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REPORT



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Glossary

ACH: cámara de compensación automatizada
ACH-Cenit: compensación electrónica nacional interbancaria administrada por el Banco de la República
ACH-Colombia: Cámara de Compensación Automatizada de Colombia S. A.
ATH: A Toda Hora S. A., red de cajeros electrónicos y agilizadores
BIS: Banco de Pagos Internacionales (por su sigla en inglés)
BVC: Bolsa de Valores de Colombia
CCDC: Cámara de Compensación de Divisas de Colombia S. A.
CDT: certificado de depósito a término
Cedec: sistema de compensación electrónica de cheques y de otros instrumentos de pago, administrado por el Banco de la República
CRCC: Cámara de Riesgo Central de Contraparte de Colombia S. A.
CR5: índice de concentración construido como la suma de las cinco mayores participaciones
CUD: sistema de cuentas de depósito, administrado por el Banco de la República para liquidación de transferencia de fondos, también denominado sistema de pagos de alto valor.
DANE: Departamento Administrativo Nacional de Estadística
DCV: Depósito Central de Valores, administrado por el Banco de la República
Deceval: Depósito Centralizado de Valores de Colombia S. A.
DGCPTN: Dirección General de Crédito Público y del Tesoro Nacional
EcP: modalidad de entrega contra pago aplicable en la liquidación de valores (DvP, por su sigla en inglés)

FIC: fondos de inversión colectiva
Finagro: Fondo para el Financiamiento del Sector Agropecuario
IBR: indicador bancario de referencia
JDBR: Junta Directiva del Banco de la República
MEC: Mercado Electrónico Colombiano de propiedad de la Bolsa de Valores de Colombia S. A.
NDF: *forward* de cumplimiento financiero (*non delivery forward*)
PIB: producto interno bruto
PSE: pagos seguros en línea
SEN: sistema electrónico de negociación administrado por el Banco de la República
SET-ICAP-FX: sistema electrónico de transacción en moneda extranjera, administrado por Servicios Integrados en Mercado Cambiario S. A., con el respaldo de la Bolsa de Valores de Colombia S. A. y SIF-ICAP de México
SET-ICAP Securities: sistema electrónico y de voz para la negociación y registro de instrumentos financieros, y proveedor de información financiera.
TES: títulos de deuda pública emitidos por el Gobierno y administrados por el Banco de la República
TRM: tasa representativa de mercado
TTV: transferencia temporal de valores

As used in English

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.: 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: Central Counterparty Risk of Colombia S.A.
CR5: Concentration index constructed as the sum of the five largest participations
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 Administrative Department 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 (CIF)
FINAGRO: Fund for the Financing of the Agricultural Sector
IBR: Benchmark Reference Index
JDBR: Banco de la República's Board of Directors
MEC: Colombian Electronic Market, owned by the Colombian Stock Exchange
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; 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

The 2021 Payment Systems Report

Banco de la República provides a comprehensive overview of Colombia's financial infrastructure in its *Payment Systems Report*, which is an important product of the work it does to oversee that infrastructure. The figures published in this edition of the report are for the year 2020, a pandemic period in which the containment measures designed and adopted to alleviate the strain on the health system led to a sharp reduction in economic activity and consumption in Colombia, as was the case in most countries.

At the start of the pandemic, the Board of Directors of *Banco de la República* adopted decisions that were necessary to supply the market with ample liquidity in pesos and US dollars to guarantee market stability, protect the payment system and preserve the supply of credit. The pronounced growth in monetary aggregates reflected an increased preference for liquidity, which *Banco de la República* addressed at the right time. These decisions were implemented through operations that were cleared and settled via the financial infrastructure.

The second section of this report, following the introduction, offers an analysis of how the various financial infrastructures in Colombia have evolved and performed. One of the highlights is the large-value payment system (CUD), which registered more momentum in 2020 than during the previous year, mainly because of an increase in average daily remunerated deposits made with *Banco de la República* by the General Directorate of Public Credit and the National Treasury (DGCPTN), as well as more activity in the sell/buy-back market with sovereign debt. Consequently, with more activity in the CUD, the Central Securities Depository (DCV) experienced an added impetus sparked by an increase in the money market for bonds and securities placed on the primary market by the national government. The value of operations cleared and settled through the Colombian Central Counterparty (CRCC) continues to grow, propelled largely by peso/dollar non-deliverable forward (NDF) contracts. With respect to the CRCC, it is important to note this clearing house has been in charge of managing risks and clearing and settling operations in the peso/dollar spot market since the end of last year, following its merger with the Foreign Exchange Clearing House of Colombia (CCDC). Since the final quarter of 2020, the CRCC has also been responsible for clearing and settlement in the equities market, which was formerly done by the Colombian Stock Exchange (BVC).

The third section of this report provides an all-inclusive view of payments in the market for goods and services; namely, transactions carried out by members of the public and non-financial institutions. During the pandemic, inter- and

intra-bank electronic funds transfers, which originate mostly with companies, increased in both the number and value of transactions with respect to 2019. However, debit and credit card payments, which are made largely by private citizens, declined compared to 2019. The incidence of payment by check continue to drop, exhibiting quite a pronounced downward trend during the past last year. To supplement to the information on electronic funds transfers, section three includes a segment (Box 4) characterizing the population with savings and checking accounts, based on data from a survey by *Banco de la República* concerning the perception of the use of payment instruments in 2019. There also is segment (Box 2) on the growth in transactions with a mobile wallet provided by a company specialized in electronic deposits and payments (Sedpe). It shows the number of users and the value of their transactions have increased since the wallet was introduced in late 2017, particularly during the pandemic.

In addition, there is a diagnosis of the effects of the pandemic on the payment patterns of the population, based on data related to the use of cash in circulation, payments with electronic instruments, and consumption and consumer confidence. The conclusion is that the collapse in the consumer confidence index and the drop in private consumption led to changes in the public's payment patterns. Credit and debit card purchases were down, while payments for goods and services through electronic funds transfers increased. These findings, coupled with the considerable increase in cash in circulation, might indicate a possible precautionary cash hoarding by individuals and more use of cash as a payment instrument. There is also a segment (in Focus 3) on the major changes introduced in regulations on the retail-value payment system in Colombia, as provided for in Decree 1692 of December 2020.

The fourth section of this report refers to the important innovations and technological changes that have occurred in the retail-value payment system. Four themes are highlighted in this respect. The first is a key point in building the financial infrastructure for instant payments. It involves of the design and implementation of overlay schemes, a technological development that allows the various participants in the payment chain to communicate openly. The result is a high degree of interoperability among the different payment service providers. The second topic explores developments in the international debate on central bank digital currency (CBDC). The purpose is to understand how it could impact the retail-value payment system and the use of cash if it were to be issued. The third topic is related to new forms of payment initiation, such as QR codes, biometrics or near field communication (NFC) technology. These seemingly small changes can have a major impact on the user's experience with the retail-value payment system. The fourth theme is the growth in payments via mobile telephone and the internet.

The report ends in section five with a review of two papers on applied research done at *Banco de la República* in 2020. The first analyzes the extent of the CRCC's capital, acknowledging the relevant role this infrastructure has acquired in providing clearing and settlement services for various financial markets in Colombia. The capital requirements defined for central counterparties in some jurisdictions are explored, and the risks to be hedged are identified from the standpoint of the service these type of institutions offer to the market and those associated with their corporate activity. The CRCC's capital levels are analyzed in light of

what has been observed in the European Union's regulations, and the conclusion is that the CRCC has a scheme of security rings very similar to those applied internationally and the extent of its capital exceeds what is stipulated in Colombian regulations, being sufficient to hedge other risks. The second study presents an algorithm used to identify and quantify the liquidity sources that CUD's participants use under normal conditions to meet their daily obligations in the local financial market. This algorithm can be used as a tool to monitor intraday liquidity.

Leonardo Villar Gómez
Governor

01

General Overview of Colombia's Financial Infrastructure

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.¹ These infrastructures include payments systems (PS), securities depositories (SDs), central counterparties (CCPs) and systems for recording operations,² as well as the other existing clearing and settlement infrastructures.

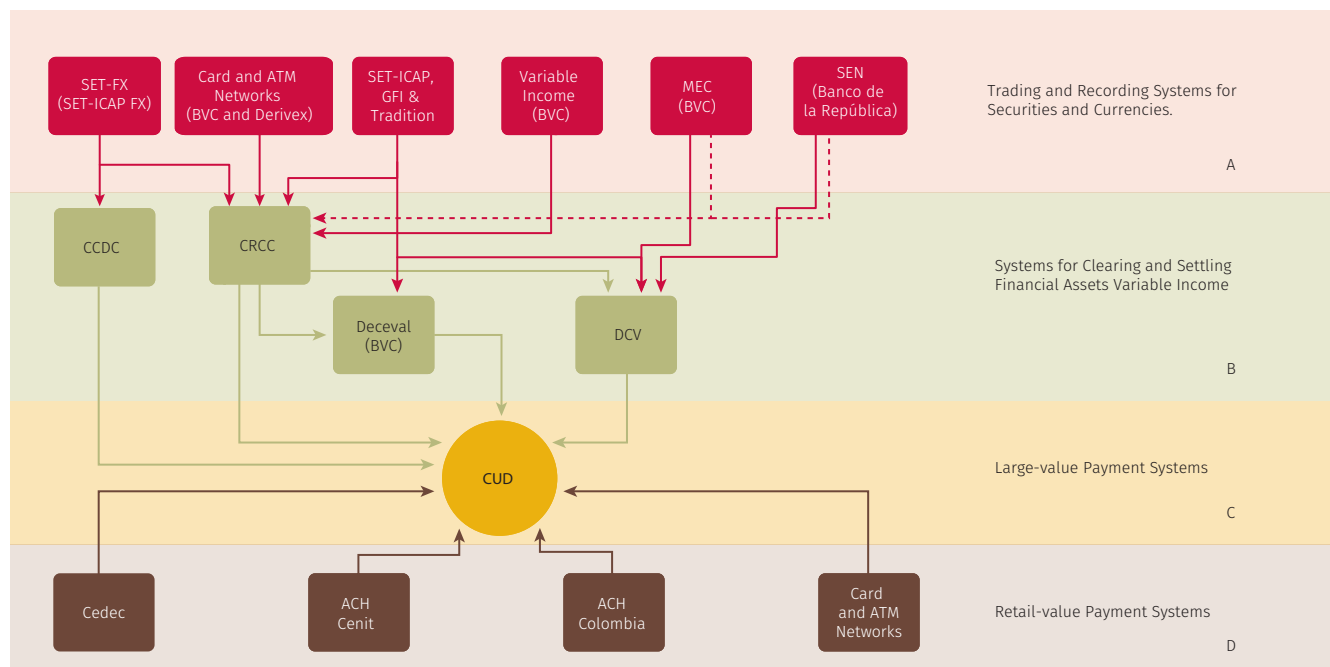
Diagram 1.1 shows the infrastructures that participate, as a whole, in the clearing and settlement of securities and other financial assets in Colombia. It also illustrates the main platforms for trading and recording these assets, so as to provide a view of the entire value chain. The core role of the 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 currencies. The former includes the Electronic Trading System (SEN), managed by *Banco de la República*, where transactions with sovereign debt securities are traded and recorded. The Colombian Electronic Market (MEC), managed by the Colombian Stock Exchange (BVC), is 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.

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

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

Diagram 1.1
Overview of Financial Market Infrastructures (FMI) and Other Participants ^{a/} (2020)



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, at the same time gross settlement in the DCV-CUD takes place.
Source: Banco de la República (DSIF).

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 systems³ that allow for trading and recording transactions between participants through the use of 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.,⁴ and the platforms for some trading and recording systems,⁵ provide trading and recording infrastructure.

Band B in Diagram 1.1 shows the systems for clearing and settling operations. Institutions use these infrastructures to settle security, foreign currency, and derivative legs resulting from the obligations they contract on those markets. Among the systems concerned with securities, Diagram 1.1 includes the Central Securities Depository (DCV), 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 Colombian Central Counterparty (CRCC), which handles

- 3 These include 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. It is intended 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.

forward 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 (as of August 2020).

The infrastructure for foreign currency includes the Foreign Exchange Clearing House of Colombia (CCDC), where exchange operations are settled in cash, and the CRCC, where standardized derivatives are cleared and settled at the representative market rate of exchange (TRM), as are non-standardized non-deliverable forwards (COP/USD). These two clearing houses merged by absorption on December 14, 2020. As a result, the CCDC was absorbed by the CRCC, and spot foreign exchange transactions are now cleared and settled through the CRCC.

Band C shows the large-value payment system (CUD, the core of the country's financial infrastructure). It is where the cash legs of operations converge to be settled, including those of operations in financial asset clearing and settlement systems, 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 1 offers a description that helps to identify and understand the role financial infrastructures play, according to the markets they support.

Table 1.1 contains a detailed description of the type of operations channeled through each system, and the daily average value and quantity of operations conducted over the last two years. These figures reflect the magnitude 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 before, the settlement of obligations from the other external systems⁶ for operations conducted by financial intermediaries and all other agents in the securities, forex, derivatives and domestic currency markets, both in large and retail values, converges in the large-value payment system (CUD). The daily average value of the transactions settled there in 2020 came to COP55.5 trillion (t), which is equivalent to 5.54% of the country's annual gross domestic product (GDP), followed by operations in the equities market (COP30.3 t), which include the DCV (COP26.9 t) Deceval, (COP3.27 t) and equity operations conducted through the BVC (COP0.14 t). Next, in order of

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 counterparty risk clearing houses, provided they are duly authorized by the competent authority to operate in Colombia.

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

	Daily Averages ^{a/}				Main Operations
	Number of Operations		Value (Billions of Pesos)		
	2019	2020	2019	2020	
Large-value Payment System					
Large Value					
CUD	6,774	6,537	50,752	55,527	-Settlement of the cash leg of operations cleared by the DCV, Deceval, the BVC, the CCDC, the CRCC, and the retail-value payment systems. -Payment of the cash leg of monetary operations; monetary policy operations: repos and remunerative deposits -Transfers of funds ordered directly by the participants. -Debit to accounts for items such as interbank clearing, VAT, GMF and commissions, among others.
Systems for Clearing and Settling Financial Assets					
Securities Depositories					
DCV ^{b/}	2,122	2,090	35,524	26,903	-Pertains to transactions with government securities on the primary market (trusteeship), the secondary market, and monetary operations by <i>Banco de la República</i> .
Deceval ^{c/}	5,239	6,941	3,752	3,278	-Comprised of transactions with government securities, corporate debt and shares of stock on the primary and secondary markets. Includes cash collateral.
Other Securities Clearing and Settlement Systems					
BVC: Variable income	2,326	3,732	188	143	-Operations with common stock, preferred stock and subscription rights. -As of August 2017, equity repos are cleared and settled at the CRCC.
Counterparty Risk Clearing Houses					
CRCC S.A.	433	2,034	3,842	4,306	-Clearing and settlement of standardized financial and energy derivatives. - Clearing and settlement of non-standardized foreign-exchange and interest rate derivatives. - Clearing and settlement of repos, cash and temporary transfer of securities (TTS). - Term operations (TES sell/buy-backs) are sent by the SEN and MEC systems to the Central Counterparty Risk Clearing House (CRCC) for respective risk management, while gross clearing and settlement are done in the DCV-CUD. An average of 648 operations daily were handled in 2020 for COP 12.55 trillion.
Forex Clearing and Settlement Systems					
CCDC ^{d/}	1,834	1,581	4,352	4,559	-Purchase and sale of dollars between exchange market intermediaries on the spot market (t + 0, t + 1, t + 2 and t + 3).
Retail-value Payment Systems					
ACH Colombia	909,622	1,048,593	4,215	4,577	-Recurring payments such as payroll, pensions, suppliers, social security, dividends and, in general, invoicing for the purchase of all types of goods and services, as well as automatic collections for these same items.
ACH: Cenit	46,741	41,327	890	987	-Mainly drafts and payments from the National Treasury to territorial entities.

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

	Daily Averages ^{a/}				Main Operations
	Number of Operations		Value (Billions of Pesos)		
	2019	2020	2019	2020	
Retail-value Payment Systems					
Cedec	40,553	22,097	757	488	-Checks for the purchase and sale of goods, services and to discharge obligations, among others.
Cards and ATM Networks	4,084,011	4,051,773	769	494	- Transactions with debit and credit cards, as well as clearing operations between ATMs.

a/ Averages calculated based on the days each infrastructure was operating.

b/ Corresponds to the settled value of operations cleared and settled through the DCV and originated 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 its reverse operations.

c/ Pertains to the settled value sent by the investor in the acquisition of a security.

d/ Nominal values in Colombian pesos as the settled value of transactions.

Sources: Banco de la República, Deceval, BVC, ACH Colombia, CCDC and CRCC.

importance, is the sum of the two ACHs (Cenit and Colombia) (COP 5.56 t); followed by settlements of the peso leg of operations carried out by the CCDC (COP 4.56 t); the value of operations with derivatives and repo, spot market transactions, and temporary transfers of securities cleared and settled by the CRCC (COP 4.3 t); interbank clearing of checks settled in the CEDEC system (COP 0.49 t); and, finally, the value of card and ATM clearing (COP 0.49 t).

02

Payments in the Market for Financial Assets

The life cycle of financial market operations begins with an order to buy, sell or transfer a financial asset and ends with the delivery of the traded asset.⁷ Official sovereign and private bonds, equities, and foreign exchange and financial derivatives are the assets that are normally traded. For final compliance, most of these operations require the financial asset to be cleared and settled, through the infrastructures created for that purpose (securities depositories, foreign exchange clearing houses and central counterparties, among others), and the money to be transferred.

That transfer of money, which involves large daily amounts, must be represented by a secure asset for final settlement of the obligation through an infrastructure that supports operations between financial intermediaries. In this regard, international best practices, as outlined in *Principles for Financial Market Infrastructures* (BIS and the International Organization of Securities Commissions, IOSCO), recommend this settlement be carried out in central bank money, so as to avoid the credit and liquidity risks that would exist if means of payment issued by commercial banks were to be used.

As mentioned in the previous section, the large-value payment system in Colombia; that is, the deposit account system (CUD) managed by *Banco de la República*, is the axis of the financial infrastructure. It is where operations originating in financial asset clearing and settlement systems are paid, as are the net multilateral obligations of entities participating in retail-value payment systems.

2.1 The Large-value Payment System

2.1.1 General Aspects and Development

There were 131 direct participants with deposit accounts in *Banco de la República*'s large-value payment system (CUD) by December 2020. Table 2.1 shows the number of participants for each type of institution. As to how the figures have evolved, Graph 2.1 and Table 2.2 show the number of operations processed

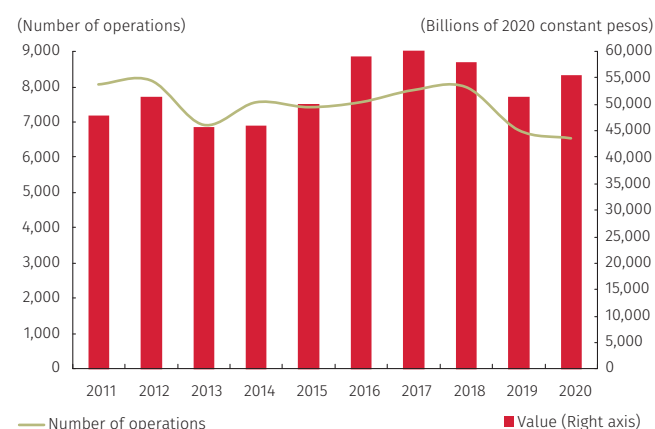
⁷ In the case of financial derivatives, it ends with the transfer of the monetary difference.

Table 2.1
Number of Participants by Type of Entity

Type of Entity	Number of Participants
Trust companies	27
Banks	25
Brokerage firms	16
Insurance companies	11
Financial corporations	10
Public financial institutions	8
Social security information operators	6
Financial cooperatives	5
Retail-value payment system (ACH Colombia and networks)	5
Pension and severance funds	4
Financial corporations	4
Companies specialized in electronic deposits and payments (SEDPE)	2
Capitalization companies	1
<i>Banco de la República</i>	1
General Directorate of Public Credit and the National Treasury	1
Ministry of Finance and Public Credit: general royalty system	1
Colombian Stock Exchange	1
Centralized securities depositories	1
Central counterparty risk clearing houses	1
Securitization firms	1
Total	131

Source: Banco de la República (CUD).

Graph 2.1
Statistics on the Number and Value of Operations in the Large-value Payment System (CUD), daily averages



Source: Banco de la República (CUD).

through the system and their value. The daily average number of operations (6,537) declined by 3.49% in 2020 with respect to the year before. However, the nominal value (COP55.5 t) was up by 9.41% compared to that same year. In real terms, the average daily value rose by 7.7%. In the annual total, the amount processed was 13.5 times Colombia's GDP⁸ in 2020; in other words, the daily average was equivalent to 5.54% of GDP, which is above what was registered in 2019, when it represented 4.78%.

8 The GDP values noted herein are official estimates developed by the National Administrative Department of Statistics (DANE) using the new base year for the national accounts, which is 2015. The preliminary GDP estimated by DANE for 2019 comes to COP 1,002 t and is used as a reference.

Table 2.2
Number of Operations in the CUD System

Year	Number of Operations	Daily Average				Annual Value			
		Value		Average Transaction Value		Number of Operations	(Billions of pesos)	Annual value (Billions of 2020 constant pesos)	(Number of times GDP)
		(Billions of pesos)	(Billions of 2020 constant pesos)	(Billions of pesos)	(Billions of 2020 constant pesos)				
2011	8,083	34,676	48,006	4.3	5.9	1,988,418	8,530,296	11,809,364	13.8
2012	8,196	38,132	51,535	4.7	6.3	2,016,269	9,380,456	12,677,584	14.1
2013	6,925	34,543	45,798	5.0	6.6	1,689,588	8,428,598	11,174,616	11.8
2014	7,570	35,925	45,948	4.7	6.1	1,847,039	8,765,618	11,211,360	11.5
2015	7,430	41,767	50,034	5.6	6.7	1,805,454	10,149,449	12,158,295	12.6
2016	7,574	52,083	59,001	6.9	7.8	1,863,090	12,812,358	14,514,081	14.8
2017	7,921	55,305	60,189	7.0	7.6	1,932,687	13,494,365	14,686,208	14.7
2018	8,007	54,977	57,990	6.9	7.2	1,969,837	13,524,386	14,265,522	13.7
2019	6,774	50,752	51,573	7.5	7.6	1,652,880	12,383,453	12,583,878	11.7
2020	6,537	55,527	55,527	8.5	8.5	1,589,352	13,516,504	13,516,504	13.5

Source: Banco de la República (CUD).

Table 2.3 shows the origin and items of transactions debiting deposit accounts in the CUD system. As illustrated, settlement of the cash leg of investments, sales and purchases, sell/buy-backs and repos in the primary and secondary markets for sovereign debt, using the delivery versus payment (DVP) mechanism in the DCV, accounted for 30.53% of the total value in 2020. Monetary policy operations with repos backed by sovereign bonds (5.3%), definitive purchases of TES (0.04%), purchases, repos with private debt and promissory notes (0.09%), non-deliverable forwards (0.01%) and liquidity operations for the payment system (intraday repos) represented 8.0%. A look at several of these figures combined shows 38.5% of all operations in the CUD were carried out with sovereign bonds held in custody at the DCV. Monetary policy operations with remunerated deposits accounted for 29.5%, of which 27.4% pertained to remunerated deposits constituted by the Ministry of Finance and Public Credit (MHCP) and 2.1%, by other types of entities.

As for direct transfers of funds in the CUD,⁹ which account for 31.4% of all operations, it is important to emphasize that 11% involve transfers (money uploads) from lending institutions to other institutions holding deposit accounts, giving

⁹ This information is generated based on discretionary use of the transaction codes each financial institution applies in the CUD system.

Table 2.3
Origin and Item of Operations for which Deposit Accounts in the CUD System Are Debited, Number and Value of Transactions (Daily Averages in Billions of Pesos)

Operations with Sovereign Debt at the DVC ^{a/}	Year 2019		Year 2020		Year 2019		Year 2020	
	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value
					(Percentage)			
Primary Market								
Placements	16	180.75	16	273.61	0.2	0.4	0.2	0.5
Payment of principal and yield	31	220.22	34	174.26	0.5	0.4	0.5	0.3
Secondary Market^{d/}								
Purchase/sales	1046	4,796.69	778	3,571.47	15.4	9.5	11.9	6.4
Money Market^{f/}								
Sell/buy-backs	309	5,167.68	337	6,400.84	4.6	10.2	5.2	11.5
Reverse sell/buy-backs	309	5,168.08	338	6,405.49	4.6	10.2	5.2	11.5
TTS	0	0.002	2	47.83	0.0	0.0	0.0	0.1
Reverse TTS	0	0.002	2	47.57	0.0	0.0	0.0	0.1
Repos between financial institutions	1	21.42	1	15.49	0.0	0.0	0.0	0.0
Reverse repos between financial institutions	1	21.41	1	15.58	0.0	0.0	0.0	0.0
Total operations with sovereign debt in the DCV	1,713	15,576	1,509	16,952	25.3	30.7	23.1	30.5
Others DCV ^{e/} (2)	24	230.95	25	132.67	0.4	0.5	0.4	0.2
Total (1) + (2)	1,737	15,807	1,534	17,085	25.6	31.1	23.5	30.8
Monetary Policy	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value
Repos to increase money supply ^{f/}	62	7,196.08	34	2,937.42	0.9	14.2	0.5	5.3
Reverse repos ^{g/}	0	0.00	0	0.00	0.0	0.0	0.0	0.0
Definitive TES purchases	6	34.89	3	19.90	0.1	0.1	0.1	0.0
Definitive private debt purchases	0	0.00	1	35.67	0.0	0.0	0.0	0.1
Repos with private debt securities	0	0.00	1	8.51	0.0	0.0	0.0	0.0
Repos with promissory notes	0	0.00	1	5.25	0.0	0.0	0.0	0.0
Non-derivable forwards	0	0.00	1	4.24	0.0	0.0	0.0	0.0
Remunerated Deposits ^{h/}	54	4,275.66	97	16,379.39	0.8	8.4	1.5	29.5
Total Monetary Policy Operations	121	11,507	138	19,390	1.8	22.7	2.1	34.9
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
Intraday repos ^{i/}	39	1,056.84	54	1,451.41	0.6	2.1	0.8	2.6
Total Operations to Provide Liquidity	39	1,056.84	54	1,451.41	0.6	2.1	0.8	2.6
Direct Funds Transfers in the CUD^{j/}	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value
Securities (Uploads and downloads of money) ^{k/}	675	5,584.62	654	6,107.23	10.0	11.0	10.0	11.0
Intraday interbank loans	24	265.93	20	247.41	0.4	0.5	0.3	0.4

Table 2.3 (Continued)
Origin and Item of Operations for which Deposit Accounts in the CUD System Are Debited, Number and Value of Transactions (Daily Averages in Billions of Pesos)

Direct Funds Transfers in the CUD ^{i/}	Number of Operations	Value	Number of Operations	Value	(percentage)			
					Number of Operations	Value	Number of Operations	Value
Reverse intraday interbank loans	15	147.24	12	148.37	0.2	0.3	0.2	0.3
Interbank loans to one or more days	16	338.57	15	400.11	0.2	0.7	0.2	0.7
Reverse interbank loans to one or more days	17	330.78	16	382.49	0.2	0.7	0.2	0.7
Interbank loans in the IBR	16	320.00	16	320.00	0.2	0.6	0.2	0.6
Reverse interbank loans in the IBR	16	321.37	16	320.04	0.2	0.6	0.2	0.6
Currencies settled outside the clearing house	50	246.90	38	220.93	0.7	0.5	0.6	0.4
Taxes	89	541.51	135	572.31	1.3	1.1	2.1	1.0
Transfers from administrators to custodians: CIF operations	250	3,921.55	124	2,318.06	3.7	7.7	1.9	4.2
Custodian transfers to administrators: CIF operations	339	2,309.35	155	1,350.03	5.0	4.6	2.4	2.4
Other transfers ^{l/}	1601	3,624.31	2,014	561.43	23.6	7.1	30.8	1.0
Deceval Placements^{m/}								
Payment of principal and yield	59	230.39	45	213.89	0.9	0.5	0.7	0.4
Purchase/sales	216	245.47	211	289.12	3.2	0.5	3.2	0.5
Sell/buy-backs	143	431.36	124	399.56	2.1	0.8	1.9	0.7
Reverse sell/buy-backs	66	95.64	52	66.95	1.0	0.2	0.8	0.1
Repos	66	96.21	53	67.22	1.0	0.2	0.8	0.1
Reverse repos	10	9.27	7	5.74	0.2	0.0	0.1	0.0
Temporary transfers of securities	11	9.32	7	5.88	0.2	0.0	0.1	0.0
Change of depositor	10	0.006	4	0.005	0.1	0.0	0.1	0.0
Term transactions	276	231.80	227	177.25	4.1	0.5	3.5	0.3
CRCC cash operations – Deceval	5	0.35	5	0.52	0.1	0.0	0.1	0.0
Total Deceval operations	0	0.00	5	11.25	0.0	0.0	0.1	0.0
Colombian Stock Exchange (BVC)^{n/}								
Central Counterparty Risk Clearing House (CRCC) ^{o/}	46	60.47	30	29.41	0.7	0.1	0.5	0.1
Foreign Exchange Clearing House of Colombia (CCDC) ^{p/}	20	22.13	19	45.16	0.3	0.0	0.3	0.1
Retail-value payment systems ^{q/}	17	787.44	17	900.47	0.3	1.6	0.3	1.6

Table 2.3 (Continued)

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

Direct Funds Transfers in the CUD ^{i/}	Number of Operations	Value	Number of Operations	Value	(percentage)			
					Number of Operations	Value	Number of Operations	Value
Automated clearing houses (ACHs)	144	1,803.13	147	1,989.81	2.1	3.6	2.2	3.6
Card and ATM networks	49	190.45	49	186.11	0.7	0.4	0.8	0.3
Checks (CEDEC and delegated clearing houses)	35	125.98	28	100.87	0.5	0.2	0.4	0.2
Total Retail-value Payment Systems	229	2,119.56	224	2,276.79	3.4	4.2	3.4	4.1
Total Direct Funds Transfers in CUD	4,282	22,292	4,244	17,438	63.2	43.9	64.9	31.4
Other Transactions	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value	Number of Operations	Value
Total Other Transactions ^{f/}	595	89.64	566	163.09	8.8	0.18	8.7	0.3
Total Debit Operations in CUD	6,774	50,752	6,537	55,527	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 and 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 a 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/ Reverse repos.

h/ Remunerated deposits. This includes the DGCPNT.

i/ Pertains to reverse intraday repo. 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 in their CUD stations.

k/ Transfer of funds (money uploads) from the 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 creditor in securities transactions (through delivery-versus-payment), with the initial transfer from the debtor 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 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 Risk Clearing House to institutions with a multilateral creditor position in pesos; initial transfers from institutions in 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 Central Counterparty Risk Clearing House, so it can guarantee the settlement of derivatives clearing (daily settlement and at contract maturity).

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).

the latter the liquidity necessary to meet the cash leg of their operations with securities. On the other hand, 4.2% are 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 operations with securities from the DCV; 2.4% are transfers of funds from the custodians to the CIF managers for sale and/or sell/buy-back operations with securities settled through the DCV; 4.1% represent multilateral netting in the retail-value payment systems

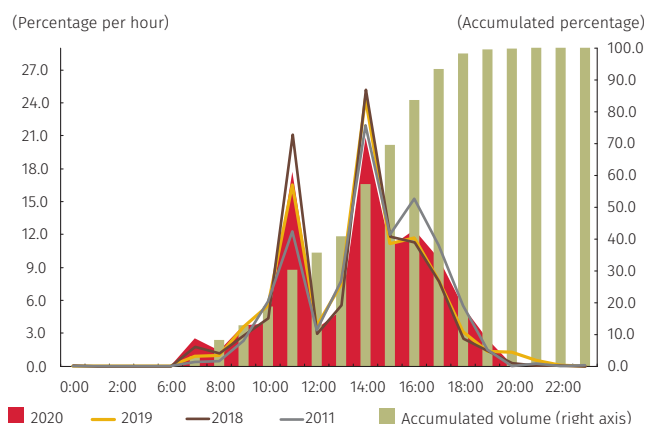
(3.58% ACH; 0.34% card and ATM networks, and 0.18% checks); 3.3% pertain to constitution and retrocession of inter-bank loans; 2.23% to settlement of the cash leg of investments, purchase/sales and money market operations backed by corporate bonds (fixed income) and equities (variable income up to August 2020) settled through Deceval; and 1.6% to multilateral netting through the CCDC.

Other direct transfers of funds account for 1.0% of the total value channeled through the CUD. The remaining percentage (1.57%) pertain essentially to the sum of operations involving transfer to the government of taxes collected by commercial banks, the settlement of forex purchases and sales outside the CCDC, cash provisions made through *Banco de la República's* treasury, settlement for the purchase/sale of equities in the BVC (up to August 2020), and the settlement of derivative contracts in the CRCC, both daily and at maturity.

A comparison of the total average daily values settled through the CUD in 2019 and 2020 (see Table 2.3) shows that the principal items with most variation include, in order of importance, the decline in direct transfers of funds in the CUD (COP 4.85 t); repos (COP 4.25 t) and purchase/sales of government securities (COP 1.22 t), offset by an increase of COP 12.10 t in remunerated deposits; COP 2.47 t in sell/buy-backs and reverse sell/buy-backs with government securities and COP 0.5 t in money uploads. The variation in these items is explained, for the most part, by a net increase of COP 4.77 t in the value of operations in the CUD between 2019 and 2020.

When breaking down the COP 12.10 t in remunerated deposits, one sees 92.8% were constituted by the MHCP (3.8 times more than the daily average in 2019) and 7.2% were constituted by other institutions participating in the CUD (6.2 times more than the daily average in 2019). As for the latter, banks accounted for 88%; special official institutions, 5.0%; finance companies, 4.0%; trust companies, 2.0%; and other types of institutions, 1.0%.

Graph 2.2
Distribution of Transactions in the CUD System, by Time Range in Value



Source: Banco de la República (CUD).

2.1.2 Indicators of Liquidity in the CUD

The payment systems have a liquidity indicator that is reflected in the concentration of payments occurring at given times during the day. In 2020 (Graph 2.2), 37.83% of the payments accumulated during the day were settled between 7:00 and 13:59 hours. A high concentration of payment settlements is observed in the four hours thereafter (between 14:00 and 17:59 hours) (54.02% of the daily total), for a total of 91.85% before 18:00 hours, which is 1.86% less timely than in 2019.

The steep peaks denoting 25%, 24% and 21% settled by 14:00 hours in 2018, 2019 and 2020, respectively, were due to the liquidity-saving mechanisms the DCV offers for settling security and cash legs and to retrocession

for operations to increase the supply of money through repos.¹⁰ The 3.0% decline in settlement by this time, between 2019 and 2020, is attributed to the aforementioned drop in purchases and sales of government securities, which leads to less efficiency in liquidity saving mechanisms, and also to a lower amount of repos, since they generate fewer chains of collateral reuse.

Table 2.4
Number and Percentage of CUD Participants that account for 70% of the Value of Payments

Year	Number of Participants	Percentage of Participants
2011	16	10.2
2012	16	10.0
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

Source: Banco de la República (DSIF).

2.1.3 Concentration, Operating Efficiency and Other Indicators

Table 2.4 contains estimates on the extent of concentration in payments made among direct participants in the large-value payment system (excluding some payments).¹¹ Using 70% of total payments as a reference, it is possible to determine how many institutions and what percentage of the total number of participants that reference covers. The result shows the concentration remained stable at 15 institutions between 2019 and 2020, but the total percentage of participants responsible for this concentration declined slightly from 10.7% in 2019 to 11.5% in 2020.¹² Specifically, while 11.5% of the most active participants (15 institutions) originated 71.86% of the payments made through the CUD in 2020 (eleven banks: 56.87%; two finance corporations: 5.49%; one trust company: 5.24%, and one brokerage firm: 4.26%), the remaining 88.5% sent barely 28.14% of the total number of payments.

As for operating efficiency in 2020, the CUD provided continuous service during 99.87% of its normal business hours. In other words, there were occasional interruptions in the provision of service for a period of time equivalent to 0.13%.

The timeline of the CUD system is depicted in Table 2.5. It shows the cumulative settlement percentages for transactions involving the more relevant items that affect deposit-account balances, according to one-hour time slots from the time the transfer service opens until it closes.¹³

¹⁰ In this time range, the retrocession process for previously granted repos ($t-n$), linked to their newly constituted ones ($t+0$), takes place in the DCV, causing an important movement in liquidity in the CUD. This movement, in addition to the liquidity of the savings cycle, generates the peaks observed in the graph. It is worth noting that repos are not included in the DCV savings cycles.

¹¹ The payments excluded are those from the General Directorate of Public Credit and the National Treasury (DGCPTN) and Banco de la República.

¹² The number of participants changed from 138 in 2019 to 131 in 2020.

¹³ Earlier editions of this report contain examples for interpreting the timeline accurately. Refer to <http://www.banrep.gov.co/es/reporte-sistemas-pago>

Table 2.5
Timeline for Settlement of Transactions at CUD (Daily Averages for 2020)

	0:00	7:00	8:00	9:00	10:00	11:00		
Operations: Origin and Concept								
Operations with Sovereign Debt at the DCV								
Primary Market	Percentage of Accumulated Settlements per Time Periods							
Placements	0.00	0.00	0.02	8.89	13.03	19.30		
Payment of principal and yield	14.38	14.38	26.71	40.73	45.19	47.10		
Secondary Market								
Purchase/sales	0.00	0.00	0.00	0.26	0.79	16.47		
Money Market								
Sell/buy-backs and repos between financial institutions	0.00	0.00	0.00	0.29	1.18	37.96		
Reverse sell/buy-backs and repos between financial institutions	0.00	0.92	3.18	6.48	8.59	65.07		
Monetary Policy								
Repos to increase money supply	0.40	0.40	0.40	0.40	0.51	0.68		
Reverse repos to increase money supply	0.02	0.09	0.89	2.91	5.61	10.56		
Provision of liquidity in the payment system (<i>Banco de la República</i>)								
Intraday repos	0.02	1.22	4.73	13.33	28.14	38.46		
Reverse intraday repos	0.05	0.05	0.07	0.47	2.86	4.95		
Direct Funds Transfers in the CUD								
Securities (money uploads/downloads)	0.35	5.83	8.93	13.44	17.18	20.19		
Intraday interbank loans	5.73	5.73	10.24	47.63	55.19	56.51		
Reverse intraday interbank loans	0.00	0.25	0.25	0.37	0.46	1.76		
Interbank Loans to one or more days	0.00	0.00	0.00	0.00	0.00	0.08		
Retrocession of Interbank Loans to one or more days	0.00	0.00	0.00	0.29	0.99	3.07		
Interbank loans: IBR	0.00	0.00	0.00	0.00	0.00	97.33		
Reverse interbank loans: IBR	0.00	0.00	0.10	1.36	2.91	5.45		
Taxes	0.01	0.05	15.08	62.44	96.32	99.77		
Custodians	1.34	1.44	2.39	7.47	17.26	23.59		
Currencies settled outside the clearing house	0.00	0.01	1.78	3.83	6.96	13.41		
Deceval								
Primary Market								
Placements	0.04	0.04	0.04	0.70	3.73	10.27		
Payment of principal and yield	0.13	0.13	0.13	0.41	1.22	1.53		
Secondary Market								
Purchase/sales	0.00	0.00	0.01	0.17	0.76	2.31		
Money Market								
Sell/buy-backs	0.00	0.00	0.00	0.01	0.19	1.98		
Reverse sell/buy-backs	0.00	0.00	8.02	22.36	38.56	51.83		
Repos	0.00	0.00	0.10	0.44	5.80	20.47		
Reverse repos	0.00	0.00	0.00	0.00	69.50	85.73		
Temporary transfer of securities	0.00	0.00	0.00	0.43	1.16	1.76		
Others								
Change of depositor	0.09	0.09	1.44	4.67	10.90	18.70		
	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 Settled Value, Daily Average (COP Billions)
Percentage of Accumulated Settlements per Time Periods											
	32.85	45.17	66.25	82.54	94.20	99.36	99.91	100.00			COP 273.61
	49.30	50.00	50.00	50.10	50.10	50.10	50.10	50.10	59.63	100.00	COP 174.26
	18.36	20.91	60.97	73.86	89.85	97.14	99.43	99.87	99.98	100.00	COP 3,571.47
	39.90	42.12	82.09	89.53	96.85	99.33	99.94	99.99	100.00		COP 6,416.32
	65.91	66.34	86.88	92.93	98.29	99.66	99.97	100.00			COP 6,421.07
	1.35	17.51	46.26	73.97	88.31	97.15	99.47	99.76	99.95	100.00	COP 2,928.87
	15.48	30.02	81.13	91.63	96.87	99.40	99.95	99.98	99.99	100.00	COP 2,937.42
	47.81	58.73	68.81	80.28	89.84	95.35	98.03	99.82	99.96	100.00	COP 1,449.00
	6.06	7.60	11.13	21.72	42.62	72.58	92.47	99.43	99.89	100.00	COP 1,451.41
	22.95	26.54	32.99	47.29	62.64	77.12	88.87	98.47	99.58	100.00	COP 6,107.23
	60.47	64.49	70.20	72.60	73.67	73.96	74.04	74.07	94.32	100.00	COP 247.41
	6.57	12.84	14.91	16.91	24.49	39.51	82.26	97.61	99.74	100.00	COP 148.37
	0.48	1.19	3.65	21.45	59.21	89.36	98.83	100.00			COP 400.11
	4.36	7.90	20.62	44.17	70.22	95.96	99.86	100.00			COP 382.49
	97.33	97.74	99.97	99.97	100.00						COP 320.00
	9.13	11.09	95.52	97.38	99.07	99.49	100.00				COP 320.04
	99.93	99.94	99.98	99.99	100.00						COP 572.31
	28.29	33.37	40.81	51.67	67.70	83.39	95.21	98.93	99.56	100.00	COP 2,318.06
	21.04	29.80	46.96	66.49	83.92	96.66	99.48	99.97	100.00		COP 220.93
	13.00	16.22	21.60	35.40	57.29	84.71	97.85	99.65	99.99	100.00	COP 213.89
	3.93	5.96	6.77	19.73	82.55	96.87	99.20	99.38	100.00		COP 289.12
	5.26	10.72	23.27	46.79	74.67	93.46	98.92	99.60	99.95	100.00	COP 399.56
	8.09	17.43	42.45	70.03	87.88	96.62	98.25	98.64	100.00		COP 66.95
	62.17	71.28	85.51	95.46	98.32	99.33	99.98	100.00			COP 67.22
	44.93	65.22	77.81	90.36	97.79	99.29	99.57	99.66	100.00		COP 5.74
	94.15	96.12	99.27	99.76	99.77	99.96	99.97	100.00	100.00		COP 5.88
	2.74	5.85	17.22	33.59	73.72	96.64	98.89	99.99	100.00		COP 0.005
	23.63	26.91	31.09	40.44	62.91	86.95	97.85	98.99	99.77	100.00	COP 177.25

Table 2.5 (Continued)
Timeline for Settlement of Transactions at CUD (Daily Averages for 2020)

	0:00	7:00	8:00	9:00	10:00	11:00
Central Counterparty Risk Clearing House (CRCC)						
Institutions pay debit positions to the CRCC	0.00	86.76	87.21	87.23	87.23	87.30
CRCC pays credit positions to institutions	0.00	80.50	92.15	92.30	92.43	93.36
Foreign Exchange Clearing House of Colombia (CCDC)						
Institutions pay debit positions to the CCDC	2.83	4.01	9.88	15.71	21.76	27.89
CCDC pays credit positions to institutions	0.00	0.00	0.01	0.01	0.01	0.01
Retail-value payment systems						
ACH	0.42	1.50	2.95	6.55	11.98	28.94
Card and ATM networks	0.99	2.07	4.89	4.09	5.39	12.12
Checks (Cedec and delegated clearing houses)	0.00	0.00	0.00	0.00	0.00	98.00
Aggregated timeline for the entire CUD system	4.88	5.39	6.13	7.98	11.19	18.71
Percentage of the number of operations processed per hour (not cumulative)	0.09	1.68	4.43	4.70	6.52	10.96

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

Source: Banco de la República (DSIF).

The transactions that were settled with the benefit of the DCV's liquidity-saving and transaction optimization facilities are highlighted in the *In Focus* segments.

2.2 Clearing and Settlement of Securities and Financial Derivatives

In this and the following subsection, reference is made to other components of the financial infrastructure for clearing and settling transactions with financial assets such as securities, financial derivatives and foreign currencies, which must interact, in turn, with the large-value payment system to settle the cash leg of the respective transaction. These systems include the central securities depositories (DCV and Deceval), the BVC, the CRCC and the CCDC. Since these infrastructures are responsible for clearing, settling or recording transactions in the fixed income, equity, derivatives, and foreign exchange markets, this edition of the *Payment Systems Report* includes a brief description of the economic variables that influenced how international and local financial markets performed during 2020, so as to put into context the clearing and settlement activity recorded by those systems.

2.2.1 The Macroeconomic Context

The way international markets performed in 2020 was determined largely by the uncertainty associated with the Covid-19 pandemic. With governments forced to adopt lockdown measures as of the end of the first quarter of the year, the global economy deteriorated quickly, as did the world's financial

	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	Total liquidated value, daily average (b)
	87.37	87.51	87.90	89.98	94.73	98.31	99.65	99.98	100.00		COP 45.16
	94.69	95.89	96.96	97.55	99.22	99.92	100.00				COP 45.16
	34.23	84.62	87.54	87.61	87.61	87.61	87.66	87.66	97.48	100.00	COP 900.47
	0.01	0.01	98.52	99.72	100.00						COP 900.47
	32.32	38.28	60.33	71.66	83.22	91.76	96.51	98.87	99.60	100.00	COP 1,501.01
	5.39	4.90	17.55	12.45	14.03	9.37	4.67	1.50	0.43	0.16	COP 186.11
	100.00										COP 100.87
	20.27	22.97	32.75	38.17	43.89	48.08	50.30	77.52	88.82	100.00	COP 55,527
	5.18	5.19	15.13	11.66	12.69	8.86	4.17	3.59	2.09	1.58	6,537

markets. A gradual process of recovery began in the second half of the year, propelled by unprecedented monetary and fiscal stimulus, progress in the development of vaccines against the virus and the partial reopening of most economies.

With differences by country in terms of efforts to control the pandemic, the decline in output in the developed economies was greater in Europe and the United Kingdom than in the United States and Japan, where the lockdown measures were less rigorous. In China, the year ended with positive figures, although there was a contraction in the first quarter. In Latin America, which is one of the regions most affected by the pandemic, the downturn in economic activity was significant, but with differences among countries.

Against this backdrop, central banks around the world reacted quickly with significant interest rate cuts and large injections of liquidity. Similarly, fiscal policy focused on providing tax support and mitigating job destruction. In developed countries, fiscal stimulus packages equal to more than 10% of GDP were announced.

Accordingly, in the United States, the policy interest rate was cut twice, accumulating 150 basis points (bp) in reductions and ending the year in a range of 0% to 0.25%. Interest rates in Europe and Japan remained unchanged at around 0%, and these countries continued to implement unconventional monetary stimulus programs. In Latin America, the central banks of Mexico and Brazil were the ones that cut their interest rates the most (300 bps), while those of Peru and Chile reduced their intervention rates by 200 bps and 125 bps, respectively.

In addition to the global pandemic, there was the uncertainty surrounding the presidential elections in the United States, the Brexit negotiations and the continuation of tensions between the United States and China. In this environment, financial assets were highly volatile.

During the year, the world's leading stock market indices showed mixed performance characterized by steep drops during the first quarter in response to the onset of the pandemic, and by valorizations during the rest of the year. The United States and Asian markets performed the best, rising by 22.4% and 12.8%, respectively, mainly due to positive performance in the technology sector, which benefited from the economic situation. In Latin America and Europe, equities fell by 0.3% and 4.0%, respectively, during the year.¹⁴

As for fixed income markets, the monetary stimulus measures in developed economies during the first quarter led to a drop in the rates on sovereign debt. However, they were up by the end of the year, given less uncertainty (announcement of vaccines and Biden as the winner of the US presidential election). In emerging market economies, sovereign bond rates decline from the start of the pandemic and remained low for the rest of the year. The measures adopted by central banks, which involved reducing intervention rates and implementing non-conventional measures, were mainly what drove this performance.

In Colombia, the pandemic caused a significant setback in economic activity due to lockdowns, quarantines, and other restrictions on mobility, which were essential to contain the spread of the virus. The year saw record low levels of business and consumer confidence, and a sharp contraction in retail sales, industrial production and overall GDP, which fell by 6.8%. In fact, the cutbacks in output during the second and third quarters of the year (15.8% and 8.1%, respectively) were the worst quarterly figures on record.

In this context, the Board of Directors of *Banco de la República* (BDBR) began a progressive cut in the policy rate, starting with 50 bps at each of the March, April and May meetings, and continuing with 25 bps at the June, July, August and September meetings. In all, the 250 bp cut during the year reduced the rate from 4.25% to 1.75%, its lowest historical level in nominal terms. In addition, the BDBR adopted a set of measures to grant liquidity to the market and provide financial intermediaries with enough funding to maintain an adequate supply of credit for households and companies. This also was done to stabilize the markets for public and private debt, and to ensure the smooth functioning of the payment systems. These measures included an increase in amounts, counterparties, terms, and eligible securities in Central Bank's temporary expansion operations (repos), an injection of permanent liquidity into the economy through definitive purchases of government bonds and securities issued by credit institutions, a reduction in the average reserve requirement from 7.0% to 5.0%, facilitation of hedging, and an increase in liquidity in dollars.

¹⁴ Banco de la República (2021). *Reporte de Mercados Financieros*, IV Quarter, 2020.

