.
Saudi Arabia	1.8	1.8	7.6	7.0
Argentina	0.5	0.6	5.8	4.9
Australia	3.1	3.0	5.2	4.9
Belgium	n. a.	n. a.	n. a.	n. a.
Brazil	0.3	0.3	4.9	3.8
Canada	2.3	2.5	5.1	4.9
Colombia	6.3	6.3	9.5	9.1
South Korea	2.6	2.7	8.4	8.1
United States	6.3	6.7	9.6	9.2
France	n. a.	n. a.	n. a.	n. a.
India	0.3	0.3	14.4	13.2
Indonesia	0.2	0.2	5.9	5.7
Italy	n. a.	n. a.	n. a.	n. a.
Japan	9.5	8.8	22.9	23.1
Mexico	0.8	0.9	8.5	9.1
United Kingdom	1.5	1.7	3.8	3.7
Singapore	7.6	8.2	12.0	11.3
Sweden	0.7	0.7	1.2	1.1
Turkey	0.3	0.2	3.5	3.3

n.a.: not available

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

## Annex 3: Financial Infrastructures and Markets

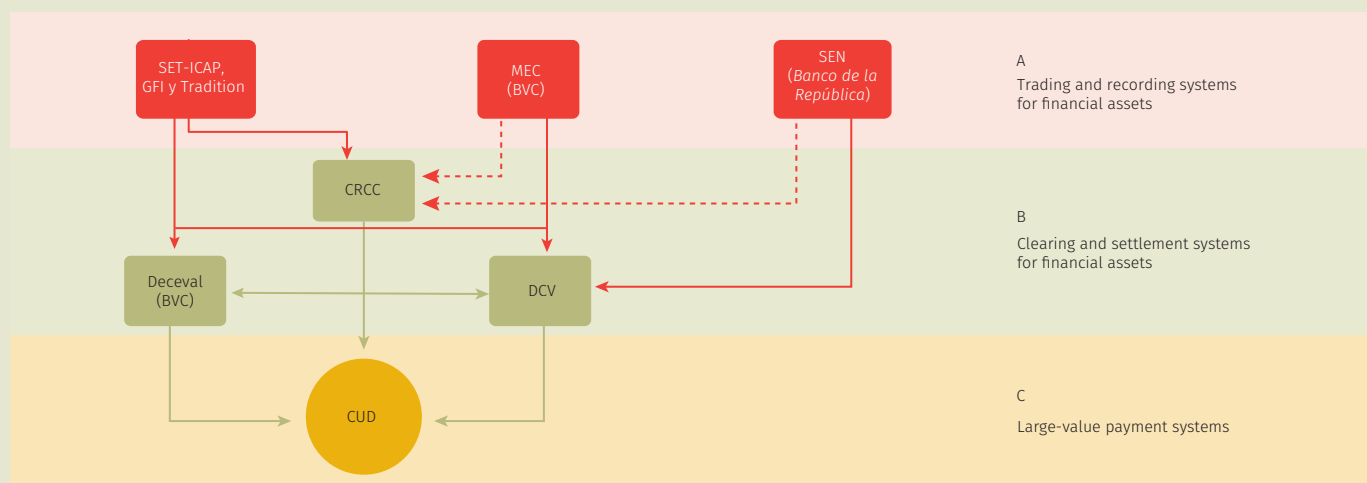
The description provided in this section makes it possible to identify and understand the role infrastructures play in the markets they support and the relationships that exist between them. For this purpose, they have been grouped into fixed income, equity, foreign-exchange, and standardized derivatives markets. More is explained about the retail-value payment systems as well.

