

# SYSTEMS R



## PAYMENT SYSTEMS REPORT

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June 2016

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# PAYMENT SYSTEMS REPORT

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Deputy Governor's Office for Monetary  
and International Investment  
June 2016

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

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# ACRONYMS IN SPANISH

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.  
CPSS: Comité de Sistemas de Pagos y Liquidación (por su sigla en inglés)  
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 - Ministerio de Hacienda  
DSIF: Departamento de Seguimiento a la Infraestructura Financiera del *Banco de la República*  
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  
GMF: gravamen a los movimientos financieros  
IBR: Indicador bancario de referencia  
IMC: intermediario del mercado cambiario  
IVA: Impuesto sobre las ventas  
JDDBR: 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  
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, como también proveedor de información financiera.

SPAV: sistema de pagos de alto valor

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

Automated Clearing House

National interbank electronic settlement managed by *Banco de la República*

Automated Clearing House

ATM network

Bank for International Settlements (BIS)

Colombian Stock Exchange

Foreign Exchange Clearing House of Colombia S. A.

Term deposit certificate

Electronic clearing system for checks and other payment instruments, administered by the *Banco de la República*

Central Counterparty Risk of Colombia S. A.

Committee on Payment and Settlement Systems (CPSS)

Concentration index constructed as the sum of the five largest participations

Deposit account system, administered by *Banco de la República* for settlement of transfer of funds, also called large-value payment system.

National Administrative Department of Statistics

Central Securities Depository, administered by *Banco de la República*

Centralized Securities Depository of Colombia S. A.

General Directorate of Public Credit and National Treasury - Ministry of Finance

Financial Infrastructure Oversight Department of *Banco de la República*

Delivery versus payment method applicable in the settlement of securities (DvP)

Collective Investment Funds (CIF)

Fund for the Financing of the Agricultural Sector

Financial transactions tax

Banking benchmark index (BBI)

Foreign exchange market intermediary (FEMI)

Sales tax

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

Colombian Electronic Market owned by the Colombian Stock Exchange S. A.

Non-delivery forward

GDP: gross domestic product

Secure Online Payments

Electronic trading system administered by the *Banco de la República*

Foreign exchange electronic transaction system, managed by Integrated Services in Exchange Market S.A, with the support of the Colombian Stock Exchange S.A. and SIF-ICAP of Mexico.

Electronic and voice system for the trading and registration of financial instruments, as well as financial information provider.

Large-value payment system (LVPS)

Public debt securities issued by the government and administered by the *Banco de la República*

Representative market rate

Temporary transfer of securities (TTS)



# INTRODUCTION

## PAYMENT SYSTEMS REPORT, 2016

As an important part of the country's financial infrastructure oversight duties, *Banco de la República*'s task consists of monitoring retail-value payment instruments and systems. These play an essential role in the overall stability of the financial system as consumer confidence and the trade of goods and services depend on their smooth operation. Although risks associated with these systems may not be deemed to be of a systemic nature, their importance is indeed significant for the economy.

As a result of this monitoring exercise, the evolution—in both amount and number of operations—of the different payment instruments has become evident throughout the different editions of the Payment Systems Report, as well as the development of subjects and concepts relating to the value chain of retail payments made within the circuit of natural persons and enterprises. In this occasion, a shaded text in the first section is included whereby the figures for each payment instrument are analyzed individually, covering an approximation to the behavior of cash by means of the evolution of banknotes in circulation, as well as the comparison between and among instruments. The analysis found that cash and cards are the payment instruments most used by individuals, while checks and electronic fund transfers are preferred among legal persons. In Colombia, as in other countries, cash availability for payments and the use of other payment instruments have shown an upward trend, as may be seen in the box, which analyzes cash evolution and the use of electronic instruments in the international sphere.

In line with the tracking of innovations in payment processes, the Report includes a box that approaches a new service rendered by an additional agent in the payment chain known as the “payment gateway,” i.e. an intermediate enterprise acting between the retail establishment and the payer, in charge of

validating their transaction. This new service has enabled the growth of electronic commerce with the commercial offer made through the Internet in the corresponding web pages.