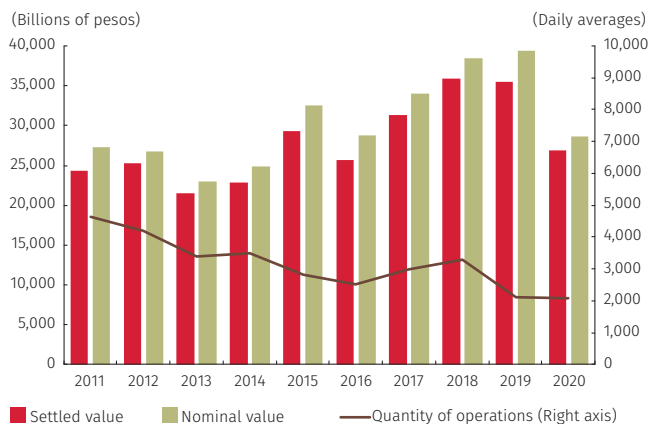
2.2.2 The Central Securities Depository (DCV)

The domestic market for official sovereign debt appreciated during the year, mostly from the second quarter onwards, in a context of expansive policies on the part of central banks, a greater appetite for risk, less and less decline in economic activity (after the 15.8% drop in the second quarter of the year) and positive expectations with regard to vaccines.

As mentioned in the macroeconomic summary, *Banco de la República's* monetary policy response during the year was instrumental in reducing the cost of public financing and ensuring the financial markets operate normally.

In this environment, the value of transactions settled through the DCV declined, largely because of less momentum in monetary operations and sales and purchases, despite more value in repos and sell/buy-backs. However, the balance in custody increased.

Graph 2.3
Central Securities Depository (DCV), Operations Conducted
(Daily averages)^{a/}



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

Graph 2.3 shows the evolution in transactions settled by the DCV in terms of nominal value (indicative), settled value (market value)¹⁵ and the number of operations. One of the aspects that stands out is the lower settled value in 2020 (COP 26.9 t), which represents a drop of 24.3% compared to the previous year. There is also a negative variation in the number of operations (1.5%), which went from 2,122 in 2019 to 2,090 in 2020.

Table 2.6 offers a breakdown of the transactions handled through the DCV, according to their origin. As for the primary market, which includes the sale of securities in different categories (mandatory, agreed and auctioned), as well as payment by the national government for yield and amortization towards the principal, the daily average number of operations in 2020 (143) saw a positive variation of 89.1% compared to the previous year,¹⁶ while the settled value (COP 510.5 b) decreased by 0.6%.

In terms of the secondary market, a breakdown by type of operation shows the settled value of purchase/sale transactions with delivery versus payment declined compared to the previous year. Specifically, the settled-value in delivery-versus-payment purchases and sales during 2020 (COP 3.7 t) compared to 2019 represents a drop of 23.5%. However, the settled value in repos and sell/buy-backs at COP 12.9 t was up 24.2. As for the number of transactions, there was a 16.7% decline in delivery-versus-payment purchases and sales, and a 9.9% increase in repos and sell/buy-backs.

¹⁵ The amount that is actually paid in trading. It represents what will, in fact, be moved out of the deposit account. It takes into account market prices and is not the nominal value.

¹⁶ Mainly through the issue of TIDIS and TDS ("Solidarity Bonds"). Corresponding to many low-cost securities.

Table 2.6
Daily Average for Operations Conducted in the DCV, by Type of Service
(Amounts in billions of pesos)

Year	Primary Market			
	Quantity	Nominal Value	Settled Value	
			Current	Constant
2011	172	343	367	508
2012	143	249	286	386
2013	128	346	371	491
2014	113	440	412	527
2015	99	338	363	435
2016	82	399	407	461
2017	76	396	422	460
2018	77	445.9	453.0	478
2019	76	565.1	513.5	522
2020	143	733.4	510.5	511

Year	Secondary Market											
	Delivery vs. Payment Purchase/Sales				Monetary Policy Purchase/Sales				Free of Payment Transfers			
	Quantity	Nominal Value	Settled Value		Quantity	Nominal Value	Settled Value		Quantity	Nominal Value	Settled Value	
		Current	Constant			Current	Constant			Current	Constant	
2011	1,609	4,602	5,197	7,194	1	21	2	3	1,040	4,057	0	0
2012	2,029	6,786	7,864	10,628	0	34	1	1	933	4,123	0	0
2013	1,667	4,890	5,700	7,557	2	15	11	15	690	3,630	0	0
2014	2,006	5,936	6,575	8,409	2	7	7	9	439	3,603	0	0
2015	1,557	4,516	4,997	5,986	1	8	8	10	170	5,134	0	0
2016	1,451	3,873	4,141	4,691	9	61	63	71	136	4,388	0	0
2017	1,825	5,657	6,294	6,850	4	26	17	18	146	4,761	0	0
2018	2,107	8,424	9,220	9,725	1	26	27	28	147	4,705	0	0
2019	1,051	4,370	4,807	4,885	7	34	35	35	145	5,518	0	0
2020	875	3,308	3,675	3,675	4	19	20	20	200	3,258	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	
2011	6	26	0	0	1,123	4,103	4,556	6,307
2012	3	11	0	0	838	4,352	5,062	6,842
2013	3	11	0	0	686	5,607	6,409	8,498
2014	1	5	0	0	722	7,026	7,703	9,852
2015	1	2	0	0	787	9,242	10,008	11,989
2016	0	1	0	0	656	9,363	10,035	11,368
2017	0	1	0	0	763	10,537	11,643	12,671
2018	0	2	0	0	787	12,405	13,600	14,345
2019	1	2	0	0	622	9,428	10,363	10,530
2020	0	1	0	0	684	11,702	12,874	12,874

Table 2.6 (Continued)
Daily Average for Operations Conducted in the DCV, by Type of Service
(Amounts in billions of pesos)

Year	Quantity	Monetary Operations		
		Nominal Value	Settled Value	
			Current	Constant
2011	263	12,702	12,980	17,969
2012	262	11,189	11,999	16,217
2013	229	8,549	8,963	11,883
2014	210	7,884	8,213	10,504
2015	207	13,292	13,943	16,702
2016	180	10,748	10,971	12,428
2017	175	12,632	12,931	14,073
2018	171	12,388	12,564	13,252
2019	220	19,526	19,807	20,127
2020	184	9,604	9,823	9,823

Source: Banco de la República (DCV).

As for other operations on the secondary market, the settled value of monetary policy purchases and sales (COP 0.020 t) fell by nearly 44% compared to the previous year.

The services provided by the DCV to *Banco de la República*, which involve open market operations (OMO) and the provision of liquidity to the large-value payment system, showed negative variations by the end of 2020. With respect to the previous year, the settled value (COP 9.8 t) amounts to 50.4% less. The number of transactions also declined, in this case from a daily average of 220 to 184, which implies a drop of 16.5%.

Table 2.7
Total Value Held in the DCV by Year-end
(In billions of pesos)

Year	Current	Constant
2011	155,818	215,714
2012	160,443	216,837
2013	183,580	243,390
2014	202,604	259,134
2015	207,943	249,101
2016	239,717	271,556
2017	265,680	289,145
2018	304,235	320,907
2019	323,440	328,675
2020	372,275	372,275

Source: Banco de la República (DCV).

With regard to the DCV's function as a depository, Table 2.7 shows the total nominal values held in custody at the end of each year since 2011, at current and constant prices.

The balance in custody during 2020, in current pesos, grew by 15.1%. As a share of this balance, 96.9% were securities issued by the Colombian government; the rest (3.1%) were securities issued by the Agricultural Sector Financing Fund (Finagro).

Of all the current issues managed by the DCV, Class B TES remained highly relevant, accounting for 93.5% of the total balance and 96.4% with respect to domestic sovereign bonds issued by the Colombian government. TDS solidarity securities were the second most important item in terms of bonds issued by the national government, with close to COP 9.74 t (Table 2.8).

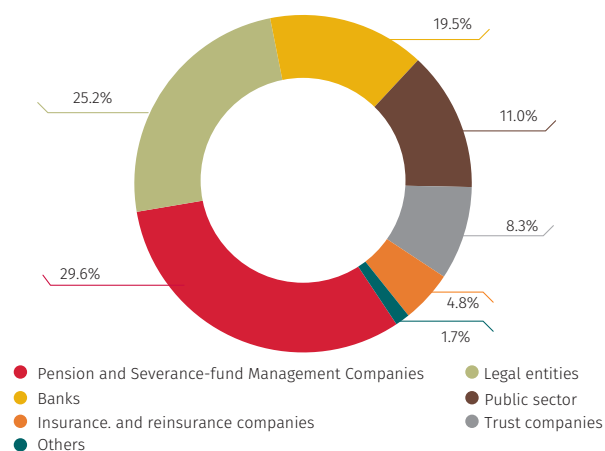
Table 2.8
Details on the Balance Held in the DCV at the End of 2019, by Issuer
 (In millions of pesos)

Issuer	Balance	Percentage
National Government		
Class B TES	348,001,513	93.5
Constant value bonds – Series A	61,587	0.02
Constant value bonds - Series B	1,154,467	0.31
Solidarity Bonds for Peace	918	0.00
Security Bonds	1	0.00
CERT	377,744	0.10
TIDIS	1,558,686	0.42
Solidarity securities (TDS)	9,741,703	2.62
National Government Total	360,896,617	96.9
Finagro		
Agricultural Development – Class A	7,928,690	2.13
Agricultural Development – Class B	3,450,091	0.93
Finagro Total	11,378,781	3.1
General Total	372,275,398	100

Source: Banco de la República (DCV).

A breakdown of the balance on deposit, by type of institution (Graph 2.4), shows companies that manage severance and pension funds (including pension liabilities), together with legal entities (including foreign companies, among others), account for the majority, with nearly 54.8% (COP 204 t). In third and fourth place are the banks, with 19.5% (COP 72.5 t), and the consolidated public sector, which includes the financial and non-financial sector and companies of a special type, with 11% (COP 40.8 t). Then come the trust companies (including trusts and collective investment funds), with 8.3% (COP 30.8 t). The remaining 6.5% is made up mostly of holdings that belong to insurance and reinsurance companies, and other financial institutions with 4.8% (COP 17.9 t).

Graph 2.4
Total Balance Held in the DCV, by Type of Institution
 (At December 2019)

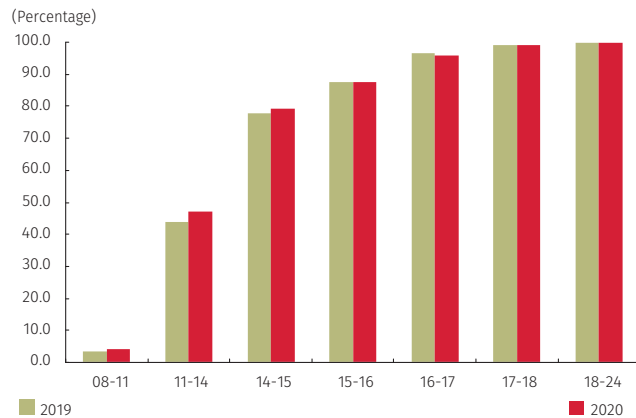


Source: Banco de la República (DCV).

The operational indicators for the DCV show the system was available to participants 100% of the time scheduled for its services in 2020. With respect to timeliness in settling transfer orders, Graph 2.5 shows that almost 95.9% of the operations were settled before 17:00 hours.

Graph 2.6 contains a breakdown of the activation mechanisms used to settle operations that were channeled through the DCV last year. For example, between 8:00 and 10:59 hours, all participants

Graph 2.5
Timeliness in Settling Transfer Orders Received in the DCV

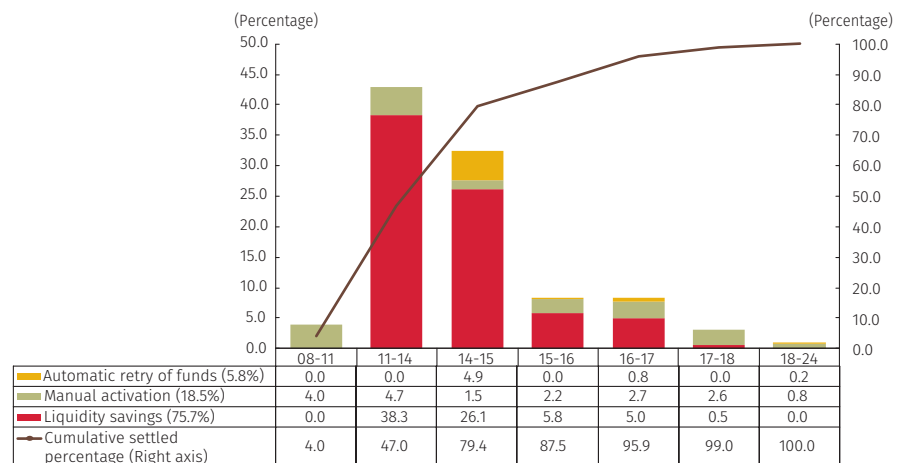


Source: Banco de la República (DCV).

activated their operations manually. Between 11:00 and 13:59 hours, the liquidity saving facility was used as well, and automatic retry of funds was added in the following time slots. The liquidity-saving facility, which is the mechanism that contributes most to settling operations, is used more during the 11:00-14:00 cycle. Accordingly, 81.5% of all transactions received by the DCV in 2020 were activated automatically (i.e., automatic retry of funds and the liquidity-saving facility), while 18.5% were activated through direct instructions from participants.

2.2.3 The Centralized Securities Depository of Colombia (Deceval)

Graph 2.6
Distribution of the Operation Activation Mechanism, by Type (2019)



Source: Banco de la República (DCV).

In an effort to guarantee market stability, protect the payment system and preserve the supply of credit, Banco de la República gave more institutions access to liquidity resources, expanded the set of securities eligible as collateral for repo operations (it received private debt securities and promissory notes, in addition to sovereign bonds), auctioned securities at terms of more than one day, and increased quotas above the estimated demand.

This expansion meant a significant increase in the supply of money. In March, when most of these operations took place, COP 14.7 t were injected into the economy (including overnight and term repos). This is equivalent to about 15.6% of the average monetary base in 2019.¹⁷

¹⁷ Banco de la República (2021). Informe de la Junta Directiva al Congreso de la República.

Moreover, in March, the BDBR authorized the definitive purchase of private debt instruments for the first time in its history. During March and April, the months in which these operations were concentrated, the Bank purchased COP 8.7 t in private securities, which accounted for 9.2% of the average monetary base in 2019. The last purchase in this program for private debt instruments was made on April 20.

These unconventional stimulus measures adopted by *Banco de la República* were fundamental to reducing the cost of private financing and to guaranteeing the operation of the Colombian market for private debt.

In this context, issues in the debt market performed extremely well. By the end of the year, COP 12.9 trillion had been issued, including 56.9% from the non-financial sector, 35.4% from the financial sector and 7.7% from the public sector. The total value of private debt instruments traded during that period (purchase/sales and sell/buy-backs) came to COP 157 t, which is 16% more than during the previous year (COP 135 t). This increase was due mainly to a rise in value with respect to purchases/sales of term deposit certificates and to bond trading, which responded to valuations, to the acceptance of private debt for repos, and to positive momentum in the primary market. However, sell/buy-backs of private debt declined by 20% compared to 2019, falling to COP 18 t.

Considering Deceval also settles equities (variable income), the developments in this market are outlined in the following section.

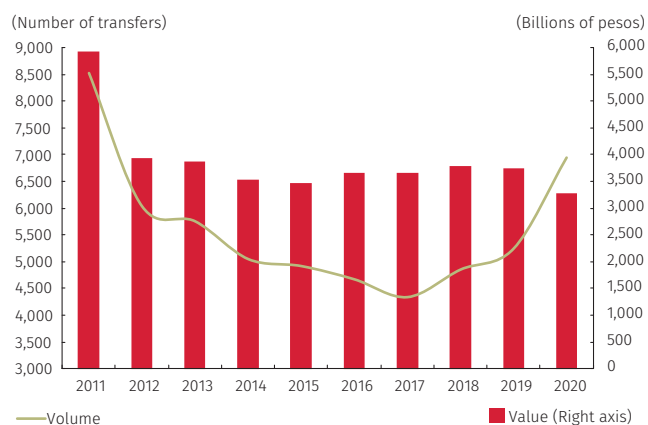
Graph 2.7 and Table 2.9 show the evolution in transactions conducted through Deceval, which include primary market operations (sale of fixed-income securities and equities); secondary market operations involving private fixed-income securities and equities (purchases and sales between depositors and free transfers of payment), and money market operations (repos, sell/buy-backs and temporary transfers of securities [TTS]) with their respective reverse transactions and cash collateral. As illustrated, the average daily volume of transactions increased from 5,239 in 2019 to 6,941 in 2020, showing

a positive variation of 32.5%. On the other hand, the average daily value of transactions was down by the end of the year, having gone from COP 3.75 t in 2019 to COP 3.29 t in 2020 (-12.6% equivalent percentage variation).

With regard to Deceval’s role as a depository, Table 2.10 shows the total amount held in custody at the close of each year since 2011, at current and constant prices. The balance in custody in current pesos fell by 2.7% in 2020.

As illustrated in Table 2.11, equities (common and preferred equities) account for the largest share of current issues managed by Deceval, with 56.9%, followed by term deposit certificates (CDTs), with 22.6%, and ordinary bonds with 10.6%. Other

Graph 2.7
Statistics on Deceval Value and Volume
 (Daily averages)



Source: Deceval.

Table 2.9
Deceval Statistics

Year	Transfers Processed								
	Volume (Number of transfers)	Daily Average			Average Value Transferred		Annual Value		
		(Billions of pesos)	(Billions of 2020 constant pesos)	(Millions of pesos)	(Millions of 2020 constant pesos)	(Number of transfers)	(Billions of pesos)	(Billions of 2020 constant pesos)	(Number of times GDP)
2011	8,520	5,932	8,212	696	964	2,095,997	1,459,175	2,020,086	2.36
2012	6,032	3,944	5,330	654	884	1,471,831	962,331	1,300,580	1.44
2013	5,752	3,867	5,127	672	891	1,403,374	943,534	1,250,936	1.32
2014	5,046	3,539	4,526	701	897	1,231,272	863,508	1,104,441	1.13
2015	4,915	3,478	4,167	708	848	1,199,378	848,744	1,016,733	1.05
2016	4,668	3,652	4,138	782	886	1,143,678	894,841	1,013,693	1.04
2017	4,335	3,662	3,985	845	919	1,049,081	886,131	964,395	0.96
2018	4,849	3,778	3,985	779	822	1,178,228	917,961	968,265	0.93
2019	5,239	3,752	3,812	716	728	1,283,659	919,146	934,022	0.87
2020	6,941	3,278	3,278	472	472	1,686,627	796,526	796,526	0.79

Source: Deceval.

Table 2.10
Total Amount Held in Deceval at Year-end^{a/}
(Billions of pesos)

Year	Current	Constant
2011	299,041	413,994
2012	362,513	489,933
2013	387,405	513,621
2014	421,697	539,357
2015	381,310	456,781
2016	440,282	498,760
2017	486,555	529,528
2018	470,519	496,303
2019	560,596	569,670
2020	545,372	545,372

a/ Balances valued on the last working day of each year. In the case of equities, the valuation price of each equity is used, multiplied by the number of equities in custody.
Source: Deceval.

instruments, such as commercial paper and acceptances, account for 9.8.

When grouping the balance in custody according to the type of security and the type of depositor, brokerage firms rank first in equities (COP 310.4 t), with 28.1% (COP 87.3 t), followed by legal entities, with 23.3% (COP 72.4 t), and banks, with 16.9% (COP 52.6 t). Companies that manage pension and severance funds accounted for 16.1% (COP 50 t), and trust companies, 11.6% (COP 35.9 t). The remaining 3.9% (COP 12.2 t) is represented by institutions such as finance corporations, insurance companies and government institutions, among others (Graph 2.8, Panel A). In all, 99.9% of the balances held in custody by brokerage firms are in a non-proprietary position, and only 0.1%, in a proprietary position. In addition, dematerialized issues accounted for 94.7% of all securities, while 5.2% were physical issues and 0.1% were foreign deposits.

As regards to fixed income securities (COP 235 t), which include CDTs (52.4%), bonds (24.7%) and others (22.9%), trust companies accounted for the largest share, with 46.1% (COP 108.4 t: 99.6% is in non-proprietary positions and 0.4% is in a proprietary position), followed by pension and severance fund

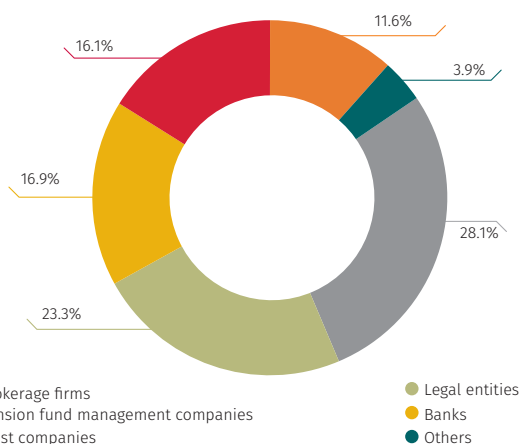
Table 2.11
Details on the Balance of Securities Held in Deceval at the end of 2019, by Type
(Millions of pesos)

Type	Balance	Percentage
Common equities	274,280,792	50.29
Term deposit certificates	123,234,890	22.60
Ordinary bonds	58,034,759	10.64
Preferred equities	36,128,455	6.62
Participation certificates securities	30,928,671	5.67
Sovereign bonds other than TES	12,707,232	2.33
Mortgage securities with credit content	3,401,601	0.62
Hybrid bonds	2,500,000	0.46
Pension bonds	1,333,338	0.24
Securities with credit content	792,285	0.15
Colombian foreign debt securities	565,385	0.10
Treasury bonds (TES)	412,925	0.08
Structured mortgage bonds	373,354	0.07
Non-mortgage securities with credit content	288,331	0.05
Real-estate investment securities	358,555	0.07
Commercial paper	19,112	0.00
Collaborative financing securities	7,530	0.00
Tax refund securities (TIDI)	4,473	0.00
Bank acceptances	30	0.00
General total	545,371,716	

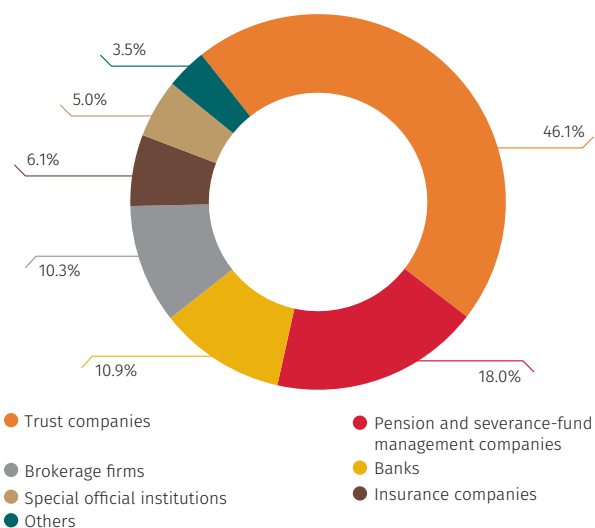
Source: Deceval.

Graph 2.8
Total Balance Held in Deceval, by Type of Entity
(December 2020)

A. Equity Income



B. Fixed Income



Source: Deceval.

managers, with 18% (COP 42.4 t), and banks, with 10.9% (COP 25.6 t). Brokerage firms account for 10.3% (COP 24.1 t) and insurance companies and special official institutions, 6.1% (COP 14.4 t) and 5.0% (COP 11.8 t), respectively. Other institutions account for 3.5% (COP 8.2 t), with legal entities, finance companies, financial corporations and other financial institutions being the most representative (Graph 2.8, Panel B). In this market, 99.3% pertain to dematerialized issues, 0.4% to foreign deposits and 0.3% to physical issues.

As for the time it takes to settle transfer orders in the large-value payment system, nearly 71.84% of all operations in 2020 were settled before 17:00 hours.

2.2.4 The Colombian Stock Exchange (BVC)

The domestic market for equities in 2020 was affected by uncertainty in the international environment, the economic repercussions of the pandemic and geopolitical tensions worldwide. In the local environment, less activity and the slowdown in domestic demand had a negative impact on the way the stock market performed.

In this context, the Colcap index dropped 13.5% during the year due to poor performance in the financial, energy and materials sectors, which account for more than 65% of the index. The equities with the worst performance were those of Ecopetrol (-32.3%), Grupo Sura (-25.5%) and PF-Grupo Sura (-24.9%).

Foreign investors were the biggest sellers during the year, posting COP 3.4 t in net sales. This is the largest annual outflow on record (since 2010). Yet, despite the negative annual figure, the months of November and December were positive, with net purchases amounting to COP 241 b.

With respect to the volume traded in the equity market, COP 34.8 t in equities were traded during 2020, including COP 30 t in spot operations, COP 3.8 t in repos and COP 1 t in TTS transactions. Compared to 2019, this volume implies a decline of 14.7% in the spot market, 59.3% in repos and 36.1% in TTS transactions. Market capitalization ended the year at COP 365 t, which is 16.3% less than in 2019.

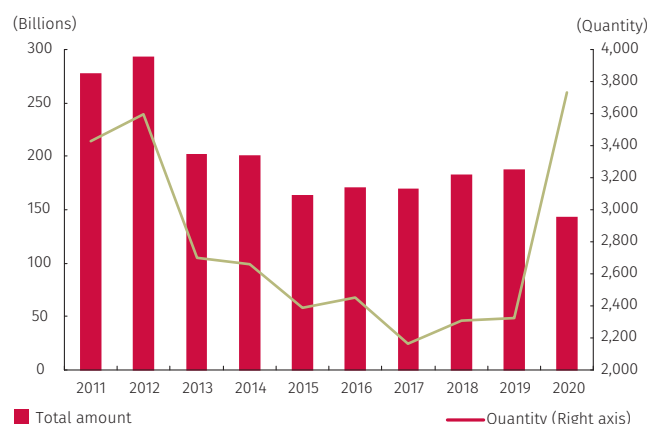
The Colombian Stock Exchange offers and manages electronic platforms that allow its participants (financial entities) to make trading offers in different markets. The one with the largest number of participants is the fixed-income market, with 106, followed by the standardized derivatives market, with 33, and the equity market, with 20. Although various types of institutions take part in the fixed-income and standardized derivatives markets (e.g., banks, trust companies, etc.), the equity market is comprised exclusively of brokerage firms.

In the equity market, the BVC managed clearing and settlement for spot market trading up until August 2020. It handed multilateral clearing using Deceval for the gross settlement of securities legs and *Banco de la República's* large-value payment system (CUD) for net multilateral cash leg settlements.

As of August 18, 2020, the BVC only negotiates and complements operations. Clearing and settlement are now done through the Colombian Central Counterparty (CRCC) and the settlement time for spot transactions was changed from $t + 3$ to $t + 2$.

This post-trade change in the spot stock market is in addition to the change in repo operations established in 2017. As a result, the BVC regulations indicate that spot, repo, sell/buy-back and TTS operations traded or registered in its system are to be cleared and settled through the Colombian Central Counterparty (CRCC).

Graph 2.9
Developments Operations on the Colombian Stock Exchange (BVC)
(Daily averages)



Source: Colombian Stock Exchange (BVC).

During 2020, transactions in the equity market (including spot, repo and TTS operations) declined compared to the year before. The daily average amount: that is, COP 143 billion (b) represents a negative variation of 23.8% with respect to 2019. On the other hand, the number of transactions, which averaged 3,732 daily, implies a positive variation of 60.5% compared to the year before (Graph 2.9). The greater participation of private citizens in the spot market, with numerous transactions for small amounts, explains most of this change.

Table 2.12 contains a breakdown of equity-market transactions conducted through the BVC, according to the type of operation. For the spot market (i.e., buying and selling), the average amount

traded daily in 2020 came to COP 123.3 b, which is 14% less than the year before, while the number of transactions was 3,696, which represents an increase of 63.1% compared to the previous year. The equity repo market posted negative performance, with a daily average of COP 15.5 b, having declined by 58.9%, with fewer daily operations (30, on average), which came to 37.9% less. Performance in the equities lending market (i.e., TTS) was negative as well, averaging 4.2 b daily in 2020. Compared to COP 6.6 b in 2019, this represents a decline of 35.6%.

Graph 2.10 shows the momentum in the receipt and delivery of money by the BVC to clear and settle spot transactions. For 2020, one sees this monetary exchange took place throughout the day, with the BVC delivering 43.3% before 12:00 p.m. and 98.2% between 12:00 and 5:00 p.m.

Compared to the amount traded in the spot market, the amounts required by the BVC as a result of the multilateral clearing process represent a savings of nearly 76.1% in terms of the liquidity needs of its participants.

As mentioned before, the BVC was in charge of clearing and settlement for the equity markets (repos and TTS) prior to 2017. Since then, this function has been performed by the CRCC. However, securities legs and cash legs are settled on a gross basis (transaction-by-transaction) in Deceval, which debits the money from the large-value payment system. Graph 2.11 shows how the

Table 2.12
Colombian Stock Exchange (BVC) Statistics

Year	Purchase/sale of equities					Equity Repos				
	Quantity	Daily Average		Annual Value		Quantity	Daily Average		Annual Value	
		Amount (Billions of pesos)		Amount (Billions of pesos)			Amount (Billions of pesos)		Amount (Billions of pesos)	
		Current	Constant	Current	Constant		Current	Constant	Current	Constant
2011	2,947	166.6	231	40,989	56,745	478	110.5	153	27,181	37,630
2012	3,199	188.2	254	45,924	62,066	396	104.3	141	25,440	34,382
2013	2,550	167.5	222	40,879	54,198	145	34.2	45	8,352	11,073
2014	2,536	165.4	212	40,353	51,612	121	33.6	43	8,193	10,479
2015	2,294	134.3	161	32,489	38,919	88	27.9	33	6,754	8,091
2016	2,380	144.4	164	35,370	40,068	59	22.3	25	5,462	6,187
2017	2,106	138.6	151	33,549	36,512	48	25.8	28	6,241	6,793
2018	2,251	147.6	156	35,876	37,841	49	29.7	31	7,228	7,624
2019	2,267	143.4	146	35,128	35,696	49	37.8	38	9,266	9,416
2020	3,696	123.3	123	29,951	29,951	30	15.5	16	3,775	3,775

Year	TTS Equities					Total				
	Quantity	Daily Average		Annual Value		Quantity	Daily Average		Annual Value	
		Amount (Billions of pesos)		Amount (Billions of pesos)			Amount (Billions of pesos)		Amount (Billions of pesos)	
		Current	Constant	Current	Constant		Current	Constant	Current	Constant
2011	1	0.2	0	44	60	3,426	277.3	384	68,214	94,436
2012	1	0.2	0	57	77	3,596	292.7	396	71,421	96,525
2013	2	0.3	0	84	112	2,697	202.1	268	49,316	65,383
2014	7	2.0	3	494	632	2,663	201.0	257	49,041	62,724
2015	7	2.0	2	475	569	2,389	164.1	197	39,719	47,580
2016	10	4.9	6	1,203	1,363	2,449	171.6	194	42,035	47,618
2017	12	5.9	6	1,431	1,558	2,166	170.3	185	41,222	44,862
2018	11	5.5	6	1,339	1,412	2,311	182.9	193	44,442	46,878
2019	10	6.6	7	1,613	1,639	2,326	187.8	191	46,007	46,751
2020	6	4.2	4	1,031	1,031	3,732	143.0	143	34,758	34,758

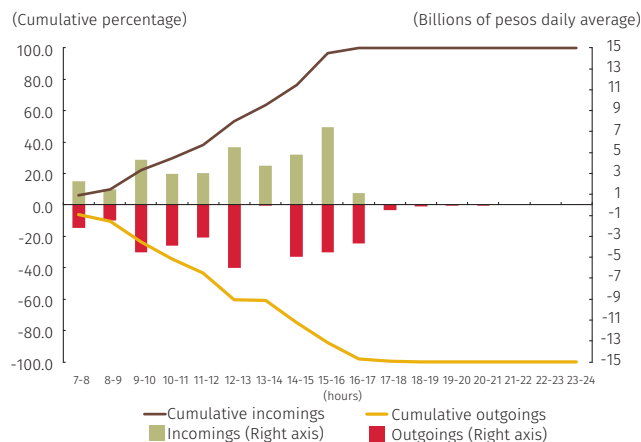
Source: Colombian Stock Exchange (BVC).

momentum in repo and TTS transactions processed in the large-value payment system evolved during 2020.

The average amount of stock repos managed by the BVC in 2020 was COP 275 b, which is 56.5% less compared to the year before when the value of these obligations was COP 633 b (Graph 2.12).

Graph 2.13 shows the average daily amount of outstanding repos, grouped according to maturity. Brokerage firms reduced the concentration of their funding at over sixty days from 39.7% in 2019 to 35.2% of all outstanding obligations in 2020. In contrast, their concentration

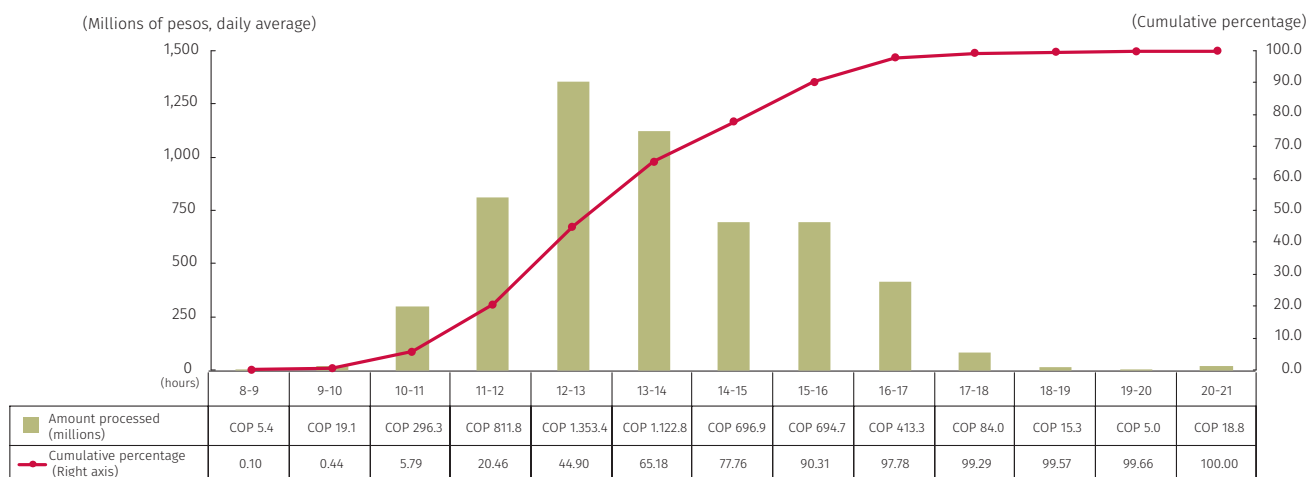
Graph 2.10
Dynamic of Payments on the Spot Market for Equities in the Large-value Payment System (Daily averages, 2020)



Source Banco de la República (CUD).

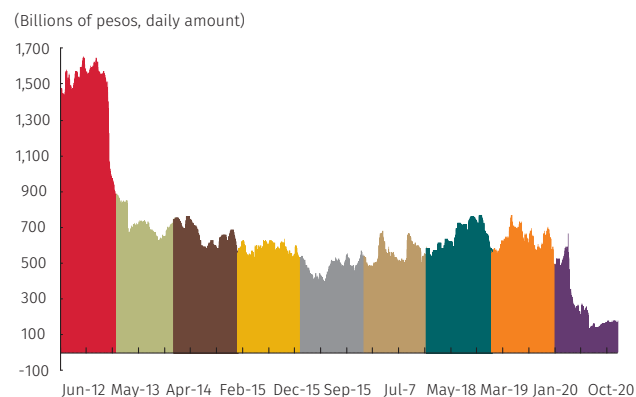
between sixteen and sixty days increased to 55% (versus 50.2% in 2019). And their concentration at a term of fifteen days or less declined slightly to 9.8%.

Graph 2.11
Developments in Transactions Settled Throughout the Day by Deceval in the BVC Market for Repos and TTS^{a/}



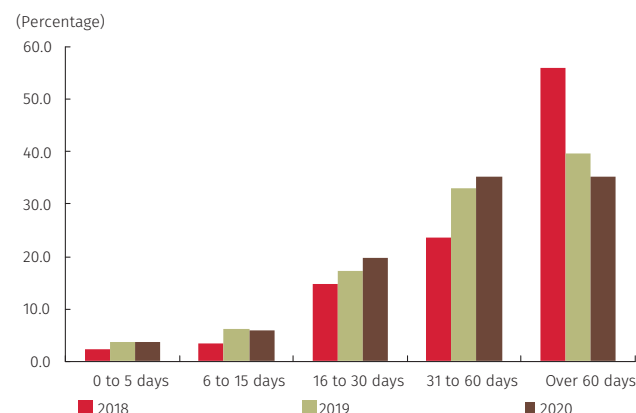
a/ Includes only the initial operation. Operations registered up to August 14, 2017; since then, equity repos have been cleared and settled through the CRCC.
Source: Banco de la República (CUD).

Graph 2.12
Developments in Repos with Equities



Source: Colombian Stock Exchange (BVC).

Graph 2.13
Developments in Repos with Equities, by Maturity: 2018-2020



Source: Colombian Stock Exchange (BVC).

2.2.5 The Colombian Central Counterparty (Cámara de Riesgo Central de Contraparte S.A. -CRCC-)

The local derivatives market was influenced during 2020 by increased volatility in international markets and by lower volumes in the spot markets.

Based on the type of underlying assets, derivative products based on TRM represented 61% of the total trading and were affected negatively by less demand for hedging products, due to the liquidity facilities in dollars (forward dollar sales with financial compliance and two-month dollar swaps) granted to brokers by *Banco de la República*. This drop, coupled with that of stock futures, led to a reduction by the end of the year compared to 2019.

TES futures were up mainly because of the increase in volatility levels on international markets and the reduction in *Banco de la República's* benchmark interest rate. Colcap futures performed positively during the year, largely due to expectations that the economy would recover in the second half of the year, which attracted investors to the market (an increase of 28% in volume with respect to the non-proprietary position).¹⁸

The value of transactions with financial derivatives cleared and settled by the CRCC during 2020¹⁹ amounted to COP 1,013.74 t, which represents an increase of 12.69% compared to the value of such transactions in 2019. The share of the sum of these operations, based on the type of product, was: 17.85% (COP 180.94 b) in the case of standardized financial derivatives and 82.15% (COP 832.8 b) for non-standardized derivatives. This means 19.34% less for standardized derivatives and an increase of 23.32% for non-standardized derivatives compared to the previous year.

Within the standardized derivatives segment, specific-reference TES futures were the product with the highest growth, having increased 2.25% from COP 71.73 t to COP 73.35 t, while TRM futures were the product that declined the most, having fallen 29.21% from COP 146.02 t to COP 103.58 t. Among the non-standardized products, NDF forwards in foreign currencies (pesos/dollars) showed the highest growth, with an increase of 26.07% from COP 603.74 t to COP 761.11 t.

The proportion of standardized futures came to 40.53% in the case of specific-reference TES futures (COP 73.35 t), 57.25% for TRM futures (COP 103.58 t), 1.2% for OIS futures (COP 2.16 t), and 1.03% (COP 1.85 t) for other products, which include futures on equities, indexes and electricity. On the other hand, the share of non-standardized products was 91.39% in foreign exchange NDF forwards (pesos/dollars) (COP 761.11 t), and 8.61% in OIS IBR and OIS IBR overnight forwards (COP 71.68 t).

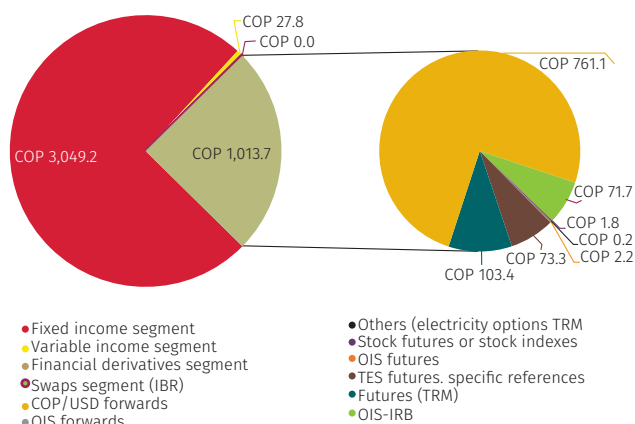
¹⁸ BVC (2020). *Informe de gestión* (Management Report).

¹⁹ Due to novation by the CRCC, a negotiated transaction is accounted for as two transactions cleared and settled in the CRCC, 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.

The total value of operations in the fixed income segment represented by government debt sell/buy-backs handled through the CRCC, for subsequent gross settlement in the DCV, rose 26.5% to COP 3,049.17 t.²⁰

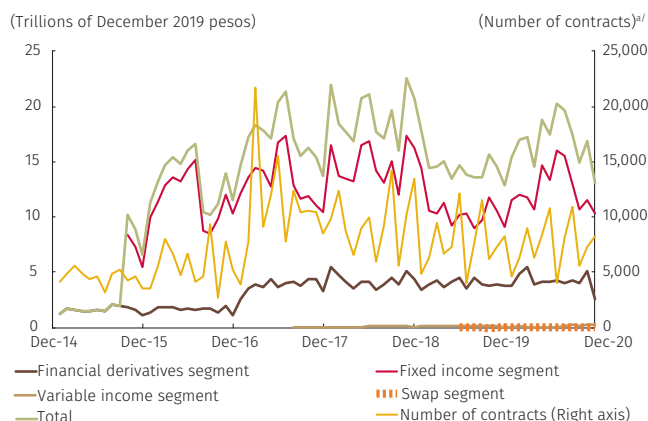
With respect to the variable-income segment, equity repo transactions declined by 59.27%, having gone from COP 18.61 t a COP 7.58 t. In August 2020, the CRCC began to clear and settle spot market and TTS operations in this segment, having accumulated COP 19.85 t and COP 0.32 t, respectively, by the end of the year (Graph 2.14).

Graph 2.14
The Central Counterparty Risk Clearing House of Colombia
Share in Trillions of Pesos, by Product
(Total value of operations in 2020)



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

Graph 2.15
Value and Number of Transaction Contracts Accepted by the CRCC
(Daily average)



a/ Financial derivatives segment. Does not include exchange rate or interest rate forwards.

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

The number of futures contracts²¹ cleared and settled through the CRCC declined from a daily average of 7,627 contracts in 2019 to 7,474 in 2020. The total value of transactions accepted for net clearing in the financial derivatives segment increased from a daily average of COP 3.77 t in 2019 to COP 4.15 t in 2020.

On the other hand, average daily gross clearing in the fixed-income segment (TES sell/buy-backs) went from COP 10.1 t in 2019 to COP 12.6 t in 2020. Average daily gross settlement in the variable-income segment (equity repos, spot, and TTS operations) increased from COP 81.5 b in 2019 to COP 114.5 b in 2020 (Graph 2.15).

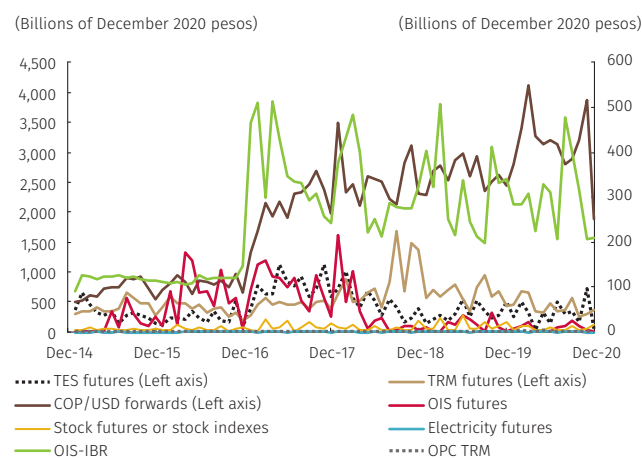
Unlike the evolution in trading figures for the BVC, which declined during 2020, incorporating spot and equity TTS operations into the variable-income segment led to an increase in securities cleared and settled through the CRCC as of August 2020, as indicated above.

A more detailed look at how the products in each segment evolved during 2020 shows the highest average daily amount accepted for TES sell/buy-backs was in July, with COP 15.99 t, and in December for equity repos, with COP 70.34 b. On the other hand, the largest average daily amounts in the financial derivatives segment were obtained in November for specific-reference TES futures, with COP 730.42 b; in February for TRM futures, with COP 23.47 b; in September for OIS futures, with COP 23.47 b; in December for stock futures, with COP 14.92 b; in March for NDF currency forwards (pesos/dollars), with COP 4.13 t; and in August for OIS-IRB, when they reached COP 478.20 b (Graphs 2.15 and 2.16).

20 This value takes into account the flows for sell/buy-backs and reverse sell/buy-backs.

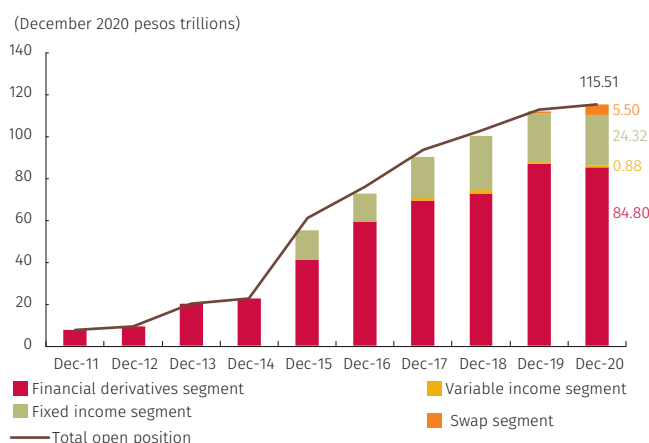
21 Only standardized products are included. Therefore, this figure does not take into account exchange rate forwards or operations in the equity and fixed-income segments.

Graph 2.16
Evolution in Operations with Products in the Financial Derivatives Segment
 (Daily average)



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

Graph 2.17
Evolution in the Open Position, by Segment at the Close of Each Year
 (Gross open position, both sides -long and short positions-)



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

The CRCC created a foreign exchange segment as of December 14, 2020 in which it began to clear and settle operations in the spot foreign exchange market with terms up to t + 3, doing so as a central counterparty without interposition. During the course of 2020, it cleared and settled 1,165 transactions daily, on average: USD 1,039.67 million gross and USD 200 million net. The liquidity savings obtained for the market through multilateral net clearing in this segment came to 84%.

The value of gross open market positions²² amounted to COP115.51 t at the close of 2020, which implies an increase of 4.32% with respect to the open position at the end of 2019. As for the share of the different segments and the amounts in the gross open position, the financial derivatives segment had an open position of COP 84.8 t (73.42%), as opposed to COP 24.32 t (21.06%) for the fixed-income segment, COP 0.88 t (0.76%) for variable income, and COP 5.50 t (4.76%) for interest-rate swaps (Graph 2.17).

With respect to 2019, Graph 2.18 shows the most representative products with declining open positions²³ were stock futures (-76.54%) and equity repos (-69.21%). On the other hand, the products with increased open positions were TRM futures (285.75%), swaps (IRS and OIS) (865.66%) and specific-reference TES futures (39.02%).

In 2020, all non-standardized operations were received from the recording systems and all standardized derivatives on equities and indexes were received from the electronic trading systems.

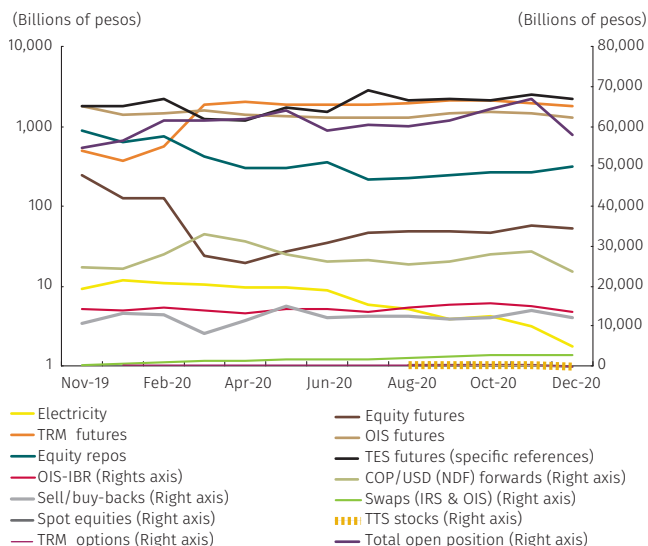
As for operations with other standardized derivatives, 5.0% were incorporated through the BVC²⁴ and Derivex trading systems, and 95% through their respective recording systems, continuing the trend witnessed in 2019 (Graph 2.19). As for TES sell/buy-backs, 23.5% came from the MEC system and 76.5%, from the SEN trading system.

22 Both the buy and sell position generated by the same transaction are taken into account. For example, when interposing in a transaction for the purchase of a TES forward contract, the open position for the CRCC will be two contracts, because one participant has a long open position, while the other has a short one.

23 The comparison takes into account the open position on the last day of November 2019 and the last day of November 2020. December is not considered, since it is a month characterized by seasonal performance.

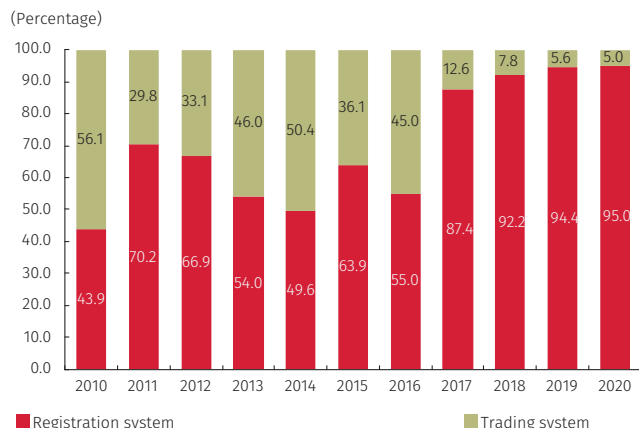
24 The regulations on the electronic trading and recording system managed by the BVC allow trading to be done directly in the system or a transaction to be recorded once it has been carried out in the over-the-counter market.

Graph 2.18
Evolution in the Open Position, by Groups of Products in 2020
(Only one side)



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

Graph 2.19
Evolution in the Number of Standardized Derivative Contracts
Received from Registration or Trading Systems



a/ Does not include equity and index contracts, which come entirely (100%) from a trading system.