### Fixed Income

Diagram A3.1 shows the infrastructures that provide trading, clearing and settlement services for operations in the fixed-income market. The flow begins at the top, with the trading and recording systems, where participants conduct their 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 to be delivered are located, so they can be sent by the system manager, and the respective process and settlement can be finalized. The securities leg is settled when the change in ownership in favor of the buyer is noted in the securities deposit account, and 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 SEN and MEC to the *Cámara de Riesgo Central de Contraparte S.A. (CRCC)* for respective risk management (dotted lines in Diagram A3.1); while gross clearing and settlement are done in the DCV-CUD (unbroken lines in the same diagram).

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



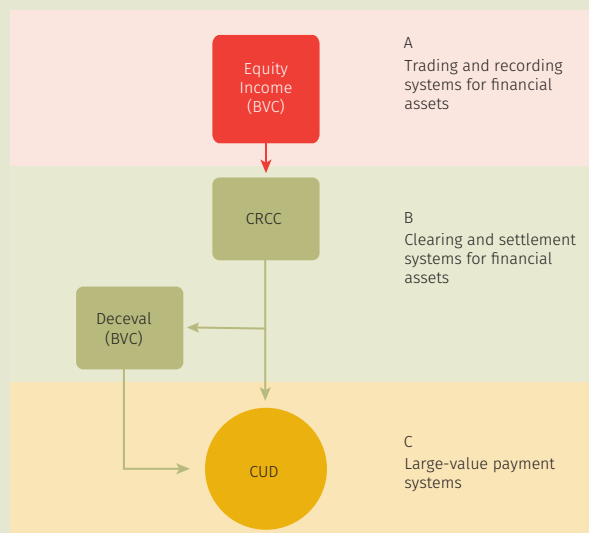
Source: Banco de la República (DSIF).

### Equity Income

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 done through the CRCC.<sup>1</sup>

<sup>1</sup> See Decree 2219 issued on 27 December 2017 by the Ministry of Finance and Public Credit. It amends several provisions in Decree 2555 of 2010 that are applicable to transactions cleared and settled in a central counterparty clearing house and the creation of a protocol for crisis or contingency situations in the securities market.

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



Source: Banco de la República (DSIF).

As shown in Diagram A3.2, the flow begins in the trading system, where participants concur to make offers on available securities. These operations are confirmed and complemented after closing. The BVC sends the trades to the CRCC for risk management, clearing and settlement. The cash leg is settled in the CUD and the securities leg, in Deceval.

### 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 whereby participants voluntarily decide which offers to accept, while the other two use voice and data systems, with foreign exchange offers received privately from each participant and then circulated to the rest of the market.

On 27 October 2020, the Office of the Financial Superintendent 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 clearing and settlement for the spot foreign exchange market began to be done through the CRCC. However, these operations did not actually involve the CRCC until 01 February 2021.

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

### Standardized Derivatives

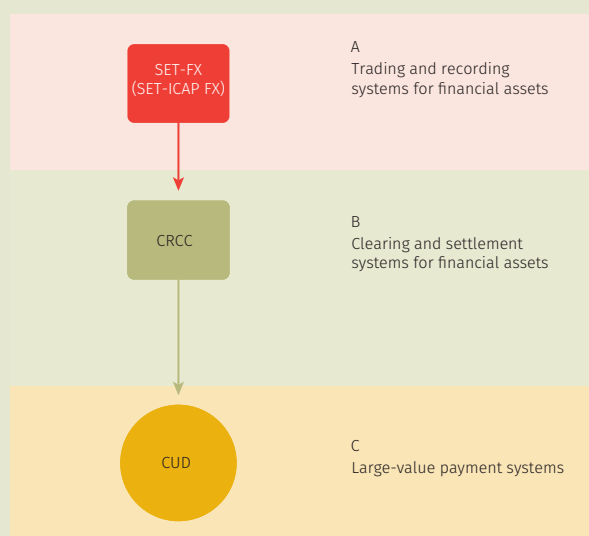
The BVC and Derivex manage the trading and recording systems for the standardized derivatives market. As shown in Diagram A1.4, the transactions handled through these systems are sent to the CRCC for clearing and settlement.