In this seventh edition of the Payment Systems Report, the boxes focus on three topics of interest to the industry that renders payments clearing and settlement services as well as to those taking part in them. First, the international debate revolving around the optimal capital level of Central Counterparties (CCPs) is approached. Due to the fact that risks arising from clearing activities are to a great extent covered by specific financial resources (i.e. margins and collective funds), CCPs must count on their own financial resources to ensure they are properly capitalized at all times to address credit, counterparty, market operational, legal and corporate risks not being hedged by specific financial resources.

Second, as a supplement to the previous Report's box about international experience on securities' temporary transfer operations, a box is included with respect to securities' lending in Colombia, and the function and role played in that market by certain financial infrastructures such as the Stock Exchange of Colombia and the Central Securities Depository.

Third, based on information on the large-value payments system—CUD, an analysis is carried out in order to establish the evolution of payments for certain periods as well as the use of diverse liquidity sources as a strategy designed to meet them. This analysis makes it possible to understand the individual behavior of each participant and helps to establish behavioral patterns (profiles), the changes of which can be analyzed over time for the purpose of identifying and dimensioning financial risks with a systemic impact, related to clearing and settlement activities in local financial markets.

In this edition, the Report is also documenting the advances attained in the applied research line regarding topics related to financial infrastructure. Particularly—for the first time in Colombia—the cost and benefit analysis regarding access to large-value payment is addressed in terms of the credit risk and the liquidity risk involved in allowing a direct and broad access, versus one that is indirect or tiered. Available literature has identified that by increasing the level of tiered access, a monotonic relationship can be found between growing liquidity savings and an increasing credit-risk exposure. In contrast, for the Colombian case, this monotonic savings–risk relationship could be maintained up to a certain indirect access level, after which liquidity needs may grow without additional risk reductions taking place. Both methodology and results are presented in the second section of this Report.

With the purpose of contributing to a better understanding of the local money market, the two works presented in the third and fourth section deal with applied research using information taken from the money market operations settled through the large-value payment system. The former, founded on basic

network analysis statistics (density and average distance), attempts to identify how financial institutions resolve in an aggregate manner the dilemma between access to financial sources (liquidity risk) and maintaining exposures to default risk (counterparty risk) in the Colombian money market. The results show that in each type of market there are certain features that condition the manner in which financial institutions as a whole resolve this dilemma. For instance, it stands out that the use of collateral permits a wider access for dissimilar types of financial institutions, but this access is far from being homogeneous and smooth. The second one, based on an amended version of the DebtRank methodology, is intended to recursively measure the contagion impacts caused by the cessation of payments on interbank loans without collateral of a given financial institution in the position of other institutions' short-term liquidity. Contagion provoked by illiquidity is assessed as the drop of Colombian interbank network financial institutions' short-term liquidity. Results show that its negative impacts are concentrated in few financial institutions. In addition, through this methodology it is possible to establish individual systemic importance, measured as the percentage share of each financial institution in the drop in the liquidity of the system as a whole. In this manner, participants bearing the highest systemic importance will be those generating greater stress on the others' short-term liquidity position. The conclusion is that potential contagion in the interbank market is limited, except in extreme cases of widespread illiquidity in the system.

José Darío Uribe-Escobar

Governor of *Banco de la República*



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# PAYMENT SYSTEMS REPORT

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# I. PAYMENT SYSTEMS IN COLOMBIA

## A. GENERAL OVERVIEW OF THE FINANCIAL INFRASTRUCTURE IN COLOMBIA

The Bank of International Settlements (BIS) defines a financial market infrastructure as a multilateral system among participating institutions used for the purposes of clearing, settling, or recording payments, securities, derivatives, or other financial transactions.<sup>1</sup> Among them, the following are included: payment systems (PSs), central securities depositories (CSDs), central counterparties (CCPs), and the financial operations registry systems<sup>2</sup>, as well as other existing clearing and settlement infrastructures.

Diagram 1 displays the infrastructures that participate in the clearing and settlement activities of securities and other financial assets in Colombia. Added to them are the main trading and registration platforms of those assets for the purpose of presenting a holistic picture of their whole value chain. Highlighted is the core role played by the large-value payments system administered by *Banco de la República*, locally known as “Sistema de Cuentas de Depósito” (CUD), which is the axis and support of the entire infrastructure, because this is where the cash settlement of the operations carried out with the different local financial assets and with the different payment instruments issued by the banks takes place.