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

According to the BVC, the increasing trend in TES futures agreed on bilaterally and then reported to the BVC, through its recording system for subsequent clearing and settlement in the CRCC, was maintained. This performance is explained by the fact that trading in notional futures (short, medium and long-term) was done initially through the trading systems. However, once specific-reference TES futures were created, it began to be done through brokerage firms, which recorded these operations to be sent subsequently to the CRCC.

Another factor is the limited liquidity on the trading platform for TES and TRM futures. Participants use the money market, the TES spot market and the foreign exchange market as references to define their strategies for the futures market. Initially, they go to the platforms where futures with these underlying assets are traded and, if they cannot obtain enough liquidity there, they turn to the over-the-counter market to do the transaction. Graph 2.19 shows the changes in the proportion of the number of standardized derivative contracts handled through electronic trading and recording systems.

Finally, as a result of the risk clearing processes, efficiencies are generated in the demand for collateral to support members' open positions, according to the different maturities and instruments. This can lower their liquidity requirements.²⁵ On a daily average, the collateral requirements in 2020 declined as follows for the most representative products: 16.6% for specific-reference TES futures; 74.8% for TRM futures and NDF foreign currency (pesos/dollars) forwards; 45% for OIS futures, 57.4% for OIS-IBR, and 40% for sovereign debt sell/buy-backs.

25 There are other reasons for the CRCC requiring its members to provide less collateral for each position. One is the completion of transactions that make it possible to close out open positions. Another is a decline in the value and volume of cleared operations that reduce the level or extent of open positions.

These liquidity savings come in the form of lower requirements for cash or securities (collateral per position) in the case of long positions (purchases) and short ones (sales) of the same product, but with different maturities (e.g., long and short positions in specific-reference TES futures with different maturities) or when there are different positions in several instruments with correlated underlying assets (e.g., long positions in TRM futures and short positions in NDF foreign exchange forwards (pesos/dollars)).

The CRCC experienced 16 delays in 2020. However, none of them affected the delivery of service and it was not necessary to use collateral.

In terms of operating efficiency in the delivery of its services, the CRCC's systems were available to participants 99.79% of the time, according to the operating hours established for 2020.

The CRCC introduced some important modifications in 2020. Above all, they include: 1) the change in internal regulations on the acceptance of operations and risk controls for spot market transactions and the temporary loan of securities in the variable-income segment; 2) *Banco de la República* being admitted as a member of the CRCC and its interposition as central counterpart in FX forward NDF (USD/COP) intervention operations; 3) the change in operating regulations to include the crisis protocol for securities and foreign exchange market infrastructures,²⁶ which establishes guidelines and minimum rules of action for infrastructure providers in the event of a crisis, so as to strengthen the operational resilience of these market by making them better prepared to deal with and recover from adverse events that threaten the normal development of their activities; and 4) creation of the foreign exchange segment and the regulations necessary for the CRCC to accept operations in the foreign exchange spot market as a result of its merger with the Foreign Exchange Clearing House of Colombia S.A., through absorption. Details on the merger and the changes in risk management are outlined in this report in the box entitled "Changes in Risk Mitigation Mechanisms with the Merger between the Colombian Central Counterparty (CRCC) and the Foreign Exchange Clearing House of Colombia (CCDC)."

26 Resolution 0674 adopted on July 27, 2020 by the Office of the Financial Superintendent of Colombia.

2.3 The Foreign Exchange Clearing House of Colombia (CCDC)

The Colombian peso depreciated against the US dollar by 4.7% during 2020, going along with the trend in oil prices and the currencies of other emerging market economies. The exchange rate ended the year at COP 3,433 per dollar, after reaching a high of COP 4,154 on March 20.

The first quarter saw the Colombian peso depreciate 23.7% against the dollar, mainly due to the deterioration in external and local economic expectations and the drop in oil prices. The reversal in depreciation witnessed from the second quarter onward was supported by international factors (fiscal stimulus and the presidential elections in the United States, despite continued trade tensions between the United States and China, as well as Brexit) and the recovery in the price of crude oil. In the final quarter, the peso continued to recoup, influenced by ratification of the country's credit rating, monetizations by the government, the expectation of additional sales related to disbursement of part of a flexible credit line (FCL) with the IMF, and the supply of dollars from foreign agents.

The volume of operations settled daily among the 33 direct participants in the CCDC who were active in 2020 came to 1,581, which represent a decline of 13.8% compared to the daily average in 2019. In terms of the gross value cleared and settled, the daily average was USD 1,242 m (COP 4,558.7 b in current pesos), which is 6.3% less in dollars and 3.1% more in current pesos with respect to 2019 (Table 2.13 and Graph 2.20).

The average daily savings in liquidity, due to multilateral netting, was 83.3%, which is 2.7 percentage points (pp) less than the year before. The gross value of operations in 2020 came to USD 1,242 m, while the net daily average was USD 200.7 m (COP 743.1 b).

From the standpoint of risk mitigation mechanisms, the CCDC modified the extent of collateral required in 2020, given extreme volatility in the peso/dollar exchange rate at the start of the pandemic, particularly between March and June 2020. For example, the amount of collateral required to back each participant's net selling position in the case of transactions cleared and settled in $t + 0$ was increased gradually by 4.5 pp, from 5.5% to 10%. For each participant's net selling position, in the case of operations settled in $t + 1$, it was raised progressively by 8.5 pp, from 6.5% to 15%, and gradually by 7 pp, from 8.0% to 15%, for each participant's net selling position with respect to transactions cleared and settled in $t + 2$ and $t + 3$. However, between May 13 and June 18 of last year, all the percentages were restored to the levels that were in effect at the start of 2020. The amount of collateral provided to the CCDC by direct participants averaged USD 79.8 m and COP 119.9 b daily.

Graph 2.21 shows the peso value of the sum of collateral deposited by the participants and the amounts when the aforementioned percentages are applied to the multilateral net values. The collateral deposited by participants allows them to operate during the day with net selling positions up to the short-position limit established by the CCDC. The amounts obtained by applying the required percentage of collateral to the multilateral net payments should tally with the collateral required to cover exchange-rate volatility in the event of default in payment on net multilateral liabilities. In some cases, more collateral might be

Table 2.13
Statistics on the Foreign Exchange Clearing House of Colombia S.A. ^{a/}

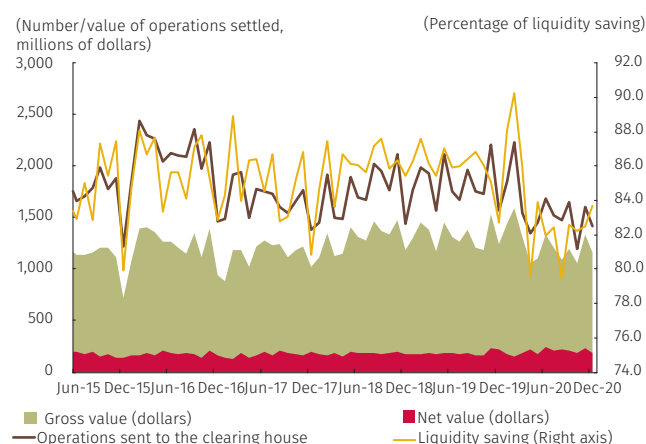
	Number of Operations (Operations sent to the CCDC)	Daily Average		Liquidity Saving (Percentage)
		(Millions of dollars)	Gross Value (Billions of December 2020 pesos))	
Average-2011	1,544	1,088.0	2,783.2	84.0
Average-2012	1,399	1,037.7	2,522.0	81.6
Average-2013	1,388	1,125.7	2,794.6	81.8
Average-2014	1,482	1,179.2	3,012.6	80.4
Average-2015	1,823	1,163.9	3,794.3	84.3
Average-2016	2,102	1,243.4	4,311.0	85.7
Average-2017	1,673	1,150.0	3,697.6	85.0
Average-2018	1,741	1,297.8	4,054.8	86.0
Average-2019	1,834	1,326.0	4,422.8	86.0
Average-2020	1,581	1,242.0	4,558.7	83.3
Jan-20	1,849	1,440.0	4,793.1	87.9
Feb-20	2,232	1,592.0	5,443.3	90.0
Mar-20	1,544	1,310.0	4,995.6	84.9
Apr-20	1,350	1,062.0	4,227.9	79.3
May-20	1,451	1,103.0	4,248.9	83.8
Jun-20	1,686	1,333.0	4,925.3	82.0
Jul-20	1,518	1,209.0	4,423.3	82.3
Aug-20	1,477	1,094.0	4,143.4	79.5
Sept-20	1,645	1,200.0	4,507.4	82.5
Oct-20	1,197	1,062.0	4,068.5	81.6
Nov-20	1,606	1,335.0	4,897.6	82.6
Dec-20	1,413	1,164.0	4,030.1	83.2

a/ These statistics include spot and next-day market operations at t + 1, t + 2 and t + 3 that reach the compliance date.

b/ The 2020 prices for securities are in current pesos. The CCDC cleared and settled foreign exchange operations on the spot market until December 14, 2020.

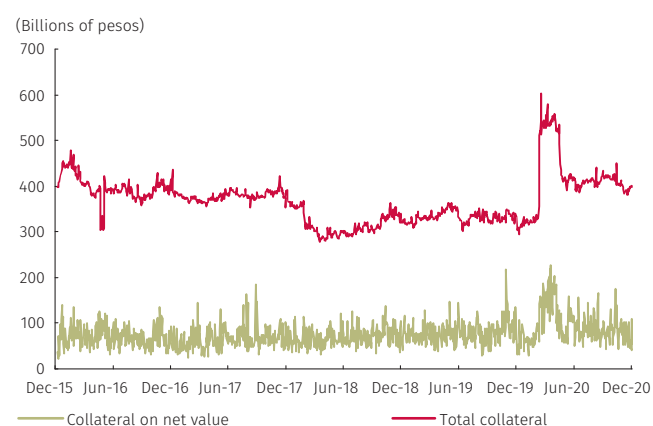
Source: CCDC S. A.

Graph 2.20
Value, Volume and Liquidity Savings in CCDC Operations
(Daily averages)



Source: Foreign Exchange Clearing House of Colombia S.A. (CCDC).

Graph 2.21
Evolution in Collateral Received for Required Collateral on Net
Values



Sources: Foreign Exchange Clearing House of Colombia S.A. (CCDC) and Banco de la República.

provided than what is required to manage default. Agents do this to reduce the operating risk generated by possible additional collateral requirements during the day. The effects of the higher percentages of required collateral between March 9 and May 13, 2020 are shown in the graph. From the end of that period until June 18, 2020, these percentages were adjusted gradually in order to return to the levels witnessed at the beginning of the year.

The peso quotas agreed between agents and their liquidity providers (LP) were kept at COP350 b with six banks. The dollar quotas were left at the USD 120 m agreed with eight banks. The largest supplier of liquidity in dollars accounted for 33.3% (USD 40.0 m) of all borrowing facilities in dollars by December 14, 2020.

On the other hand, the CCDC experienced two delays in paying multilateral obligations to several of its direct participants. A delay in paying an obligation resulting from the multilateral net balance is defined in the CCDC regulations as payment made after the deadline stipulated in the regulations (2:30 p.m.), provided it is not made after 8:00 a.m. the day following the date the payment is due, in which case the participant is considered to have defaulted. Transactions with LP are conducted as of 2:45 p.m., provided the participant has not made the payment. These events occurred in dollars, for a total value of USD 8.55 million. The use of liquidity providers for USD 2.9 m was necessary in one of the two events; however, there were no instances of default (Table 2.14).

As for operating efficiency in service delivery, the CCDC's systems were available to participants during 99.9% of the time, pursuant to the schedule established for 2020.

According to the information provided in the box in this report concerning the merger between the Colombian Central Counterparty (CRCC) and the CCDC, the latter ceased its operations on December 14, 2020, the date the merger was completed.

Table 2.14
Foreign Exchange Clearing House of Colombia S.A. (CCDC): Delays and Defaults by CCDC Participants in 2020

	Number of Delays	Value of Delays	Number of LPs Used	Total Value of LP Use	Defaults	Value of Defaults
Dollars	2	USD 8,555,000.00	1	USD 2,905,000.00	0	USD 0.00
Pesos	0	COP 0.00	0	COP 0.00	0	COP 0.00

Source: CCDC S.A.

In Focus 1

Using CUD Data to Analyze the Persistence of Interbank Market Relationships

“Interbank Lending Relationships in Colombia” (León and Miguélez, 2021a) and “Reexamining Interbank Lending Relationships: Are funds available at a similar price?” (León and Miguélez, 2021b) are summarized in this section. These papers evaluate the persistence of relationships between financial institutions in the Colombian interbank market.

Using data from *Banco de la República*’s large-value payment system (CUD), an infrastructure monitored by the DSIF, the persistence of such relationships in the Colombian interbank market was assessed from a network perspective, in terms of both the availability and price of funds.

Stable and strong relationships among financial institutions are considered essential for interbank markets and financial stability. A temporary break in these relationships would signal changes in the willingness of institutions to lend or borrow from one another. This could create tension and increase systemic risk.

Persistence in lending relationships has been documented in the financial literature as a determinant of liquidity exchanges in money markets and, therefore, as a vital factor in the evolution and stability of financial markets. In that sense, this section highlights the information that can be extracted from the data in financial infrastructures, as well as the usefulness of implementing appropriate methodologies for its analysis.

The Data Set Used

The database pertains to interbank lending transactions and bilateral funding rates in the interbank market for 1,606 reporting days, from January 2, 2014 to August 4, 2020.¹ While transactions can be observed directly in the large-value payment

(CUD) system, because their reporting under codes determined by *Banco de la República* is mandatory, the funding rates were inferred² by applying a Furfine-type algorithm to interbank payment transactions.³

During the period analyzed, 21,210 interbank loans between forty banks were identified. Most were overnight transactions (57% in number and 51% in value). The average duration was approximately three days; the mode and median were overnight.

Using the database, a network was constructed in which the connections between participating institutions were identified for each day (i.e., loans from institution i to institution j at time t), and spread between the amount-weighted average interbank rate and the overnight IBR was assigned to them. Applying this difference makes it possible to identify variations in the price of funding that are caused by changes in bilateral relations, leaving aside those prompted by changes in macroeconomic conditions.

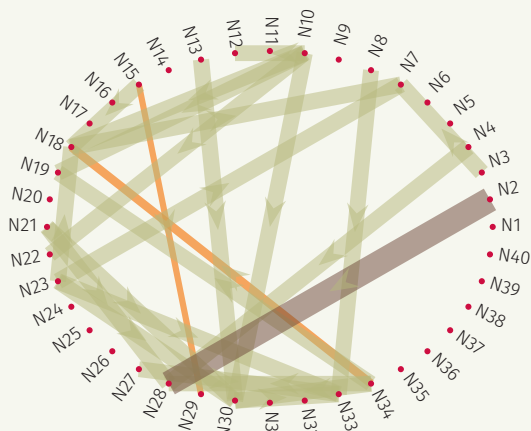
Graph A shows the network on July 28, 2017, the day when the amount of interbank loans in the sample was the highest in terms of value. The nodes represent each institution, and the arrows reflect transfers of funds from the lender to the borrower. The width and color of the connections represent the rate resulting from the difference (spread) between the amount-weighted average rate on loans between participants and the overnight IBR rate.

¹ In the first paper, the information pertains only to loan transactions and runs through September 30, 2019 (1,400 days).

² Although the main option is to use the information institutions report to the Office of the Financial Superintendent of Colombia, this presents identification problems (among other complications that make it difficult to use).

³ It was designed and tested for the Colombian market in León et al. (2016). The best fit for the algorithm was evaluated with the information institutions report to the Office of the Financial Superintendent of Colombia. Approximately 99.2% of the interbank transactions identified in number and value match the reported loans.

Graph A
Interbank Market Network in Colombia on July 28, 2017



Source: León, C. & Miguélez, J. (2021b). Interbank Relationship Lending Revisited: Are the funds available at a similar price? *Borradores de Economía*, 1151, Banco de la República.

The Survival Coefficient

With network analysis, the survival of links between elements of a network over a period of time can be used to evaluate the persistence of relationships in the interbank market. Following the approximation by Onnela *et al.* (2003),⁴ the survival coefficient is used to this end, so as to measure how stable the network in the Colombian interbank market was during the period in question.

The survival coefficient represents the fraction of connections that are found in lending networks, consecutively, and is calculated as follows:

$$\bar{s}_t = \frac{|\cap_{k=0}^n E_{t-k}|}{|E_{t-k}|}$$

Where $0 \leq \bar{s}_t \leq 1$ is the survival coefficient from time $t-k$ to time t ; E_t measures the set of network connections at time t , k is the number of stages, \cap is the intersection operator and n , the total number of stages. When $k=1$, the coefficient measures the persistence in the connections in two consecutive networks (from time $t-1$ to time t).

According to this formula, only connections that persist for the entire period, without interruption, are taken into account. Therefore, if the link between two institutions disappears at least once in k stages, it

4 There are other approximations, such as the number of transactions, the number of days with transactions between banks during a certain period, from a network perspective or by matching interbank transactions with a null model.

is not counted as a surviving connection (even if it reappears later).

The Persistence of Relationships in the Colombian Interbank Market

To measure the persistence of funds available at similar prices, the initial availability network⁵ was transformed by establishing a connection when the value of the spread is less than or equal to a π coefficient, as a maximum acceptable increase. In this sense, the unavailability of funds or a considerable increase in their price denotes a break in the relationship between two institutions.

By construction, the larger the π coefficient, the closer the network is to one based solely on the availability of funds (a very large maximum value will accept any difference between the rate and the IBR).

Graph B shows the survival coefficient for $\pi = 10$ bp (an increase equal to or greater than 0.1% in the spread, which institution i charges institution j from day $t - 1$ to day t , will imply a break in their relationship). Therefore, in the case of $\pi = 10$ bp and a single period ($k = 1$) approximately 38% of the relationships survive from one day to the next for the same spread, on average, while 13.7%, 6.2% and 1.6% survive in the case of $k=5, 10$ and 20, on average and in that order.

These measurements suggest that relationships between financial institutions in Colombia's interbank networks are not occasional: there is funding at similar prices on consecutive days. However, survival tends to be less in the two-week and four-week ranges ($k = 10, 20$).

When $\pi=0$, the availability of funding is restricted to transactions with spreads that do not increase. In that case, 16% of relationships persist from one day to the next ($k=1$), on average. However, this scenario is unlikely: small changes in the spread could be due to factors other than the relationship of trust between institutions (due to maturities or rate rounding). When $\pi \rightarrow \infty$ relationships are based solely on the availability of funds, the price of funding is irrelevant. In this case, 38% of the relationships persist from one day to the next, on average, which is the same as the case of persistence based solely on the existence of relationships, because any difference in the spread is accepted.

5 The price of interbank loans is not considered in León & Miguélez (2021a), contrary to León & Miguélez (2021b).

Graph B
Survival Coefficient Time Series for $\pi = 10$ bp



Source: León, C. & Miguélez, J. (2021b). Interbank Relationship Lending Revisited: Are the funds available at a similar price? *Borradores de Economía*, 1151, Banco de la República.

Finally, a random reconnection of the relationships between lending and borrower banks was done in each observation to verify whether these results respond to a chance assignment between institutions. The findings indicate the survival coefficients that were obtained deviate significantly from the random model networks. Consequently, it was concluded that evidence of relationships in interbank lending in the Colombian market does exist.

Final Comments

The assessment of relationships between financial institutions in the Colombian interbank market began by focusing on the availability of funds (León and Miguélez, 2021a). Their price was incorporated later (León and Miguélez, 2021b). In this sense, these papers allow us to examine lending relationships in the interbank market from the standpoint of overall market discipline, which includes the availability and price of funds as determinants.

The findings show the proportion of bilateral interbank funding relationships that survive at similar prices is substantial. Approximately 38% of the relationships in the Colombian interbank lending market survive from one day to the next, regardless

of the spread in price or accepting a spread of up to 100 bp. In fact, about 16% survive when no price variations are accepted. For longer periods, the extent of survival is less. The results are robust to changes in the price similarity threshold.

This leads to the conclusion that interbank lending relationships exist in the Colombian market. The findings also highlight the value of the information that can be extracted from the data in financial infrastructures, as well as the usefulness of implementing appropriate methodologies for its analysis.

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In Focus 2

Regulatory Changes in 2020 for Central Counterparty Risk Clearing Houses

The regulations on central counterparties are established in External Resolution 12/2008, which was issued by the Board of Directors of *Banco de la República* and amended through BDBR External Resolution 22 of September 25, 2020. The central counterparties, henceforth CRCCs as they appear in the corresponding Resolutions, are authorized therein to include cash in U.S. dollars as assets that may be provided as collateral. They also are authorized to clear and settle peso/dollar purchase and sale transactions on the spot market, as counterparties.

With respect to the first change, the BDBR decided that collateral received in foreign currency shall be subject to completion of the transactions cleared and settled through the CRCC and may be seized in the event of delays or default, as provided for in the regulations of the respective CRCC.

Regarding clearing and settlement as a counterparty in peso/dollar purchase and sale contracts on the spot market, the following elements were included in the regulation as being necessary for adequate risk management in such operations. With the exception of the last two, these elements are those authorized for foreign exchange clearing and settlement systems through External Resolution 4/2006:

- Contracts are to be settled by transferring: 1) domestic currency, through the deposit accounts the participants and the CRCC have with *Banco de la República*, and 2) foreign currency, through the deposit accounts the participants and the CRCC maintain with financial institutions abroad.
- Institutions overseen by the Office of the Financial Superintendent of Colombia (SFC), the Ministry of Finance and Public Credit (General Directorate of Public Credit and the National Treasury) and *Banco de la República* may operate with the CRCC as settlement members in these contracts, doing so on a proprietary or non-proprietary basis.
- CRCCs may serve as intermediaries in the foreign exchange market. When acting in that capacity, they may: 1) clear and settle purchase/sale contracts on the spot market, as a counterparty; 2) enter into peso/dollar spot purchase and sale operations with exchange market intermediaries, in accordance with the operational regime authorized in External Resolution 1/2018 and as needed to adequately carry out operations accepted by the CRCCs, in the event of delays or default by one or more participants; and 3) enter into peso/dollar derivative transactions on the spot market that are settled within three business days thereafter, doing so with authorized liquidity providers and with the exchange market intermediaries referred to in Part 1, Article 8 of BDBR External Resolution 1/2018, in the event of delays or default by one or more participants.
- CRCCs shall not be subject to the regulations on proprietary position, proprietary spot position or gross leveraged position.
- In their capacity as exchange market intermediaries, CRCCs are to comply with the obligations outlined in Article 9 of BDBR External Resolution 1/2018.
- CRCCs must have agents who can provide liquidity in Colombian and foreign currency to ensure payments for purchase/sale contracts on the spot market are made in due course. In the case of foreign currency, liquidity providers must be foreign agents who carry out derivative transactions in a professional capacity, foreign financial entities or foreign exchange market intermediaries. In addition, through Regulatory Circular DOAM-316, *Banco de la República* decided that CRCCs may not concentrate more than 35% of foreign currency liquidity in a single liquidity provider.
- Within one year from the time CRCCs begin to clear spot purchase and sale transactions, they are to adopt a risk control system and have a scheme of security rings for these operations, pursuant to the same terms that apply to the other segments cleared by CRCCs. While these elements are being built into the system, CRCCs must allocate a portion of their liquid assets

exclusively to address the residual risks not covered by the required collateral. This portion of their liquid assets must pertain to the security ring that includes specific own resources (skin in the game), regardless of the value of the default fund.

- The specific rules on clearing purchase and sale contracts in the spot market must be stipulated in the regulations and in circulars, independent

of the rules foreseen for the other products cleared by CCRCs.

- Finally, the BDBR temporarily authorized CRCCs, through External Resolution 27 of November 27, 2020, to manage the country's foreign currency clearing and settlement systems pursuant to the terms and conditions outlined in BDBR External Resolution 4 of 2006. This authorization was in effect from November 27, 2020 to 30 April 2021.

Box 1

Changes in Risk Mitigation Mechanisms with the Merger between the Colombian Central Counterparty (CRCC) and the Foreign Exchange Clearing House of Colombia (CCDC)

According to the Colombian Central Counterparty (CRCC), foreign-exchange market operators indicated it would be beneficial for the market to explore mechanisms that would allow the interposition of a central counterparty in forex spot operations, so the bilateral quotas could be eliminated in the trading systems, thereby increasing transparency and liquidity, in addition to permitting more growth in the market. On June 30, 2020, the CRCC and the Foreign Exchange Clearing House of Colombia S.A. (CCDC) notified the Office of the Financial Superintendent of Colombia (SFC) of their merger by absorption. The SFC, on October 27, 2020 through Resolution 0939, did not object to the merger by absorption between the CRCC, as absorbing institution, and the CCDC, as the absorbed institution. On December 14, 2020, the merger was completed and clearing and settlement in the forex spot market began to be done through the CRCC.¹ However, there was no

¹ The Board of Directors of *Banco de la República* adopted External Resolution 27 of November 27, 2020, authorizing the central counterparty risk clearing houses referred to in BDBR External Resolution 12/2008 to manage the country's forex clearing and settlement systems during the period between November 27, 2020 and April 31, 2021.

temporary interposition by the CRCC for operations until February 1, 2021.

Since the merger changes the type of financial infrastructure that will manage the clearing and settlement processes, this box illustrates the changes introduced in terms of mechanisms for risk mitigation, considering this activity will no longer be carried out by a foreign exchange clearing and settlement system, but by a central counterparty clearing house.

Banco de la República is the country's foreign exchange authority. Therefore, its Board of Directors is responsible for issuing the rules on the foreign exchange market. This box focuses on the changes *Banco de la República* (Banrep) required the CCP (henceforth CRCC) to implement so it could be authorized to clear and settle peso/dollar spot market transactions.

1. Background

Pursuant to Law 964/2005, also known as the Securities Act, *Banco de la República* regulates the forex clearing and settlement systems in Colombia and their operators. The SFC oversees these systems and, prior to December 14, 2020, the CCDC was the only one authorized under this license. When the CRCC and the CCDC merged, the CCDC system ceased to exist.

As provided for in External Resolution 4/2006 and other provisions, the Board of Directors of *Banco de la República* (BDBR) regulates these systems, authorizes them to clear and settle foreign exchange purchase and sale transactions, enables them - as foreign exchange market intermediaries (IMC) - to enter into foreign exchange purchase and sale transactions (spot or derivatives) with liquidity providers (LPs), so they may function adequately, and allows them to access FX swap contracts through Banrep's window.

Central counterparty clearing houses, on the other hand, are subject to Law 964/2005 and Decree 2555/2010 with respect to the clearing and settlement of securities transactions, and BDBR External Resolution 12/2008 on the clearing and settlement of transactions with foreign exchange components.

The CRCC is overseen by the SFC and is the only infrastructure provider in the Colombian financial market that interposes itself between the parties through novation in transactions.² Its risk management model is based on: 1) access requirements for clearing members; 2) the establishment of trading limits, margin calls and open positions

² With novation, the CRCC becomes every buyer's seller and every seller's buyer, thereby eliminating the original link between the initial counterparties.

(exposures), and 3) a model of collateral requirements for members in multiple scenarios. It also has a scheme to deal with delays or defaults by its members, which include a series of security rings to allow it to withstand default by its two main clearing members. This scheme also contemplates requirements on ordinary and extraordinary individual collateral, loss mutualization mechanisms, allocation of some of the CRCC's own resources (skin in the game), recovery mechanisms for pre-funded resources and resolution mechanisms.

2. Changes in Risk Mitigation Mechanisms

Novation is the main change brought about by the corporate merger between the CRCC and the CCDC. The legal bond that exists bilaterally at the moment transactions are confirmed disappears in novation and, once the CCDC accepts the transaction; that is, once the parties comply with the necessary prerequisites in terms of collateral and limits, two independent relationships are created between the CCDC and the two counterparties, with the CRCC becoming every buyer's seller and every seller's buyer. According to Mariño *et al.* (2019) and Núñez and Valdeolivas (2019), centralized clearing transforms the complex network of relationships in a market with bilateral clearing into a simple and transparent network. This creates some changes in the perception of counterparty and liquidity risks. On the one hand, the participants exchange multiple counterparties for a different one that is designed to manage these risks. On the other hand, it increases the liquidity of markets and cleared products, possibly due to an increase in the institutions interested in participating in these markets.

The changes in clearing and settlement on the peso/dollar spot market are outlined below, taking into account the type of clearing, the mechanisms used to manage liquidity risk and those designed to manage counterparty risk. Also described are the tools defined by the CRCC to recover the level of resources received from members, to lend continuity to the service, and to make a decision in the face of extreme events in which the aforementioned tools and mechanisms are not enough. The types of clearing and settlement will be maintained. Clearing will still be based on multilateral netting, while the mode of settlement will continue to involve payment versus payment of multilateral netting.

2.1 Liquidity Risk Mitigation Mechanisms

Table B1.1 lists the liquidity risk mitigation mechanisms used by the CCDC and those foreseen by the CRCC as a result of the corporate merger. To mitigate liquidity risk in the event a participant delays or defaults on payment of its obligations and considering that settlement is made on a "payment versus payment" basis, the CCDC applied the settled value; that is, the participant's multilateral right to obtain the missing funds in the event of a delay. Accordingly, it had pre-approved quotas in pesos and dollars with liquidity providers (LPs), so FX swap transactions could be carried out on a one-day basis to purchase the missing currency in cash and return it the following day, provided the participant subsequently fulfilled the obligation. If not, the transaction was closed out once and for all. Moreover, in the event of any failure to obtain the resources from a LP, the CCDC was authorized to do so through other foreign exchange market intermediaries (IMCs). Finally, in extreme cases where external problems were identified (e.g., closure of foreign lines

Table B1.1
Changes in Liquidity Risk Mitigation Mechanisms

CCDC	CRCC
Collateral provided in advance by participants in the operation	Collateral provided in advance by participants in the operation
Pre-approved quotas with liquidity providers (LP) in dollars and pesos	Pre-approved quotas with liquidity providers (LP) in dollars and pesos
Fx Swap	Fx Swap
Definitive purchase	Definitive purchase
FX spot and derivative operations with other exchange market intermediaries	FX spot and derivative operations with other foreign exchange market intermediaries
BR-Fx swap in extreme events	BR-Fx swap in extreme events
	Capacity to use cash collateral provided by other members
	CRCC capital in cash and securities
	CRCC overdraft facilities

Source: Banco de la República, CCDC and CRCC.

of credit), the CCDC could turn to Banrep to enter into an Fx swap operation that would allow it to continue with multi-lateral clearing.

With the merger, the CRCC will keep the mechanisms adopted by the CCDC. It also will include the foreign exchange segment in the liquidity sources it anticipates for the other segments it operates. These sources include the ability to make temporary use of cash collateral provided by other members, the CRCC's liquid assets (cash and TES), and the authorized overdrafts it has arranged with domestic commercial banks.

2.2 Counterparty Risk Mitigation Mechanisms

Table B1.2 shows the counterparty risk mitigation mechanisms used by the CCDC and those contemplated by the CRCC. As mentioned, the corporate merger between these clearing houses was completed on December 14, 2020 and, on that date, FX spot market transactions began to be cleared through the CRCC in three stages. In the first, the CRCC clears these operations under the same terms and pursuant to the same regulations that applied to the CCDC; in other words, those applicable to foreign exchange clearing and settlement systems in general. In the second stage, the CRCC will clear forex transactions through novation, and will adjust its risk management model to include specific own resources and its capital as part of a scheme to manage counterparty risk. In the third stage, anticipated for when the CRCC completes its first year of operation as a central counterparty, it will expand the model foreseen in stage two to include a default fund and several mechanisms to recover prefunded resources, so as to lend continuity to the service.

The first column shows the mechanisms and resources that were available to the CCDC. The limit on the short position (SPL) in each currency was intended to restrict the short

position in pesos and dollars and, in doing so, to cover - with the LP quotas - a possible default by its two main participants. On the other hand, the CCDC required participants to provide collateral to deal with possible adverse situations in the markets. In the case of payment default on a multilateral obligation, this collateral was to be used to cover a potential deficit, provided the multilateral right to obtain the missing currency proved to be insufficient. If the shortfall continued after the collateral had been used, the CCDC retained the collateral deposited by the original counterparties and used it to cover the balance due. In extreme cases where these resources were not enough, the CCDC had to withdraw some transactions from netting and recalculate the multilateral net payment schedule for some participants.

The mechanisms established by the CRCC for its first year of operation in the spot market for foreign exchange are described in the second column. The requirements for prior collateral from participants and a limit on the short positions in each currency are maintained. Although the name used is different from that of the CCDC, its objective and calculation are the same. Additionally, with elimination of the legal and operational relationships inherent in the initial bilateral transaction, the CRCC will not retain the collateral provided by the original counterparties. However, its capital will be involved in two tranches to meet possible balances of debtors that are not covered by the resources of the defaulting members. The first tranche pertains to the CRCC's own resources that are earmarked specifically for the foreign exchange segment (skin in the game) and the second, to the remaining CRCC capital that will be available to cover possible unpaid balances of debtors in all segments. This differentiation provides clarity on the use of financial resources in the event of default by a member who participates in more than one segment of the CRCC, since a declaration of default cuts across all segments; that is, a payment default by a member in a particular segment shall be considered in default in all the segments where the member participates.

Table B1.2
Changes in Counterparty Risk Mitigation Mechanisms in the Foreign Exchange Segment

CRCC	CRCC-First year of operation	CRCC-After the first year of operation
Short-position limit	Short-position limit (now latent obligation to deliver)	Limit on latent obligation to deliver
Prior collateral provided by defaulting participant	Collateral provided by the defaulting member	Collateral provided by the defaulting member
Collateral provided by the original counterparties	Security ring (skin in the game) CRCC capital	Security ring (skin in the game) CRCC capital Collective collateral fund Mechanisms to recover prefunded resources

Source: Banco de la República, CCDC and CRCC.

The third column in the table shows the CRCC's risk mitigation mechanisms after its first year of operation. In addition to those established during that period, the CRCC will have a loss mutualization tool known as the Default Fund (DF), whereby all members participating in the foreign exchange segment will be jointly and severally liable for residual losses, once the defaulting member's individual collateral and the CRCC's own specific resources (skin in the game) have been exhausted. The CRCC also provides for recovery mechanisms that involve its ability to request members to replenish the DF's resources in the event of persistent unpaid balances attributed to the default of one or more members. The replenished resources will be used once the collateral established by these members, the CRCC's own resources earmarked specifically for the foreign exchange segment, and the DF have been exhausted. The recovery mechanisms include ones designed to lend continuity to service in the segment. In other words, after the resources to replenish the DF have been used, the CRCC may request a mandatory and voluntary contribution from its members to avoid having to liquidate and cancel the segment.

For members participating in the forex spot segment, this new counterparty risk management scheme eliminates the uncertainty they experience with significant changes in their multilateral obligations or rights, by removing some transactions from the clearing and settlement process and seeing their cash flows affected.

3. Final Comments

Clearing and settlement in the spot forex (peso/dollar) market has changed substantially in terms of the risk management model, which evolved from one based on the definition of a limit to short positions and the requirement to provide prior guarantees, to a model that also contemplates a series of security rings specific to the members of the central counterparty. This change poses an important challenge to members participating in this segment, since they will be responsible for ensuring that the procedures and controls of their only counterpart are calibrated constantly to mitigate the possibility of a negative impact on their capital in the event of losses caused by other participants. For its part, the CRCC should, in the same vein, guarantee that its risk management scheme promotes centralized clearing without exposing its shareholders' capital (see McPartland and Lewis, 2017).

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03

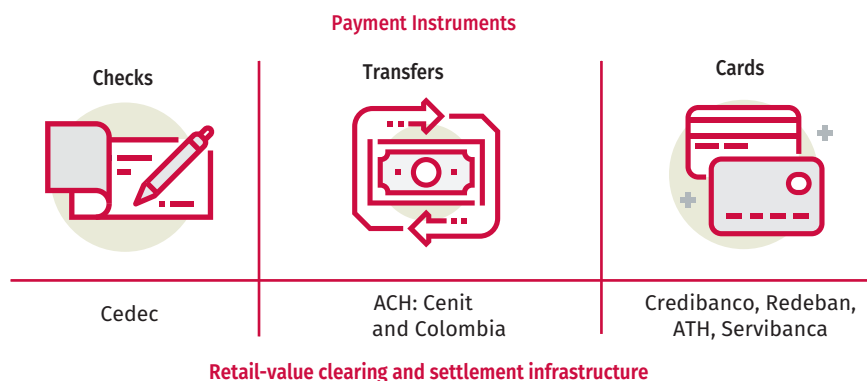
Payments in the Market for Goods and Services

Retail payments are usually defined as those made in the market for goods and services, where at least one of the parties to the transaction, be it the payer or the beneficiary, is not a financial institution (BIS, 2016). This differentiates retail payments from those made in the market for financial assets.

Retail payments are used frequently in different types of transactions between private citizens, companies and national or local government administrations (legal entities). They are involved daily in trade and business activity in general, in the distribution and collection of payments made by government agencies, and in payments between individuals, among others (BIS, 2016).

The infrastructure is associated specifically with each of the retail-value payment instruments in the economy and includes the Electronic Clearing System for Checks (CEDEC), managed by *Banco de la República*, the automated clearing houses for electronic payments (ACH), ACH-Cenit (managed by *Banco de la República*) and ACH Colombia, which receive electronic payment orders for the transfer of funds, and the Credibanco, Redeban, ATH, and Servibanca networks, among others, which process credit and debit card transactions carried out at commercial establishments and automated teller machines (Diagram 3.1).

Diagram 3.1
Retail-value Infrastructure Operating Through the Use of Payment Instruments in Colombia



Source: Banco de la República (DSIF).

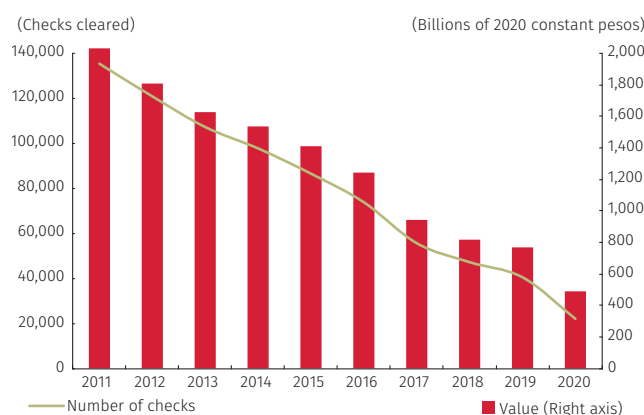
3.1 Retail-value Payment Systems

The function of the country's retail-value payment systems is to clear and settle operations carried out with the various payment instruments that are available in Colombia. The main ones are checks, credit and debit transfers through the ACHs (electronic payments between companies and people), and credit and debit cards. Their main features, amount and number of operations are described in this section.

3.1.1 Check Clearing Houses and the CEDEC System Managed by *Banco de la República*

3.1.1.1 The Clearing System for Checks (CEDEC)

Graph 3.1
Value and Number of Checks Cleared Through Cedec
(Daily averages)



Source: Banco de la República (Cedec).

In 2020, 5.4 million checks (22,097 per day, on average) were cleared for a total of COP 118.5 t (a daily average of COP 0.48 t),²⁷ which comes to 12% of GDP. These figures are less than the 9.9 million checks registered in 2019 for COP 185.5 t and imply respective reductions of 45.95% and 36.1% (Graph 3.1 and Table 3.1).

Graph 3.2 compares the average daily number and value of transactions cleared through CEDEC each month during 2019 and 2020. The number and value of checks cleared through this financial market infrastructure fell sharply after Covid-19 was declared a pandemic in March 2020. Although some recovery was observed in the months thereafter, it does not equal the levels registered in January and February 2020.

As for liquidity needs, Table 3.1 shows daily gross clearing in 2020 averaged COP488 b. However, as a result of multilateral netting, COP100.87 b were required to settle the obligations between financial institutions (Table 2.3). So, the liquidity savings came to 79.32%.

According to the data reported by commercial banks, intrabank checks (the drawer and the drawee share the same financial institution; so, the checks are not sent to CEDEC or physical clearing houses) accounted for 39.8% of the value and 75.2% of the total number of interbank checks cleared in 2020, with a decline of 35.68% in value and 32.9% in the number of checks compared to 2019 (Table 3.2).

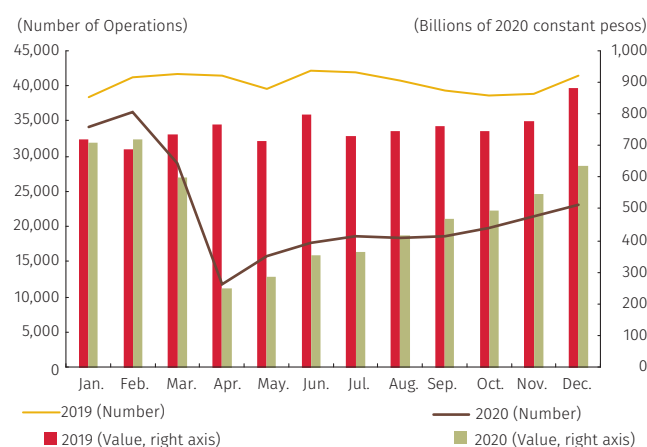
²⁷ These figures on the use of checks only take into account interbank payments; that is, payments between the customers of different financial institutions. Consequently, they do not include intrabank checks, which are settled within each institution and do not go through a check clearing house. Statistics on intrabank payments are provided at the end of this section.

Table 3.1
Statistics on Checks Cleared through Cedec

	Number of Checks	Daily Average				Annual Value				
		Number of Operations	Value		Average Transaction Value		(Millions of Checks)	(Billions of Pesos)	(Billions of 2020 Constant Pesos)	(Number of Times GDP)
			(Billions of Pesos)	(Billions of 2020 Constant Pesos)	(Millions of Pesos)	(Millions of 2020 Constant Pesos)				
2011	135,334	1,467	2,031	10.8	15.0	33.3	360,922	499,662	0.58	
2012	120,857	1,336	1,806	11.1	14.9	29.5	326,056	440,661	0.49	
2013	107,239	1,226	1,626	11.4	15.2	26.2	299,225	396,712	0.42	
2014	97,762	1,201	1,536	12.3	15.7	23.9	293,048	374,813	0.38	
2015	86,537	1,179	1,412	13.6	16.3	20.9	285,374	341,857	0.35	
2016	73,852	1,094	1,239	14.8	16.8	18.1	268,009	303,605	0.31	
2017	55,674	863	940	15.5	16.9	13.5	208,944	227,398	0.23	
2018	47,254	777	819	16.4	17.3	11.5	188,771	199,116	0.19	
2019	40,553	757	770	18.7	19.0	9.9	185,567	188,571	0.17	
2020	22,097	488	488	22.1	22.1	5.4	118,569	118,569	0.12	

Source: Banco de la República (Cedec).

Graph 3.2
Evolution in amount and daily average value per month, CEDEC



Source: Banco de la República (Cedec).

3.1.1.2 Indicators of Concentration and Operating Efficiency

There were 25 institutions involved in the check clearing process by December 31, 2020 (Table 3.3), which is one more than in 2011.²⁸ However, the trend in the concentration of operations continued as it has for quite some time. This is illustrated by the CR5 indicator, which shows the five major participants accounted for 70% of the value cleared.

As for operating efficiency, CEDEC was available 99.75% of the time in 2020. In other words, there were occasional interruptions that affected the delivery of service for a period of time equivalent to 0.25% of the total.

3.1.2 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 the commercial banks. They cleared 265.9 million transactions in 2020, 13.94% more than in 2019. On average, this amount equals 1,089,920 payment instructions daily (41,327 were processed through ACH-Cenit and 1,048,593 through

²⁸ For this indicator and CEDEC, the comparisons in previous editions of the *Payment Systems Report* were with respect to a decade earlier, when the use of checks as a payment instrument was highly relevant.

Table 3.2
Comparison Between Interbank and Intra-bank Checks in Value and Number

Year	Interbank Checks Cleared ^{a/}		Intra-bank Checks ^{b/}			
	Number (Number of Checks)	Value (Billions of Pesos)	Number (Number of Checks)	(As a Percentage of Interbank Checks)	Value (Billions of Pesos)	(As a Percentage of Interbank Checks)
2011	33,292,130	360,922	15,721,623	47.2	104,216	28.9
2012	29,489,131	326,056	13,362,676	45.3	98,033	30.1
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

a/ The number and value of checks cleared through Cedec.

b/ Checks that are settled within each financial institution and do not go through the check clearing house

Sources: Commercial banks and Banco de la República (Cedec)

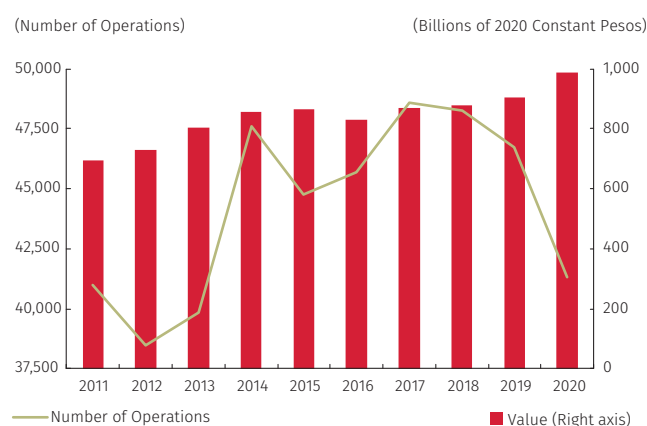
Table 3.3
Cedec
(Participants and concentration)

	Total Participants	CR5 (Percentage)	Number of Participants Accounting for 70% of the Amount Cleared
2011	24	70.8	5.0
2012	24	70.3	5.0
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

Source: Banco de la República (DSIF).

ACH-Colombia) for COP5.5 t in total (COP0.987 t in ACH-Cenit and COP4.57 t in ACH-Colombia). The gross amount cleared by these ACHs in 2020, as a whole, came to COP1,357.7 t; that is, 8.92% more than in 2019 and 1.35 times nominal GDP in 2020. The net amount settled through these infrastructures in 2020 totaled COP483.5 t (COP1.98 t daily, on average) and was equivalent to 35.61% of the gross value, representing a liquidity savings of 64.39%.

Graph 3.3
Value and Number of Operations in ACH Cenit
(Daily averages)



Source: Banco de la República (Cenit).

3.1.2.1 ACH-Cenit

As illustrated in Graph 3.3 and Table 3.4, more than 10.08 million transactions (41,327 daily, on average) were processed through ACH-Cenit in 2020, including credit and debit operations. The respective gross amount was over COP240.8 t (COP987.1 b daily, on average). These figures, when compared to those for 2019, imply a reduction of 11.9% in the number of operations and an increase of 10.5% in their value. The low amount of liquidity savings (1% for 2020) resulting from the net amounts cleared through ACH-Cenit is due to the payments sent by the DGCPTN and the General System of Royalties, which accounted for the majority (90%).

Credit operations made up a large share of the total number of transactions (97.4%) in 2020 and in value

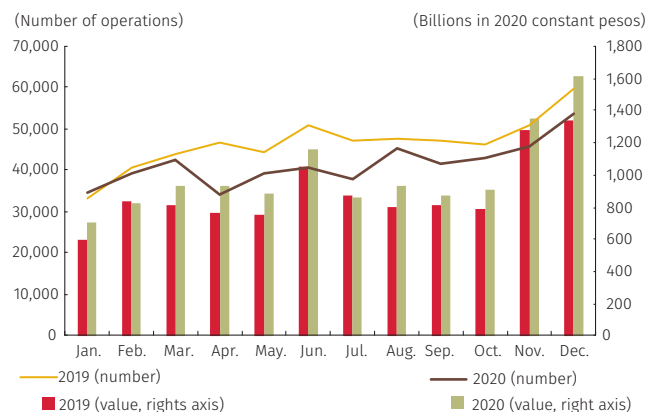
Table 3.4
ACH Cenit Statistics^{a/}

Year	(Number of Operations)	(Billions of Pesos)	Daily Average			(Millions of Pesos)	(Millions of 2020 Constant Pesos)
			Value	Average Value per Operation			
			(Billions of 2020 Constant Pesos)				
2011	41,005	500.4	692.7	12.2	16.9		
2012	38,504	539.2	728.7	14.0	18.9		
2013	39,852	607.0	804.8	15.2	20.2		
2014	47,586	670.8	857.9	14.1	18.0		
2015	44,743	722.8	865.8	16.2	19.4		
2016	45,697	733.8	831.3	16.1	18.2		
2017	48,572	797.7	868.1	16.4	17.9		
2018	48,284	832.8	878.4	17.2	18.2		
2019	46,741	890.0	904.4	19.0	19.3		
2020	41,327	987.1	987.1	23.9	23.9		

Year	Number of Operations			Value of Transactions (Billions of Pesos)			Annual Value (Billions in 2020 Constant Pesos)	Number of Times GDP
	Credit	Debit	Total	Credit	Debit	Total		
2011	10,042,726	44,405	10,087,131	122,829	268.0	123,097	170,416	0.20
2012	9,378,640	93,385	9,472,025	132,504	129.0	132,633	179,252	0.20
2013	9,522,192	201,586	9,723,778	147,926	188.5	148,114	196,369	0.21
2014	11,035,981	574,941	11,610,922	163,238	429.0	163,667	209,333	0.21
2015	10,410,511	417,239	10,827,750	174,408	505.5	174,914	209,534	0.22
2016	10,909,837	285,842	11,195,679	179,164	617.7	179,782	203,660	0.21
2017	11,549,242	205,292	11,754,534	192,463	574.9	193,038	210,087	0.21
2018	11,567,335	165,728	11,733,063	201,849	511.2	202,360	213,450	0.21
2019	11,249,571	201,856	11,451,427	217,549	493.9	218,043	221,572	0.21
2020	9,817,581	266,197	10,083,778	240,297	566.3	240,863	240,863	0.24

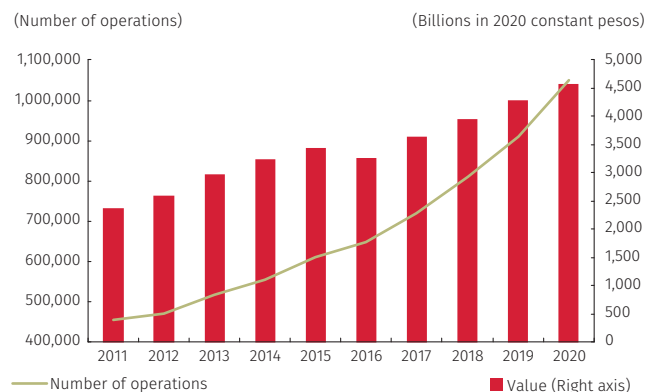
a/ Includes debit and credit transfers.
Source: Banco de la República (Cenit)

Graph 3.4
Evolution in Daily Average Number and Value per Month in Cenit



Source: Banco de la República (Cenit).