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

### Retail-value Payment Systems

The retail-value payment systems are illustrated in Diagram A1.5. 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); namely, ACH-Cenit (also managed by Banco de la República) and ACH Colombia, process orders for retail-value electronic payments and funds transfers or collections generated by associated institutions on behalf of their clients (persons or legal entities) with checking or savings accounts, while the Credibanco, Assenda Red, Mastercard, ATH, Servibanca and Redeban networks process debit and cre-

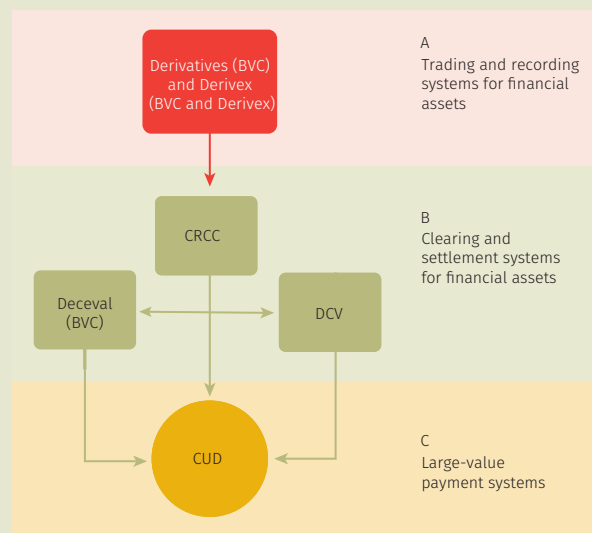
Diagram A3.3  
Flow of Operations in the Foreign Currency Market



Source: Banco de la República (DSIF).

<sup>2</sup> 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



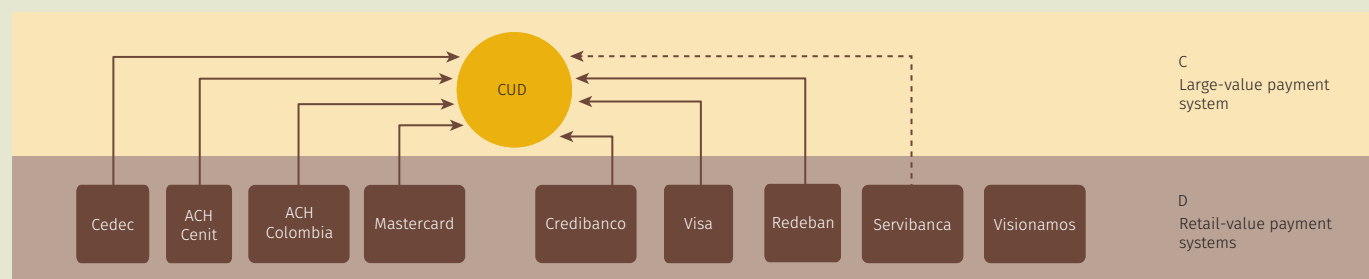
Source: Banco de la República (DSIF).

dit card transactions, among others, done at ATMs and commercial establishments.

Credibanco, Mastercard Colombia and Visa Colombia have their own deposit accounts with the large-value payment system and, therefore, can clear and settle their operations directly, using the resources in those accounts. The other networks do not have a deposit account of their own with the central bank system.<sup>3</sup> Consequently, they only clear operations, which are then settled by a commercial bank through a deposit account opened in its name with *Banco de la República*. There is also *Visionamos*, a network that belongs to the solidarity sector of the economy and processes credit card transactions that are covered by participating cooperatives or international franchises.

Although each entity performs a specific function within the structure of the payment systems, a substantial proportion of the obligations generated by their participants in the clearing process are settled, ultimately and for the most part, through the CUD large-value payment system.

Diagram A3.5  
Flow of Operations in Retail-value Payment Systems



Source: Banco de la República (DSIF).

3 The dotted lines in Diagram A1.5 refer to the fact 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.