Graph 3.5
Value and Number of Operations in ACH Colombia
(Daily averages)



Source: ACH Colombia.

Table 3.5
Statistics on ACH Colombia

Year	Daily Average					Annual Value			
	(Number of Operations)	Value		Average Value per Operation		(Number of Operations)	(Billions of Pesos)	(Billions of 2020 Constant Pesos)	(Number of Times GDP)
		(Billions of Pesos)	(Billions of 2020 Constant Pesos)	(Millions of Pesos)	(Millions of 2020 Constant Pesos)				
2011	455,086	1,711	2,368	3.8	5.2	111,951,241	420,796	582,550	0.7
2012	471,629	1,921	2,596	4.1	5.5	116,020,691	472,495	638,572	0.7
2013	516,603	2,238	2,967	4.3	5.7	126,051,206	546,108	724,028	0.8
2014	556,449	2,536	3,243	4.6	5.8	135,773,574	618,750	791,391	0.8
2015	611,228	2,877	3,446	4.7	5.6	147,917,150	696,124	833,905	0.9
2016	648,858	2,877	3,259	4.4	5.0	158,970,262	733,736	831,190	0.8
2017	721,067	3,340	3,635	4.6	5.0	174,498,262	808,298	879,689	0.9
2018	808,832	3,750	3,956	4.6	4.9	196,546,261	911,333	961,274	0.9
2019	909,622	4,215	4,283	4.6	4.7	221,947,874	1,028,475	1,045,121	1.0
2020	1,048,593	4,577	4,577	4.4	4.4	255,856,641	1,116,811	1,116,811	1.1

Source: ACH Colombia.

(99.76%). Debit operations grew 31.87% in number and 14.66% in value with respect to 2019 (Table 3.4).

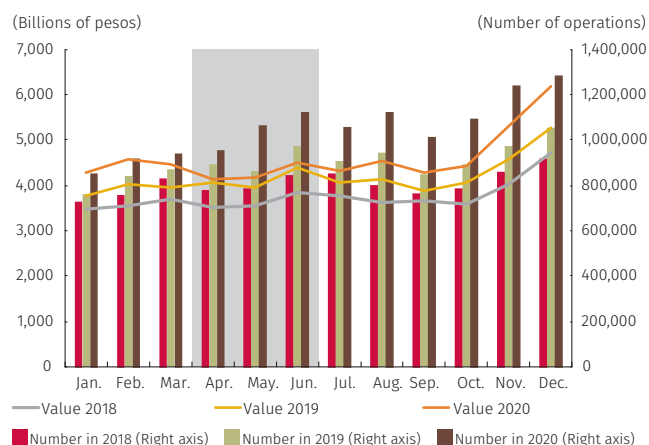
Graph 3.4 compares the average daily number and value of operations cleared by Cenit each month in 2019 and 2020. One sees a decline in the number of transfers as of March 2020 and an increase in their value with respect to 2019. This could be attributed to the declaration of the pandemic, a temporary situation that continued in the rest of 2020. As for operating efficiency, Cenit was available 99.76% of the time. In other words, there were occasional interruptions in service for a period equivalent to 0.24% of the total.

3.1.2.2 ACH-Colombia

ACH-Colombia processed 255.8 million transactions in 2020, including both credit and debit operations, for more than COP 1,116.8 t gross. These figures imply an increase of 15.28% in the number of operations and 8.59% in value with respect to 2019 (Graph 3.5 and Table 3.5).

ACH-Colombia settles the net amounts associated with clearing in five intra-day operating cycles. Once the net positions are calculated, the participants with net debtor positions transfer the funds to ACH-Colombia's account, so it can distribute them to the participants with net creditor positions. The net amount settled in 2020 came to

Graph 3.6
Evolution in Daily Average Number and Value per Month in ACH



Source: ACH Colombia.

COP245.9 t (COP1,012.1 b daily, on average), which is equivalent to 22.1% of the gross value. This represents a liquidity savings of 77.9%.

Graph 3.6 compares the average daily number and value of operations cleared by ACH Colombia in 2018, 2019 and 2020. One sees a slowdown in the rate of growth in the value of operations between April and June 2020, after Covid-19 was declared a pandemic in March 2020. The values registered in those three months were very similar to those processed during the same months in 2019 (see shaded area in the graph). This trend in value began to recover in July 2020. On the other hand, the number of transfers since May 2021 grew at higher rates than in 2019.

Table 3.6 shows the CR5 concentration rate, which is constructed as the sum of the five largest percentages or proportions of the value of transactions. In 2020, it was 74.37% for credit operations, which represents a small increase of 0.5% compared to 2019. The CR5 rate for debit transactions reflects a slight decline of 2.93%, having gone from 92% in 2019 to 89.3% in 2020.

Graph 3.7 shows how the use of the PSE button has evolved. This service, provided by ACH Colombia, experienced a massive increase of 66.5% in 2020 with respect to the number of operations, but not in value, which declined by 0.1% compared to 2019.

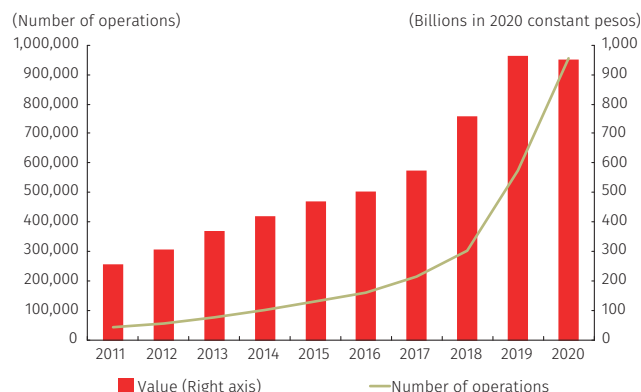
ACH Colombia inaugurated an instant payment service called Transfiya at the beginning of 2020. It enables a person to transfer or receive money from another person in less than ten seconds, using the respective mobile phone numbers.

Table 3.6
ACH Colombia
(Participants and Concentration in the Value of Payments Sent)

Year	Credit Transactions			Debit Transactions		
	Number of Participants	CR5 (Percentage)	Number of Participants that Clear 70% of the Value	Number of Participants	CR5 (Percentage)	Number of Participants that Clear 70% of the Value
2011	21	68.0	6	21	77.8	5
2012	20	76.1	6	20	71.2	5
2013	21	68.5	5	21	93.5	5
2014	20	70.24	5	20	92.1	5
2015	20	70.22	5	20	88.1	5
2016	20	73.50	5	20	85.3	5
2017	23	73.80	5	23	91.00	5
2018	25	74.32	5	25	92.91	5
2019	27	74.00	5	27	92.00	5
2020	27	74.37	5	27	89.30	5

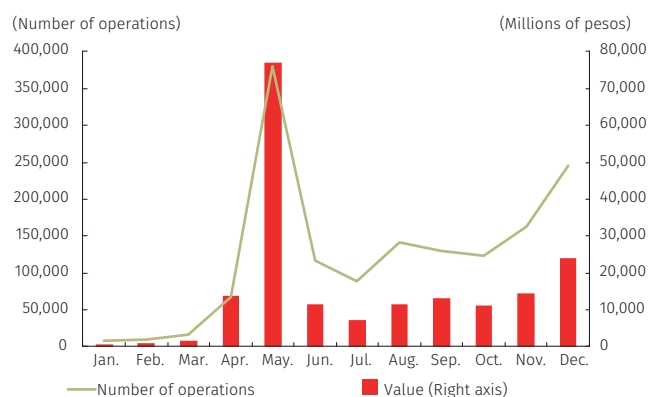
Source: ACH Colombia.

Graph 3.7
Value and Number of Operations Using the PSE Service (ACH Colombia)



Source: ACH Colombia.

Graph 3.8
Monthly Value and Number of Immediate Payments through Transfiya (ACH Colombia)



Sources: ACH Colombia.

The current maximum on transfers through this service is COP 250,000 per transaction, with a daily limit of five transfers and COP 1,250,000 in total. At the time this report was written, eleven participants were affiliated with Transfiya: seven banks, two mobile wallets, one financial cooperative and one company specializing in electronic payments and deposits (Sedpe).

Graph 3.8 shows how its use has evolved monthly in terms of the number and value of transactions. May 2020 is the month with the highest number and amount of these transactions.

To complement the statistics on the use of electronic funds transfers as a payment instrument, Table 3.7 shows the figures on intrabank transfers, based on information provided by the commercial banks from 2011 to 2020. In these cases, the drawer and the drawee of the funds share the same bank, which means the operation is not cleared through an ACH.

In terms of the number of operations, intrabank transfers were equivalent to 187.4% of all interbank transfers in 2020. This amounts to an increase of 41% with respect to 2019. As to value, intrabank transfers were 2.4 times more than interbank transfers.

Table 3.7
Comparison Between Interbank and Intrabank Operations in Value and Number

Year	Interbank Transfers Cleared ^{a/}		Interbank Transfers ^{b/}			
	(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)
2011	122,038,372	543,893	82,950,682	68.0	1,347,365	2.5
2012	125,492,716	605,128	70,701,523	56.3	1,005,437	1.7
2013	135,774,984	694,222	96,171,547	70.8	1,050,129	1.5
2014	147,384,496	782,417	112,103,184	76.1	1,025,864	1.3
2015	158,744,900	871,038	145,895,871	91.9	1,581,650	1.8
2016	186,252,796	1,001,336	189,358,265	101.7	2,393,927	2.4
2017	186,252,796	1,001,336	179,104,744	96.2	2,138,592	2.1
2018	208,279,324	1,113,693	304,602,311	146.2	2,965,085	2.7
2019	233,399,301	1,246,518	353,430,214	151.4	2,773,874	2.2
2020	265,940,419	1,357,674	498,345,093	187.4	3,236,407	2.4

a/ 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 ACHs.

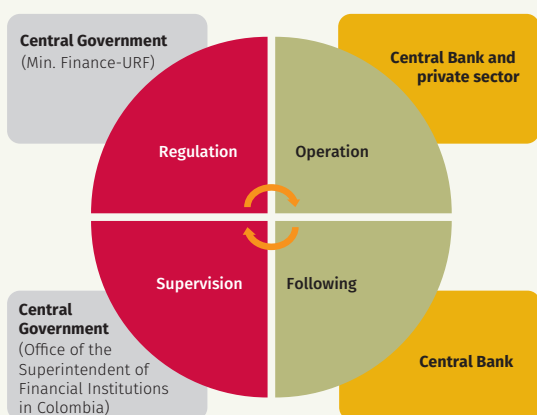
Sources: Commercial banks and ACHs.

In Focus 3

New Rules on Retail-value Payment Systems

In Colombia, matters concerning regulation and oversight of retail-value payment systems are the responsibility of the central government. Clearing and settlement systems and payment initiation process, in general, are operated by the central bank and the private sector. *Banco de la República* is responsible for overseeing payment systems and payment instruments (Diagram A).

Diagram A
Institutional Arrangement of Retail-value Payment Systems in Colombia



Sources: Fundamental Law on the Financial System, BDBR External Resolution 5 of 2009 and Decrees 2555 and 1692 of 2020.

Given this institutional arrangement, the Financial Regulation Unit (URF) of the Ministry of Finance is in charge of issuing the rules on the retail-value payment system. Recently, with Decree 1692/2020, the country acquired a new rule on the matter, which is described in this section.

The decree is based on several aspects, one of which is the fact that the retail-value payment system is essential not only for the financial sector to operate adequately, but also to increase efficiency and formality in the economy, which contributes to the digital transformation of the country and society by facilitating financial inclusion.

The principles established for operation, regulation and oversight of retail-value payment systems focus on promoting access, transparency, integrity, stability, efficiency, innovation and the adoption of global

standards that allow for interoperability within payment systems. With respect to users, the philosophy is to ensure their protection and safeguard their interests.

The contents of the decree are divided into three parts. The first focuses on definitions and principles, the second concerns the rules applicable to the institutions that manage retail-value payment systems, which are in charge of clearing and settling transactions, and the third refers to acquisition.

As to the first part, it is important to point out that new definitions are included throughout the payment process, such as those on new payment means and instruments, the agents involved, processes and fees. Diagram B lists these definitions according to their role in the respective stage of the payment process.

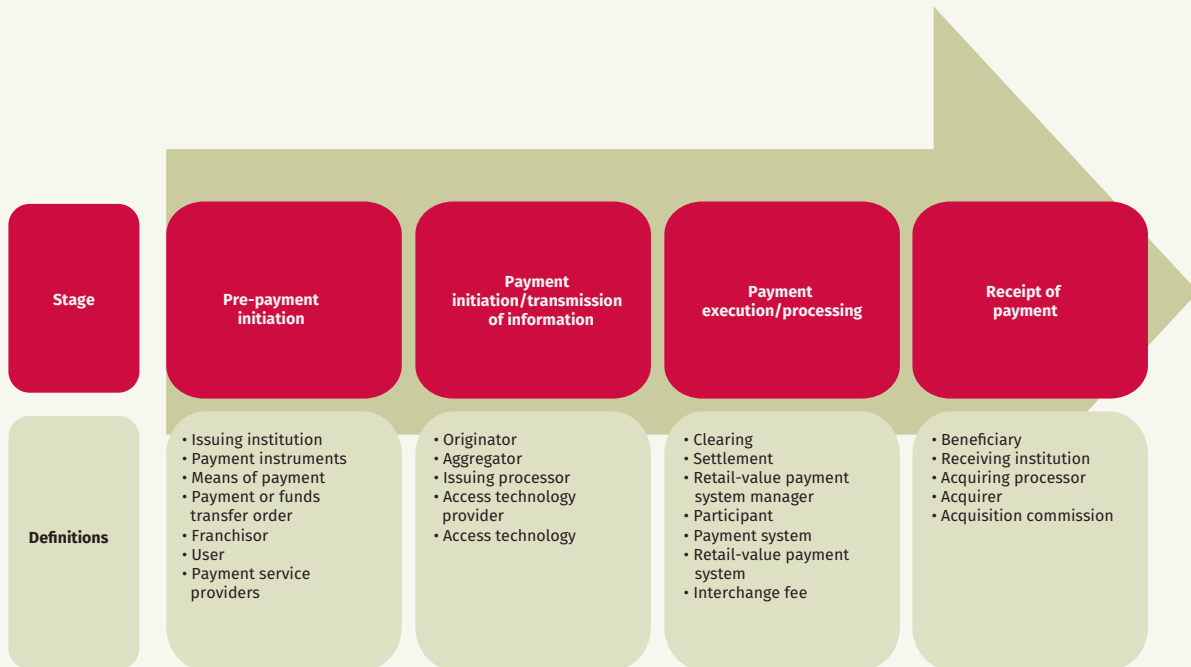
In terms of the rules applicable to the institutions that operate retail-value payment systems (IORVPS), the decree stipulates that clearing and settlement is exclusively their responsibility. This is an important change from the previous regulation, since it implies separating acquisition from the clearing and settlement of a transaction. The decree also indicates the following institutions are authorized to hold equities in IORVPSs: credit institutions, companies providing financial services, other financial institutions and those specialized in electronic deposits and payments (Sedpe). Together, they may own any percentage of the equities. Consequently, IORVPSs cease to be technical and administrative services companies, since their equity holders are no longer required to hold at least 51% of the subscribed equities. In this way, the new regulation seeks to eliminate possible conflicts due to the equity holding structure and to facilitate access to clearing and settlement systems for different participants.

Responsibilities of Retail-value Payment System Managers

Access

Their responsibility, in this regard, is to determine objective criteria and fees with respect to access for potential participants so as to ensure compliance with the following principles: non-discriminatory

Diagram B
Definitions Related to the Payment Process



Source: Ministry of Finance (Decree 1692 of 2020); adaptation by Banco de la República.

treatment, transparency, encouragement to competition (free and fair), avoidance of abuse of a dominant position, and a guarantee that practices with a negative impact on access to payment systems by one or some of the participants shall not be used.

Information for Participants and the Public

In general, the provisions on information indicate the institutions managing retail-value payment systems have a new obligation, which is to provide information on their websites, or through any other medium for broad distribution, regarding topics such as the following:

- Characteristics of the system.
- Access requirements for participants.
- Fees and commissions charged for clearing and settlement.
- Costs and requirements for linking merchants, as applicable to each of the acquirers participating in the system.
- The value of the acquisition commission charged by acquirers participating in the system, specified for each of the categories of commercial establishments or sectors and based on the classification established by the acquirers. If the acquirer delegates its services to an aggregator,

it also must indicate the commission on acquisition charged by that payment service provider.

- The interchange fee and the criteria used to determine it. When this fee is determined by the franchisor, the latter must provide the payment system manager with that information.
- The deadlines for crediting payments to participants in the system.

Obligations concerning transparency on the part of acquirers and institutions receiving payment are to be determined by the Office of the Financial Superintendent of Colombia with respect to the time frame or maximum period allowed for crediting funds to users, so this information can be compared.

Conflicts of Interest

The managers of retail-value payment systems must establish administrative and organizational policies and procedures to prevent, address and disclose conflicts of interest.

Participants

Participants may not be restricted from joining and being a part of institutions that manage other retail-value payment systems.

Risk Management Systems

Institutions managing retail-value payment systems are required to have adequate risk management schemes inherent in their activities, including contingency and information security plans to guarantee the continuity of their operations and the management and mitigation of credit, legal, liquidity, operational and systemic risks.

High Operational, Technical and Safety Standards

These apply to its operations and those of its participants.

Requirements for Participants

These requirements include a policy on handling and protecting personal data, policies and procedures to prevent and control the risk of money laundering and terrorism financing; and responsibilities concerning information for beneficiaries regarding their fees, commissions and payment procedures.

Rules on Fees for Interchange, Access and Clearing and Settlement

Interchange fees between participants will always be set by the franchises for fund transfers initiated with franchised payment instruments. Franchises may not differentiate interchange fees, depending on the institution managing the retail-value payment system where the transaction is processed.

For payments or funds transfers initiated with non-franchised payment instruments, and for access fees and those for clearing and settlement services, the decree indicates how they are to be set. This depends on the relationship between the participants and the payment service providers and the retail-value payment system (whether or not they are investors).

Other Services Provided by Retail-value Payment System Managers

Retail-value payment system managers may be providers of services for acquirers and issuers, offering their services and products in an unbundled manner and charging individual fees for each of them. The decree also allows them to perform activities related

to the processing and provision of technology for correspondents, collection points and automated teller machines, as well as related activities. This change is associated with the ban on IORVPSs carrying out activities involving acquisition. They may do so only as payment service providers to acquirers.

In addition, the decree establishes conditions for retail-value payment system managers on matters such as boards of directors, access committees, regulations, information, handling conflict of interest, purpose and interoperability, among others. The first conditions listed are new to the regulations and are aimed at promoting corporate governance standards, by providing for greater transparency in decision-making. The decree includes the definition of finality in retail-value payment systems, which was not previously regulated, and stipulates that transfer and collection orders will be understood as accepted at the moment they enter the system.

The third part of the decree deals with acquisition and is one of the main adjustments ordered therein. This activity may be developed not only by credit institutions, but also by new entities such as Sedpe and companies not overseen by the SFC. As for the latter, it specifies the SFC is to keep a record of the companies that are involved in acquisition and are not subject to oversight. The SFC will authorize companies to be registered in the List of Acquirers without Oversight, provided they comply with the general requirements listed below:

- They must be corporations.
- Have subscribed and paid-in capital equal to or greater than 1,700 times the minimum monthly wage as provided for by law.
- Have a mechanism to keep funds received from the settlement of payment orders or funds transfers separate from funds pertaining to their own resources or those of others, apart from their users. For this purpose, they may enter into alliances with credit institutions or establish free-standing trust, among others.
- As of the first year of operation and each year thereafter, they must demonstrate they have subscribed and paid-in capital equal to at least 2.0% of the value of the funds received from the settlement of payment orders or funds transfers in the last twelve months.

The purpose of these requirements is to evaluate the solvency of companies that are not subject to oversight. The idea is to be able to assess these requirements before a company is accepted as an acquirer in

the first retail-value payment system where it hopes to develop its activities. The decree also addresses related issues for such companies without oversight, such as denial of an application for registration, registration and access to payment systems, and the deposit of funds. For acquirers that are subject to oversight (credit institutions and Sedpe) and involved in acquisition, it indicates they will not have to meet any additional capital or solvency requirements other than those contemplated already in current regulations.

The decree creates payment service providers, defined as agents in the payment system that have been delegated by the acquiring or issuing institution to perform one or more of its function. This definition includes, among others, the acquiring processor, the aggregator and the access technology provider. The different activities related to acquisition and, clearing and settlement are listed in Table A. According to the decree, activities such as linking merchants to retail-value payment systems, providing merchants with access technologies that allow for the use of payment instruments, and processing payment orders may be

done by the acquirer, as well as the payment service provider. This last category includes the managers of low value payment systems in their capacity as the acquirer's payment service provider.

With respect to oversight by the SFC, the decree stipulates it must make sure the institutions that manage retail-value payment systems adopt an adequate structure for corporate governance; rules and high operational, technical and disciplinary standards; adequate systems to deal with and manage the risks inherent in their activities; suitable procedures to prevent these institutions from being used for criminal activity; and satisfactory systems to disclose financial and commercial information for the participants.

Action to prevent retail-value payment systems managers from resorting to practices that restrict competition will continue to be the responsibility of the Superintendency of Industry and Commerce (SIC), in accordance with the powers conferred through Decree 2153 of 1992 and the regulations that modify or replace it, as well as any other coinciding regulations.

Table A
Activities by Agents: Acquisition and Clearing and Settlement

Activities/Agents	Acquirer	Payment Services Provider			Retail-value Payment Systems Manager	
		Acquiring Processor	Aggregator	Access technology provider		Acquirer's payment service provider (acquiring processor)
Links merchant to retail-value payment systems.	x	x	x			x
Provides access technology to allow for the use of payment instruments.	x	x	x	x		x
Processes payment orders.	x	x	x			x
Credit the resources of the commercial sector.	x					
Collect the resources from the commercial sector.			x			
Processes and provides technology with respect to correspondents, collection points and automated teller machines, and related activities.					x	
Clearing and settlement.					x	

Source: Ministry of Finance (Decree 1692 of 2020).

Decree 1692 of 2020 was issued to modernize the rules on retail-value payment systems in order to promote access, transparency, integrity, stability, efficiency, innovation, interoperability, and to protect the interests of those who use payment services. In general, the decree separates and defines the various activities carried out in retail-value payment

systems and the responsibilities of their participants, pursuant to the regulation as outlined therein, including strengthening standards on corporate governance, as well as a higher level of transparency in the requirements for access to the system and the commissions and fees charged to users and participants.

3.2 Payment Instruments

Cash, cards (debit and credit), checks and electronic funds transfers are the main payment instruments used in the Colombian economy to discharge monetary obligations in the market for goods and services. Cash and cards²⁹ are among the most used by individuals, while legal entities rely more on electronic funds transfers and checks (Table 3.8).

These payment instruments, as opposed to cash (banknotes and coins), involve an electronic process or incorporate an electronic format at some point in the payment process (checks are an example). They are used to convey orders to

Table 3.8
Main Payment Instruments in the Colombian Economy, 2020

Market	Instrument	Use in Terms of Value, by Originator (percentage)	
		Individuals	Legal Entity
	Cash ^{a/}	87.0	n. d.
	Debit Card	94.1	5.9
Goods and Services	Credit Card	91.6	8.4
	Check	13.6	86.4
	Transfers	4.8	95.2

n.a. Not available

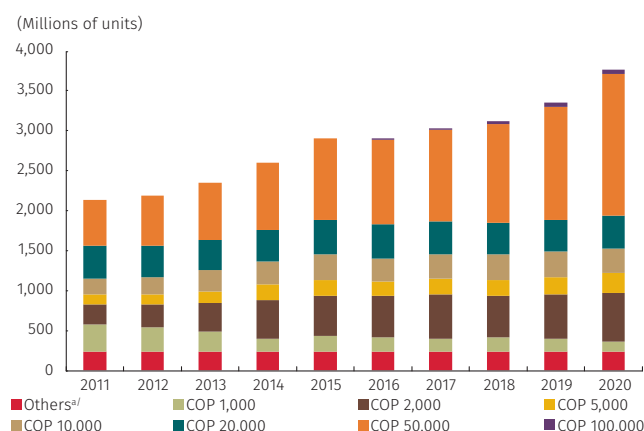
a/ Banco de la República. "Encuesta de percepción sobre el uso de instrumentos de pago," 2019. Percentage of individuals that use cash for routine payments.

Source: Banco de la República, Office of the Superintendent of Financial Institutions in Colombia, commercial banks and ACH Colombia.

transfer funds from a payer's account with a financial institution to a payment beneficiary to compensate for good and services provided, or to transfer resources as such. An international comparison is provided at the end of this section as a point of reference on the use of these payment instruments in other countries.

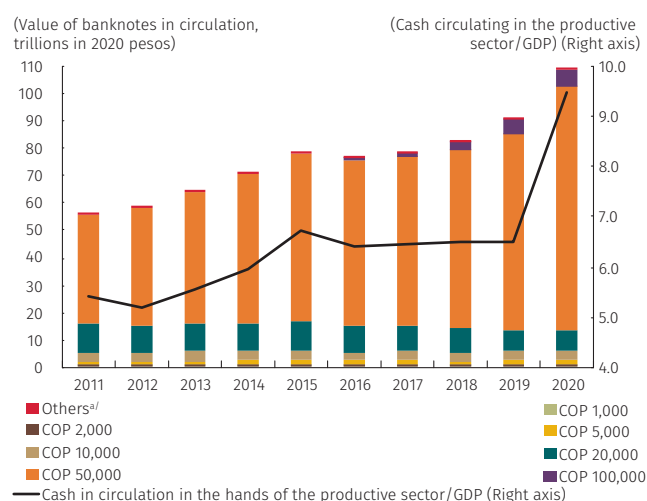
29 Generally speaking, these instruments are used for retail-value payments.

Graph 3.9
Banknotes in Circulation



a/ These include the following denominations: COP 500, COP 200, COP 100, COP 50, COP 20, COP 10, COP 5, COP 2, COP 1.
Source: Calculations by Banco de la República.

Graph 3.10
Value of Banknotes in Circulation and Cash/GDP



a/ These include the following denominations: COP 500, COP 200, COP 100, COP 50, COP 20, COP 10, COP 5, COP 2, COP 1.
Source: Calculations by Banco de la República.

3.2.1 Cash

Banco de la República has been conducting a survey³⁰ to monitor the use of cash as a payment instrument. An alternative way to track the use of cash is to analyze the amount of banknotes and coins in circulation, which is understood as an approximation to the potential use of cash in the economy and not as a direct reference to payments made in cash.

To identify the changes in the amount of banknotes in circulation up to 2020,³¹ Graph 3.9 shows their number increased annually between 2011 and 2020 by 6.6%, on average, and amounted to 3,772 million units in 2020.

As to the number of units by denomination, the larger ones (COP 100,000, COP 50,000, COP 20,000 and COP 10,000) accounted for nearly 68%, while the remaining 32% included the lower denominations (COP 5,000, COP 2,000 and the rest).³²

Graph 3.10 illustrates how the total value of all banknotes in circulation evolved, in real terms, during the 2011-2020 period. The average increase in real value during that time was approximately 7.8%, which amounted to nearly COP 108.7 t in 2020.

With respect to the denominations that account for the value of cash in circulation, the 50 thousand-peso note made up 82% of the total value in circulation in 2020, while the 20 thousand-peso note accounted for 7.0%, and the 100 thousand-peso note, 5.0%. The other denominations were each below 3.0%.

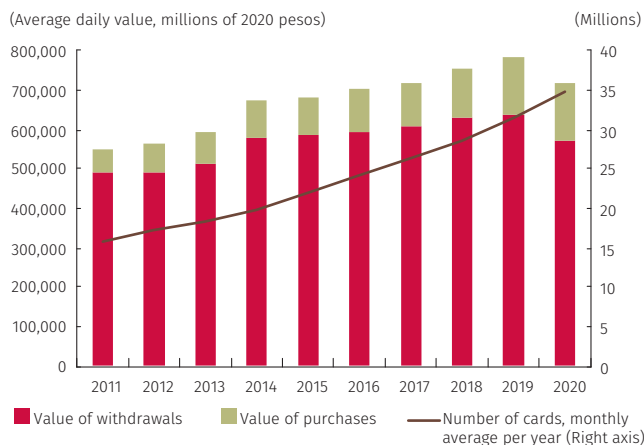
30 The latest survey pertains to the second half of 2019. It indicates cash is used in most routine monthly payments for food, beverages, clothing, transportation, housing and public utilities, among other items (with respect to the number and value of these transactions, 88.1% and 87.4% involve cash, in that order). Similarly, businesses ratify the public's response and say cash is the instrument of payment their customers prefer. The findings of this survey are described, in detail, in Point 3.3 of the *2020 Payment Systems Report* (see: <https://www.banrep.gov.co/es/publicaciones/reporte-sistemas-pago-2020>).

31 Only the evolution in banknotes is discussed, since they accounted for 98% of the cash in circulation during the period from 2011 to 2020, on average. Coins made up the other 2.0%.

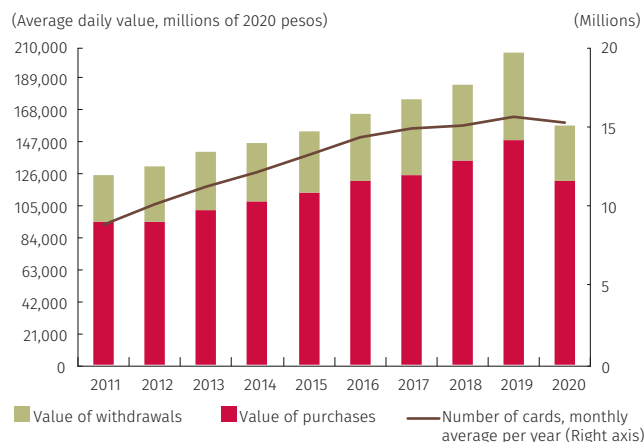
32 The fifty thousand-peso note (COP 50,000) accounts for the largest share, with 47%, followed by the two thousand-peso note (COP 2,000), with 16%.

Graph 3.11
Value of Banknotes and Cash in Circulation as a Percentage of GDP

A. Debit card

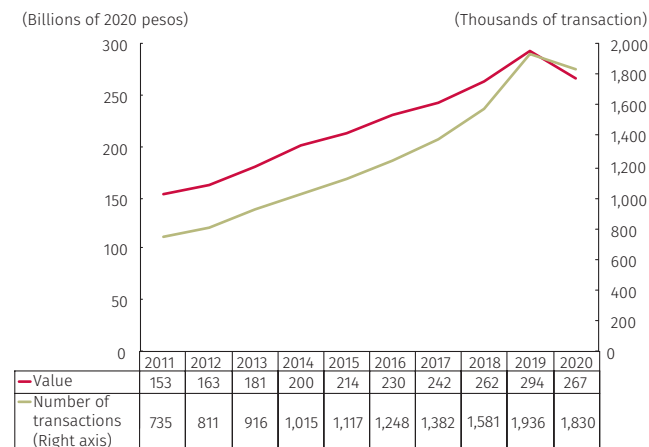


B. Credit card



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

Graph 3.12
Purchases with Debit and Credit Card
(Daily average)



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

The amount of cash in circulation in the productive sector of the economy, as a share of GDP, averaged 6.4% between 2011 and 2020, and has trended higher in the last few years. The proportion in 2020 was 9.5%.

3.2.2 Cards

The use of debit and credit cards has grown steadily in recent years. However, it did decline in 2020 (Graph 3.11). The number of debit cards averaged 34.9 million per month in 2020, and COP 718.6 b in daily use, on average. Of that amount, 80% pertain to withdrawals and the other 20% to purchases.

The number of credit cards averaged 15.3 million per month in 2020, and COP 157.3 b in daily use, on average, with purchases accounting for around 77% and cash advances, 23%.

The last few years have witnessed a rising trend in purchases made with debit and credit cards. However, they declined in 2020, both in value and the number of transactions. The average daily value that year was COP 267.2 b and the number of transactions came to 1.8 m, with respective negative variations of 9.0% and 5.4% compared to the year before (Graph 3.12).

Based on purchase data reported by the commercial banks, Graph 3.12 shows individuals account for 94% of all debit card purchases and 92% of those made with credit cards. Most of their transactions correspond to amounts up to COP 1 m (79% with debit cards and 59% with credit cards).

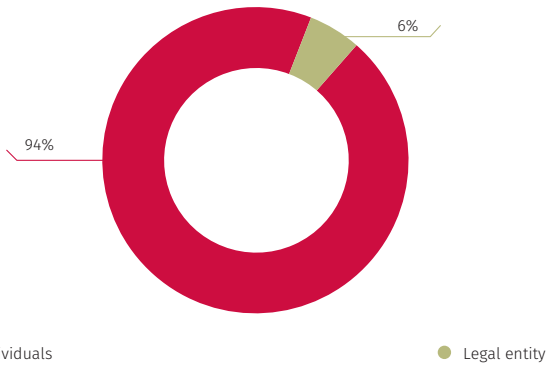
3.2.3 Checks

The use of checks has shown a decreasing trend in the last ten years. Interbank and intrabank checks, as a whole, accounted for COP 676.8 b in average daily gross payments during 2020. A similar result is evident in the series for interbank checks. One sees an annual decline in both the number and value of transactions, with a daily average of COP 488 b and 22,000 transactions in 2020 (Graph 3.14).

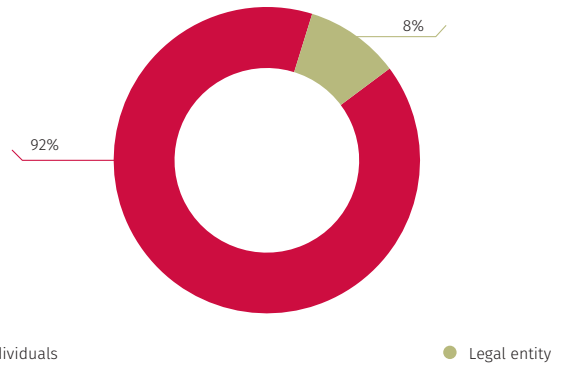
Based on data reported by commercial banks, Graph 3.15 shows 86% of checks, in terms of value,

Graph 3.13
Debit and Credit Cards, by Originator: 2020
 (Share in value)

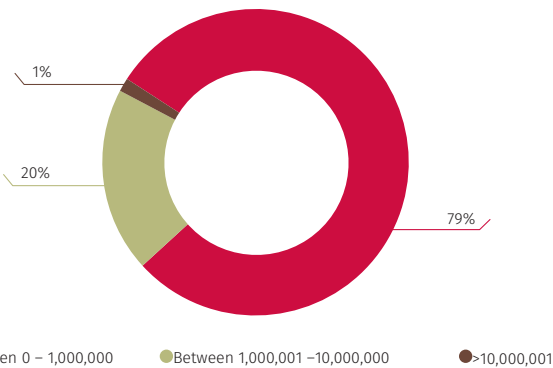
A. Debit cards
 i. Total



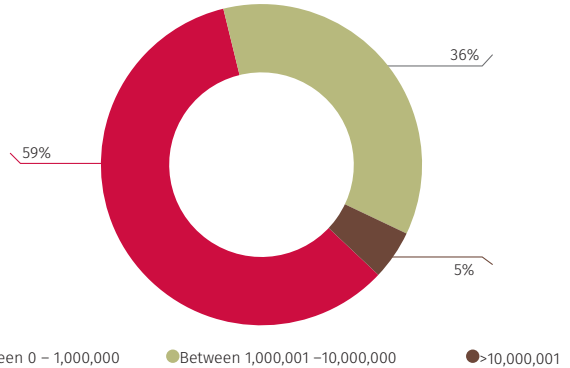
B. Credit cards
 i. Total



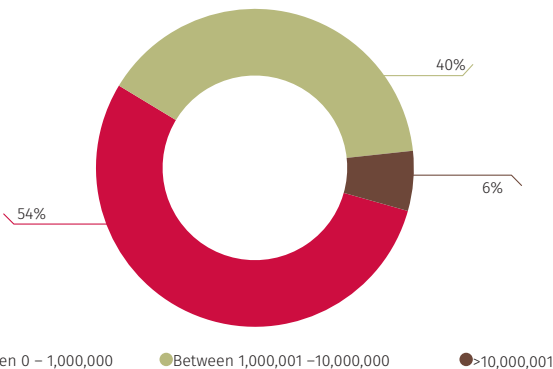
ii. Individuals



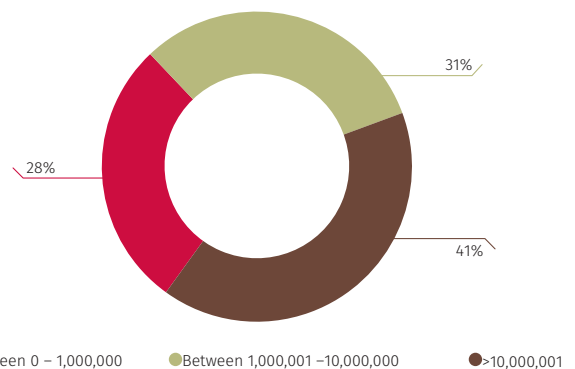
ii. Individuals



iii. Legal entity

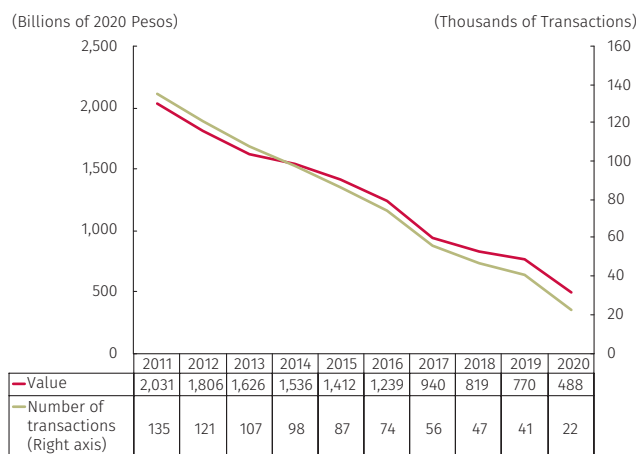


iii. Legal entity



Source: Commercial banks.

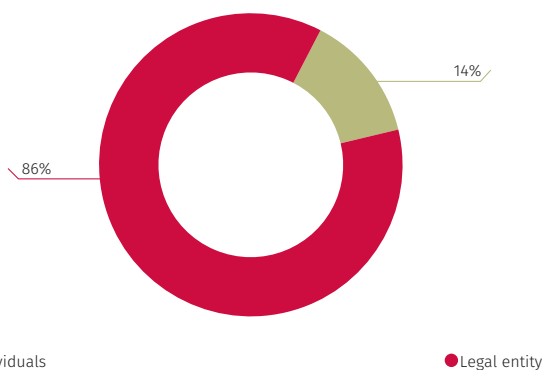
Graph 3.14
Interbank Checks
(Daily average)



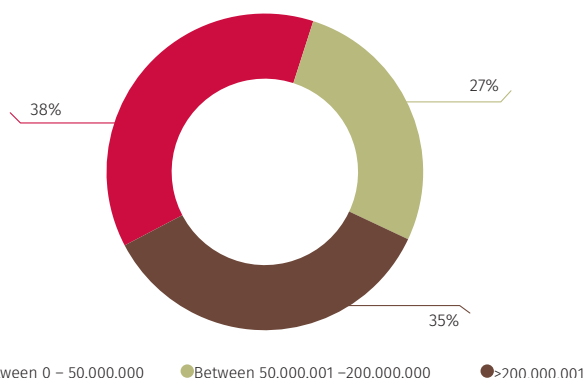
Source: Banco de la República.

Graph 3.15
Checks by Originator, 2020
(Share in value)

A. Total



B. Legal entity



are drawn by companies and the other 14%, by people. Most of those drawn by companies (38%) are checks for amounts up to COP 50 m, followed by checks for more than COP 200 m (35%), while 51% of the checks drawn by individuals are for amounts up to COP50 m.

3.2.4 Electronic Funds Transfers

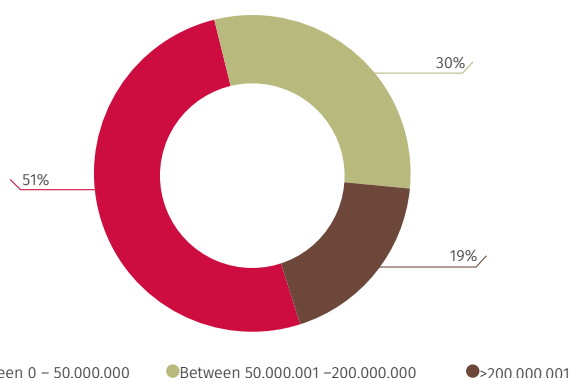
The use of electronic funds transfers (debit and credit) has increased in recent years. In 2020, interbank and intrabank transfers accounted, together, for COP 18.9 t in average daily gross payments, becoming the electronic payment instrument most widely used in the Colombian market for goods and services.

Interbank transfers (those done by ACH Colombia and ACH Cenit) trended upward, both in value and the number of transactions, averaging COP 5.6 t and 1.1 m transactions daily in 2020 (Graph 3.16).

Based on the data provided by ACH Colombia in 2020 (COP4.6 t daily, on average), 95% of all transfers originate with companies and only 5.0% are used by individuals (Graph 3.17).

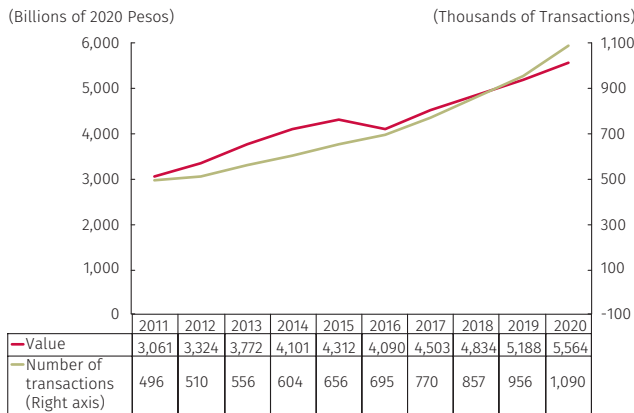
In all, 59% of the electronic funds transfers ordered by companies are for more than COP 200 m. On the other hand, 95% of those ordered by individuals (natural persons) are for less than COP 50 m.

C. Individuals



Source: Commercial banks

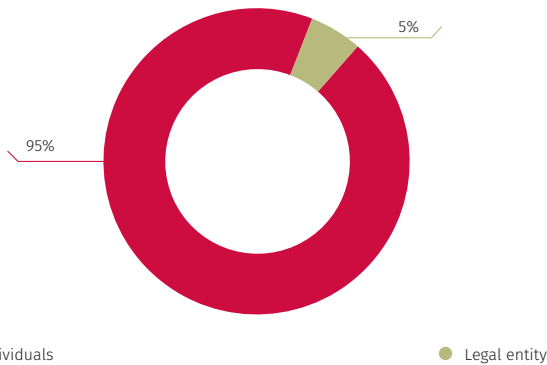
Graph 3.16
Interbank Transfers
(Daily average)



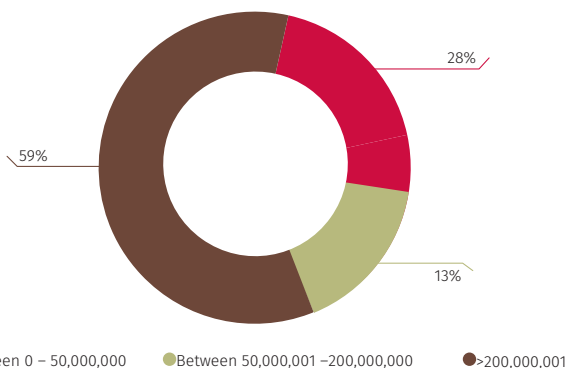
Sources: ACH Colombia and Banco de la República.

Graph 3.17
Transfers by Originator, 2020
(Share in value)

A. Total



B. Legal entity



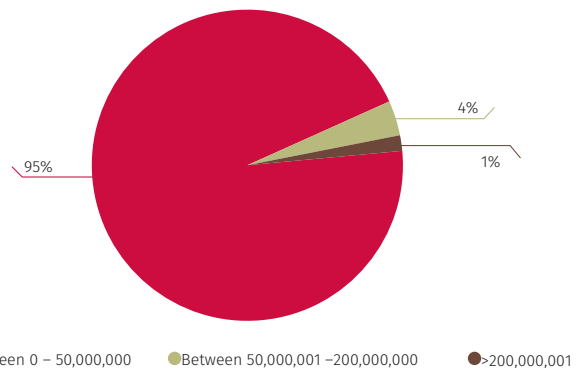
3.2.5 Comparative Use of Payment Instruments with Electronic Processes: Cards, Checks and Electronic Funds Transfers

The information on payment instruments provided in this section is split between individuals and legal entities. This classification is based on who initiates the transaction. As noted earlier, individuals make the most use of debit and credit cards, while electronic funds transfers and checks are used more often by companies and other types of legal entities.

3.2.5.1 Number of Transactions

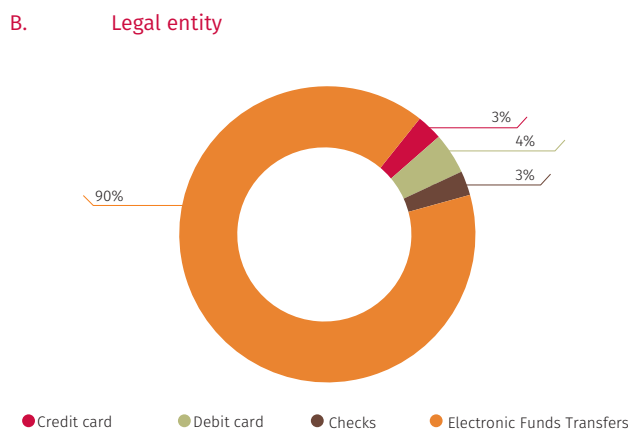
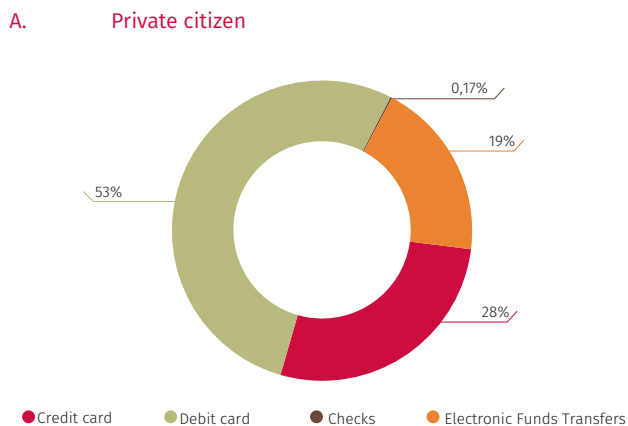
With respect to number, Graph 3.18 shows that during 2020 53% of the transactions carried out by individuals were made through debit cards and 28% of those with credit cards. These payment instruments jointly amount to a share of 81%. Transfers accounted for 19% and checks, less than 1.0%. As for legal entities, transfers represented the largest share of their transactions (90%), followed to a lesser extent by debit cards (4%) and checks and credit cards (with 3.0% each).

C. Individuals



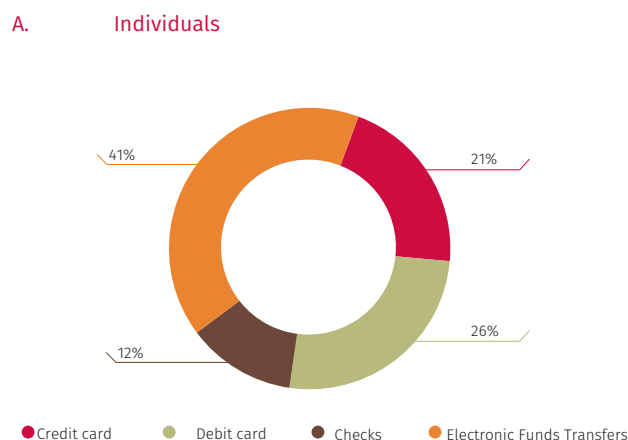
Source: ACH Colombia.

Graph 3.18
Share in the Number of Transactions, 2020



Sources: Office of the Superintendent of Financial Institutions in Colombia, ACH Colombia, Banco de la República and commercial banks; calculations by Banco de la República.

Graph 3.19
Share of Value, 2020



Sources: Office of the Superintendent of Financial Institutions in Colombia, ACH Colombia, Banco de la República and commercial banks; calculations by Banco de la República.

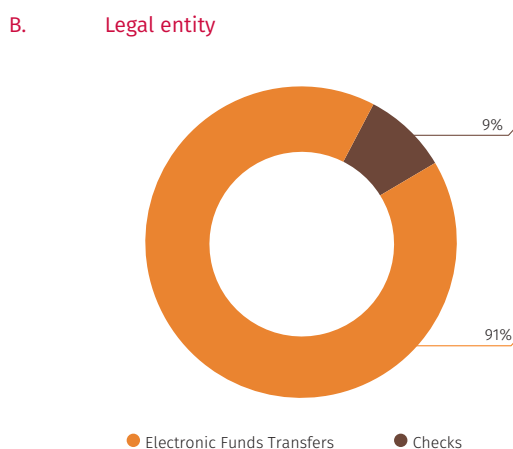
3.2.5.2 Value of the Transactions

As to the value of transactions originating with individuals (Graph 3.19), debit cards accounted for 26% and credit cards, 21%. Together, their share was 47%. Checks, on the other hand, represented 12% and transfers, 41%. In terms of legal entities, electronic funds transfers accounted for 91% in value and checks, 9.0% (the use of cards by legal entities is not representative).

3.2.6. International Comparison of Payment Instruments

The following is a graphic comparison of the evolution of payment instruments (electronic funds transfers, checks, credit and debit cards) for different indicators based on data up to 2019,³³ such as the number of operations per capita, the value of transactions per capita, in dollars,³⁴ and the value of transactions with respect to GDP. Other indicators included are the value per capita in dollars and the value with respect to GDP for cash in circulation (Graph 3.20).

In this instance, the comparison includes twenty countries and Colombia, all with information available in the comparative statistics published by the BIS. In the indicators concerning the number of transactions, Colombia is in the lower



33 The year with the latest information as of April 2021.

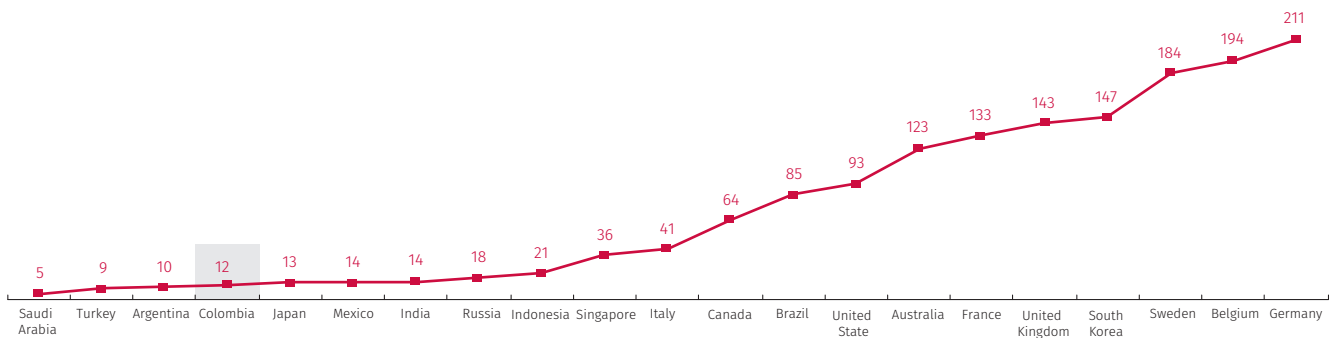
34 In general, the indicators that include value are presented in dollars, given the impossibility of doing a comparative analysis in local currencies. To mitigate the exchange-rate effect, the BIS uses the average annual exchange rate.

quartile of the distribution, with ample room to increase its position with respect to the countries in the sample.

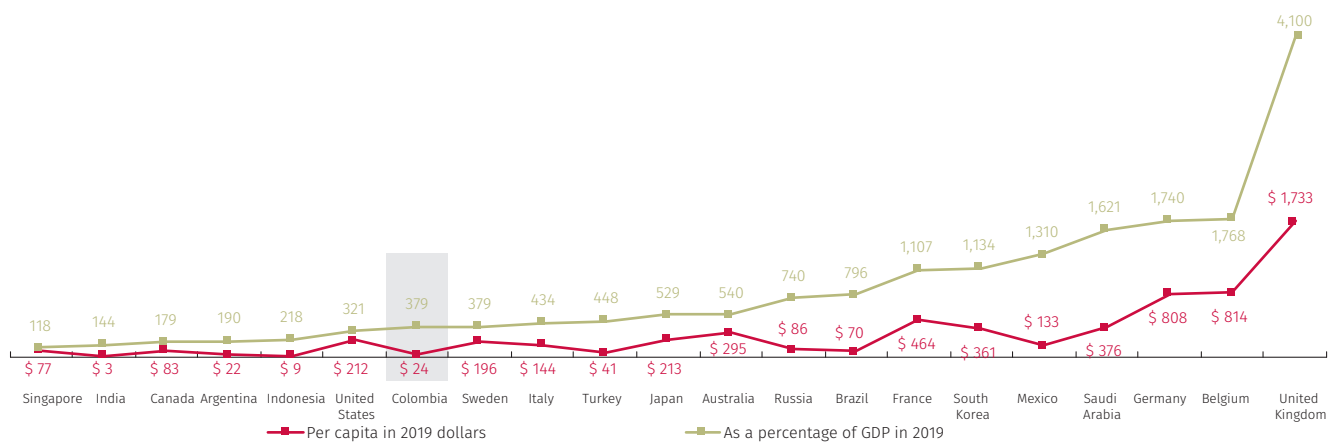
Generally, the indicators of value relative to GDP represent an intermediate position for Colombia within the group of selected countries. By type of instrument, value with respect to the product in transfers was 3.79 times GDP (the range is between 1.2 and 41 times the GDP for the countries in the sample). In checks, it represented 24% (maximum 2.2 times GDP); in debit cards, 5.0% (maximum 50%); in credit cards, 6.0% (maximum 37); and in cash, 7.0%.

Graph 3.20
Payment Instrument, International Comparison, 2019

A. Electronic Funds Transfers
i. Number of transactions per capita



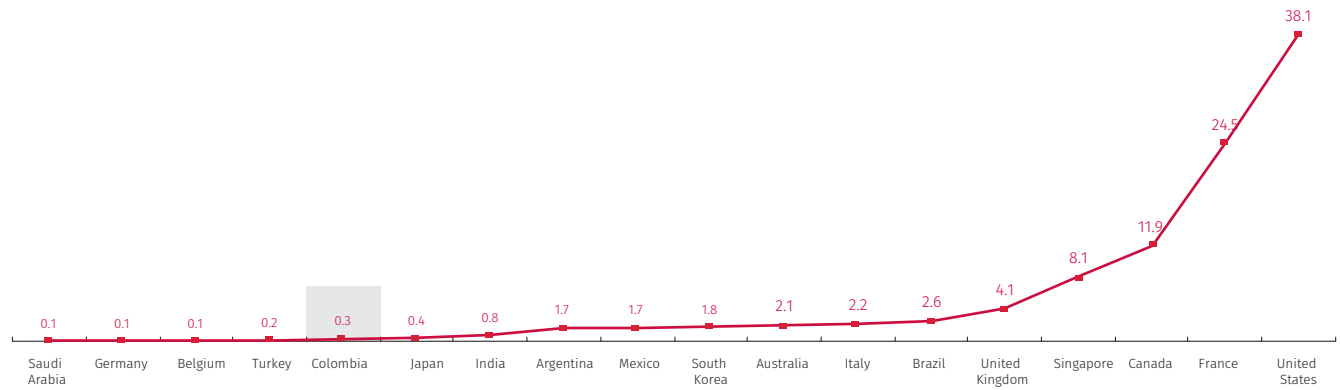
ii. Value per capita and in relation to GDP



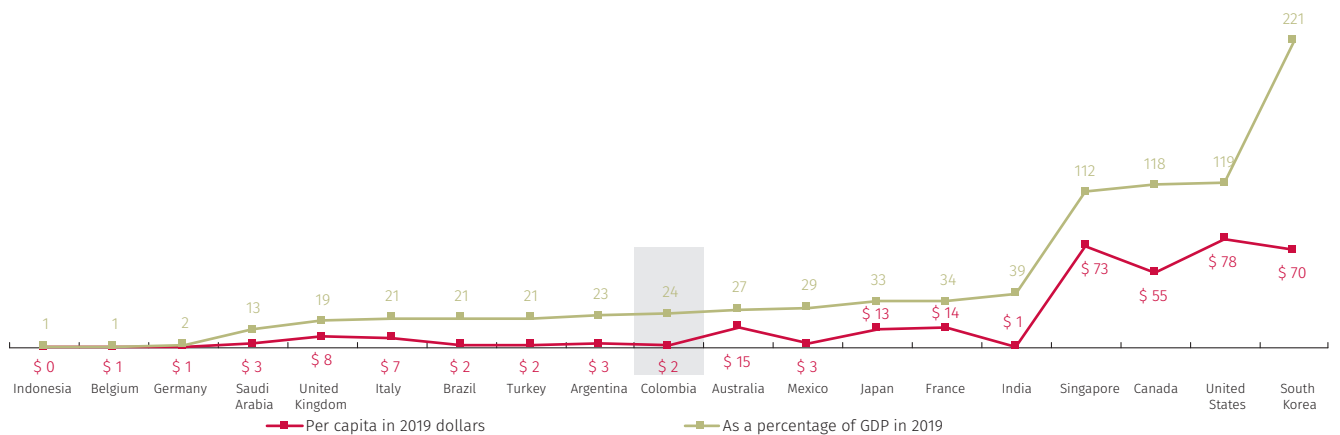
Graph 3.20 (continued)
Payment Instrument, International Comparison, 2019

B. Checks

i. Number of transactions per capita

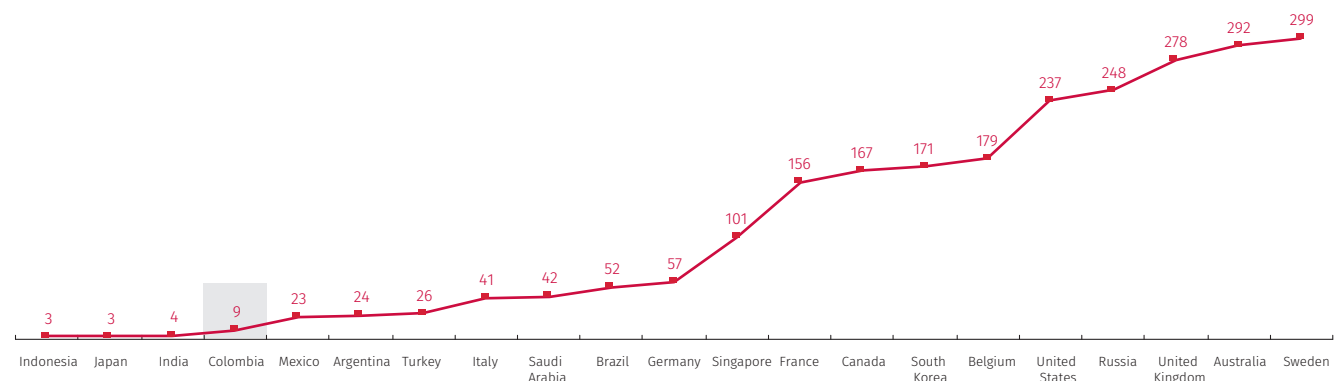


ii. Value per capita and in relation to GDP



C. Debit Cards

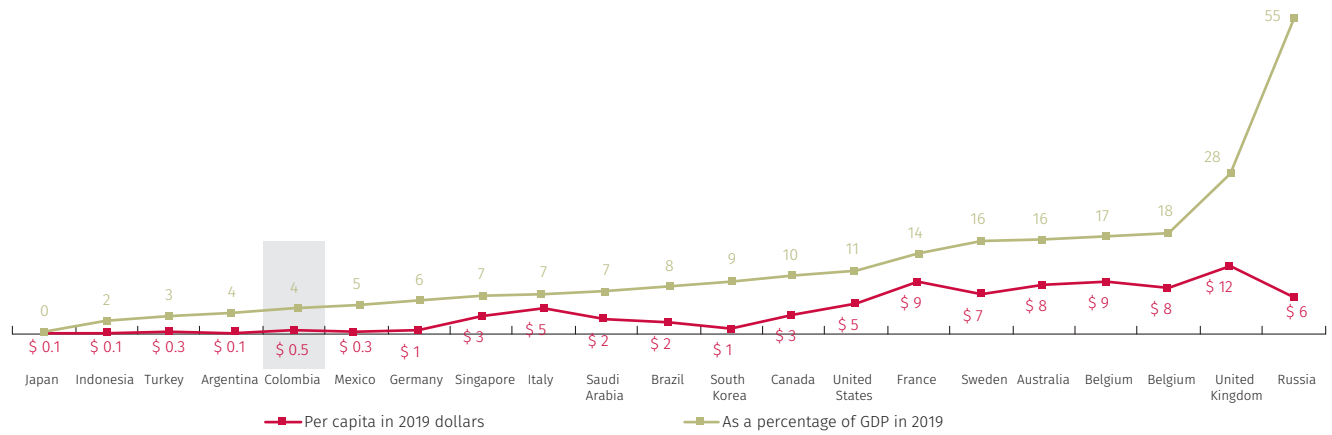
i. Number of transactions per capita



Graph 3.20 (continued)
Payment Instrument, International Comparison, 2019

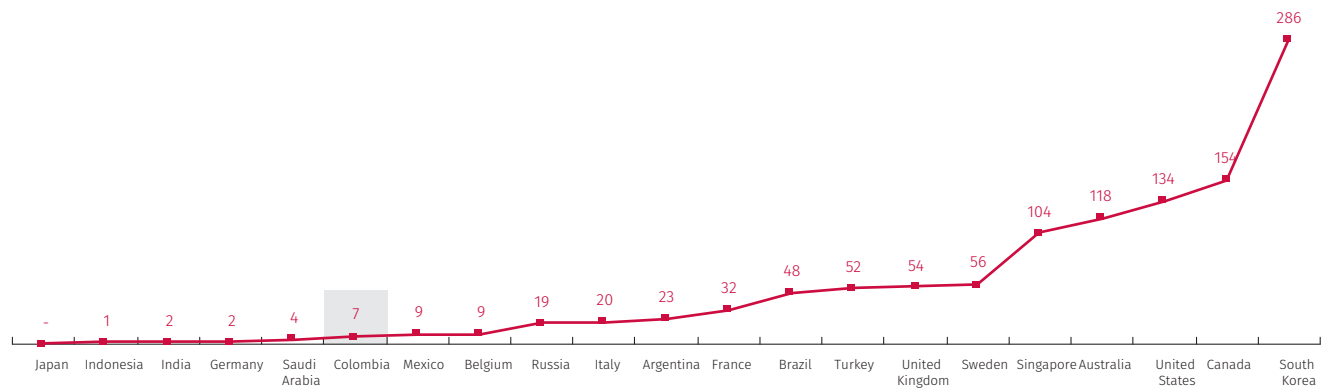
C. Debit Cards

ii. Value per capita and in relation to GDP

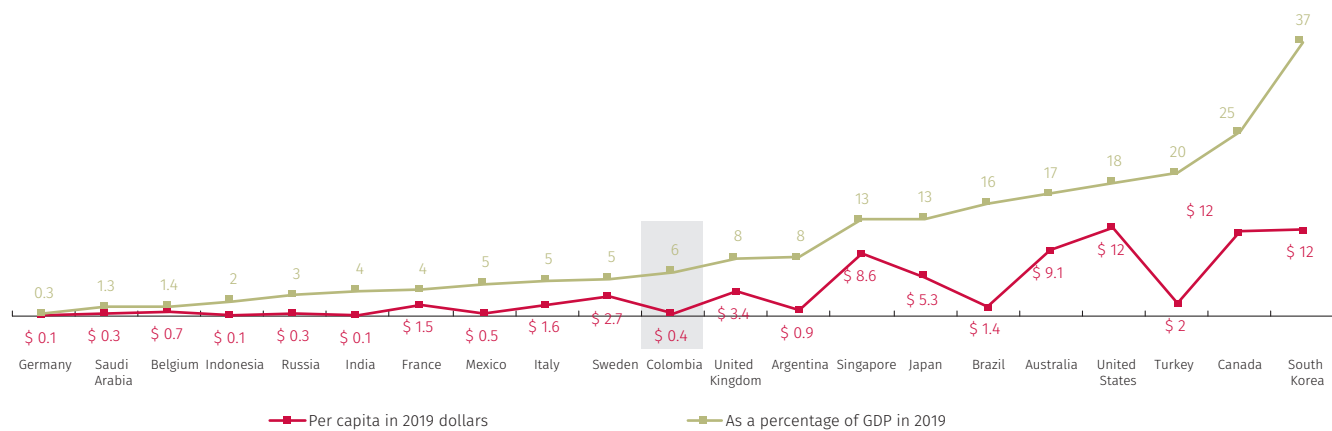


D. Credit Cards

i. Number of transactions per capita



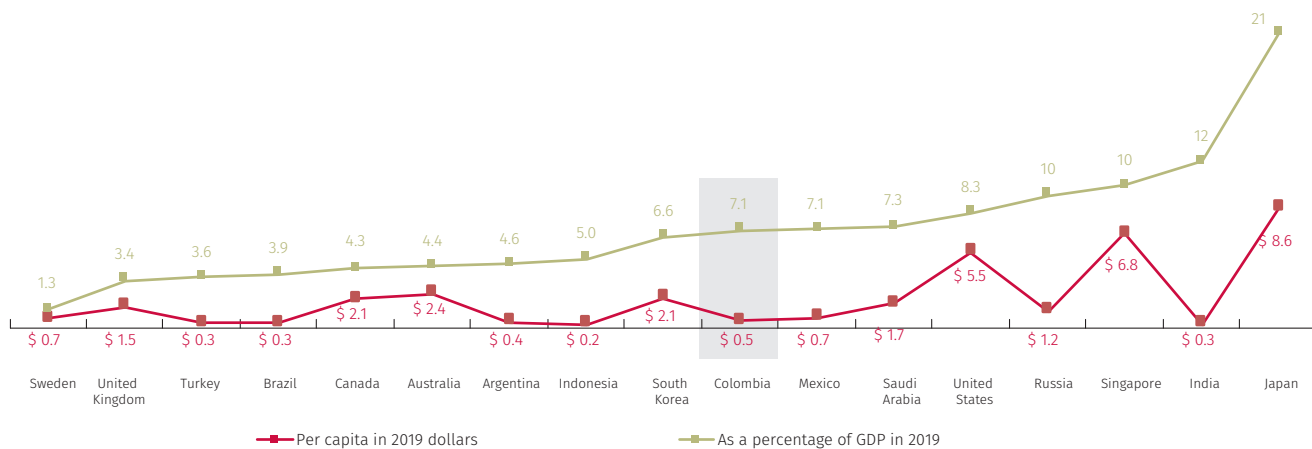
ii. Per Capita Value and as a share of GDP



Graph 3.20 (continued)
Payment Instrument, International Comparison, 2019

E. Cash in Circulation

i. Value per capita and in relation to GDP



Sources: BIS (Red Book), ACH Colombia, Office of the Financial Superintendent of Colombia and Banco de la República (DSIF).

Box 2

How the Use of Mobile Wallets Has Evolved

The rapid growth of the *fintech* industry is partly explained by the unsatisfied demand for financial services. In the case of Latin America, the literature indicates this unsatisfied demand is the result of an inadequate supply of banking, payment and transfer services.

As far as the *paytech* industry is concerned (i. e.: the payment-oriented segment of the *fintech* industry), mobile wallets allow users to employ their mobile devices (e. g., mobile phones and tablets) to make payments through transfers between accounts, as well as online and face-to-face purchases. In other words, a mobile wallet replicates a physical wallet on a mobile device, allowing the user to store and use different payment instruments to make mobile payments.

The literature indicates there are several reasons why mobile wallets and mobile payments are particularly important in developing countries. For example, Iman (2018) emphasizes that mobile payments facilitate providing financial services to the unbanked population by promoting and encouraging payment services, especially person-to-person transfers. Although mobile payments have been around for some time, Kaur *et al.* (2020) say mobile wallets have contributed a new and more versatile way to process payments via the internet. Additionally, Mumtaza *et al.* (2020) argue that mobile wallets can be a real alternative to cash, given how easy they are to use and the positive impact they have on cashless transactions.

On the other hand, the factors that determine the use of mobile wallets and mobile payments by the population have been identified in the literature. Ease of access and use, perceived usefulness and security, efficiency, transparency, limited access to banking services and the high cost of transfer services are the most predominant ones (see Iman, 2018; Karsen *et al.*, 2019; Kaur *et al.*, 2020; Mumtaza *et al.*, 2020). However, the use of mobile wallets tends to be limited and mixed in developing countries (see Kaur *et al.*, 2020; Mumtaza *et al.*, 2020), where differences in internet access, literacy, access to banking services and infrastructure determine this heterogeneity.

Research on the use of mobile wallets and mobile payments focuses on aggregate indicators, such as the value and number of payments, and the number of users. Although these indicators are important when evaluating the use of mobile wallets, their scope is limited because

they do not capture changes in user behavior and the subsequent change in patterns of use. In other words, there is no user perspective in the study of payment services. This shortcoming is not unique to research on the use of mobile wallets and mobile payments but is widespread in the literature on payments (see Singh, 1999; Unger *et al.*, 2020).

The findings of a study by León (2021), in which different types of indicators were used to assess developments in the use of a Sedpe mobile wallet, are presented in this box. In addition to the number of users and the value of transfers, indicators are used to measure the complexity of the transfer network among users of the mobile wallet under study. In this case, the complexity of the transfer network makes it possible to evaluate the evolution in mobile-wallet use from the user's perspective, where an increase in complexity is consistent with more diverse and sophisticated utilization by the users.

1. How to Measure Use?

It is customary to measure the use of a payment scheme based on the number of users and the value of transfers between them. As would be expected, the greater the number of users and the value of their transfers, the greater the use of the payment system. However, this type of indicator focuses on use of the technology and not on how users employ the payment system (Singh, 1999). In this sense, traditional indicators omit the relationships between users and the structure that emerges from these relationships as a source of information on the use of payment schemes.

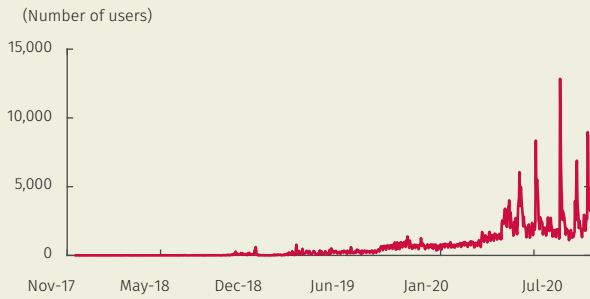
As Maurer (2012) says it is essential to use indicators that recognized the fact that users not only use the technology, but also become designers and innovators of the payment system. With this in mind, transfers between users can be employed as a source of information on the relationships between them and the structure that emerges from those relationships. Thus, León (2021) constructs a network of transfers between users of a Sedpe mobile wallet to calculate indicators that capture various aspects of user usage.

In addition to calculating the number of users and the value of transfers between them, a variety of indicators are calculated for each day, based on the transfer network. They include the density of the transfer network, the average number of counterparties in the network, the reciprocity and transitivity of relationships, the number of sub-networks in the network, the number of sub-networks with two or more users, the number of users in the largest sub-network, and entropy in the network.¹ Graph B2.1 shows how these indicators evolved

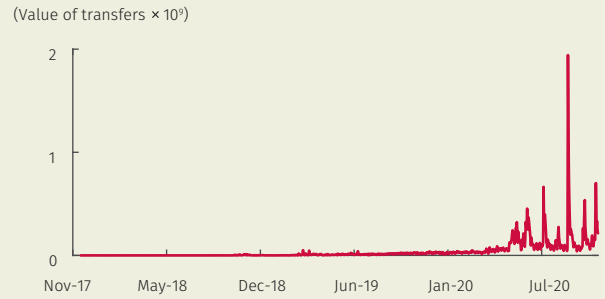
¹ All these indicators are possible measurements of the complexity of the transfer network and, hence, the use of the payment scheme. As described in León (2021), these indicators fall into two categories of measurements of complexity; *difficulty in their description and degree of organization* (See Simon, 1962; Lloyd, 2001; Mitchell, 2009).

Graph B2.1
Network Indicators

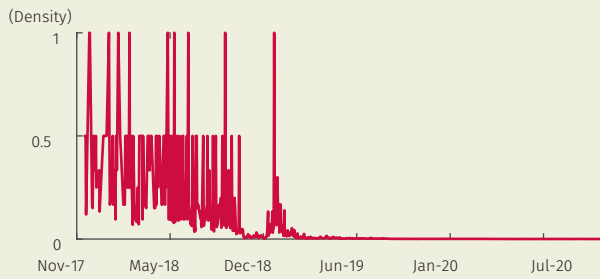
A.



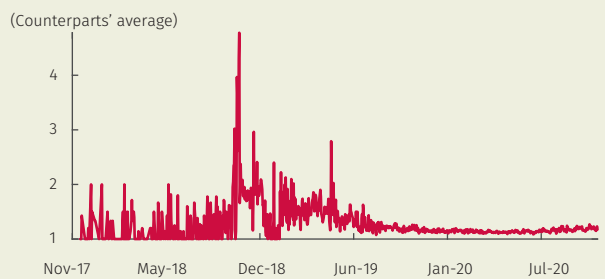
B.



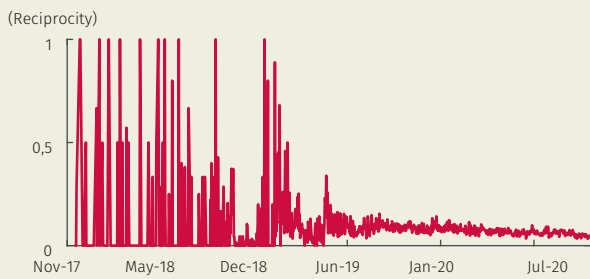
C.



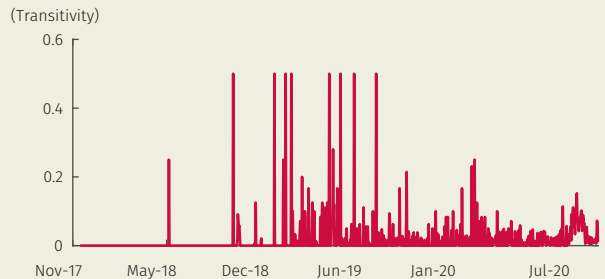
D.



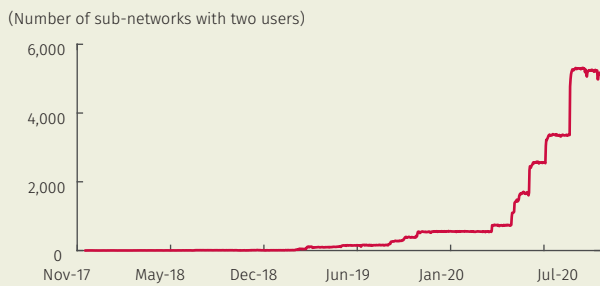
E.



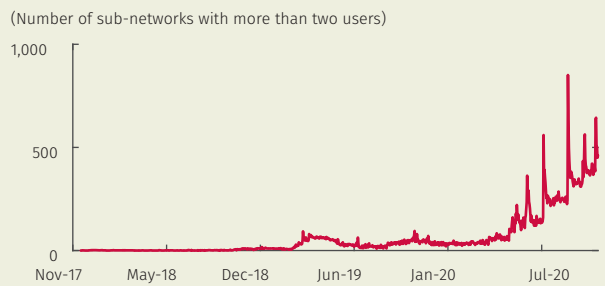
F.



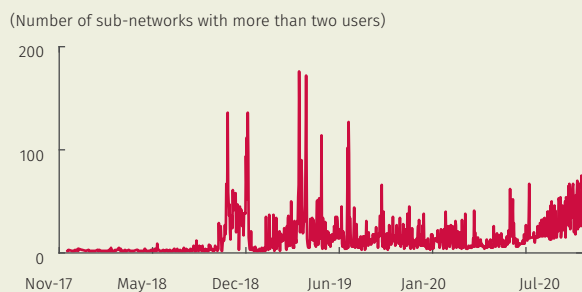
G.



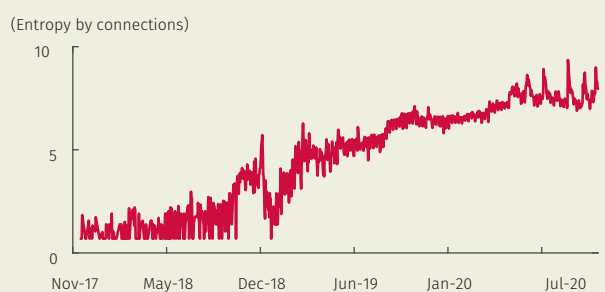
H.



I.



J.



Source: León (2021).

daily during the period from 17 November 2017 to 25 November 2020.

Regarding the number of users and the value of transfers between them, both obviously increased. This behavior is particularly noticeable during 2020, a year when the Covid-19 pandemic brought subsidies for low-income citizens, which were delivered by national and local governments through mobile wallets. The average number of users in the last 100 days reached 2,620, with some days exceeding 5,000 users. The value of transfers averaged COP 183 million (m) in the last 100 days, with some values exceeding COP 1 billion.

The density of the transfer network declined. Density is calculated as the proportion of relationships between users with respect to the total number of possible relationships. From 36% in the first 100 days of the sample, it dropped to less than 1.0% in the last 100 days of the sample. This reduction was anticipated, since the average number of counterparties per user is not expected to increase with the number of mobile wallet users. This low density and the limited number of average relationships per user (about 1.2 in the first and last hundred days of the sample) are consistent with what has been observed in many other network cases documented in the literature.

The reciprocity and transitivity of relationships identifies the incidence of groups composed of two and three users who are fully related. Reciprocity is calculated as the proportion of two-way relationships between two users, where both users send and receive transfers from each other. There is a downward trend in the incidence of reciprocal relationships. As expected, it becomes rare over time for two users to exchange transfers with each other on the same day.² Transitivity, on the other hand, is calculated as the proportion of relationships between three users where all three send or receive transfers to or from each other, forming a group of three interconnected users. The incidence of transitory relationships is low, except on a few days during 2018 and 2019. The limited degree of transitivity shows it is uncommon to find a situation where three users make transfers among themselves. When there are groups formed by three users, there is usually no relationship between two of them.

As for the number of sub-networks with two users, this indicator quantifies the incidence of relationships involving only two users. Therefore, it provides a measure of the prevalence of simple relationships in the transfer network, which are presumed to be person-to-person (P2P) relationships. The number of sub-networks with more than two users is a measure of the presence of more complex relationships between

users, where person-to-person and person-to-business (P2B) relationships are presumed to exist. Both indicators show an upward trend, with the number of sub-networks with two users growing faster than the number of sub-networks with more than two users. However, the increase in the number of sub-networks with more than two users is significant, having reached 345.88 on average in the last 100 days of the sample. The trend in the number of users in the largest sub-network is upward as well, averaging 34.25 in the last 100 days of the sample. Taken together, this suggests the relationships between users involve not only to person-to-person transfers, but perhaps person-to-business transfers as well.

Entropy is a measure of the complexity of the connective structure of the network.³ During the period under review, the trend in network entropy also increased, with a brief phase of decline in early 2019. This suggests the connective structure of the network has become more complex over time, which is consistent with the trend in other indicators, such as the number of users, the number of sub-networks with more than two components, and the number of users in the largest sub-network. These indicators are also used as measures of complexity.⁴ In short, the indicators suggest users not only increased the number and value of their transfers, but the use of mobile wallets to make transfers also evolved towards an increasingly complex structure.

2. How to Visualize Use?

Since utilization is analyzed on the basis of transfers between mobile wallet users, it also is possible to visualize the change in the connective patterns resulting from the relationships between users. This visualization pertains to networks of transfers between users, where the nodes represent the users, and the arrows represent the transfers made by one user to another during a day. Graph B2.2 illustrates eight transfer networks on eight dates in the period under study, presented in chronological order.

A look at the networks in Graph B2.2 and the video with the complete series of networks⁵ shows the mobile-wallet transfer network obviously has evolved into a more complex connective structure. Initially, it starts with a network of a few users with simple relationships (networks a to c). Then,

2 Initially, users may have exchanged transfers on the same day, when testing the mobile wallet. Also, exchanges of this type may be due to transfers made by mistake or when trying to correct an error. As users learn and their number increases, the incidence of transfer exchanges becomes low.

3 Entropy is a metric commonly used to measure the structural complexity of a network (Wen and Jiang, 2019). It represents the amount of information required to develop a statistical description of the network (Morzy, *et al.* 2017). Since it increases with connectivity and other network complexity factors (e.g., cycles, branches), it satisfies the criteria required for it to be a measure of complexity (Bonchev and Buck, 2005).

4 For example, the number of users in the network (i.e., the size of the network) is a simple measure of its complexity (Mitchell, 2009, Morzy, *et al.* 2017). Likewise, the number of sub-networks indicates the presence of a hierarchical organization, which is typical of complex systems (Simon, 1962 and Mitchell, 2009).

5 To view the entire network series in one video, go to https://youtu.be/D_BTDP1Rx44, or use the following QR code:

Graph B2.2
Selected Database Network

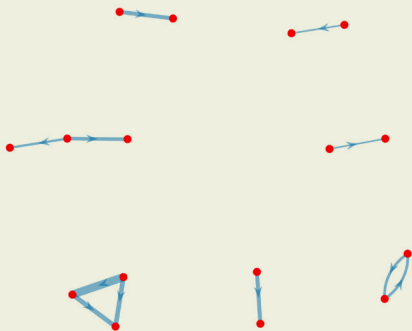
A. November 18, 2017



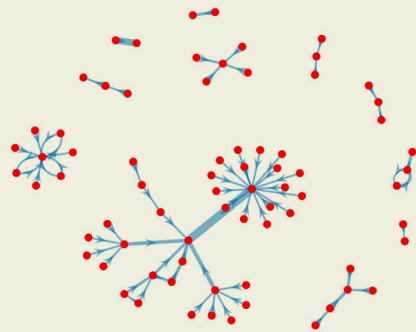
B. April 16, 2018



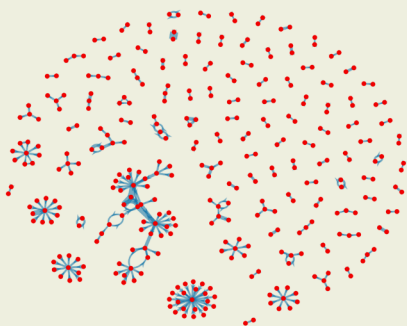
C. August 17, 2018



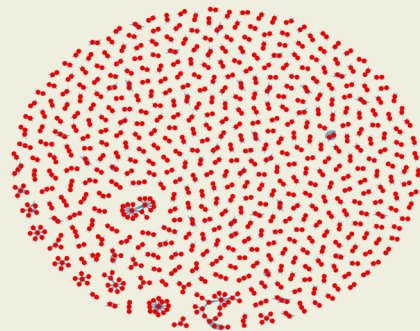
D. January 25, 2019



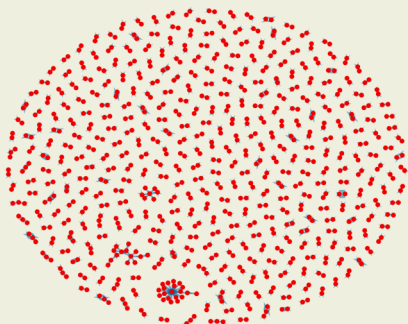
E. June 29, 2019



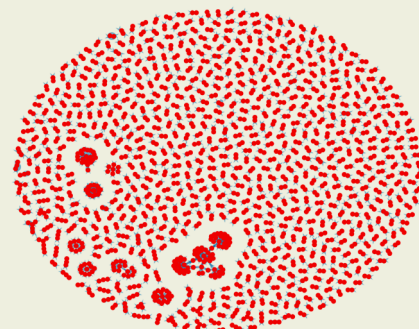
F. October 28, 2019



G. March 9, 2020



H. November 15, 2020



Source: León (2021).

it evolves into several dozen (networks *d* to *e*), several hundred (networks *f* to *g*), and several thousand users (network *h*), who maintain increasingly complex relationships. With this complexity, it is evident the relationships between users are no longer simple transfers between two users disconnected from the rest and have given way to connecting patterns in the form of stars, chains and loops.

The number of sub-networks with more than two users grew during the period, which is consistent with the indicators reported and analyzed above. This increase is accompanied by the emergence of a particular structure: star-shaped sub-networks with a central user who merely receives transfers from several surrounding users. They, in turn, do not connect to each other. This connective pattern matches what is expected in a person-to-business relationship where the central user is a seller of goods and services who receives transfers through a mobile wallet in return for those goods and services. The buyers are not connected to each other, and the seller does not transfer money to them. In some cases, star-shaped networks are related to other similar ones, where these relationships occur between the central nodes of each star. The latter

suggests the possible existence of business-to-business relationships. Figure B2.3 presents four sections (close-ups) of networks showing these connective patterns.

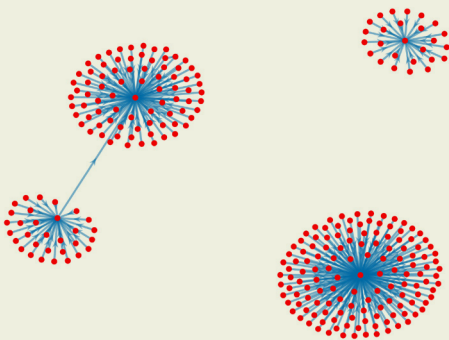
3. Conclusions and Contribution

The article by León (2021) examines the payment scheme of a Sedpe mobile wallet. In contrast to the literature on the adoption of payment technologies and services, the bilateral transfer networks between users of this mobile wallet are constructed, analyzed and visualized. In addition to studying the evolution in the number of users and the value of their respective transfers, the increase in the complexity of the structure of the mobile-wallet transfer networks is quantified and visualized. Doing so makes it possible to study the evolution in transfer patterns among mobile wallet users, from the day the first transaction occurred (November 18, 2017) up until November 25, 2020.

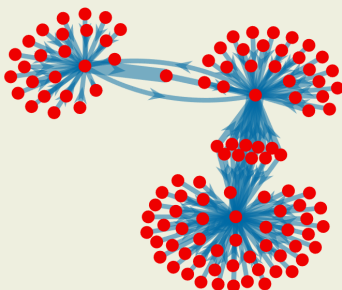
Besides the expected increase in the number of users and the value and number of transfers, one sees the pattern of transfers between mobile wallet users becomes more

Graph B2.3
Star-shaped Networks

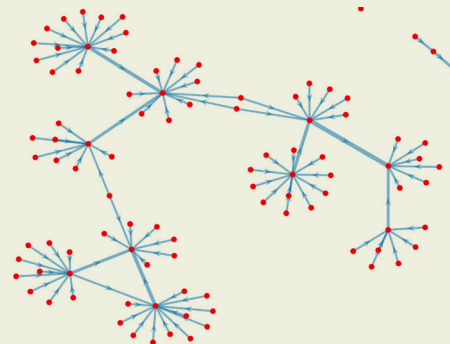
A. October 28, 2018



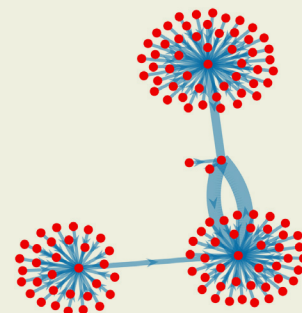
C. May 17, 2019



B. December 6, 2018



D. July 14, 2019



Source: León (2021).

complex in time. The change in transfer networks illustrates (both visually and quantitatively) that users find new ways to use mobile payments beyond person-to-person transfers, presumably including person-to-business and business-to-business payments. This can be explained by the well-known difficulty small businesses have in receiving payment instruments other than cash. In this case, the mobile wallet not only facilitates person-to-person transfers but also those between people and businesses. The results also show the Covid-19 pandemic accelerated the change in the mobile payment scheme for this mobile wallet.

The findings are useful to *paytech* industry players by making it possible to examine the evolution in a payment scheme from the standpoint of its users. For institutions that are responsible for regulating, overseeing and monitoring retail-value payment systems, this perspective and the results allow for a better understanding and analysis of mobile wallets and mobile payments. For the regulation and provision of retail-value payment services, the emergence of connective patterns typical of person-to-business transfers highlights the limitations small merchants face in terms of receiving payments made with non-cash instruments, as well as the possibility of using mobile wallets to address such constraints. For players in the *paytech* industry, this perspective and the results provide elements for the design and implementation of new products and services. For the government, it will allow for a look at how government-to-person transfers are distributed and used by the population. For example, based on the data for the Covid-19 pandemic period, it will be possible to explore how the population used the subsidies granted by the government. This information can be used to design and implement transfer programs for these segments of the population.

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Box 3

Several Effects of the Covid-19 Pandemic on the Payment Patterns of the Colombian Population

In Colombia, as in most countries, quarantines, lockdown measures, closure of non-essential businesses and travel restrictions have been imposed to alleviate the strain of the Covid-19 pandemic on the health care system.¹ These measures have led to a reduction in economic activity and consumption, forming a combination of adverse shocks that could generate deep recessions in many countries in the years ahead (World Bank, 2020). This economic environment has given rise to different opinions on the possible effects of the virus on the population's payment patterns. Some claim the way people pay for goods and services has been transformed by innovations such as smartphones, online banking, and contactless payments (UK Finance, 2020). Others point out this environment may have further accelerated the move toward digital payments in commercial activities (Carstens, 2021), and these changes could be long term (Auer, Cornelli and Frost, 2020). This box offers a diagnosis of the effects of the pandemic on the population's payment patterns, based on a descriptive analysis of data on cash in circulation and payments with other instruments, (i.e., credit and debit card), and data on consumption and consumer confidence.

1. Cash in Circulation

One aspect of *Banco de la República's* mission is to supply banknotes and coins to the economy through its distribution channels. The first channel is accessed by commercial banks, whose cash requests represent, on average, 92.7% of the total

¹ The year 2020 was marked by the Covid-19 virus, which suddenly appeared in the city of Wuhan (China) at the end of 2019 and quickly spread throughout the world, affecting the normal course of activities carried out by the population. On March 12, 2020, a health emergency was declared in Colombia, empowering the country's president and its municipal mayors to take extraordinary measures of a preventive, mandatory and transitory nature aimed at containing the spread of the virus within the country (see Resolution 385 of March 12, 2020, Ministry of Health and Social Protection).

amount of cash supplied annually by Colombia's central bank. The second channel represents 2.8% of cash, on average, and is made up of retail windows located in Bogota and in thirteen other cities with central bank treasury services. The third channel supplies cash (4.5%, on average) to complementary cash centers operating in twenty-two cities throughout the country, nine of which do not have treasury services.

Cash in circulation is a balance that changes daily and is held by financial entities, the real sector and the general public (*Banco de la República*, 2020a). Figures on cash in circulation, measured for this exercise by banknotes of all denominations, point to an unprecedented increase during 2020.² The annual rate of growth in the value of banknotes in circulation rebounded considerably as of March (marked by the dotted line in Graph B3.1) and even surpassed the record high of 20% observed in October 2015. The average annual growth rate in 2020 was 23.21%, much higher than what was observed in 2019 (12.07%) and 2018 (9.34%).

Graph B3.1
Cash (Banknotes) in Circulation



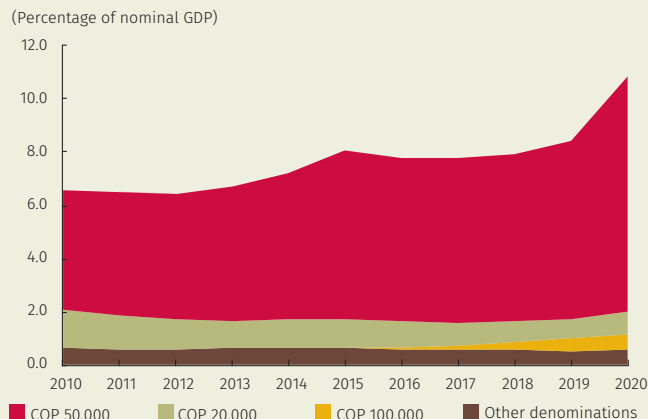
Source: Banco de la República (DSIF calculations)

This upward trend in the demand for banknotes began to reverse in August 2020, but the results for the second half of the same year continued to be much higher (26.36%) than those on record for the first half of 2020 (19.99%). The ratio between the value of banknotes in circulation, by type of denomination and nominal GDP, was constructed in an effort to examine this situation more closely (Graph B3.2). The findings show a notable increase in this indicator, which went from 8.40% in 2019 to 10.84% in 2020. The denomination with the largest circulation was the 50 thousand-peso note (8.87% of GDP), which is the second largest bill in Colombian currency. It also is the largest denomination available and dispensed at ATMs.

A widespread increase in banknotes in circulation during 2020 was also recorded in other countries, such as the

² This generalization is consistent with the total value of cash in circulation, 2.43% of which was represented by coins in December 2020.

Graph B3.2
Banknotes in Circulation as a Percentage of Nominal GDP



Source: Banco de la República (DSIF calculations)

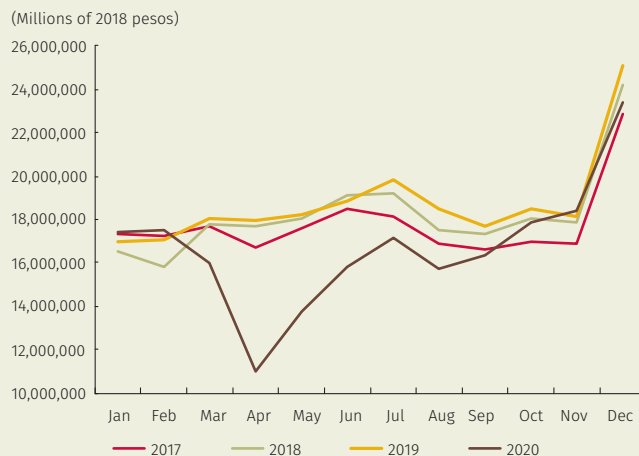
United States, Canada, Italy, Spain, Germany, France, Australia, Brazil and Russia. While these results can be attributed to the transaction and precautionary motives behind the demand for cash, they are most likely due to the latter, which would be evidence of banknotes hoarding driven by panic (Goodhart and Ashworth, 2020). To understand the results at the local level and assess which of these motives drove the demand for cash in Colombia, figures on credit and debit card use, private consumption and the consumer confidence indicator are used in the following sections.

2. Cash Withdrawals and Advances

The public's demand for cash is usually measured by data on credit and debit card withdrawals. For the Colombian case, this measurement may be somewhat limited because the proportion of people with access to financial services is still far below the population that should have access to them: 47.7%, according to the survey on the provision of banknotes, coins and payment instruments (Banco de República, 2020b). This causes the Colombian public to make considerable use of cash for routine retail payments, which came to 87% in 2019, according to the same survey. Consequently, the indicators on cash withdrawals and cash advances presented in this section refer exclusively to the population with access to financial services. The following statistical description is based on the figures for withdrawals and advances between 2017 and 2020. They were obtained from the SFC and are expressed in constant prices.

The value of debit card withdrawals in 2020 was lower than it was between 2017 and 2019. The largest reductions occurred in March and April. Although the value of debit card withdrawals rebounded from May onwards, it remained low until September (see Graph B3.3). As of October 2020, these figures returned to the levels on record for the last three years; however, compared to what was observed in 2019, they were 10.87% less.

Graph B3.3
Debit Card Withdrawals

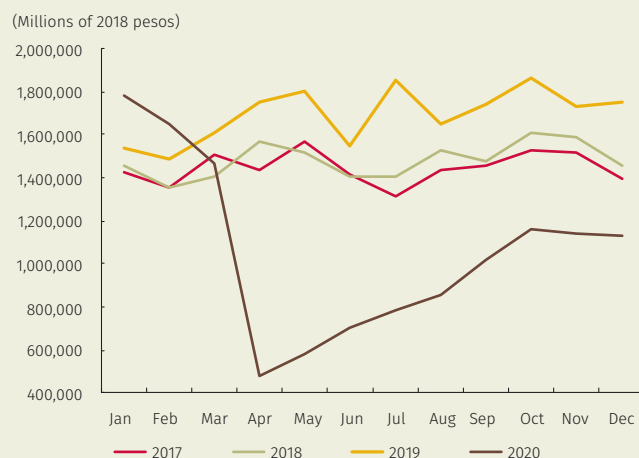


Source: Office of the Financial Superintendent of Colombia and DANE, calculations by Banco de la República.

The impact of the Covid-19 pandemic was even greater in the case of credit cards. Their use for cash advances declined as of April 2020 and, throughout the rest of the year, it remained well below the levels observed in previous years (Graph B3.4). Therefore, it is not surprising that credit card advances declined by 37.14% compared to what was observed in 2019.

The public's access to cash through card withdrawals and advances shrank by 13.05% in 2020. The sharpest drop was between March and April, coinciding with the strict containment measures adopted at the onset of the pandemic. The value of debit card withdrawals returned to its usual levels as of October, while credit card withdrawals are still well below the levels seen in 2017.

Graph B3.4
Credit Card Cash Advances

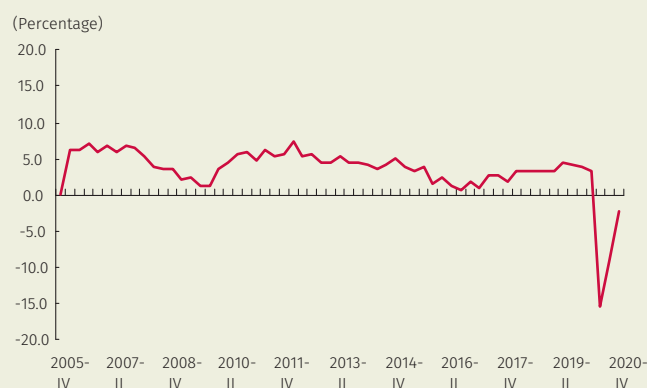


Source: Office of the Financial Superintendent of Colombia and DANE, calculations by Banco de la República.

3. Private Consumption

The lockdown measures and restrictions on the public’s mobility as a result of the pandemic had a considerable effect on private consumption, represented in this case by household spending. A review of the quarterly figures for individual household expenditure on end consumption, at constant 2015 prices, shows the annual growth rate in the second quarter of 2020 was 15.41% less than during the same quarter in 2019. The rates for the third and fourth quarters of 2020 were also negative (-8.99% and -2.16%, respectively). As a result, private consumption for all of 2020 was down by 5.85% (Graph B3.5).

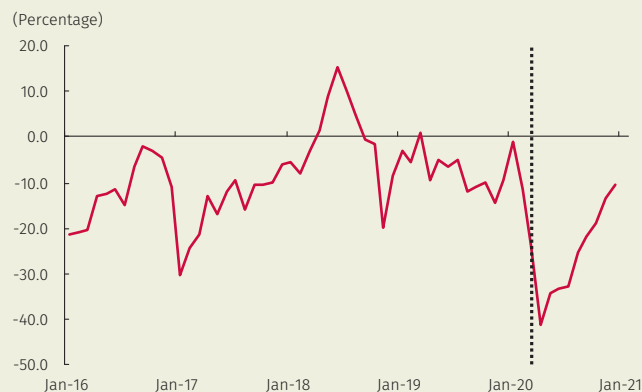
Graph B3.5
Household Consumption



Source: DANE (DSIF)

The drop in private consumption coincides with the consumer confidence index, which had shown poor results since April 2019 (Graph B3.6). At the beginning of 2020, the lockdown measures, the closure of commercial establishments and job losses further accentuated the drop in the consumer confidence index. By April 2020, it was at its lowest point in the last five years (-41.3%). Although it

Graph B3.6
Consumer Confidence Index



Source: Fedesarrollo (Encuesta de opinión de consumidor, EOC)

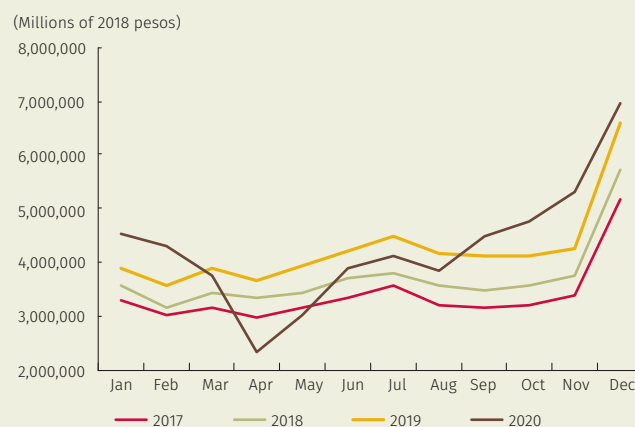
recovered slightly as of May, the results for the months thereafter remained low.

According to SFC figures on credit and debit card transactions, and DANE data on private household consumption, card purchases accounted for 13.25% of quarterly private consumption during 2020, on average, with debit cards making up 7.26% and credit cards, 5.99%. The value of debit card purchases began to decline in February 2020, mirroring the trend observed in the previous four years. However, the contraction became even more pronounced in March and April 2020, coinciding with the beginning of the health emergency caused by the pandemic (Graph B3.7). Debit card purchases improved slightly in May, reversing the downward trend witnessed in this indicator during previous months. As a result, the annual growth rate for 2020 was less than 1.0% (i.e., 0.90%).

Credit card purchases behaved similarly to those made with debit cards, contracting sharply between February and April 2020, and improving somewhat as of May. However, in this case, the rebound in the figure on use was not enough to cushion the drop in the annual growth rate (-19.21%), since the extent of purchases during most of the months thereafter was less than in 2019. Furthermore, the figures for December evidence an abnormal drop in the use of this payment instrument. Generally, the results for December are higher than those for the other months of the year, due to the seasonal effect of Christmas and the year-end holiday (Graph B3.8). One possible explanation for this outcome is the increase in credit card purchases during November, propelled by the third sales-tax-free day in 2020, which the national government scheduled for the 21st of that month.

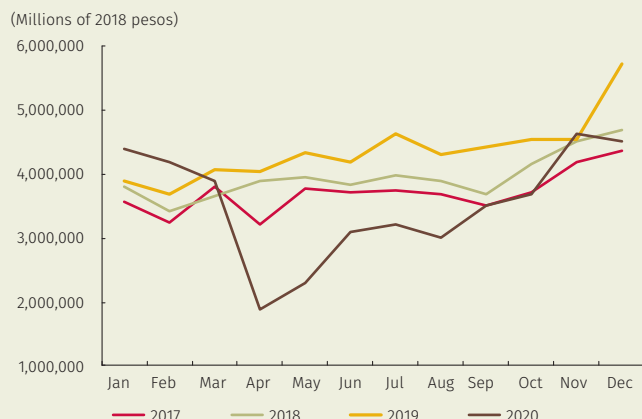
Retail trade performance in 2020 is consistent with the reduced use of credit and debit cards, and signals a drop in the value of retail sales between March and September, followed by a slight rebound between October and

Graph B3.7
Debit Card Purchases



Source: Office of the Financial Superintendent of Colombia and DANE, calculations by Banco de la República.

Graph B3.8
Credit Card Purchases

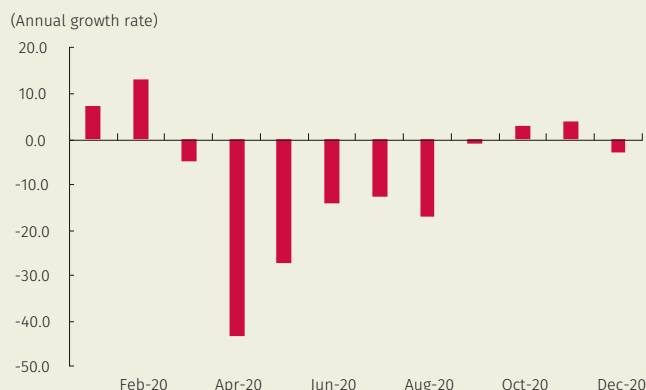


Source: Office of the Financial Superintendent of Colombia and DANE, calculations by Banco de la República.

November (Graph B3.9). The annual rate of growth in the retail trade index was -7.77%.

Most retail trade in Colombia is done through face-to-face purchases. However, e-commerce data from Statista shows Colombia ranked fourth in Latin America for sales of this type during 2019, after Brazil, Mexico and Uruguay (BlackSip, 2020). In e-commerce, purchases are made mostly online, and to a lesser extent through landline or mobile phone assistance. The use of electronic payment instruments (i.e., credit cards and electronic funds transfers) predominates in purchases of this type. However, some commercial establishments allow the use of cash in e-commerce, through cash on delivery or prepayments made on payment platforms. Between January and August 2020, the value of e-commerce sales rose by 14% and the number of transactions, by 53.8%, resulting in a drop in the average

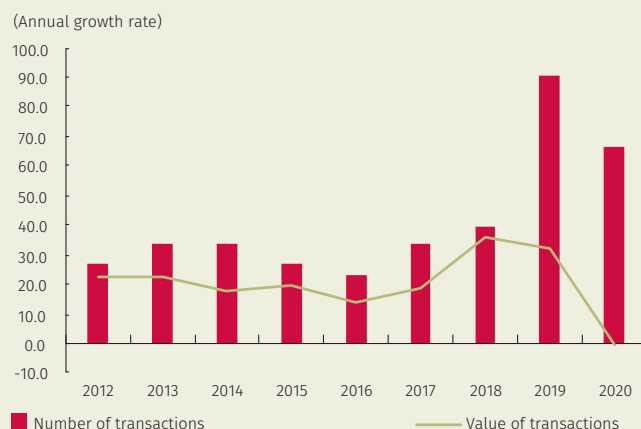
Graph B3.9
Retail Trade



Source: DANE (*Encuesta Mensual de Comercio*).

value of consumer purchases online (CCCE, 2020).³ These results coincide with those for electronic funds transfers through PSE during all of 2020: their number increased by 66.5% and their value declined by 0.05% (see Graph B3.10). For the most part, PSE payments reflect person-to-business transactions and, therefore, are a good proxy for electronic funds transfers for goods and services.⁴

Graph B3.10
Average Daily Payments for Goods and Services through PSE



Source: ACH Colombia.

During 2020, interbank transfers increased both in number (13.9%) and value (8.9%). Intrabank transfers rose even more (41.0% in number and 16.7% in value). These figures, taken as a whole, largely represent transactions between companies.

In short, since the onset of the Covid-19 pandemic, inter- and intra-bank electronic transfers - which originate mostly with businesses - registered an increase in both the number and value of transactions versus 2019. The slump in the consumer confidence index and the drop in private consumption led to changes in the public's payment patterns. The behavior of electronic payments ordered by individuals declined compared to 2019. Purchases with credit and debit cards fell, while payments for goods and services through electronic funds transfers by PSE rose in number, but sank in value, generating a drop in their average daily value. These results, coupled with the considerable increase in cash in circulation, could indicate a possible precautionary hoarding of paper money by the public, or an increased use of cash as a payment instrument, given the high dependence on cash observed in routine retail-value payments at the local level. However, a formal

3 The average value of online purchases, known as the average ticket, declined with the onset of the Covid-19 pandemic, going from COP 184,038 in December 2019 to COP 113,690 in April 2020. Between January and August 2020, the average ticket was even lower due to the fact that, although sales of food, technology and appliances increased, there was a sharp downturn in sales in the tourism sector (CCCE, 2020).

4 In the same vein, PayU's figures on the use of instruments in 2020 reveal a drop in the share of credit card and cash in online sales, and a rebound in PSE payments (BlackSip, 2020).

study is needed to provide better elements of analysis to associate the hypothesis on the increase in the demand for cash with a precautionary motive.

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Box 4 Profile of the Population Using Electronic Funds Transfers for Routine Payments

The Financial Infrastructure Oversight Department (DSIF) at *Banco de la República* does a survey¹ to measure aspects of the general public's preferences concerning the use of payment instruments (cash, cards, check and electronic funds transfers) to make routine monthly payments in the market for goods and services and the acceptance of those instruments by merchants;² in other words, these payment are limited to the purchase of food, beverages, clothing and public utilities, as well as those for transportation and housing. Therefore, this measurement does not include payments for luxury or durable goods and services or those generated in the market for financial assets (e.g., payments for household appliances, hotel stays, vehicle purchases, financial obligations other than mortgage loans, or the purchase of equities or government bonds).

In this category of "routine payments" for goods and services, cash is the most used and untraceable instrument compared to electronic alternatives, such as debit and

credit cards, checks³ and electronic funds transfers (which leave a record of each transaction). This being the case, *Banco de la República's* perception survey has been necessary to identify how the use of cash has changed during the last eight years.

The results of the survey with respect to measurements of the quantity (number of transactions) and value of retail-value payments made by the public on a monthly basis allow for identifying preferences in the use of payment instruments. The public's opinion between 2017 and 2019 regarding the number and value of transactions showed cash and debit cards were perceived as being used less and electronic funds transfers as being used more,⁴ having increased from 0.4% to 2.7% in number and from 0.9% to 3.2% in value during the period in question (Table B4.1). It is interesting to examine the demographic profile that characterizes electronic funds transfer users.

Table B4.1
Routine Payments

Use of Payment Instruments/ Years	Number of Operations		Value of Operations	
	2017	2019	2017	2019
	(Percentage)			
Cash	92.4	88.1	89.6	87.4
Debit card	5.8	5.1	7.3	5.3
Credit card	1.3	2.1	2.0	2.0
Electronic funds transfers	0.4	2.7	0.9	3.2
Other	0.1	2.0	0.2	3.1
	100	100	100	100

Source: *Banco de la República* (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

Generally speaking, the Colombian population with some type of financial product comes to 47.7% (Graph B4.1).⁵ We identify the profile of the population that is able to transfer funds;⁶ that is, members of the public with a checking or savings account, relating them to income and payment levels; educational level; occupation and social security; age, marital status, socio-economic bracket and gender; as well as the use of transfers in the different cities where the survey was conducted.

1 Every two years, *Banco de la República's* Financial Infrastructure Oversight Department, with advice on methodology from the Office for Economic Studies, conducts a national survey on the supply of banknotes and coins, and other payment instruments (EPBMIP). The findings presented here are from the survey done in 2019 (the fourth survey). The primary purpose of this measurement is to gauge the public's perception and that of businesses (merchants) on the supply of cash (banknotes and coins) in the economy. The data sheet and general results of the survey are provided in the 2020 *Payment Systems Report*, which is available at https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/9876/rept_sist_pag_2020?sequence=1&isAllowed=y

2 Electronic funds transfers are a payment instrument that enable funds to be transferred electronically from the sender's account to the beneficiary's account, either in the same bank or a different one. If the funds are transferred within the same institution, they are called intra-bank transfers. If they are from one institution to another, they are called inter-bank transfers. Depending on who orders the transfer, it is classified as a debit or credit. The former requires whoever is debiting the funds to be pre-authorized to do so by the owner of the account where the funds are held. In the case of a credit, the account owner orders the funds to be transferred from his/her account to the beneficiary's account.

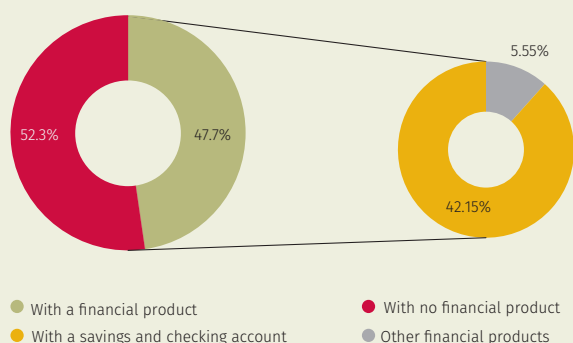
3 Checks are included in this category of the survey because they are cleared and settled electronically.

4 Hereinafter, the term "transfers" or "electronic funds transfers" will be used interchangeably.

5 For the purpose of the survey, checking and savings accounts, debit and credit cards, checkbooks and loans of any type are regarded as financial products.

6 According to information from ACH Colombia, individuals accounted for 5.0% of the value of electronic funds transfers by 2020 (legal entities, 95%) and 41% of the number of transactions (59% were ordered by legal entities).

Graph B4.1
General Public
Availability of Financial Products, 2019



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

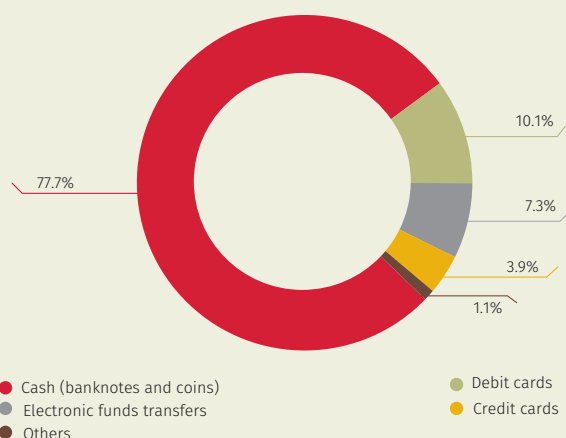
1. How does the public pay when electronic transfers can be used (42.15%) as a payment instrument?

The segment of the public that is able to transfer money and use it as an instrument to pay for the purchase of goods and services represents 42.15% of the population. In 2019, this segment reported having a savings or checking account in their own name (Graph B4.1). In the nationwide total, the same group perceived their payments, in terms of value, as being made primarily with cash (77.7%), debit cards (10.1%), electronic funds transfers (7.3%), and credit cards (3.9%) (Graph B4.2).

2. Income Level and Payment Habits

By income level, 41.2% of those who make transfers earn between one and two times the legal minimum monthly

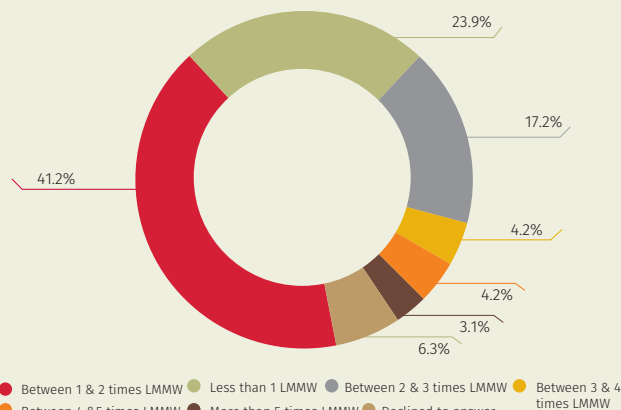
Graph B4.2
Population with Transfers
(Share pertaining to the instrument used to make the most payments in terms of value)



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

wage (LMMW),⁷ followed by 23.9% who earn less than the legal minimum monthly wage. Therefore, around 65.0% of those who make transfers in their own name earn up to two times the minimum monthly wage (Graph B4.3).

Graph B4.3
Income Level



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

As for the level or extent of regular payments, 85.1% of the population who are able to transfer funds reported their payments amount to as much as twice the legal minimum monthly wage (Graph B4.4), while 46.9% of this population indicated their payments amount to as much as the LMMW.⁸

By cities, the population that uses electronic funds transfers as their main payment instrument is concentrated primarily in Bogotá (59.2%), followed by Cali and Medellín, with percentages near 7.0% (Map B4.1).

3. Educational Level, Occupation and Social Security

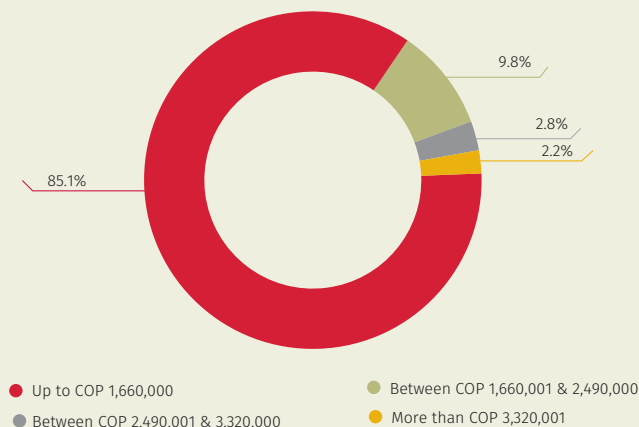
As regards to educational level, the largest fraction of the population making transfers has at least a high school diploma; that is, a complete secondary education (22.4%), followed by those with a university degree (20.1%), a technical diploma (15.8%) and postgraduate studies (9.1%).⁹

7 The vast majority of those who have no financial products and, therefore, pay with cash, earn no more than the minimum monthly wage (52.8%).

8 Approximately 83% of the population who have no financial products and pay in cash reported a level of regular monthly payments up to twice the minimum monthly wage (LMMW). The majority of this segment (54.2%) indicated the level of their payments can be as high as the minimum monthly wage (LMMW)

9 The vast majority of those who do not have financial products and pay cash have no more than a secondary education (71.9%). This group includes, in ascending order, those with a partial primary education (9.1%), a full primary education (11.0%), some secondary schooling (22.2%) and a complete secondary education (29.6%).

Graph B4.4
Level of Routine Expenses



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

Map B4.1
Use of Electronic Funds Transfers as the Main Payment Instrument, by City



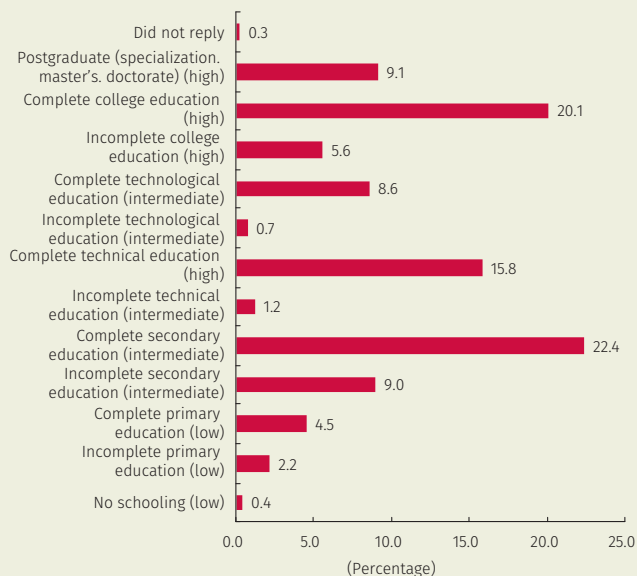
Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

Other percentages include some secondary schooling (9.0%), full technological training (8.6%) and a complete primary education (4.5%) (Graph B4.5).

Among the occupations of those who use transfers (i.e., the population that is able to use them as a payment

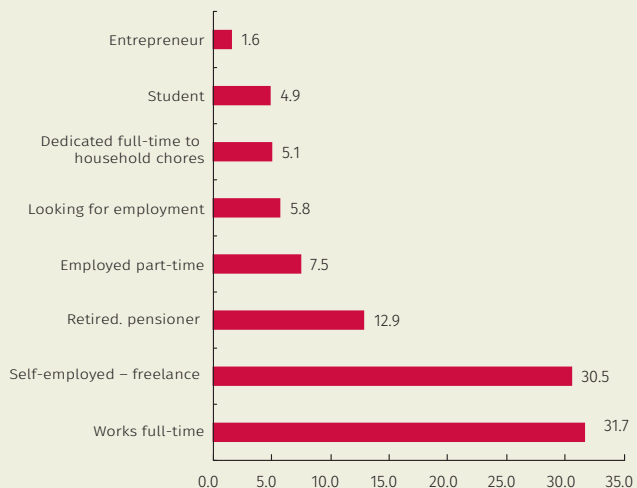
instrument), full-time employees are the most prominent (31.7%), followed by the self-employed (30.5%) and, in third place, retirees (12.9%) (Graph B4.6).¹⁰ The survey also shows that 69.1% of those who are able to make electronic funds transfers also contribute to social security.¹¹

Graph B4.5
Educational Level



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

Graph B4.6
Occupation of the Population with Electronic Funds Transfers



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

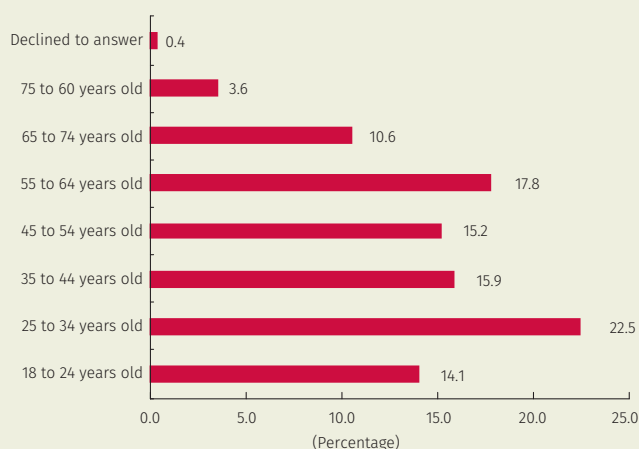
¹⁰ In terms of occupation, those who pay in cash and have no financial products largely reported being self-employed (37.3%), dedicated full-time to household chores (25.3%) or seeking employment (11.6%).

¹¹ The survey showed 28.2% of those with no financial products contribute to social security.

4. Age, Marital Status and Socio-economic Bracket

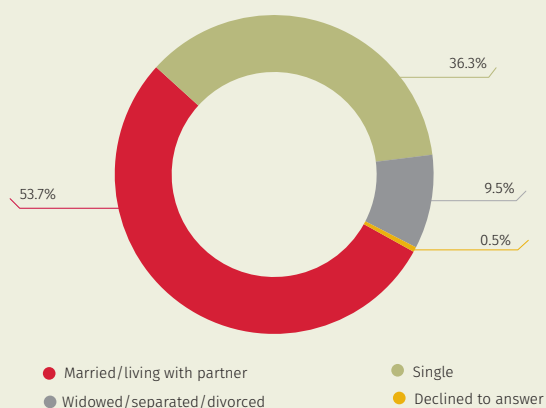
By age, the population that uses transfers is primarily from 25 to 34 years old (22.5%), 55 to 64 (17.8%), 35 to 44 (15.9%), and 45 to 54 (15.2%). In other words, 71.4% of those who use this instrument are between 25 and 54 years of age (Graph B4.7). As for marital status, 53.7% reported being married or living with a partner, 36.3% were single, and 9.5% were widowed, separated or divorced (Graph B4.8).

Graph B4.7
Age



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

Graph B4.8
Marital Status

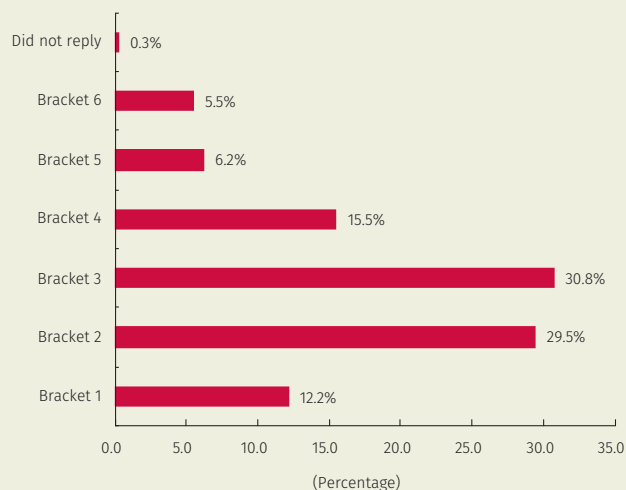


Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

With regard to socio-economic bracket, the majority of those who are able to make transfers reported being in socio-economic brackets three (30.8%), two (29.5%), and four (15.5%) (Graph B4.9).

In conclusion, the profile of the population with savings and checking accounts and the ability to make electronic funds transfers differs from the profile of the population

Graph B4.9
Socioeconomic Bracket



Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

without financial products in terms of their demographic characteristics, such as income, payment and education levels, occupation and social security.

The former largely use the various payment instruments as follows: cash (77.7%),¹² debit cards (10.1%), transfers (7.3%), and credit cards (3.9%). The vast majority of the people this segment of the population report:

- Earning up to twice the LMMW (65.0%);
- Having a level of payments up to twice the LMMW (78.3%);
- Having at least completed their secondary education (83.6%);
- Being an employee (31.7%) and self-employed (30.5%); and
- Contributing to social security (69.1%).

At the same time, the majority of those without financial products, and who only use cash as a payment instrument, are characterized as:













- Earning up to the LMMW (52.8%);
- Having a level of payments up to the LMMW (54.2%);
- Having no more than a complete secondary education (74.0%);
- Being self-employed (37.3%), dedicated full-time to domestic chores (25.3%) or being unemployed (11.6%); and
- Contributing to social security (28.2%).

12 The members of the general public who use cash account for 87.5%.

Profile of the Population

With No Financial Products vs. With a Savings and Checking Account

Comparison of Demo Graphic Profiles

Use of cash	 87.4%	 77.7%
Monthly income	 Up to 1 LMMW 52.8%	 Up to 2 LMMW 65.0%
Level of payments	 Up to 1 LMMW 54.2%	 Up to 2 LMMW 78.3%
Educational level	 No More than a Secondary Education 74.0%	 At Least a Secondary Education 83.6%
Main occupation	 Self-employed 37.3%	 Employee 31.7%
Social security	 Contributors 28.2%	 Contributors 69.1%

Source: Banco de la República (Encuesta nacional sobre provisión de los billetes y monedas e instrumentos de pago, 2019).

04

Changes in Technology and Innovation in Retail Payments

The international financial crisis of 2008 is recognized as a turning point in the development of retail payments. It marked the start of the third phase of the *fintech* industry (or *fintech* 3.0), which is characterized by the provision of a much broader range of financial services, including payment services.³⁵

Dissatisfaction with the traditional financial industry and governments in the wake of the crisis spurred the development of bitcoin, which was launched in 2009. The initial motivation behind bitcoin was to provide a peer-to-peer (P2P) electronic payment system, independent of central banks, governments and institutions in the traditional financial system. The bitcoin system, which features a form of electronic cash based on cryptography and a distributed record of transactions (blockchain), represents a major change in the way retail payment services can be provided.

Although bitcoin has not fulfilled its initial purpose in terms of being a person-to-person payment system,³⁶ it has sparked changes in technology and innovation in retail payments. As a result, and based on the initial motivation for bitcoin, a number of private and government agents have ventured into the use of technological innovations to improve existing retail-value payment systems or to develop new ones.

35 The different stages of the *fintech* industry are described and analyzed in the fourth section of the *2020 Payment Systems Report*, with an emphasis on payments.

36 As documented in the *2020 Payment Systems Report*, the view that bitcoin and others like it will not become a new payment instrument, but rather a new type of asset has gained ground. Consequently, when referring to these instruments, the term crypto assets is preferred to cryptocurrencies (ECB, 2015; Arango *et al.*, 2018; Parra *et al.*, 2019).

One of the improvements made in existing retail-value payment systems was to reduce the time it takes for funds to be credited to the beneficiary's account in the event of an electronic funds transfer. With instant payments, retail-value payment service providers try to offer users a fast-acting and reliable payment option. One of the key factors in building financial infrastructure for instant payments is the design and implementation of so-called overlay services or schemes. These consist of a technological development that allows open communication between the various agents in the payment chain, achieving a high level of interconnection and interoperability between different payment service providers. For that reason, the first part of this section examines the case of instant payments in India as an example of achieving interoperability in the overlay payment scheme.

The second part looks at digital money in central banking, better known as central bank digital currencies (CBDC). In this case, central banks develop a system whereby the nation's currency is issued and circulates digitally. Like bitcoin, CBDCs aim to offer a person-to-person electronic payment system, but one that is still dependent on the central bank and, in some cases, also on the institutions in the financial system. Like bitcoin, digital currencies in some instances are based on cryptography and distributed transaction recording (blockchain). To better understand the impact the issue of CBDCs would have on the retail-value payment system, the third part of this section focuses on how they would interact with the cash provided by the central bank and the electronic money offered by commercial banks in the form of bank account deposits.

Instant payment systems and CBDCs imply major changes in the payments ecosystem for goods and services in the economy. However, smaller scale changes can have an important impact on the user's experience with the retail-value payment system. Such is the case with the introduction of new forms of payment initiation, such as the use of biometrics, near field communication (NFC) technology and QR codes. The third part of this section examines the QR code, as a technological development to facilitate the initiation of transactions in retail-value payment systems, and looks at how its use has evolved in Colombia. The QR code is a technological development dating back to the mid-1990s. It allows payments to be initiated in a practical and simple way, through the use of a mobile phone.

These changes in retail-value payment systems should affect the way users manage their transactions. They are expected to improve the user's digital experience and discourage the use of face-to-face channels. Therefore, the fourth part of this section describes the progress in the use of digital channels versus face-to-face channels, providing an overview of how developments in technology and innovation in retail payments in the Colombian case have impacted the way financial service users make retail payments.

4.1 Instant Payments in India: An Example of Interoperability in Overlay Payment Schemes

A decade ago, the situation in the market for payments for goods and services in India was characterized by a national banking system that offered different payment options, with very few interoperable institutions, and without the technical compatibility required for the payer of one institution to transfer funds immediately to the beneficiary of another institution (i.e., with delays in the time it took for the beneficiary to receive payment). In addition, there were several closed non-bank payment schemes offering payment services that were limited to a single system, preventing interconnection with other systems for the provision of payment services. In those closed schemes, payments were processed, cleared and settled by the platform or system provider, independent of any other system (see D'Silva, *et al.*, 2019).

Based on that diagnosis, India set out to develop a digital financial infrastructure that would take advantage of the fact that, within its jurisdiction, the country's central bank is involved extensively in retail-value payments (as the institution responsible for part of their operation, regulation and oversight). In order to expand the digital payments market, the main components of that infrastructure include an overlay scheme, which is a unified payment interface that facilitates the relationship between the different applications created for message and data exchange, and a system for instant payment clearing and settlement. This part of Section 4 is intended to explore the Indian case as an example of a solution for different payment service providers (PSPs) to participate in the payment value chain and to achieve an interoperable payment scheme.

Today, now that the country's digital financial infrastructure is up and running, payments in India are enabled by instant person-to-person, person-to-business, business-to-business, and government-to-person electronic funds transfers, characterized by an interconnected technological network that extends from the beginning of the payment process to the end (Diagram 4.1) (see Derryl *et al.*, 2019).

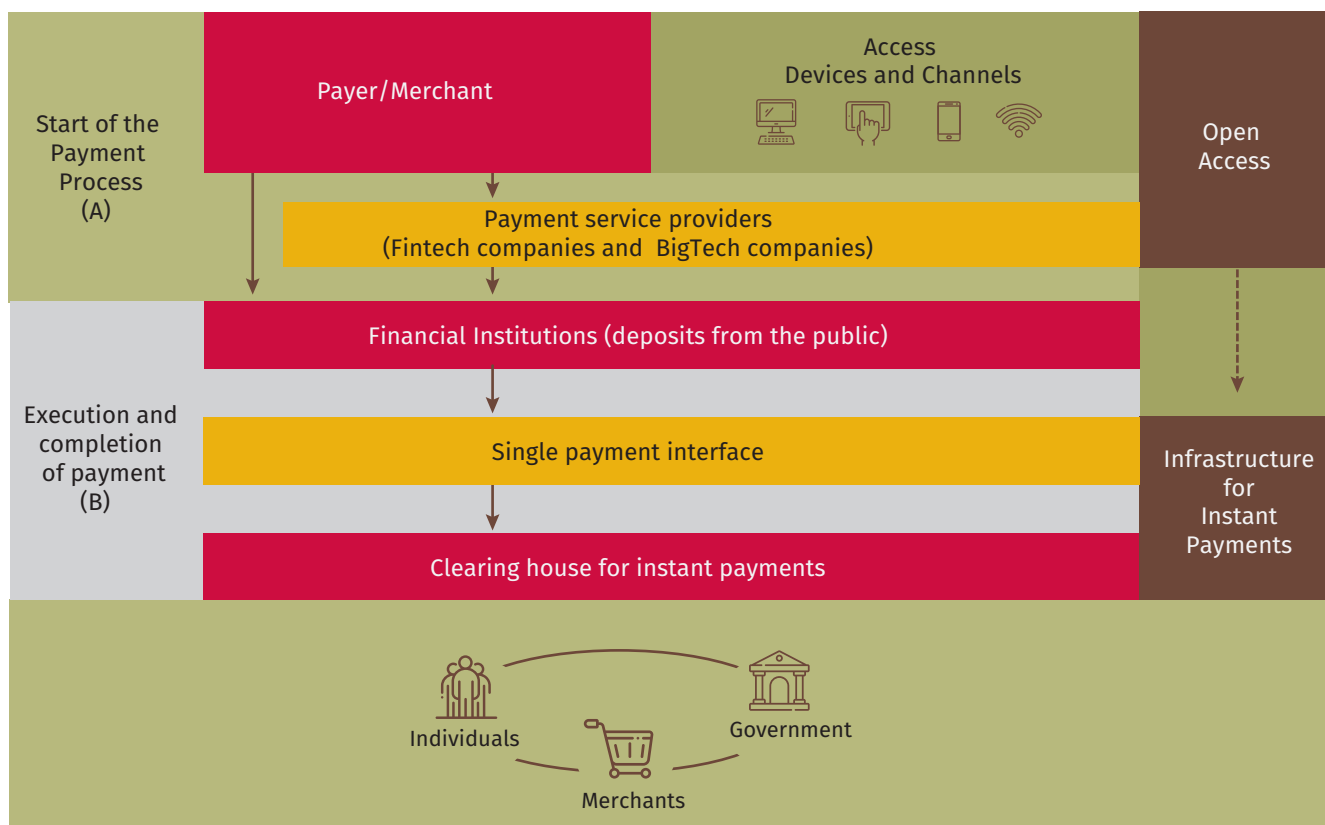
As regards to the first stage of the payment process (Diagram 4.1, Panel A), bank account holders in India are able to send and receive money immediately through a mobile phone (from payer to payee, the latter can be the merchant). Users, both payers and payment beneficiaries, can create a virtual payment address and link it to any bank account. The virtual payment address acts as the user's financial address (with no need for additional payee information, such as an account number or other details) (see NPP Australia Limited, 2019). Besides a virtual payment address, a link via a mobile number, a bank code and an ID number (or a QR code capturing any of the linking methods listed here) is possible as well.

In India, any regulated payment service provider may use the instant payment system directly to transfer funds. The payment channels include telecommunication networks, the postal system and the banking network, among others. Once the various PSPs receive payment order requests, they proceed to the payment execution and finalization stage by accessing the

instant payment technology infrastructure, which consists of the two parts described below (Diagram 4.1, Panel B).

- a. The first is a unified payment interface, which is a layer that facilitates the relationship between two applications for an exchange of messages or data. It is a space where information can be accessed and exchanged. In the case of the digital technology platform in India, it was built as an overlay on top of the clearing and settlement service for instant payment. It can be accessed by different PSPs, such as *fin-tech* companies and tech giants (who are often the new PSPs interested in offering applications).³⁷ The PSPs have open access to account information at financial institutions in order to offer their services. However, it is only the financial institutions that have access to the instant payment clearing and settlement system, which is the second component of the digital financial infrastructure in India. The interface stores the data contained in the clearing messages between participating financial institutions and the data in the settlement messages between these institutions and the payment clearing house.

Diagram 4.1
Payment Infrastructure in India



Source: BIS Papers No. 106. "The Design of Digital Financial Infrastructure: Lessons from India" by Derryl D'Silva, Zuzana Filková, Frank Packer and Siddharth Tiwari, Monetary and Economic Department, December 2019; adaptation by Banco de la República.

³⁷ An application (app) is a software program that is used especially in mobile devices to perform a specific function.

- b. The second part, as noted, is the instant payment clearing service. Developed by the National Payments Corporation of India, a non-profit organization owned by the Reserve Bank of India (RBI) and 56 commercial banks, it is the system responsible for clearing and settling instant payments. Operational since 2016, it is regulated and supervised by the RBI. As of December 2019, 143 banks were participants in this instant payments clearing service, representing more than 90% of the country's banks (see D'Silva *et al.*, 2019).

It is this infrastructure, as a whole, that ensures interoperability between service providers and has made India a pioneer in open access to payment systems. Other markets, including China and the European Union, are currently considering payment system access agreements.

India's real-time payment system is regarded as one of the most innovative in the world (see NPP Australia Limited, 2019). Operating 24 hours a day, seven days a week (24/7), it handles interbank transfers and permits different methods for identifying customers (listed above) and the payment service providers that transfer funds, admitting the latter into the overlay systems.

A greater number of agents offering payment services and communicating with each other, given the interoperability enabled by the technological infrastructure for instant payments, has led to fewer card payments, which declined by 10%, and a surge in transactions via the instant payment infrastructure. These transactions increased almost tenfold, surpassing cards as a frequent payment instrument (see Minsait, 2020).

Overlay systems, of which financial technology companies such as *fintechs* and *bigtechs* are a part, have developed different ways to interconnect with customers (by building innovative and user-friendly interfaces for ordering and receiving payments), and have accounts with financial institutions, which - as participants in the instant payment clearing service- clear and settle their transactions (see D'Silva *et al.*, 2019).

The functions described in this section have enabled *fintech* and *bigtech* companies to offer payment services such as the following:

- Google Pay. Through this app, customers can transfer funds between all banks participating in the instant payment infrastructure, besides making payments such as mobile top-ups and those for utilities (e.g., water, electricity and gas) (see Google, 2020).
- WhatsApp. This app can be used to send and receive money (see Foreign Affairs, 2018).
- Paytm, PhonePe and OlaMoney. As small-sized local payment service providers, they connect to the instant payment clearing service through regulated payment service providers (see D'Silva *et al.*, 2019).

The digital financial infrastructure developed in India has also reduced costs for users, given the increase in competition among banks, as reflected in interest rates and banking services in general. This is because the new technology, used in instant payment services, allows customers access to

information on the services offered by different banks. For example, retail customers can carry out transactions with their accounts at Bank 1 using Bank 2's mobile banking application and, thus, compare the services offered by both institutions (see D'Silva *et al.*, 2019).

In conclusion, based on a diagnosis of the retail payments market, with closed schemes and very few interoperable providers, it is possible to design and implement a model for instant, regulated, participatory and technologically inclusive payments based on an overlay scheme that constitutes a fully interoperable ecosystem for payments through instant electronic funds transfers, due to its ease of use for customers in general and guaranteed access for the different payment service providers to clear and settle their transactions.

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4.2 Retail CBDC as a Complement to Cash

Supplying cash to the population and businesses is a function that is part of *Banco de la República’s* mission. It does so by issuing and circulating physical money in the form of cash (i.e., banknotes and coins in circulation) and in the form of bank deposits for eligible financial institutions. Cash, as a payment instrument, allows the bearer to generate secure payments and transactions by facilitating the settlement of obligations immediately and with the backing of the central bank.³⁸ People with access to products offered by financial intermediaries can, alternatively, use their credit and debit cards, or transfer funds electronically, depending on the type of transaction (face-to-face or non-face-to-face), the amount and the beneficiary (individuals or businesses).

Continuing technological development could generate a paradigm shift in the market for payments, especially after the introduction of stable digital currencies offered by *fintech* companies.³⁹ The supply of private digital money, driven by technological developments, has sparked interest in the topic among central banks, mainly because there are no regulations on how these new forms of money should operate. This also has motivated research on the possibility of issuing currency in a digital format to offer central bank users an immediate and secure payment alternative. According to the latest BIS survey on the subject, 86% of the central banks surveyed are doing theoretical or practical research on the possible benefits and drawbacks of issuing retail CBDC. However, the survey also reveals that widespread issuance of such digital currencies still seems a long way off (Boar and Wehrli, 2021).

Central bank digital currency is known as retail or general purpose CBDC and could be used as a payment instrument or as a store of value (see Ferrari, Mehl and Stracca, 2020).⁴⁰ A digital currency of this type would be denominated in the national unit of account and would represent a direct obligation with the central bank, implying zero risk (Bank of Canada *et al.*, 2020; Bank of England, 2020). Retail CBDC could receive some remuneration (Ferrari *et al.*, 2020), in which case the rate the central bank would pay on digital currency holdings could be used to regulate its demand through a pricing mechanism (see Meaning, Dyson, Barker, and Clayton, 2018). Alternatively, it could be designed without the possibility of remuneration, in which case CBDC would be

38 Cash is a unit of account because the prices of all goods and services in an economy are valued in local tender. Cash also serves as a means and instrument of payment because it enables transactions, and as a store of value because it remains relatively stable over time (Erlandsson and Guibourg, 2018).

39 US Coin, Dai, Paxos and Facebook-backed Diem are some of these currencies (Frost, Shin and Wierdsma, 2020).

40 Another type of central bank digital currency is the wholesale CBDC, which allows both commercial banks and clearing houses to make their payments.

a form of digital cash. Providing this new form of money would expand the payments ecosystem in which commercial banks, private payment service providers and data service providers could participate, along with the central bank (Bank of Canada *et al.*, 2020).

A retail CBDC has the potential to compete with cash and commercial bank money, which are the existing and publicly available forms of currency.⁴¹ Cash is a form of physical money offered by a central bank to satisfy the demands of its users. Commercial banks participate in providing cash by buying central bank money to meet the demands of customers who want to withdraw money from their deposit accounts (i.e., who want to exchange commercial bank money for central bank money (cash)). Commercial bank money is a type of electronic currency and is offered by commercial banks in the form of deposits in bank accounts. This type of money is part of a commercial bank's liabilities and is created when value is credited to the deposit accounts of bank customers (i.e., when they receive payments or credits in their accounts).⁴²

4.2.1 The Views of Several Countries on Retail CBDC as a Complement to Cash

From a central bank's perspective, a digital form of its currency, if issued for use by the general public, could replace or coexist with cash. This section focuses on the views expressed by central banks in some countries as to how their digital currencies would be introduced into the economy. This does not mean these countries have already decided to issue a CBDC. It is only their point of view on the matter.

- Sweden is one of the countries that has made the most progress in terms of retail CBDC and is currently broadening its functionalities with a pilot test that will end in February 2022. On the possibility of issuing a digital currency, Sveriges Riskbank has stated its CBDC, if issued, would be intended as a complement to cash (Skingsley 2016; Auer, Cornelli and Frost, 2020).
- China is another country that has made significant headway with respect to CBDC. The second phase of its retail CBDC pilot project is currently underway, with the support of four state-owned commercial banks. According to the country's central bank (People's Bank of China), if it were to decide to issue a retail CBDC, it would serve as a complement to the M0, which includes cash in circulation (Auer *et al.*, 2020).
- Theoretical studies and experiments with digital currency are underway in the euro zone but, for now, there are no plans to issue a CBDC.

41 The fundamental difference between commercial bank money and central bank money is that the latter has very low (almost zero) credit risk and no liquidity risk (see CP-MI-IOSCO, 2012), while the former can generate both types of risk. Another difference is that central bank money anchors the local monetary system by providing a reference value with which the money supplied by commercial banks maintains convertibility at par (Chaum, Grothoff and Mosser, 2021).

42 Central bank reserves are another form of money and are used by commercial banks and other intermediaries that have deposit accounts with the central bank.

However, the EU's position on the matter leans towards introducing a digital euro as a complement to cash (ECB, 2020). The European Central Bank has said banknotes are here to stay because, even if they cannot be used in e-commerce, they can be hoarded as a store of value. The ECB is committed not only to issuing cash, but also to supporting the European Commission's efforts to maintain the use of this form of physical money (Jeffery, 2021).

- Japan is a particularly interesting case, due to a strong dependence on cash and slow adoption of electronic payment instruments observed in that economy (see Fujiki, 2020). The Bank of Japan says it has no plans to issue a central bank digital currency; however, it is currently conducting a proof of concept in an effort to better understand its technical functionalities. If issued, Japan's CBDC would function as a complement to cash since, according to the country's central bank, it will maintain its commitment to offer cash as long as the demand for this form of money persists (Bank of Japan, 2020).
- Like Japan, the United States has no immediate plans to issue a retail CBDC. However, the Federal Reserve is carrying out internal experiments to build and evaluate several distributed ledger platforms and is involved in external studies with researchers at the Massachusetts Institute of Technology to assess the effects of a digital currency intended for users of central bank money (Brainard, 2020). On this topic, the Federal Reserve says a digital currency, if it were to be issued, would be a complement to cash (see Cheng, Lawson and Wong, 2021).
- The Bahamas is the only country with a retail CBDC (the Sand dollar) in circulation nationwide as of October 2020, issued by the central bank and distributed through authorized financial institutions (King, 2020). The Sand dollar is intended as a complement to cash and, according to the country's central bank, there are no plans to rescind the latter. On the contrary, the central bank continues to work to improve the security and durability of the country's banknotes (Sand dollar, n.d.).

These cases coincide with the position of BIS General Manager Agustín Carstens, who has said a retail CBDC should complement and not replace cash (Carstens, 2021). Cash plays a very important role in the economy, since it is the only payment instrument that can be used for transactions anywhere in the country, regardless of the existence of services such as energy and internet, which are essential for issuing and using digital money (see de Almeida, Fazendeiro and Inácio, 2018). A retail CBDC that coexists with cash and commercial bank money would give users access to a wide variety of payment options and forms of money.⁴³

⁴³ Bjerg (2017) introduces quite a comprehensive theoretical model of the possible ways in which a retail CBDC could interact with cash and commercial bank money.

Conclusion

The central banks included in this review agree it is far more likely their digital currency would be offered as a complement to cash. However, it may be premature to say so for sure. Besides supply-side considerations (involving the issuer), there are factors on the demand side that also would play a key role in the potential of a CBDC to complement or replace cash and commercial bank money. The adoption of this new form of electronic money by users could depend on multiple factors, such as inertia in the use of existing payment instruments and the barriers to access that could arise due to the coverage of services such as the internet and electricity, which are essential for this new technology to operate. In short, there are still many aspects to be reviewed before considering the possible issuance of a retail CBDC in Colombia. Therefore, it is useful to be aware of the new developments and contributions made in other countries that are studying this topic or are developing pilot projects on their digital currencies.

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4.3 QR Codes: A Trend in Mobile Payment Initiation

4.3.1 Background on the Invention of QR Codes

Two American engineers, Joseph Woodland and Jordin Johanson, invented the barcode in 1952.⁴⁴ It began to be used on a mass scale in Japan as a solution to an ergonomic problem that was causing carpal syndrome difficulties for supermarket cashiers (1966), who were required to type in a large amount of data when the consumer paid for purchases.⁴⁵ Later, the design of optical barcode readers allowed barcodes to be entered into a POS system,⁴⁶ which minimized customer waiting time at the checkout counter and reduced human error in manual data entry and inventory updating.

As the use of these codes became more widespread, their limitations became evident, including the fact that they could only store twenty alphanumeric characters due to their one-dimensional reading. The printing had to be of high quality (i.e., a small defect or scratch on the bars, as well as any element that interfered between the packaging and the scanner, made the code unreadable). The code had to appear on a flat surface, and the reflection of metallic or shiny packaging prevented it from being read correctly.

In the 1990s, Denso Wave, a company dedicated to the design, development and manufacture of automotive components, asked its chief engineer, Masahiro Hara, to design and implement barcode readers that could decode data more quickly. The goal was to improve control at the firm's production sites.

44 A code based on the representation of a set of parallel lines of different thickness and spacing, which together contain character strings that allow the recognition of characteristics associated with a certain product (e.g., price).

45 See <https://www.qrcode.com/en/history/> and Denso Wave (2020).

46 POS: point of sale.

Since barcodes collected information in only one direction, Hara set out to innovate with a new mechanism that made it possible to code information in both the transverse and longitudinal directions (two dimensions). In doing so, he added information to the 2D design, indicating its location by means of a position detection pattern situated at three corners of the code. Furthermore, to avoid confusion in recognizing the code accurately when a similar shaped figure was nearby, he found the ratio that least appeared on the printed matter was 1:1:3:1:1:1. Thus, he was able to create a device to determine the orientation of the code by looking for this unique ratio, regardless of the scanning angle, which could be any angle of 360°.

A year and a half later, Hara successfully developed the QR (i.e., quick response) code, which is capable of storing approximately 7,000 characters, including kanji characters.⁴⁷ It can be read ten times faster than a barcode and has an error correction function that made highly accurate decoding possible, even if the characters were partly broken.

Denso Wave launched the QR code in 1994 and, in an effort to popularize its use, the company announced the specifications would be available to the general public at no cost. The use of QR codes became widespread in Japan in 2002, due to the marketing of mobile phones with a QR code reading function and the approval and inclusion of these codes in the ISO (i.e., International Standards Organization).

Today, QR codes are used by many physical and digital businesses for quick registration, to display geolocation or contact information and to redirect customers to their websites, among many other uses.

⁴⁷ Kanji is a writing system imported into Japan from China many centuries ago. It consists of simplified drawings or images (called ideograms) that express an idea; e.g., (high) + (blood) + (pressure), which means high blood pressure.

4.3.2 QR Codes in the Context of Mobile Payments

The focus in this section of the report is on the relevance of the QR code as an initiation mechanism for mobile payments. A wide variety of merchants now use these codes as an initiation method for instant payments⁴⁸ and for other instruments, such as credit and debit cards in deferred payments, typically via mobile wallets.⁴⁹ As a result, consumers do not have to look in their wallets for cash or other physical payment instruments.

In the context of mobile payments, the QR code is understood as a two-dimensional matrix code that can identify the merchant, its account number, the amount and currency of the transaction, as well as complementary data on country, city and postal codes, among others. The customer opens their payment service provider's application⁵⁰ and scans the QR code with the camera in their smartphone to complete the payment. The QR code is classified, within the stages of the mobile payment value chain, as a payment initiation method.

Mobile payments can be classified depending on whether the transaction between the consumer and the merchant is face-to-face (proximity) or non-face-to-face (remote). Diagram 4.2 shows the definitions of each, according to the European Payments Council, as well as the instruments and technology that can be used to make the respective payment. In both types of transactions (proximity and remote), it is possible to initiate the transaction with QR codes.

In addition to the instrument and the technology⁵¹ being used (e.g., QR codes), the payment can be assessed as having been successful or otherwise, depending on whether or not it satisfies the expectations of the stakeholders in the process (i.e., consumer, merchant and payment service provider). This is an important aspect to emphasize. The most relevant expectations mentioned by the European Payments Council are efficiency and speed of payment initiation, confidentiality and trust, immediacy and confirmation of payment enabling the exchange of the item or service, low

48 Gartner (2020) defines mobile payment as a financial transaction done using a mobile phone, including payment for goods and services, remote purchases, and the transfer of money between individuals.

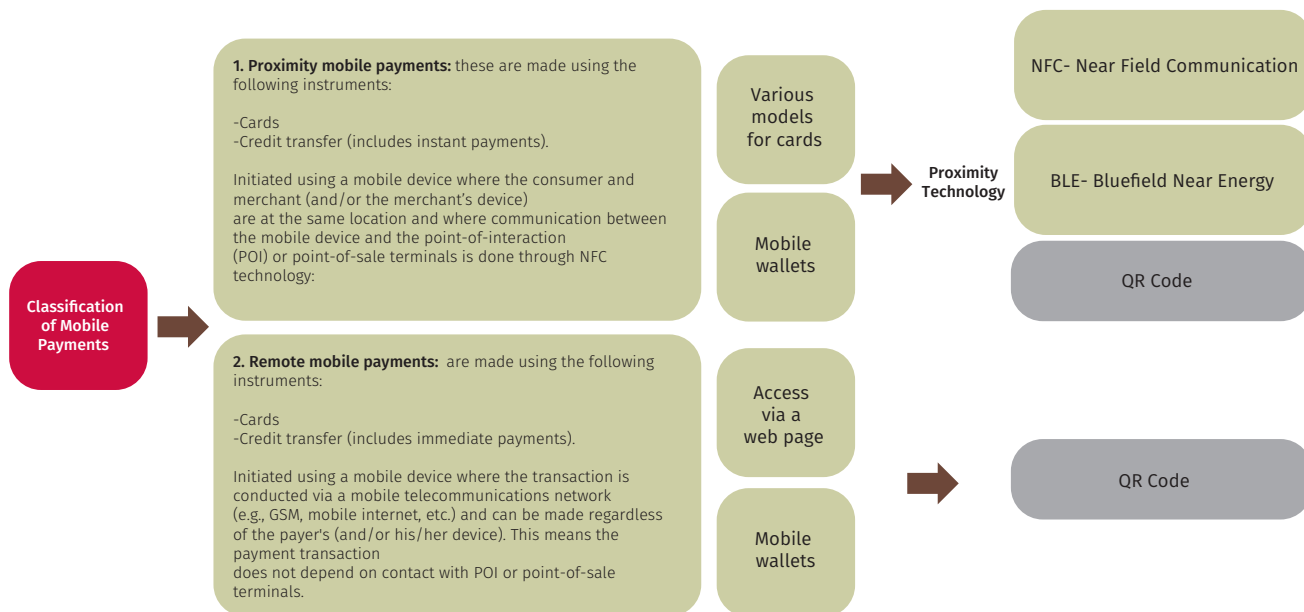
49 A digital wallet is a service that allows the bearer to securely manage and use a variety of services/applications, including those for payments. A mobile wallet is a digital wallet accessed via a mobile device (e.g., phone, tablet).

From the consumer's perspective, a mobile wallet is basically an application that allows the consumer to securely access, manage or even record information relevant to payments that is, personal information necessary to identify the bearer and to use payment instruments.

50 Non-bank payment service providers (PSPs) are companies that offer payment services to end-users. Generally, banks and other PSPs offer retail or consumer-facing services. These can include the provision of digital wallets and mobile interfaces that provide users with access to their bank accounts or store credit card details.

51 The European Payments Council classifies as a technology the different mechanisms that can be used to initiate face-to-face payments (NFC, Bluetooth and QR codes) or remote payments (QR codes).

Diagram 4.2
Classification of Mobile Payments



Source: European Payment Council (2017). White paper on mobile payments; adapted by DSIF.

usage costs, cost-effectiveness (e.g., for the merchant), supplanting cash, and customer retention/affiliation (EPC, 2017).

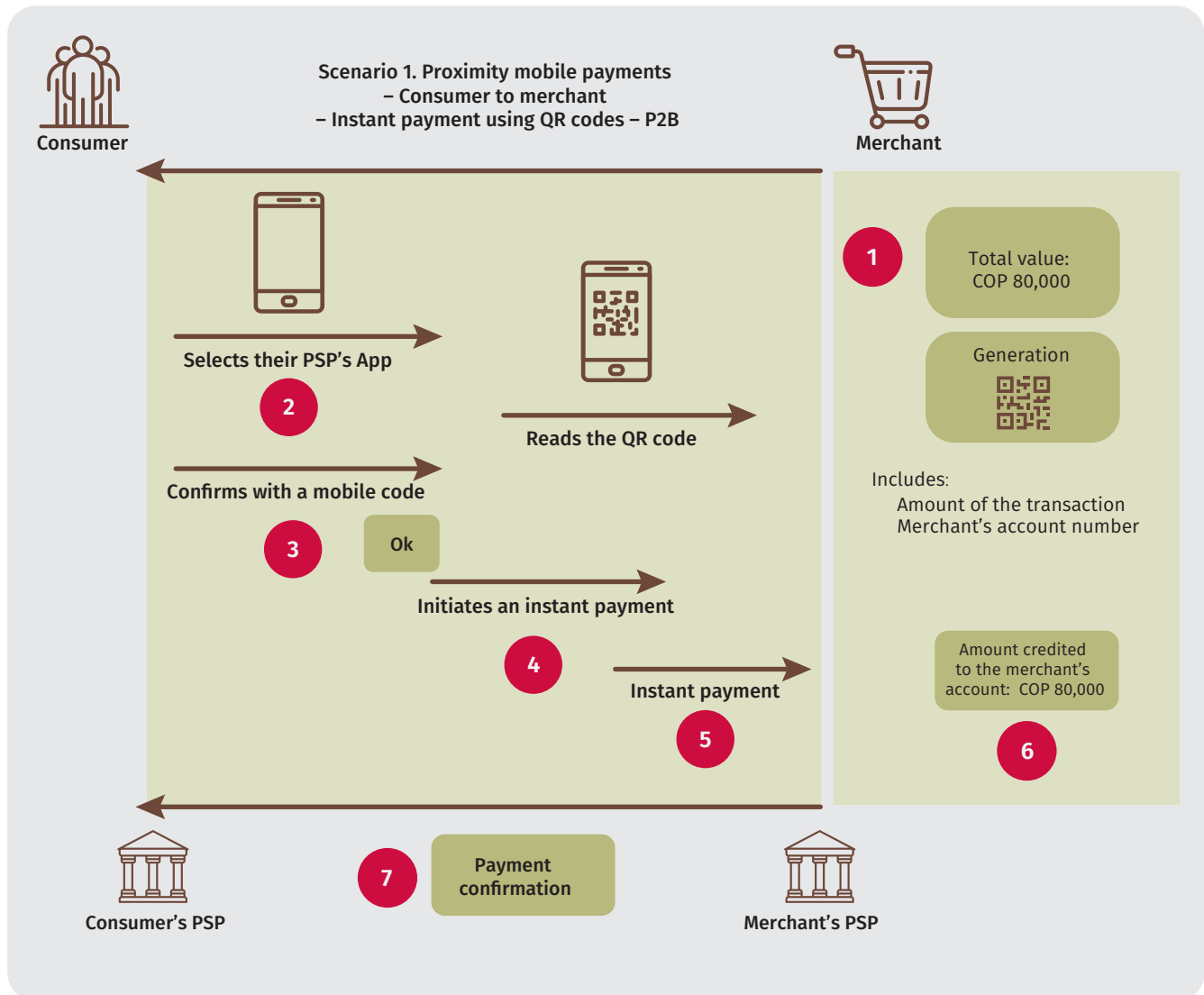
In keeping with the aforementioned classification of mobile payments, a proximity scenario (face-to-face purchase of an item or service) is described below to illustrate the steps that are required for the transaction to be completed successfully by meeting the expectations of the interested parties (Diagram 4.3):

This scenario illustrates a payment procedure where the consumer's PSP is different from the merchant's PSP:

- The merchant begins by logging into the POI terminal to generate a QR code with the transaction amount and account number.
- The consumer selects the application on their mobile device and scans the QR code from the POI terminal.
- To confirm the payment transaction, the consumer enters their mobile code on their mobile phone.
- The consumer's application initiates an instant credit transfer with the consumer's PSP.
- The consumer's PSP processes and sends the transaction to the merchant's PSP.
- The PSP credits the merchant's account immediately.
- The merchant is able to confirm receipt of the payment and has access to the funds.

A practical example, in the case of remote purchases, is the experience of a consumer (payer) who uses their mobile device to pay a bill for goods or services previously delivered by the merchant (payee or beneficiary). The payer

Diagram 4.3
Proximity Mobile Scenario - P2B



Source: European Payment Council (2017). White paper on mobile payments; adapted by DSIF.

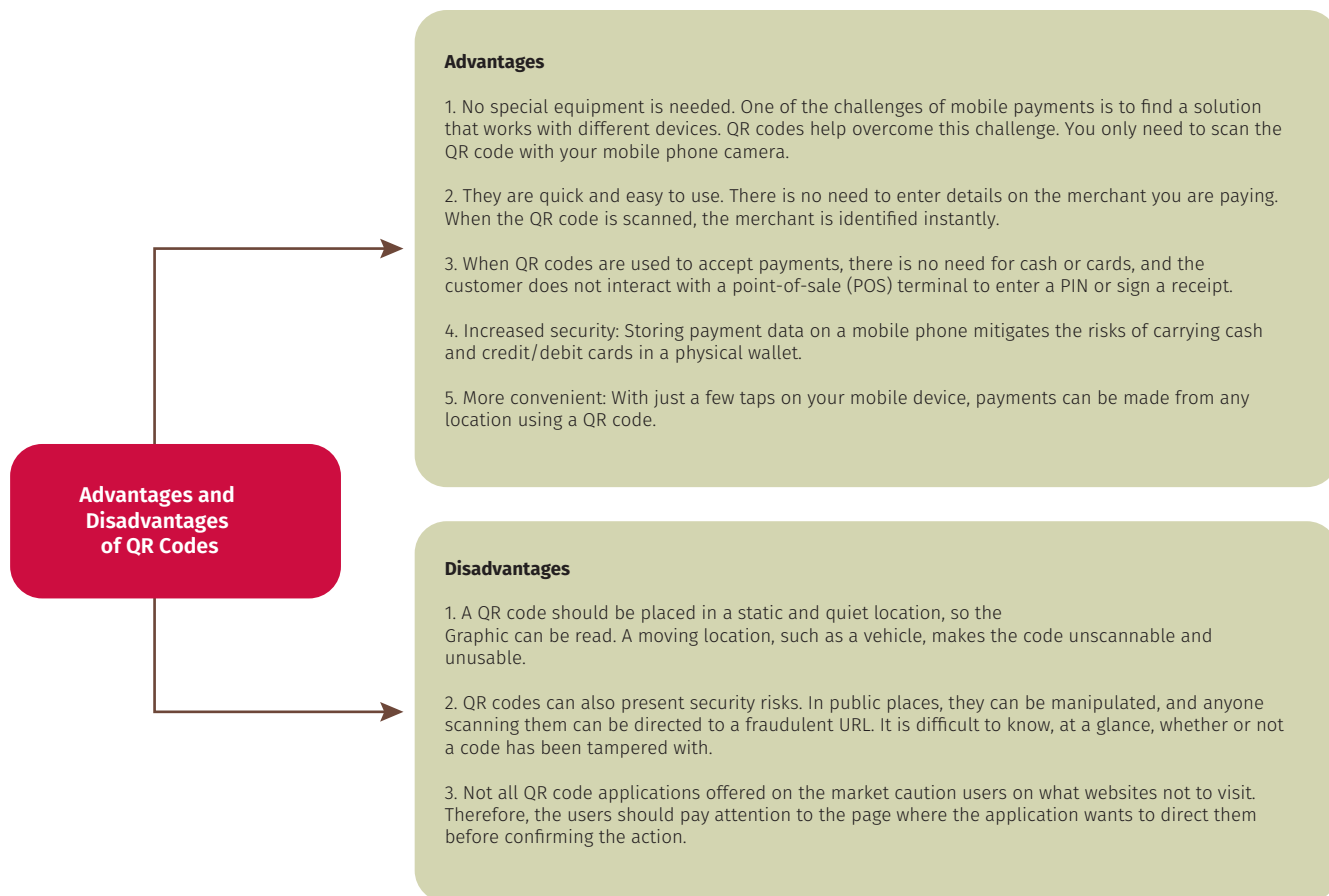
and payee can and often will have payment accounts with different PSPs. The consumer is redirected from the merchant's website to the mobile service of its PSP, where authentication takes place.

The process begins when the merchant sends/generates an invoice for the consumer with a QR code that includes the merchant's name, the amount of the transaction and the beneficiary's account number. It continues with the consumer reading the QR from the mobile app and ends with the funds being credited immediately to the merchant and confirmation of payment being made available to both parties.

4.3.3 Advantages and Disadvantages of QR Codes

In general, the advantages of using QR codes to initiate mobile payments are rooted in their practicality, ease and low cost for consumers and merchants. Their important disadvantages concern the potential fraud cybercriminals can perpetrate by impersonating the webpages or accounts of the beneficiary of the funds. Diagram 4.4 details the pros and cons of using QR codes.

Diagram 4.4
Advantages and Disadvantages of QR Codes



Source: Designed by DSIF.

4.3.4 Global Overview of the Use of QR Codes for Mobile Payments

The way consumers pay for goods and services usually is attributed to their habits, conditioning factors and familiarity with the means and instruments of payment existing in each country. Consequently, changing those habits is often a very complex process, as consumer inertia, apathy or apprehension towards innovative payment alternatives slows down the overall course of their adoption. If the current payment process meets customers’ needs and they feel comfortable and secure, they will have little incentive to change (Gartner, 2020).

While the United States spent the last decade upgrading bank cards with magnetic stripes with chips, China experienced a revolution in retail payments, migrating from a card-based system to two new payment systems that have come to dominate person-to-person and person-to-retailer transactions. China's new system is based on mobile wallets and payment initiation with QR codes and operates through its own large technology companies - Alipay with Alibaba (China's version of Amazon) and WeChat Pay with Tencent (China's version of Facebook) (Klein, 2019). After years of keeping its distance, the Chinese regulator has begun to intervene in these schemes, interested mainly in the traceability of funds and interoperability (GSMA™, 2020).

Mature Asian markets such as Japan, Korea, Taiwan and Hong Kong have a high degree of bank account penetration and innovative *fintechs* that have been crucial to generating momentum in the use of QR codes for mobile payment initiation. Typically, the focus has been on payment services for micro-merchants, whose transaction volumes have sparked the interest of regulators in providing support for national harmonization (interoperability, security, efficiency and promotion of mobile payments). While Japan, Korea and Taiwan maintained a national focus (resolving local payments), Hong Kong and Singapore, with their relatively small populations and high levels of tourist traffic, have a more international focus: resolving purchases by foreign consumers who are visiting these countries.

Developing markets in Asia, such as those in India, Indonesia and other Southeast Asian countries, have high levels of cash usage that have prompted local regulators to take a proactive approach. Considerable investment funding (e.g., private equity) has also accelerated the pace of *fintech* development. Many of these companies are adopting schemes similar to those used by the Chinese tech giants, and high levels of smartphone penetration continue to support growth in the use of QR codes to initiate payments at commercial establishments. Interoperability is focused at the national level, as in the case in India, which implemented a common standard called Bharat QR,⁵² a QR code-based digital payment mechanism that merchants and mobile commerce websites are using already.

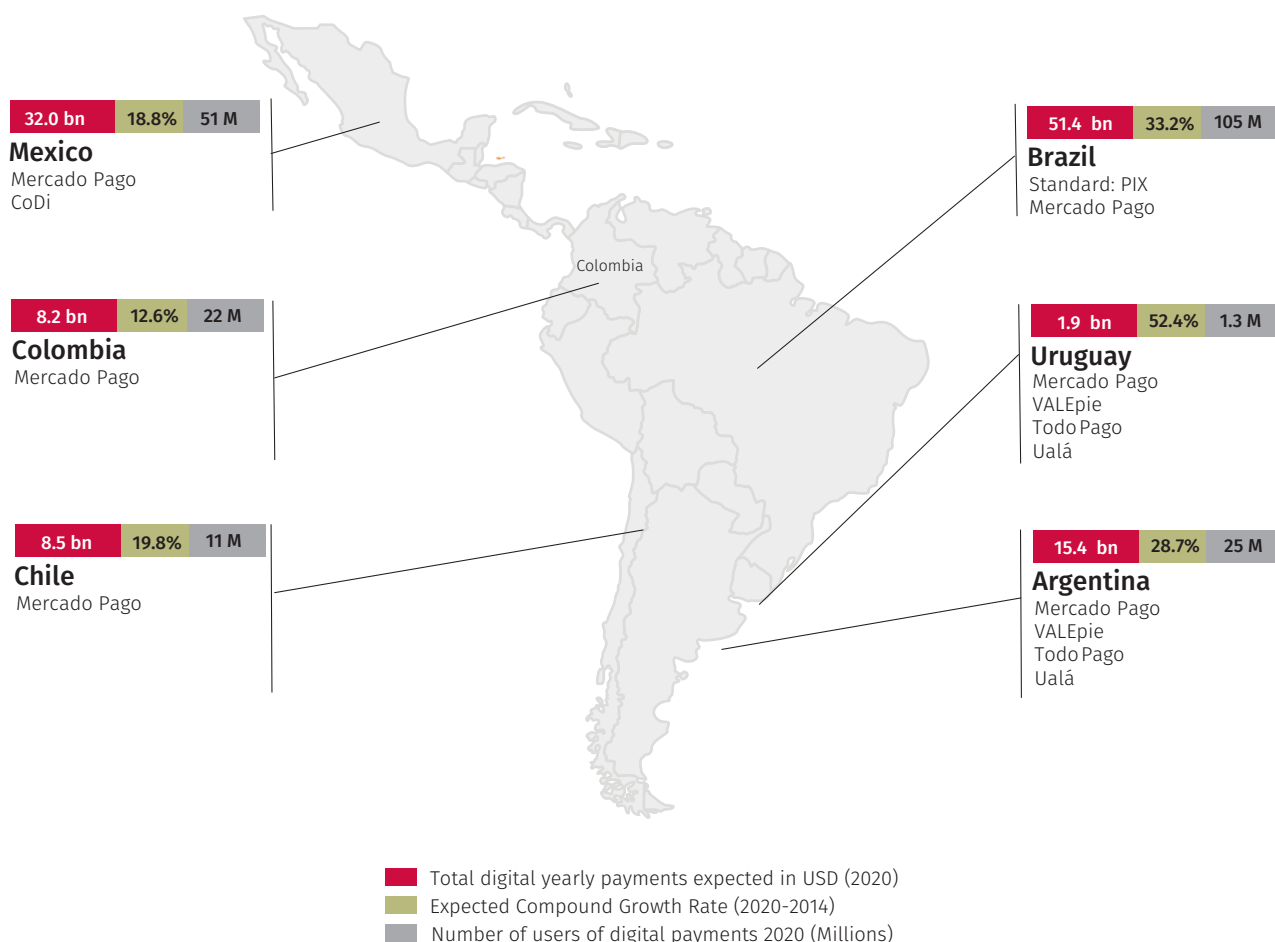
Like Southeast Asia, the African countries are cash-dominated and extremely fragmented in their approach to merchant payments with QR codes. However, their differences are rooted in relatively low levels of smartphone and bank account penetration, which make relevant growth in QR code payment initiation complex.

The UK and Europe, as well as the US, remain heavily dominated by the use of card payments and NFC, with many mobile wallets being used for card payments. PSPs are now working steadily to constantly support the growing consumer demand for the use of QR codes to make payments. The European Payments Council has led QR code interoperability initiatives, but no standardized system for the European Union has been achieved so far.

52 It is a national interoperable system for processing payments initiated with standardized QR codes.

On the other hand, QR code payments at commercial establishments are starting to gain momentum in Latin America, mainly because of Mercado-Libre’s Mercado Pago and PayPal, which have been dominant for some time. Also, there is a growing desire on the part of governments in the region to reduce the use of cash. Initiatives such as PIX⁵³ in Brazil and CoDi⁵⁴ in Mexico will fuel participation from neighboring countries. As per a GSMA study⁵⁵ on digital payments in Latin America related to the implementation of mobile payments using QR code initiation methods, Map 4.1 contains figures on total annual payments expected by 2020, as well as the anticipated compound growth rate and the number of digital payment users in some Latin American countries.

Map 4.1
Evidence of QR Implementation for Digital Payments in Latin America



Sources: GSMATM (2020). QR Code Merchant Payments, a Growth Opportunity for Mobile Money Providers. <https://mapamundi.online/america>; adapted by DSIF.

53 PIX is a platform developed by Banco do Brasil to facilitate instant 24/7 payments through the use of mobile phones and QR codes.

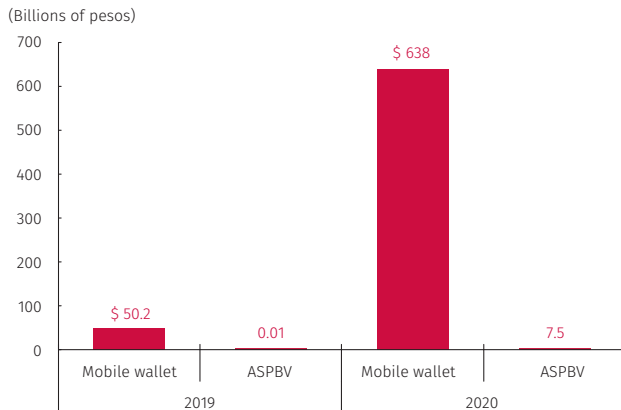
54 CoDi® is a platform developed by Banco de México to facilitate instant 24/7 payments through the use of mobile phones and QR codes, at no cost to the consumer or the merchant.

55 An association of mobile communications operators and related companies (GSMA: Global System for Mobile Association).

4.3.5 The Use of QR Codes for Payments in Colombia

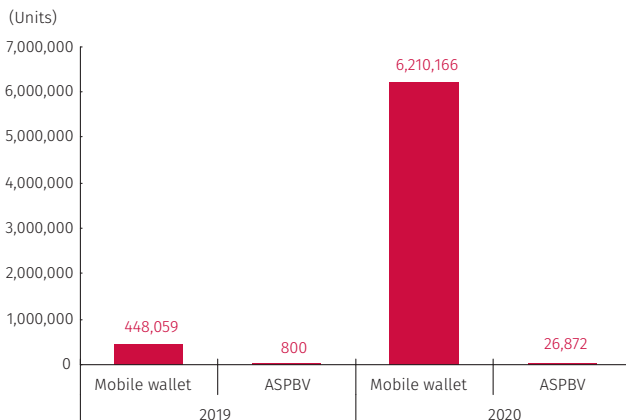
Several commercial banks in Colombia have offered mobile wallet payment applications since 2019, which allow payments to be initiated using QR codes. However, the most relevant mobile wallets operate on closed platforms and with exclusive QR code design, preventing interoperability.⁵⁶ Moreover, for the payment process to work, the consumer's account or means of payment and the merchant's must be with the same financial institution. In other words, these schemes only allow payments and intra-bank funds transfers.

Graph 4.1
How the Value of Mobile Payments Initiated with QR Codes Has Evolved



Source: SF and RVPSM data; constructed by Banco de la República.

Graph 4.2
How the Number of Mobile Payments Initiated with QR Codes Has Evolved



Source: SF and ASPBV data; constructed by Banco de la República.

Three retail-value payment systems managers (RVPSM)⁵⁷ offer the functionality of payments initiated with QR codes, which are standardized and interoperable with credit and debit card instruments. Financial resources for the merchant are credited after a clearing and settlement process involving accounts with the central bank.

An important step forward with respect to QR codes as payment initiation technology for the acquisition of goods and services in Colombia is related to regulations on the matter issued by the Office of the Financial Superintendent of Colombia (SFC). Circular 006 of March 2019 establishes rules on interoperability, security, quality and confidentiality of information. It also references international guidelines aimed at standardizing the structure of the data, which is necessary to process payments effectively.

As for the use of this technology in Colombia, graphs 4.1 and 4.2 show how mobile transactions initiated with QR codes evolved in value and number during 2019 and 2020.⁵⁸ Given the amount observed in 2020 as a reference (COP 638 b), these transactions were 3.4 times more than the amount of instant transfers made through Transfiya and 0.28 % of the transfers made using the PSE service (traditional non-instant transfers of payment for goods and services) in that same year.

56 The interoperability of payment initiation with QR codes is intended to standardize the structure of the fields where the information required for the transaction is transmitted, so all the stakeholders in the payment process speak the same language and carry out the respective technological developments according to that standard.

57 Redeban, Credibanco and ATH.

58 The mobile wallet series was constructed with information reported to the SFC by commercial banks (non-interoperable closed schemes). The RVPSM series was reported by the retail-value payment system managers (interoperable schemes).

According to additional preliminary data obtained from the SFC for 2021 (up to March 2021), the number of transactions in just the first quarter was already equivalent to 81% (5.01 million) of the total number of transactions carried out in 2020 (6.2 million), and their value was 72% (COP 460 b) of the total transacted in 2020 (COP 638 b). These statistics lead to the conclusion that users' preference for initiating payments with QR codes is growing.

4.3.6 Conclusions

Mobile payments with QR codes are becoming more and more widespread, and their use as an instant payment initiation method is growing at an increasing rate worldwide. Interoperability, in particular, is a prerequisite for the industry to meet consumer/merchant expectations through the use of QR codes as a payment initiator.

There is constant pressure from consumers and merchants to lower the costs and fees associated with the use of payment methods. QR payments are seen as a possible solution to that challenge, mainly for micro-merchants.

Several countries still have limited internet and smartphone coverage for their populations, which is the infrastructure necessary for the growth of QR code-initiated payments.

In Colombia, there is a growing interest in the use of QR codes as an initiation method for mobile payments. This is evidenced by the changes in the figures analyzed for 2019, 2020 and 2021 (up to March). Although the SFC issued the regulation on the use of QR codes to promote interoperability, among other aspects, the most popular mobile wallets in the country belong to PSPs that offer closed systems with exclusive QR code design, which only boost intrabank payments.

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4.4 Behavior of Access Channels in the Payment Process: Evolution in the Use of Digital and Face-to-face Channels

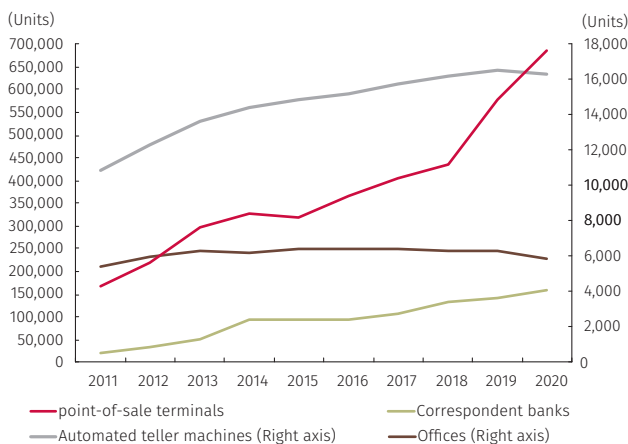
Payment transactions in the market for goods or services require the use of access channels. Their function is to connect the payer to his/her financial institution, so payment can be initiated.⁵⁹ These channels include the internet, the offices of financial institutions, correspondent banks, point-of-sale terminals, the mobile telephone network, ATMs, and audio response.

The retail trade has incorporated non-face-to-face sales with respective payment innovations that have been reinforced on the basis of technological developments. From the standpoint of payment channels, these include, for example, use of the internet, which allows for communication and agreements between sellers and buyers of goods and services. In general, the trend in use of the internet and mobile telephony has been growing. In Colombia, the proportion of the population who used the internet at home was 83.1%, and the mobile phone was the device most used to connect to the internet (84.9%).^{60, 61}

Accordingly, digital channels such as the internet and mobile telephony support a large part of e-commerce.⁶² The evolution in access channels up to 2020 is examined in this section, as is the evolution in both digital and face-to-face channels during the last ten years.

By the end of 2020, there were 684,225 point-of-sale terminals at commercial establishments in Colombia, in addition to 159,075 correspondent banks, 16,293 ATMs and 5,913 branch offices. (Graph 4.3). During the last ten years, correspondent

Graph 4.3
Quantity of Payment Channels



Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2011- 2020*); calculations by Banco de la República (DSIF).

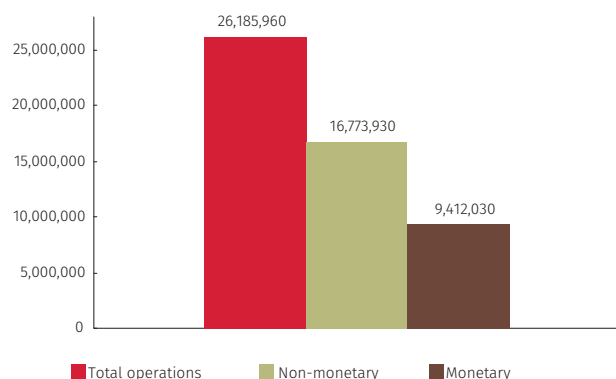
59 They also connect the payee to receive a payment.

60 DANE (2018). “Boletín Técnico: indicadores básicos de tenencia y uso de tecnologías de la información y comunicación (TIC) en hogares y personas de 5 y más años de edad” (Technical Bulletin: Basic Indicators on Ownership and Use of Information and Communication Technology (ICT) among Households and Individuals Age 5 and Older). As complementary information, and according to the Quarterly ICT Bulletin published by the Ministry of Information and Communication Technologies, as of September 2020, internet access was mobile and fixed, with 60.3 out of every 100 inhabitants in Colombia having mobile access and 15.2 out of every 100 inhabitants having fixed access. The number of telephone lines was 130 per 100 inhabitants.

61 In 2019, it was estimated that 7.9% of the population made purchases online (Colombian Chamber of E-Commerce. 2020. “Comercio electrónico en Colombia”, August).

62 According to “Política Nacional de Comercio Electrónico” (Electronic Commerce Policy) by Conpes (Draft 1, 12/06/2020), electronic commerce is defined as the sale or purchase of goods or services through computer networks using 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 contemplates products or services being offered individually or packaged, and available for purchase through the use of personal computers, laptops, tablets and mobile phones of varying degrees of complexity.

Graph 4.4
Total Monetary and Non-monetary Operations
(Daily average, 2020)



Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2020*); calculations by Banco de la República (DSIF).

banks have increased at an average annual rate of 30%. In turn, the increase in point-of-sale terminals was 18%, as opposed to 5.0% for ATMs and 1.0% for branch offices.

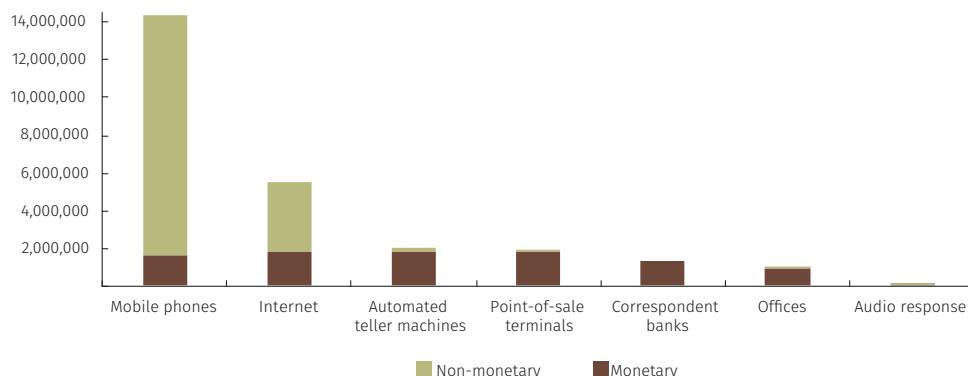
4.4.1 Number of Transactions

In all, the number of operations in 2020 averaged around 26 m daily (26,185,960): 64% were non-cash transactions (16,773,930)⁶³ and 36%, cash transactions (9,412,030) (Graph 4.4).

The mobile telephone network was the channel used the most in 2020 (14,329,545), followed by the internet (5,470,051). ATMs are in a smaller range of operations (2,044,198), along with point-of-sale terminals (1,896,483), correspondent banks (1,316,649), branch offices (990,375), and audio response (138,360) (Graph 4.5).

Graph 4.5
Operations by Channel

(Average daily number, 2020)



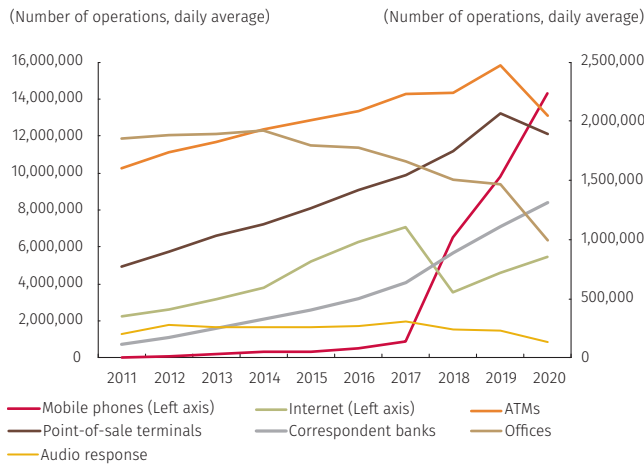
Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2020*); calculations by Banco de la República (DSIF).

Non-cash operations are concentrated largely in the digital channels, such as mobile telephony (88%) and the internet (67%) (Graph 4.5). The number of monetary transactions (those involving money movement) for each of the channels is under two million and includes the following: ATMs (1,873,289), point-of-sale terminals (1,848,927), the internet (1,798,903), mobile telephony (1,662,229), correspondent banks (1,316,649), branch offices (907,789) and audio response (4,244).

In the last ten years (2011-2020), the number of transactions in all channels increased at an average annual rate of 16%, with a growing trend in mobile telephony, the internet, ATMs, point-of-sale terminals and correspondent banks during that period, and a declining trend in branch offices and audio response (Graph 4.6).

63 These are customer inquiries to check bank balances.

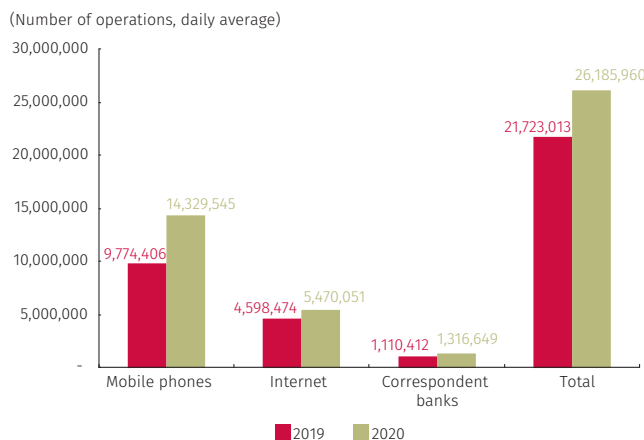
Graph 4.6
Number of Operations
(Daily average)



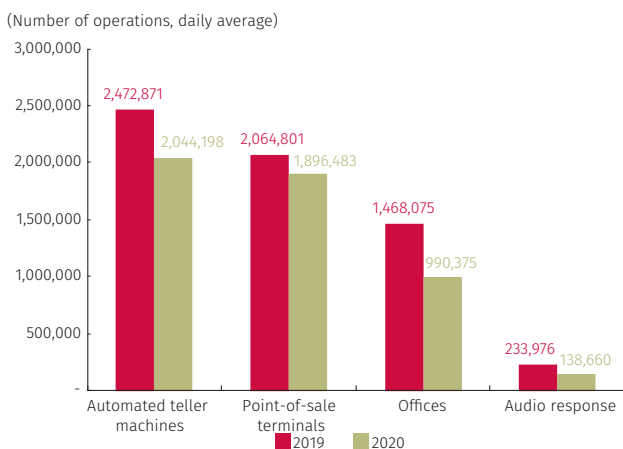
Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2014-2020*); calculations by Banco de la República (DSIF).

Graph 4.7

A. Growth of Channels between 2020 and 2019



B. Decline in Channels between 2020 and 2019



Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2020*); calculations by Banco de la República (DSIF).

When comparing the number of transactions carried out in 2020 versus 2019, one sees the channels grew, in general (21%) (Graph 4.7, Panel A). Digital channels that is: mobile telephony (47%) and the internet (19%), as well as correspondent banks (19%), registered positive changes (Graphs 4.6 and 4.7, panel A). In contrast, ATMs, point-of-sale terminals, branch offices and audio response were the channels that declined (Graph 4.7, panel B).

4.4.2 Value of the Transactions

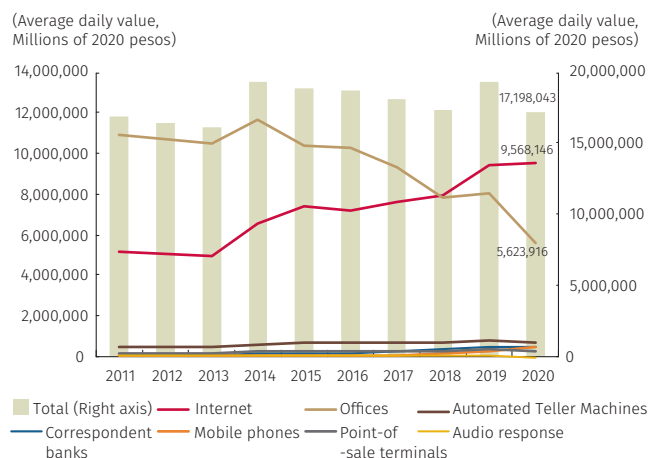
The value of average daily transactions in 2020 totaled COP 17.2 trillion (t) (Graph 4.8). The internet and branch offices were the most representative. The daily average for the internet was COP 9.6 t, and branch offices, COP 5.6 t. Below these, in millions of pesos, were the following channels (Graphs 4.8 and 4.9): ATMs (COP 706,228 m), correspondent banks (COP 512,473 m), mobile telephony (COP 491,413 m), point-of-sale terminals (COP 293,833 m) and audio response (COP 2,034 m). During the last ten years (2011-2020), the value of transactions in all channels increased at an average annual rate of 1.0%, with an upward trend in mobile telephony, correspondent banks, the internet, ATMs and point-of-sale terminals, and a downward trend in audio response channels and branch offices (Graph 4.9).

Compared to 2019, the value of transactions in 2020, by channels, declined 11%. The digital channels showed an upward trend, with mobile telephony growing 92% and the internet, 2.0%; the variation in correspondent banks was positive as well (19%) (Graph 4.10). However, audio response channels, branch offices, ATMs and point-of-sale terminals declined (Graph 4.10, panel B).

In conclusion, the number of transactions made through payment channels increased at an average annual rate of 16% in the last ten years, amounting to approximately 26 million transactions per day by 2020, on average (64% are non-cash transactions). In terms of value, the channels as a whole declined by 1.0% during the same period, accounting for COP 17.1 t by 2020.

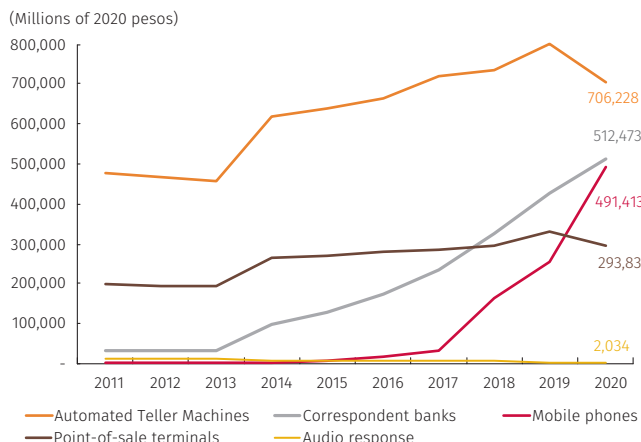
There was a growing trend in digital channels over the last ten years and particularly between 2019 and 2020, when both the number and value of transactions increased. The opposite was true for most of the face-to-face channels, such as branch offices, ATMs and point-of-sale terminals.

Graph 4.8
Value of Operations through Payment Channels
(Daily average)



Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2014- 2020*); calculations by Banco de la República (DSIF).

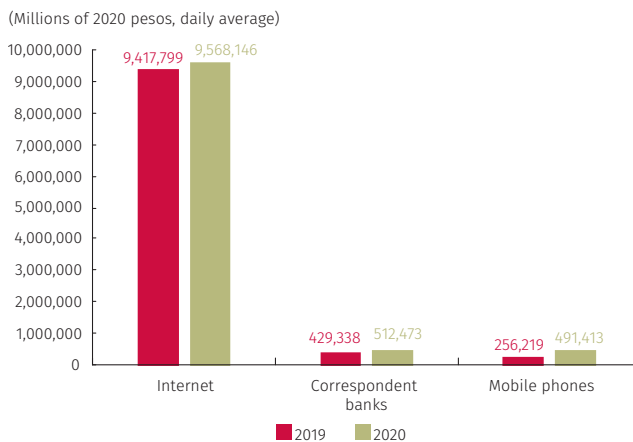
Graph 4.9
Daily Value under COP 800,000 Million



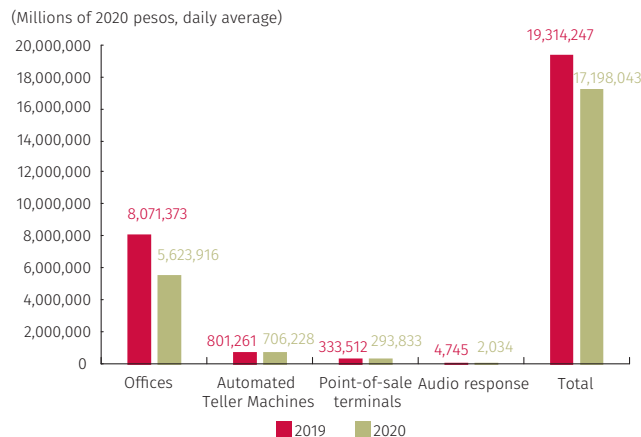
Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2014- 2020*); calculations by Banco de la República (DSIF).

Graph 4.10

A. Growth in Channels between 2020 and 2019



B. Decline in Channels between 2020 and 2019



Source: Office of the Financial Superintendent of Colombia (*Informe de operaciones, 2020*); calculations by Banco de la República (DSIF).

05

Applied Research Papers

5.1 Capital Requirements for Central Counterparties: An Analysis of the Colombian Case

5.1.1 Introduction

Due to the growing and important role of central counterparties (CCPs) in global financial markets, it is imperative to lend continuity to the service provided by these institutions, not only because of the benefits they offer to the markets, but also because of the impact conclusion or liquidation of any one of them would have on the markets, on the participants and on the financial stability of the jurisdictions where they operate and to which they are interconnected. According to “Recovery of Financial Market Infrastructures” (BIS, 2014), a CCP’s failure to provide a critical service is likely to have a significant negative impact on participants or third parties, cause contagion, and undermine overall confidence in the markets it serves. Because CCPs concentrate and manage a significant portion of the system’s financial risk on behalf of clearing members and their clients, it is essential that they be adequately capitalized and subject to effective regulation and rigorous oversight.

According to the principles applicable to financial market infrastructures (PFMIs) (BIS, 2012), CCPs are subject to a number of risks that could jeopardize their viability and financial soundness, including credit, liquidity, general business, custody and investment, operational and legal risks. For example, in the case of credit or liquidity risks, default by one or more members can result in significant liquidity losses or shortfalls. In the case of investments of participants’ own cash or the collateral they provide, the failure of a custodian bank or high-risk investments also can lead to losses or shortfalls of this type. Therefore, a CCP should identify, monitor and manage its risks and maintain enough net liquid assets, supported by its net capital, to cover potential general business losses, so it can continue to operate and provide services as a business, should such losses materialize. Likewise, its net liquid assets must be enough at all times to ensure an orderly recovery or the termination of fundamental operations and services.

This section provides some examples of capital requirements for CCPs in several jurisdictions and how CCPs commit their capital to their general schemes for managing the risks to which they are exposed. The capital requirements in Colombia are analyzed, and the structure and capital levels of the Central Counterparty of Colombia (CRCC) are evaluated.

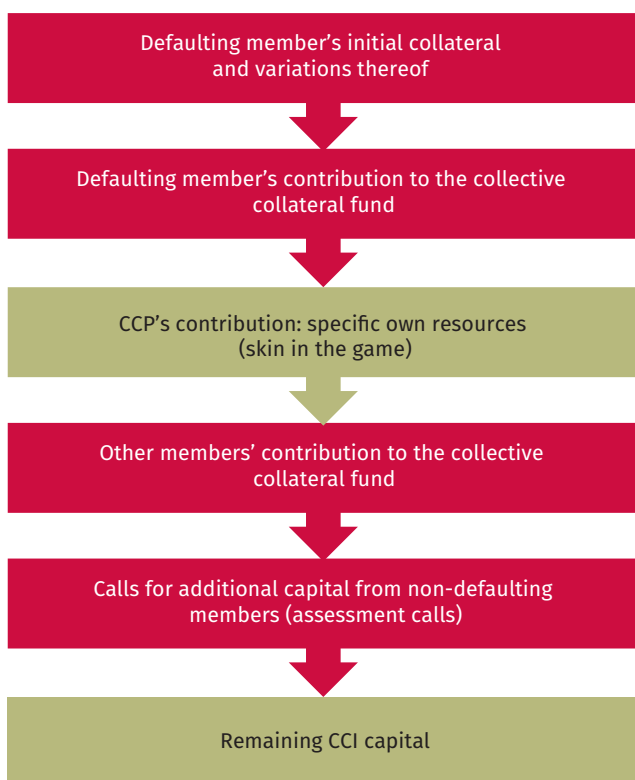
5.1.2 Financial Resources Involved in CCP Risk Management

CCPs are exposed to the risks inherent in the activities required to clear and settle accepted transactions and to the risks associated with their corporate activities. The main clearing and settlement risks facing CCPs are counterparty and liquidity risks. To mitigate them, CCPs rely on the resources provided by members (collateral) and their own capital. The risks associated with a CCPs corporate activities include operational, legal, custody and business risks, among others. These are covered with the CCP's capital, should they materialize.

Counterparty and liquidity risks are hedged mainly with the financial resources provided by members through individual collateral and loss-sharing or default funds. However, if these resources are insufficient, a CCP draws on its capital in two stages: the first involves the CCP's own resources contributed specifically to each business segment,⁶⁴ while the second consists of the remaining CCP capital that will be available as a last security ring, once the solidarity resources from the other members and the recovery mechanisms provided by the CCP have been exhausted.⁶⁵ Diagram 5.1 shows the order in which these resources are used; the financial resources required from members are shown in red and the CCPs' contributions, in green.

According to "Model Risk at Central Counterparties: Is Skin-in-the-Game a Game Changer?" (BIS, 2020), which looks at 39 groups of CCPs, it is evident that most of the resources prefunded by CCPs are collateral requirements (about 90%), while approximately 8.0% are contributions to the

Diagram 5.1
Order of Use of the Security Rings in a CCP^{a/}



a/ According to Wendt (2015), the structure of the security rings varies among CCPs and there is no single internationally defined structure. Source: Banco de la República.

64 The importance of using CCP contributions prior to using non-defaulting members' resources is outlined in two papers published by the BIS: "Central Counterparty Capitalization and Misaligned Incentives" (February 2019) and "Model Risk at Central Counterparties: Is skin-in-the-game a Game Changer?" (May 2020). They explain how profit maximization and CCPs' limited liability do not allow for a proper alignment of incentives with CCP participants. Additionally, the second paper concludes that higher capital requirements for CCPs are associated with more prudent margin models.

65 Recovery mechanisms are the tools available to CCPs to replenish or request additional resources from their members in the event that prefunded contributions to hedge against default by their members are exhausted.

default fund. In this sense, specific proprietary resources play a limited role in loss absorption. Similarly, “EU-wide CCP Stress Test 2017,” a report by the European Securities and Markets Authority (ESMA) on the results of stress tests applied to sixteen CCPs, shows the average composition of these security rings is 80% in collateral and margins contributed individually by the members, 15% in solidarity funds, 0.5% in specific proprietary resources contributed by the CCP, and 4.5% in other CCP resources.

Moreover, the PFMI indicates CCPs must have their own financial resources to ensure they are adequately capitalized at all times, so as to be able to address the credit, liquidity and other risks not covered by the financial resources mentioned for the security rings (e.g., operational, legal and business risks). With this in mind, it is common for financial authorities around the world to establish a minimum capital requirement for setting up a CCP. However, not all jurisdictions have developed capital requirements in their regulations that are different for each of the risks to which CCPs are exposed. The following are some examples of CCP capital-requirement regulations in several jurisdictions.

5.1.3 International Experience with Regulatory Capital Requirements for CCPs

The regulatory requirements applicable to the European Union (EU), the United States of America (USA), Brazil and Colombia were analyzed to examine the risks regulatory authorities have taken into account when establishing capital requirements for CCPs. Table 5.1 shows the capital requirements that have been established in each jurisdiction, depending on the risks they are intended to hedge. Importantly, the EU regulation sets a minimum capital requirement for incorporation, another for liquidation or restructuring, and is the only one with capital requirements differentiated by the types of risk to which CCPs are exposed. The US regulation, on the other hand, establishes an initial capital requirement, one for liquidation or restructuring purposes and another to cover business risk. The Brazilian regulation requires CCPs to have a minimum amount of capital and capital to hedge business risk. In the Colombian case, the regulation requires only a minimum amount of capital for incorporation, which is indexed to inflation.

Table 5.1
International Experience: Capital Requirements for CCPs

Jurisdiction	Minimum permanent start-up capital	Capital required to liquidate or restructure	Capital required for operational and legal risks	Capital required for credit risks: not covered by the security rings	Capital required for business risk	Coverage of the security rings (number of members)
Europe	Regulated	Regulated	Regulated	Regulated	Regulated	2
United States	Regulated	Regulated			Regulated	2
Brazil	Regulated				Regulated	2
Colombia	Regulated					1

Source: European Commission Regulation No. EU-152 and EU-153/2013; <https://www.ecfr.gov>; <https://www.law.cornell.edu/cfr/text/17/39.11>; Central Bank of Brazil Circular 3057, as per Art. 5 in Law 10214 of March 27, 2001.

From the standpoint of hedging financial resources to mitigate counterparty risk, all jurisdictions, with the exception of Colombia, require maintaining sufficient resources to hedge against default by the two main clearing members in the event of extreme but possible market fluctuations. Colombia only requires hedging against default by the main clearing member.⁶⁶

After analyzing the international experience in regulating capital requirements, it is clear the European Union regulation is the one that offers more detail in terms of the risks for which capital is required and develops methods to quantify them. This section compares the main elements of that regulation and the Colombian one so as to provide a conceptual basis for evaluating the CRCC's capital levels.

The European Banking Authority (EBA) approved a set of draft technical standards on capital requirements for CCPs.⁶⁷ They indicate the exercises to quantify the capital needed to hedge the different risks to which CCPs are exposed are to be carried out by the CCPs and submitted periodically to the competent authorities. In any case, the added capital required for CCPs must be at least equal to the sum of the items described in Table 5.2.

The EBA regulation also states a CCP must have at least EUR 7.5 million (approximately USD 8.44 million as of December 2020) in permanent and available initial capital, and the default fund and other specific financial resources must enable it, at all times, to cover default by at least its two largest clearing members. On the other hand, this regulation stipulates the first tranche of proprietary resources contributed by CCPs, before using the non-defaulting members' joint and several resources, is to be calculated "by multiplying the minimum capital, including retained earnings and reserves, by 25%".

There is now an ongoing debate as to whether CCPs in the EU should make additional contributions to the security-ring structure. In this respect, "EU Hands CCP Members a Narrow Win on Skin in the Game," published by *Central Banking* in August 2020, mentions the European authorities are evaluating whether to require a second tranche of specific proprietary resources. It would be between 10% and 25% of the initial required capital and would count as capital in addition to that required at the start.

66 However, the internal regulations of the only CCP in Colombia (i.e., Cámara de Riesgo Central de Contraparte S. A.) call for hedging against simultaneous default by its two main clearing members.

67 This was done through the EMIR regulation (on OTC derivative transactions, central counterparties and trade repositories) adopted by the European Commission. This agency defined technical standards on capital requirements for central counterparties in Delegated Regulation 648 /2012 (see: <https://eur.lex.europa.eu/legalcontent/ES/TX-T/?uri=CELEX%3A32012R0648>) and in supplementary technical analyses 152 and 153 of 2013 (see: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0153>).

Table 5.2
Capital Requirements for CCPs Operating in the European Union

Item	Calculation Method
Capital required to liquidate or restructure	Gross monthly operating expenses multiplied by a number of months sufficient to ensure orderly liquidation or restructuring of its activities, even in a situation of market stress. The number of months shall be proposed by the CCP and authorized by the competent authority.
Capital required for operational or legal risks	A CCP must calculate its capital requirements for operational risk, including legal risk, using either the Basic Indicator Approach or the advanced measurement approaches outlined in Directive 2006/48/EC, which defines requirements on minimum own funds for operational risk.
Capital required for credit and market risks not hedged with specific resources	The risk weightings established for investment and finance companies in Europe shall be the reference standard for calculating this capital.
Capital required for business risk ^{a/}	Business risk capital requirements shall pertain to the CCP's approved estimate and shall be subject to a minimum amount equal to 25% of the CCP's gross annual operating expenses. Since the level of business risk is highly dependent on a CCP's individual situation and may result from factors such as inefficient procedures, an adverse environment in the market, an ineffective response to technological developments, or a poorly executed business strategy, capital requirements are to be based on a CCP's own estimates, subject to approval by the competent authority.

a/ Business risk refers to the risk a CCP assumes by virtue of its efficiency and the potential for changes in general business conditions that could adversely affect its financial situation due to a decline in its revenue or an increase in its expenses that would result in a loss charged against its capital.
Source: European Commission Regulation No. EU-152 and EU-153/2013.

5.1.4. Colombian Regulations

Decree 2555/2010 stipulates the minimum amount of capital that must be accredited to request the incorporation of a central counterparty clearing house (CCP) is 19 billion in 2007 Colombian pesos. This amount must be maintained permanently by the CCP and adjusted annually according to the consumer price index (CPI) provided by DANE. In 2020, the minimum capital requirement was COP 32.16 billion (approximately US 9.4 million as of December 2020). The same decree requires clearing houses to have enough financial resources on hand to withstand, at the very least, default by the counterparty with the largest position, under extreme but possible market conditions. Additionally, Law 964 /2005 specifies a CCP's assets are to be allocated preferentially to meet obligations assumed by the CCP itself. There is no differentiation in the regulation between the capital required to cover instances of default by members and that required to hedge other risks to which CCPs are exposed.

There is only one central counterparty in Colombia: the Cámara de Riesgo Central de Contraparte de Colombia S.A. (CRCC). The following is an analysis of its capital, based on the requirements specified in the European regulation, since it is the broadest and most specific in quantifying hedging against risk.

5.1.5 Assessment of the CRCC's Capital Levels

The CRCC's capital levels were evaluated in light of the capital tranches in its counterparty and liquidity risk management scheme, and the capital required to hedge against other risks. Generally speaking, the CRCC's internal regulations and procedures include the requirements established in the European Union regulation, which exceed those required by Colombian regulations.

a. Capital Involved in Mitigating Counterparty and Liquidity Risks

The CRCC has a security ring very similar to the scheme observed internationally (outlined in Diagram 5.1), and the amount of collateral that members are required to provide is intended to hedge against default by the CRCC's two main clearing members. Furthermore, the make-up of the financial resources allocated to cover instances of delay or default is similar to that stipulated by the European authorities. The collateral required from members represents 86.36%, the default funds account for 10.7% and specific proprietary resources (skin in the game), 0.44%. The specific proprietary resources pertain to 25% of the minimum capital required to incorporate this type of infrastructure in Colombia. The amount is updated annually and, if used, it is replaced within six months from the date it is used. An assessment of the remaining capital the CRCC earmarks for its final security ring is outlined below, following an analysis of the capital required to hedge against risks other than counterparty and liquidity risks.

b. Capital Involved in Mitigating Risks Not Covered by Security Rings

Although the CRCC's internal regulation does not specify the amount of capital to be allocated to hedge against the risks not covered by its security rings, the CRCC's management periodically provides the institution's risk committee with an estimate of the resources needed to hedge against such risks.

The amount of capital to be allocated to mitigate risks not covered by the security rings, according to the EU methodology, was estimated in light of the following terms: 1) the capital required for liquidation or restructuring purposes should be equivalent to one semester's operating expenses, 2) the capital required for operational and legal risks should be equivalent to 18% of average annual income, 3) the capital required for credit and market risks not covered by specific resources should be equivalent to 2.0% of the CRCC's contributions to its security rings, and 4) the capital required for business risk should be equivalent to 25% of annual operating expenses. The additional capital to support the other non-hedged risks can be determined with the following formula:

$$Ka = (Goba \div 12 \times mlr) + (0,18 \times Iop) + (0,02 \times K) + (0,25 \times Goba)$$

Where:

Ka = additional capital

$Goba$ = annual gross operating expenses

mlr = number of months needed to liquidate or restructure, applying the minimum established in the EU regulation (six months).

Iop = average annual operating income

K = capital committed to the security rings

Based on this formula and the percentages required to determine the specific amount of own financial resources (skin in the game), the exercise described below was done to approximate the capital the CRCC needs to hedge its potential risks.

According to Colombian regulations, the minimum amount of capital required to establish a CCP was COP 32.16 billion in 2020. The CRCC's July 2020 financial statements show COP 54.67 billion in total capital, which is COP 22.51 billion more than the capital required to incorporate a CCP. The specific amount of own financial resources defined in the CRCC's internal regulation is 25% of the minimum capital required to incorporate a CCP; that is, COP 8.04 billion for 2020.

Table 5.3 provides details on how the capital required for each of the risks not covered by the security rings is calculated and shows a hypothetical distribution of the CRCC's capital to hedge the various risks associated with its operation. In applying the formula noted above, it was determined: 1) the capital needed to hedge against the risks not covered by the CRCC's security rings comes to COP 14.5 billion for 2020 (the sum of the amounts in the yellow boxes); 2) the resources not required by Colombian regulations amount to COP 22.48 billion, including the specific proprietary resources involved in the security rings (green box); and 3) the CRCC's capital (COP 54.67 billion at July 2020) is sufficient to comply with the regulatory requirements, the specific proprietary resources and the risks not covered by the security rings.

Graph 5.3
Evaluation of the CRCC's Capital Structure with Reference to the European Regulations

Jurisdiction	Minimum permanent initial capital	Specific proprietary resources (skin in the game)	Capital required for liquidation or restructuring purposes	Capital required due to operative and juridical risks	Capital required due to credit risks, not covered by security rings	Capital required due to corporate risk
Europe	EUR 7.5 million (COP 32,981 m)	25% of permanent initial capital	Monthly operative expenses x 6	18% of the annual income average	2% of contributions by the CRCC to security rings:	25% of operative annual net expenses: 3,483.50
Colombia	COP 32,160 m	COP 8,000 m	COP 6,967 m	COP 3,382 m	643.2 m	3,483.5 m
Non-regulated capital requirement				COP 22,475 m		

Note: The following is the meaning of the colors used in the row for the Colombian case: orange means the capital requirements are regulated and met; grey means they are not regulated and are met according to the CRCC's internal regulations; and yellow means they are not regulated but the CRCC quantifies them and periodically presents them to its risk committee.
Source: CRCC and Banco de la República.

Finally, under the assumption that the regulatory requirements implicitly seek to cover the ultimate risks associated with the CRCC's corporate activity, the remaining capital, as the last security ring for all segments, would be COP 32.19 billion (the CRCC's capital level minus the non-regulated capital requirement).

5.1.6 Final Considerations

Due to the fact that there is only one central counterparty in Colombia (the CRCC), and the services it provides involve processes that are crucial to normal operation of the country's securities and foreign exchange markets, the CRCC must have the capital it needs to hedge against the risks to which it is exposed.

The CRCC has a capital level in excess of what is stipulated in Colombian regulations, and it is sufficient to cover other risks, according to the approach used in this section. However, maintaining this condition presents challenges for the CRCC as it increases its supply of services or incorporates new products or segments into its operations.

CRCC risk management has adopted several of the risk-mitigation mechanisms established in the European jurisdiction, even though local regulations do not require them. One example is informing its risk committee of the estimated risks not covered by the security rings. Another is allocating part of the CRCC's capital as specific funds to manage default by its members. These resources would be equivalent to 25% of the capital required to establish a CCP. A third mechanism involves keeping the CRCC's comprehensive risk model calibrated to address possible default by its two main clearing members.

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5.2 Heterogeneity in the Use of Intraday Liquidity Sources in the Large-value Payment System

This section contains a summary of “Heterogeneity in the Use of Intraday Liquidity Sources in the Large-value Payment System (CUD),” which identifies and quantifies the sources used by CUD participants to meet their daily obligations contracted in the local financial market (Ortega, Cepeda and Martínez, 2021).

Financial entities send and receive a large number of payments throughout the day. These payments are the result of obligations and rights contracted on their own behalf or on behalf of third parties (clients). Occasionally, when faced with events that are difficult to predict, some institutions lack liquidity due to mismatches between the time payments are sent and the time they are received (Bhattacharya, Haslag and Martin, 2009). Accordingly, these institutions resort to the central bank, to other financial institutions, or make use of alternative sources to meet their short-term liquidity needs.

When access to liquidity sources is subject to the delivery of an asset as collateral, the cost of its use is less than the explicit cost of liquidity from uncollateralized sources, since the latter reflects not only the cost of the capital, but also the credit risk of the institution needing liquidity (Furfine, 1999). In the first case, collateral fulfills the function of reducing credit risk for the institution providing liquidity, since the institution that delivers it at the beginning of the contract has an incentive to recover it (Kahn and Roberds, 2009).⁶⁸ Repurchase agreements (repos), sell/buy-backs, and temporary transfer of securities (TTS) are collateralized sources, while bank loans are uncollateralized sources. Other sources of liquidity include balances in central bank deposit accounts at the beginning of the day and liquidity savings obtained through liquidity-saving mechanisms in financial market infrastructures (FMIs).

At the beginning of the trading day, financial institutions estimate the cash they will need to make payments (Klee, 2007) and identify the sources of liquidity that will allow them to do so. In this context, it is natural to ask how financial institutions fund their intraday payments, considering the sources of liquidity that are available. This paper tries to answer that question based on an intraday liquidity source discrimination algorithm that can be applied to break down the payments made by commercial banks (CB), financial corporations (FC), finance companies (CFC), financial cooperatives (FCP), brokerage firms (BF) and trust companies (TC), through a multiple imputation of data for the Colombian case. Daily information from the local large-value

68 Specifying a haircut associated with the collateral also helps to mitigate market risk.

payment system (CUD) between July 2018 and July 2020 was used for this purpose.

The CUD, which is owned and managed by *Banco de la República* (Banrep), is a real-time gross settlement system. It benefits from the liquidity-saving mechanisms (LSM) of the Central Securities Depository (DCV), which are used to reduce resource requirements in the settlement of transactions with sovereign bonds by activating several optimization cycles during the day.⁶⁹

The balances that financial institutions participating in CUD have on hand in deposit accounts are used to meet payment obligations contracted in the financial markets. This intraday balance is regarded as an integral unit of cash because it reflects the cumulative position of a single asset (money) but does not differentiate between the various items that increase or reduce it. This paper contains a breakdown of this cash unit, so as to identify the funding pattern for each type of institution when it comes to financing its intraday payments. This is done to track intraday liquidity management, to facilitate monitoring and to be able to identify early signs of intraday liquidity risk.

Research on the use of liquidity sources is of special interest to central banks, since a normal and continuous flow of payments between financial institutions is fundamental for the financial system to operate properly. Bernal, Cepeda and Ortega (2012) compared the use of liquidity sources by the most active CUD participants (commercial banks, brokerage firms and trust companies) during two periods (May 2002 and May 2010) that were marked by sharp differences in functionality and market conditions.⁷⁰

The study by Ortega *et al.* (2021) differs from the one by Bernal *et al.* (2012) in three ways:

- Ortega *et al.* (2021) designed and applied an algorithm to process each CUD movement, which consists in adding the payments received to the liquidity sources and deducting the payments sent from the liquidity sources used. The implementation of this algorithm is conditioned to the consumption priorities of the liquidity sources that the authors

69 In large-value payment systems with real-time gross settlement, payments are settled individually, on a gross basis and at the time the payment is sent, which means these systems require considerable amounts of liquidity to ensure their normal operation (Martin and McAndrews, 2008).

70 The main differences in functionality and market conditions are: i) In 2002, the system lacked LSMs; that is, all transactions were settled gross, which meant high liquidity requirements for participants. By 2010, the existence of LSMs allowed the CUD to reduce these liquidity needs for sovereign bond market participants. ii) In 2002, as opposed to 2010, there was no transaction fee scheme based on time windows that provide incentives for settling operations early. iii) In 2002, the General Directorate of Public Credit and the National Treasury irrigated its liquidity surpluses directly into the market through repo operations, causing friction in the application of monetary policy. As of June 2005, through an inter-institutional agreement, these surpluses are deposited with *Banco de la República* and receive remuneration in exchange.

established as initial parameters.⁷¹ This was done according to defined rules based on criteria associated with the sources, such as explicit interest rates, participation in the total value of the payments, participation by institutions with authorized access, participation by institutions that use the liquidity source, a dummy to determine whether or not it has liquidity-saving mechanisms, a dummy to determine if a reserve requirement is in effect, and if there is FMI involvement. The algorithm was run with each intraday transaction, respecting the strict sequence in which these transactions are recorded, and not at the end of the day, as in the study by Bernal *et al.* (2012). This allows for more precise findings.

- The study by Ortega *et al.* (2021) considers a broader group of liquidity sources (e. g., liquidity surpluses, money market operations with private debt, and resources transferred to the custodians of collective investment funds (CIF)).

These differences in the methodology used to quantify intraday liquidity sources allowed Ortega *et al.* (2021) to conclude that liquidity savings, incoming payments (i.e., dynamic source) and overnight balances were the ones that contributed the most to payment settlements in the CUD. Moreover, they determined this ranking does not hold by type of institution, since the results show a degree of heterogeneity in their preferences. This can be attributed to a number of aspects such as the nature of their business, the regulations to which participants are subject, economic and market conditions, availability of the sources in question, and their respective costs.

The nature of their business is particularly important for trust companies, given the liquidity they receive in their capacity as custodians of collective investment funds. It also is relevant for credit institutions (CF, FC, CFC and FCP), because their activity in terms of taking deposits from the public means they must comply with reserve requirements, which they partially satisfy through overnight balances that can be used to settle their intraday obligations in the payment system.

5.2.1 Intraday Liquidity Sources

An important source of liquidity to guarantee the settlement of daily operations is provided by the central bank as a way to smooth the flow of payments between financial institutions. Intraday repos and monetary policy repos are among the various mechanisms used by the central bank for this

71 For example, if an institution is going to make a payment of COP 100 and, at that moment, has previously accumulated sources of liquidity (i.e., sell/buy-backs, interbank loans, Banrep repos and incoming payments (dynamic)), the algorithm cover this payment using these funding sources, pursuant to the priorities defined by the authors, starting with the highest priority and advancing to the following ones until the indicated amount is completed.

purpose. They are represented by agreements to sell and repurchase collateral at a future date and at a price established in the contract.⁷²

The money market assembles a set of operations that allow financial institutions to offer and access the liquidity these operations provide. They include repos with other financial institutions, sell/buy-backs, interbank loans and TTSs. Sell/buy-backs differ from repos with other financial institutions because they are not subject to haircuts or restrictions on the mobility of the collateral received and, therefore, are usually preferred to repos (Cardozo *et al.*, 2016).

There are other types of additional sources of liquidity, such as the balances institutions have in their deposit accounts with the central bank at the beginning of the trading day, liquidity savings, incoming payments (dynamic), money transfers to deposit accounts with the central bank, and the resources some institutions receive to carry out CIF operations in their capacity as custodians of securities.

The balance in deposit accounts with the central bank at the beginning of the trading day is a source of liquidity that allows the institutions with these accounts to meet their payment obligations. This balance has no explicit cost, but its use has an implicit one (opportunity cost) that is represented by the interest its owners would have received had they invested or lent those resources. In the Colombian case, the beginning of the trading day in transactional terms occurs at 7:00 a.m. For credit institutions (CB, FC, CFC and FCP), the balances available in the CUD at the end of the trading day are part of the available reserve they use to meet their reserve requirements and constitute an important source of liquidity for settling their daily operations.

The liquidity savings generated through LSMs facilitate the operation of large-value payment systems with real-time gross settlement, without the need for considerable use of liquidity. According to Martin and McAndrews (2008), these mechanisms function as arrangements that allow financial institutions to queue payments and condition their final settlement to incoming payments. In Colombia, these LSMs are activated by cycles in the DCV, which occur at 11:50, 14:20, 15:30, 16:15, 16:50 and 17:45 hours. Two types of sources emerge from these cycles: liquidity surpluses and liquidity savings. During a cycle, when the difference between the sum of amounts in its favor and the sum of what a financial institution owes is positive, a liquidity surplus is generated and credited to its account. Otherwise, if its net position is negative, a liquidity savings is generated for the institution, equivalent to the sum of the transactions in its favor.

Incoming payments (i.e., dynamic) are a liquidity source that stems from recirculating the funds received from other financial institutions. Therefore,

⁷² All repos require the legal transfer of the collateral during the term of the contract, and an interest rate (repo rate) is agreed upon. At the end of the contract term, legal transfer of the collateral is reversed, which is when the institution that accessed liquidity is obliged to buy it, and for which it pays the amount pertaining to the loan and the interest stipulated for accessing that particular source of funding (Choudhry, 2010).

using them does not generate a cost. However, the financial institution has no certainty as to when it will receive these payments.

Money uploads to deposit accounts with the central bank are a source of liquidity for commercial banks and trust companies. During the day, these institutions receive the amount of money they had transferred to banks at the end of the previous day, that is, before the closing of the payment system. This transfer of funds to commercial banks is done in exchange for a previously agreed payment. Money uploads to accounts with the central bank are a source of liquidity that implies a cost for commercial banks (remuneration for these resources), but not for brokerage firms and trust companies.

The only financial institutions authorized to act as custodians by holding the customer's securities and money for care and safekeeping are trust companies. Their purpose is to comply with the operations determined by the client, guarantee the securities are kept safe, clear and settle operations, and manage the patrimonial rights resulting from the securities they hold in custody (Decree 1498 of July 15, 2013). By law, collective investment funds are subject to custody, and their managers (i.e., brokerage firms, trust companies and investment management companies) are obliged to contract custody of the securities that make up the portfolios of these funds (Decree 1242 of June 14, 2013). Securities custody began to operate in July 2015, when trust companies started to receive money in their CUD deposit accounts sent by CIF managers, so that the centralized securities depositories (DCV and Deceval) could settle the cash leg and the securities leg (*Banco de la República*, 2016) of the transactions carried out by CIF managers. The funds trust companies receive as custodians provide them with a source of liquidity to settle payments ordered by the CIFs.

5.2.2 Algorithm for Classifying Intraday Liquidity Sources

To understand how financial institutions fund their payments, the authors developed an algorithm to discriminate liquidity sources and uses (ADFUL). It has two purposes. The first is to break down the cash unit (i.e., the intraday balance in the CUD) for each institution, using the information observed in the initial balances and the intraday transactions that are carried out (credit and debit movements). The second is to classify and quantify sources and uses of liquidity for the institutions, establishing a series of rules that define consumption priorities.

The complete process to identify the use of liquidity sources by each of the CUD's participating institutions is described in four stages. The first stage is designed to identify the execution parameters represented by the transactions (debit, credit) and by the codes of transactions and sources. The criteria used to establish consumption priorities and the way they are assigned are explained in the second and third stages. Finally, in the fourth stage, the necessary procedures and the logic applied to calculate the sources and uses of liquidity are explained. A detailed description of the process and the algorithm can be found in the paper by Ortega, Cepeda and Martínez (2021).

The logic of ADFUL, together with the initial consumption priority parameters defined through rules established on the basis of the aforementioned criteria, made it possible to methodically quantify the intraday funding sources used by each participant in the CUD system. The following sections show the combined results, by type of institution and type of liquidity source.

5.2.3 Results by Type of Institution

The analysis of preferences and the use of liquidity sources is based on the values identified by the algorithm for each institution. To facilitate presenting them and to keep the information on individual institutions private, the results are presented in aggregate form, by type of institution and on a monthly basis. The results reported in the aggregates correspond to the average institution of the group.

5.2.3.1 Commercial Banks

Overnight balances are the main source of intraday liquidity for commercial banks. Their daily average during the period in question (COP 7.8 t) represents 29.9% of all payments sent by these institutions (COP 26.3 t). This important use of the overnight balance as a source of funding obeys the considerable amount of resources⁷³ these types of institutions have available in deposit accounts, so as to comply with reserve requirements on their deposits from the public, as well as the possibility of using them to settle their obligations in the payment system.

Commercial banks also fund a large proportion of their payments using other sources, such as liquidity savings and incoming payments (i.e., dynamic). On average, these accounted for 24.4% (COP 6.4 t) and 20.9% (COP 5.5 t) of total payments, respectively. On the other hand, liquidity surpluses and overnight repos contributed in equal amounts to 9.6% (COP 2.5 t) of the value of payments. Other sources such as money uploads, interbank loans and sell/buy-back operations with sovereign debt accounted, as a whole, for 4.9% of the value of payments settled by these institutions.

5.2.3.2 Financial Corporations

Financial corporations occupy second place in terms of the value of payments sent by credit institutions through the CUD, with a daily average of COP 2.7 t for the period in question. In all, 80.6% of the average daily payments made by financial corporations were funded with liquidity savings (43.0% - COP 1.2 t), incoming payments or dynamic (19.9% - COP 0.5 t), overnight repos (9.1% - COP 0.2 t) and sell/buy-backs with sovereign debt (8.7% - COP 0.2 t). The combined share of these sources in the total value of payments was above 70% every month.

⁷³ In 2019, the available reserve deposited by commercial banks accounted for 98.2% of the total reserve deposited by credit institutions.

The remaining sources of liquidity each account for less than 10% of the payments sent by these institutions: intraday repos (5.3%), and overnight balances (3.9%). The low contribution from this last liquidity source is explained by the small volume of deposit taking by financial corporations compared to the value of the payments they originate in the CUD.

Interbank loans, liquidity surpluses and money uploads account for proportions under 4.0%, and 10% collectively, which comes to COP 0.26 t of the total value of payments sent by these institutions.

5.2.3.3 Finance Companies

Finance companies generate COP 0.1 t in payments, on average. These are equivalent to 0.2% of all payments in the CUD. Incoming payments (i.e., dynamic) and overnight balances are the sources these institutions use the most to fund their intraday payments. Together, they account for 76.3% of all their payments. Overnight repos are another liquidity source widely used by finance companies and account for 20.6% of their daily payments, on average.

5.2.3.4 Financial Cooperatives

The sources most representative of payments made by financial cooperatives are overnight balances, which account for 65%, and incoming payments (i.e., dynamic), 34%.

5.2.3.5 Other Financial Entities

Trust companies and brokerage firms are second only to commercial banks in generating the largest amount of payments in the CUD with respect to value. With a daily average close to COP 5.4 t for trust companies and COP 5.0 t for brokerage firms, these institutions account for 13.0% and 11.9% of daily payments, in total. Since they are subject to reserve requirements and, as such, are not required to maintain reserves, the overnight balance in their deposit accounts represents approximately 1.5% of the total value of their payments, which is offset by a greater dependence on money uploads (around 20%).

5.2.3.6 Trust Companies

The average daily value of the liquidity trust companies obtained from CIF managers during the period in question for their work as custodians was COP 2.4 t, a figure that represents 45.2% of their daily payments. Other sources, such as incoming payments or dynamic (18.8%), money uploads (18.4%) and intraday repos (15.0%) also account for a large share of the liquidity used by these institutions for daily payments, but much less than the liquidity from their role as custodians.

The share of funding from other sources for trust-company payments is lower. In this group, liquidity surpluses, overnight balances and liquidity savings together account for 4.7% of payments.

5.2.3.7 Brokerage Firms

The most important sources for brokerage firms are liquidity savings, incoming payments (i.e., dynamic) and money uploads. Together, they account for 76.6% (COP 3.8 t) of the daily payments these firms made during the period under study.

Brokerage firms also obtain intraday liquidity from sell/buy-backs with sovereign debt (which they contract and settle with their counterparties on a gross basis), from their work as CIF managers, and from liquidity surpluses. Liquidity obtained through sell/buy-backs with sovereign debt accounted for 7.5% (COP 0.37 t) of their payments, resources received from their work as CIF managers,⁷⁴ 5.7% (0.28 t), and liquidity surpluses, 2.6% (0.13 t).

Table 5.4
Value Settled by Type of Source and Institution, Daily Average (July 2018 - July 2020)
(Billions of pesos)

Sources of Liquidity	Commercial Banks	Financial Corporations	Finance Companies	Financial Cooperatives	Brokerage Firms	Trust Companies	Total	Share of Total Payments
Liquidity savings	6,398.3	1,159.7	0.1	0.0	1,485.9	54.0	9,098.0	23.1%
Dynamic (incoming payments)	5,480.4	535.9	46.3	1.2	1,214.3	993.1	8,271.2	21.0%
Overnight balance	7,848.0	110.1	33.2	2.4	85.8	71.6	8,151.1	20.7%
Overnight BR repos	2,529.2	97.6	0.5	0.0	127.0	128.6	2,882.8	7.3%
Custody	2,513.1	245.3	21.5	0.0	88.8	14.1	2,882.7	7.3%
Money uploads	121.3	0.0	0.0	0.0	283.7	2,392.8	2,797.9	7.1%
BR repo payment systems	606.2	67.6	1.8	0.0	1,104.2	972.6	2,752.4	7.0%
Sovereign debt sell/buy-backs	83.9	148.7	0.6	0.0	4.3	795.4	1,033.0	2.6%
Interbank loans	314.2	235.8	0.0	0.0	374.8	9.7	934.6	2.4%
Other sources	358.7	98.6	0.2	0.0	104.8	8.6	570.9	1.4%
Third party repos and private debt sell/buy-backs	0.3	0.0	0.1	0.0	88.9	0.3	89.7	0.2%
Value of payments	0.0	0.0	0.0	0.0	4.8	0.2	5.0	0.0%
Percentage share in the total value of daily payments	26,253.7	2,699.3	104.3	3.7	4,967.4	5,441.0	39,469.3	100%
Percentage share in the total value of daily payments	66.5%	6.8%	0.3%	0.0%	12.6%	13.8%	100.0%	100.0%

Source: Authors' calculations based on Adful results.

⁷⁴ In their capacity as CIF managers, brokerage firms receive liquidity in the CUD from the custodians, after having made sales for the CIFs, and from the banks that transfer money to them as ordered by their customers when investing in CIFs.

5.2.4 Findings by Type of Liquidity Source

The use of liquidity sources in the payments made by the institutions considered in the study is compared in this section. As illustrated in Table 5.4, the sources institutions use the most, in absolute terms, are liquidity savings, incoming payments (i.e., dynamic) and overnight balances, each with an average share of over 20%. Other sources, such as liquidity surpluses, money uploads, Banrep overnight repos and custodians, each account for approximately 7.0% of daily payments. Sell/buy-backs with sovereign debt, intraday repos and inter-bank loans each represent less than 3.0% of their payments.

In the specific case of repos and sell/buy-backs with sovereign debt, it is worth noting that, although they are negotiated bilaterally on a one-to-one basis, many of these transactions are settled through LSMs, benefiting from the liquidity savings obtained through multilateral netting. Out of an average daily total of COP 6.0 t during the period in question, 66.6% were settled through these mechanisms and the remaining 33.4% were settled individually; that is, one by one, as negotiated. In the case of sell/buy-back, 78.3% of their average daily value (COP 5.9 t) was settled through LSMs and the other 21.7%, individually.

The benefits of LSMs are shown in Table 5.4, which contains the average results (values and share) on the use of liquidity sources presented in a cross-sectional manner. At the aggregate level, the most relevant sources are liquidity savings, incoming payments (i.e., dynamic) and overnight balances. The commercial banks have payment patterns similar to those identified for the average in the CUD, since they account for most of the payments in terms of value (COP 26.3 t). This is explained by a heavy dependence on overnight balances (COP 7.8 t), liquidity savings (COP 6.4 t) and incoming payments or dynamic (COP 5.5 t), and by a moderate dependence on liquidity surpluses (COP 2.6 t) and overnight repos (COP 2.5 t). Other institutions, such as trust companies and brokerage firms, differ from the average preferences identified in the aggregate. Their work as CIF custodians is the source of liquidity used most intensively by trust companies (COP 2.4 t), while brokerage firms are highly dependent on liquidity savings (COP 1.5 t), incoming payments or dynamic (COP 1.2 t) and money uploads (COP 1.1 t).

5.2.5 Conclusions

In general, liquidity savings, incoming payments (i.e., dynamic) and overnight balances were the sources used the most to settle payments in the CUD. However, this ranking does not hold when the results are broken down by type of institution, since there are differences in their preferences, attributable to a number of aspects, such as the nature of the business, the regulations to which companies and institutions are subject, economic and market conditions, the availability of liquidity sources and their respective costs.

The availability of sources may be a constraint on funding decisions for some institutions. In the case of monetary policy repos, *Banco de la República* determines the institutions that may have access to this type of liquidity. On the other hand, interbank loans are determined by the level of trust established previously between the counterparties.

Decisions on the selection of a particular source also depend on its cost, the regulatory framework and other factors such as the haircut and use of the DVC's LSMs.

The availability of liquidity sources and their use also hinge on financial market activity and macroeconomic factors. In the first case, the high turnover in sovereign debt during trading in the last half of 2018 allowed for liquidity savings to be the most relevant source. In the second case, the effects of the lockdown forced by Covid-19 (i. e., which caused demand and supply shocks) generated an increase in the use of overnight balances as of April 2020 and a reduction in the use of liquidity savings and incoming payments (i.e., dynamic).

5.2.6 Contribution

The ADFUL algorithm is a tool for quantifying the use of liquidity sources in a more refined way; namely, it identifies new sources (liquidity surpluses, money uploads incoming payments (dynamic) and CIF resources) and measures use at the moment each payment is settled. This makes it possible to identify patterns of behavior for each participant in the payment system, and to recognize signs of potential risk based on changes in such patterns. All of this is helpful in monitoring financial market infrastructures.

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Papers Produced Recently by the Financial Infrastructure Oversight Department

Pattern Recognition of Financial Institutions' Payment Behavior¹ (Reconocimiento de patrones en el comportamiento de pagos de instituciones financieras)

Carlos León
Paolo Barucca
Óscar Acero
Gerardo Gage
Fabio Ortega

The findings derived from using a supervised machine learning methodology to identify the behavior of financial institutions in the Colombian large-value payment system are presented in this paper. The transactional data that result from the settlement of financial institutions' transactions in local currency are used. An artificial neural network is trained to learn the general payment patterns of each financial institution in order to classify new (out-of-sample) payment patterns. Having the ability to identify financial institutions by their behavior in the payment system can be important when it comes to the oversight done by financial authorities. This capability provides additional tools to detect relevant changes in the way financial institutions interact with each other, either as a consequence of changes in the behavior of individual institutions or changes in the market as a whole.

1 Published in the *Latin American Journal of Central Banking*, Vol. 1, 2020 (<https://www.sciencedirect.com/science/article/pii/S2666143820300119>). Preliminary version in *Borradores de Economía*, No. 1130, *Banco de la República*, 2020 (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/9901/be_1130.pdf)

Interbank Relationship Lending in Colombia² (Relaciones de préstamo interbancario en Colombia)

Carlos León
Javier Miguélez

Based on daily data from January 2014 to September 2019, this paper uses a survival ratio to measure the incidence of stable lending relationships among financial institutions in Colombia. The results show 58% of the connections survive from one day to the next, on average. For periods of five, ten and twenty days, this coefficient declines to 36%, 28% and 22%, respectively. It was found the results are not due to factors such as randomness, the presence of low-amount relationships, or the presence of financial institutions other than credit institutions seeking resources in the intraday interbank market. Additionally, a preliminary review of the survival ratios during the first weeks of stress related to the Covid-19 pandemic and the fall in oil prices suggests that confidence in the Colombian interbank market was not seriously affected.

2 Published in *Physica A*, No. 573, 2021 (<https://www.sciencedirect.com/science/article/abs/pii/S0378437121001941>). Preliminary version in *Borradores de Economía*, No. 1118, *Banco de la República*, 2020 (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/9862/be_1118.pdf).

Securities Cross-holding in the Colombian Financial System: A Topological Approach³ (Las posiciones cruzadas de títulos valores en el sistema financiero colombiano: una aproximación topológica)

Carlos León
Javier Miguélez

Based on network analysis, this research manages to identify, visualize, quantify and examine the cross-positions between financial institutions in the Colombian market, which include three types of securities: equities, bonds and term certificates of deposit. This is of particular interest in the Colombian case because this type of exposure has not been studied, despite the fact that it is approximately 1.5 times greater than that of loans between financial institutions. Based on weekly information from January 2016 to September 2019, the results show the Colombian financial system's exposure derived from holding securities issued by financial institutions is low (even when considering the possibility of cross-positions between securities of different types). This finding is stable throughout the study period. The topology of the network of securities issued and held by financial institutions in Colombia suggests the potential effect of circular interdependencies on financial stability is minor.

Quién es quién en la red de coautoría en Colombia⁴ (Who's Who in the Co-authorship Network in Colombia?)

Carlos León and Angélica Bahos-Olivera

This article is intended to further the study of co-authorship networks in the field of economics, limited to the case of articles published in journals indexed in Scopus between 2010 and 2019, where at least one of the authors is affiliated with an institution in Colombia. The aim is to contribute to an analysis of the connective structure of the Colombian network and its impact on the production and spread of knowledge, as well as to quantify the importance of the authors as participants in that network. Although the co-authorship network in Colombia is not extremely interconnected, there are a few highly interconnected authors who keep it united and with a short distance between its participating authors. This type of connective structure, known as a "small-world network," suggests a co-authorship network facilitates the creation and spread of knowledge through the joint publication of articles and the learning that comes from collaboration among authors. The importance of the authors affiliated with *Banco de la República*, who contribute a great deal to the connective structure of the Colombian network, is highlighted.

3 Published in *Studies in Economics and Finance*, 2021 (<https://doi.org/10.1108/SEF-10-2020-0398>). Preliminary version in *Borradores de Economía*, No. 1134, *Banco de la República*, 2020 (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/9914/be_1134.pdf).

4 Accepted for publication in *Revista de Economía del Rosario*. Preliminary version in *Borradores de Economía*, No. 1146, *Banco de la República*, 2020 (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/9950/be_1146.pdf).

Interbank Relationship Lending Revisited: Are the Funds Available at a Similar Price?⁵ (Reexaminando las relaciones de préstamo interbancario: ¿están los fondos disponibles a un precio similar?)

Carlos León
Javier Miguélez

A methodology to quantify the persistence of interbank lending relationships in a practical and permanent way (with daily frequency) is developed in this research, under the premise that the availability of funds at a similar price determines the existence of stable and strong relationships. Therefore, a series of networks containing information on the cost of uncollateralized interbank lending among financial institutions in Colombia was constructed and used to calculate the survival ratio (i.e., the proportion of relationships that survive during a period). Based on daily information from January 2014 to August 2020, it was found that about 38% of lending relationships persist from one day to the next at a similar price. It was concluded there is evidence of interbank lending relationships in the Colombian case. This methodology not only makes it possible to determine if interbank lending relationships exist, but it also provides an additional tool to better monitor and study interbank market confidence, which is of critical importance to financial stability.

The Dawn of a Mobile Payment Scheme: The Case of Movii⁶ (El surgimiento de un esquema de pagos móviles: el caso de Movii)

Carlos León

This research examines the payment scheme for the mobile wallet developed by Movii, which is the first *fintech* in Colombia operating under a financial (non-bank) license for electronic deposits and payments. Unlike the literature on the adoption of payment technologies and services, bilateral transfers between Movii users were employed to build, visualize and analyze the mobile wallet's transfer networks. In doing so, the author studied the evolution in transfer patterns between Movii users from the day the first transaction occurred (November 18, 2017) up until November 25, 2020. Besides an increase in the number of users and the value and number of transfers, the pattern of transfers between Movii mobile wallet users was found to become more complex over time. The way transfer networks have evolved illustrates (visually and quantitatively) that users find new ways to use mobile payments beyond person-to-person transfers, presumably including person-to-business and business-to-business payments. This can be explained by the well-known difficulty small businesses have in receiving payment instruments other than cash; in this case, the mobile wallet not only facilitates person-to-person transfers but those between people and businesses as well. The results also show the Covid-19 pandemic accelerated the evolution in Movii's mobile payment scheme.

5 Published in *Borradores de Economía*, No. 1151, Banco de la República, 2021 (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/9957/be_1151.pdf)

6 Published in *Borradores de Economía*, No. 1157, Banco de la República, 2021 (https://repositorio.banrep.gov.co/bitstream/handle/20.500.12134/10003/be_1157.pdf).

Annex 1 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. In addition, more is explained about the retail-value payment systems.

Fixed Income

Diagram A1.1 shows the infrastructures that provide trading, clearing and settlement services for operations in the fixed-income market. The flow starts at the top with the trading and registration systems where, using automatic matching mechanisms (SEN and MEC) and hybrid voice

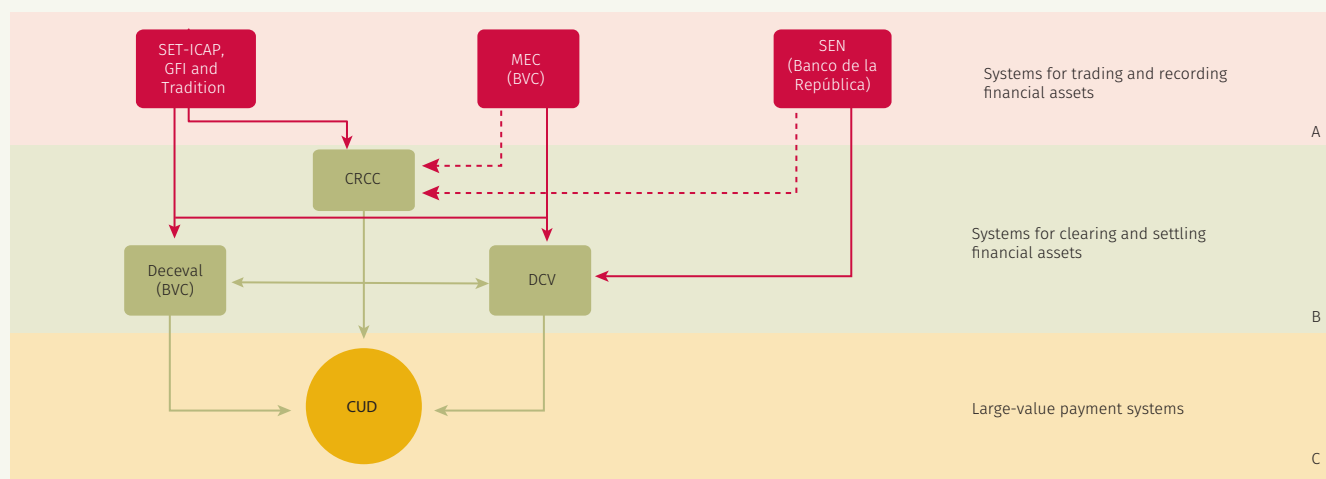
and data systems (SET-ICAP Securities, GFI and Tradition), participants carry out their operations. In each of these transactions, the seller must inform the system manager of the depository where the securities to be delivered are located, so the system manager can send them and so the respective process and settlement can be completed. 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 CUD large-value payment system.

Forward operations (TES sell/buy-backs) are sent by SEN and MEC to the Colombian Central Counterparty (CRCC) for respective risk management (dotted lines in Diagram A1.1); while gross clearing and settlement are done in the DCV-CUD (continuous lines in the same diagram).

Equity Income

The BVC manages the value chain in the spot market for equities in Colombia, from trading to clearing and settlement. In the case of forward transactions (equity repos), it also manages trading, but clearing and settlement are done through the CRCC.¹

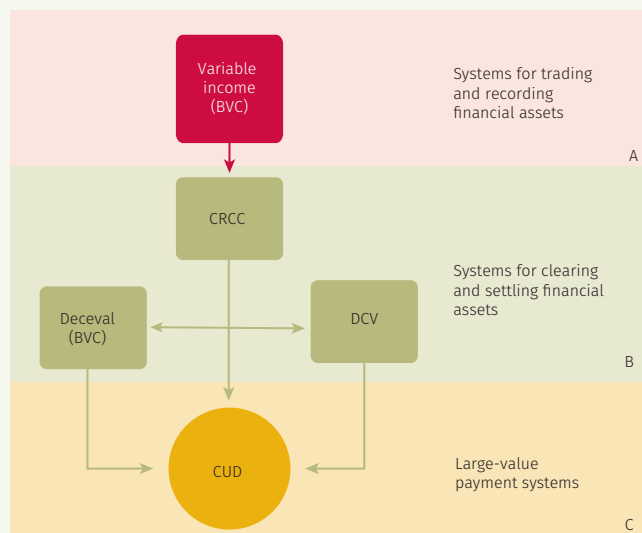
Diagram A1.1
Flow of Operations in the Fixed-income Market



Source: Banco de la República (DSIF).

¹ See Ministry of Finance Decree 2219 of December 27, 2017. It amends Decree 2555/2010 with respect to several provisions applicable to transactions that are 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 A1.2
Flow of Operations in the Market for Equities



Source: Banco de la República (DSIF).

As illustrated in Diagram A1.2, the flow starts in the trading system, where participants compete with offers for available securities. These operations are confirmed and complemented after closing. The BVC sends the operations 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 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. The CRCC and the Foreign Exchange Clearing House of Colombia S.A. (CCDC)² are in charge of the processes for clearing and settling operations that can be accepted pursuant to the conditions set forth in their respective regulations. The CCDC clears and settles only forex (peso/dollar) spot market transactions between its participating financial institutions.³ The CRCC, on the other hand, clears and settles cash-settled

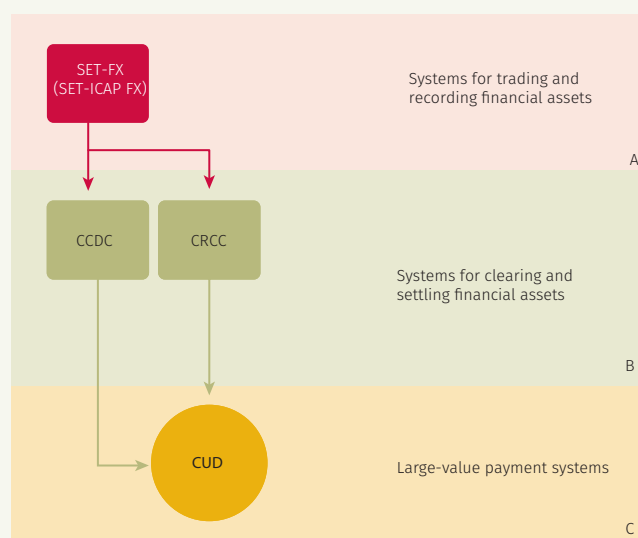
2 These two clearing houses merged by absorption on December 14, 2020. As a result, the CCDC was absorbed by the CRCC. Consequently, transactions in the spot market for foreign exchange are now cleared and settled through the CRCC.

3 External Resolution 4 adopted in 2006 by the Board of Directors of Banco de la República stipulates that institutions overseen by the Office of the Financial Superintendent of Colombia, the Ministry of Finance and Public Credit (General Directorate of Public Credit and the National Treasury) and Banco de la República may act as direct participants, subject to the regime and other applicable provisions that regulate their activities.

NDF forwards (peso/dollar) between its members on proprietary or non-proprietary basis (Diagram A1.3).

The CCDC now processes spot and next day transactions from SET-ICAP-FX. As a central counterparty, it also clears and settles NDF peso/dollar transactions from all authorized systems. However, all those transactions now come from SET-ICAP-FX.

Diagram A1.3
Flow of Operations in the Foreign Exchange Market



Source: Banco de la República (DSIF).

Standardized Derivatives

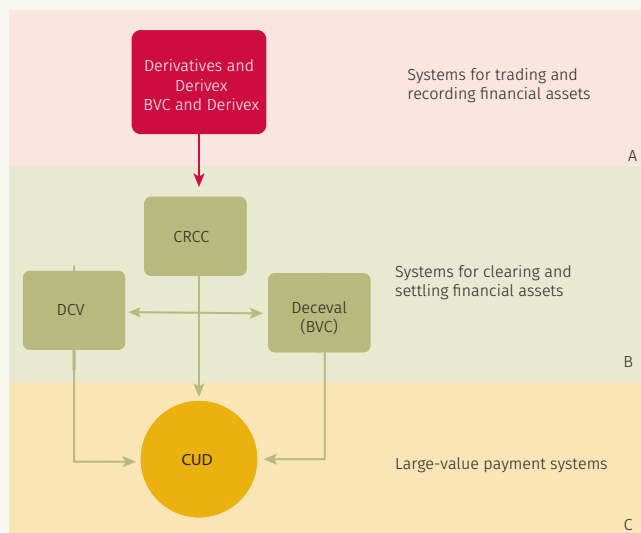
The BVC and Derivex manage the trading and recording systems for the standardized derivatives market. As illustrated in Diagram A1.4, the transactions handled through these systems are sent to the CRCC for clearing and settlement.

From that moment onward, the CRCC, as the central counterparty, does the novation for the operations. As a result, 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 depicted in Diagram A1.5. The Electronic Check Clearing House (Cedec), managed by Banco de la República, clears checks and other payment instruments at the national level. The automated clearing houses for electronic payments (ACH); namely, ACH-Cenit (also managed by Banco de la República) and

Diagram A1.4
Flow of Operations in the Market for Standardized Derivatives



Source: Banco de la República (DSIF).

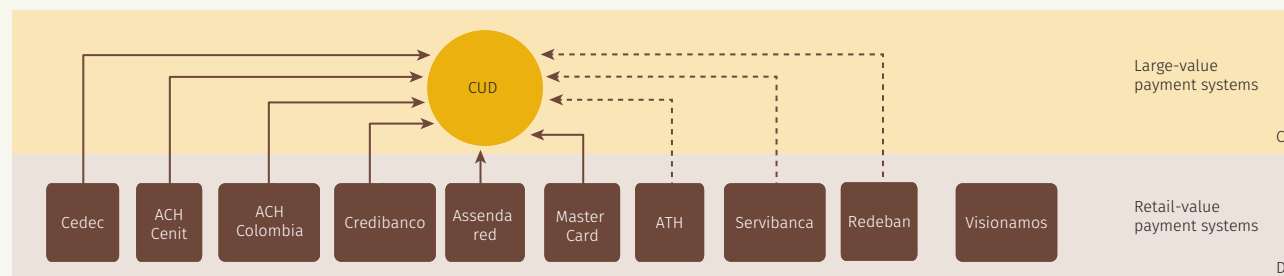
ACH Colombia, process orders for retail-value electronic payments and funds transfers or collections generated by associated institutions on behalf of their clients (persons or legal entities) with checking or savings accounts, while the Credibanco, Assenda Red, Mastercard, ATH, Servibanca and Redeban networks process debit and credit card transactions, among others, made at ATMs and commercial establishments.

Credibanco, Assenda Red and Mastercard have deposit accounts with the large-value payment system and, therefore, are able to clear and settle their operations directly, using the resources in those accounts. The other networks do not have a deposit account of their own in the central

bank system.⁴ Consequently, they merely 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 institution performs a specific function within 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 A1.5
Flow of Operations in the Retail-value Payment System



Source: Banco de la República (DSIF).

⁴ The dotted lines in Diagram A1.5 refer to the fact that these ATM and card networks do not have a deposit account of their own 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, which in turn settles through Cenit.