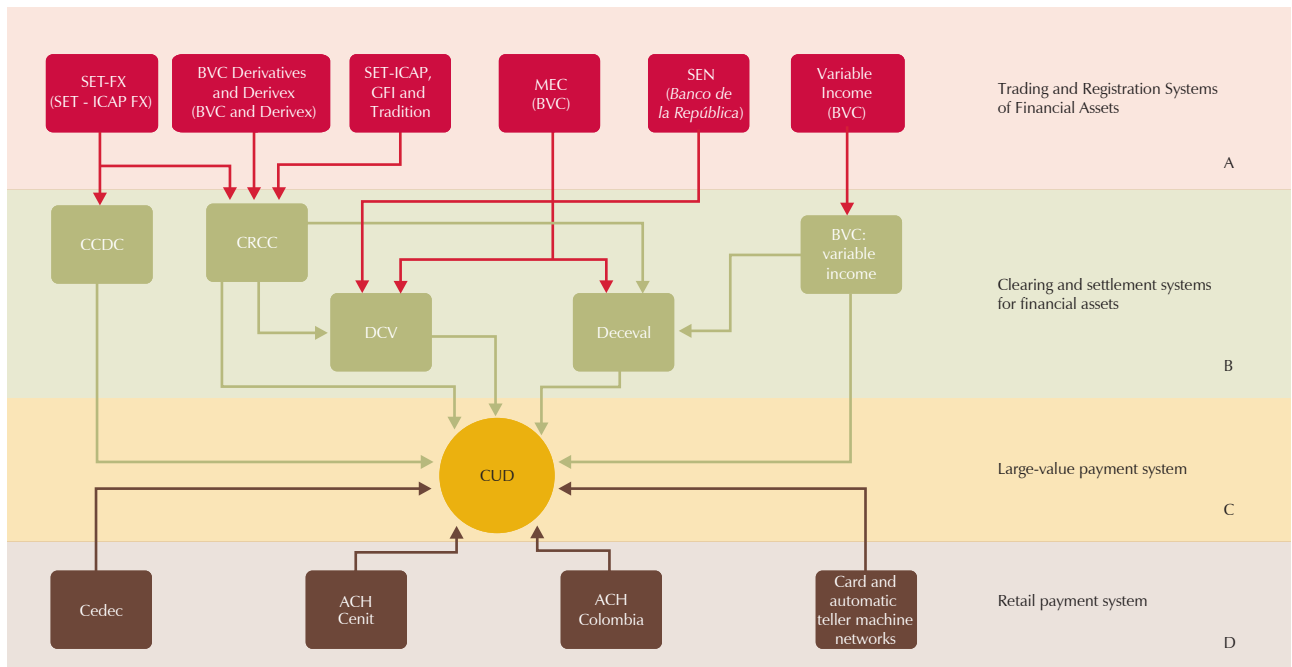
In slot A of the upper part of Diagram 1, the trading and registration systems for both securities and foreign currencies are included. Among the former are the electronic trading system “Sistema Electrónico de Negociación” (SEN) administered by *Banco de la República*, whereby operations with public debt securities are

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1 Committee on Payment and Settlement Systems and Technical Committee of the International Organization of Securities Commissions, “Principles for financial market infrastructures” March 2011; available at: [http://www.bis.org/publ/cpss94\\_es.pdf](http://www.bis.org/publ/cpss94_es.pdf)

2 In the registration systems, the information carried out in the over-the-counter market is reported by the affiliated financial intermediaries in both their own name and in the name of their third parties.

Diagram 1  
Global Overview of the Financial Market Infrastructures (FMIs) and Other Participants (2015)



Source: Banco de la República (DSIF).

traded and registered, and the Colombian electronic market “Mercado Electrónico Colombiano” (MEC) administered by the “Bolsa de Valores de Colombia” [Colombian stock exchange] (BVC), where public and private debt is traded and registered. In addition, the BVC manages the variable income market and the standardized financial derivatives with underlying assets other than energy-related commodities.

There are systems like Derivex, which manages the standardized derivative market where the underlying assets are energy-related commodities, and other trading and registration systems<sup>3</sup> that, through hybrid mechanisms (voice and data), allow for the trading and registration of operations among and between participants.

With respect to foreign currencies, the foreign-exchange electronic transaction system (SET-FX) administered by SET-ICAP FX S. A.<sup>4</sup>, as well as the platforms of some trading and registration systems<sup>5</sup>, are suppliers of operation trading and registration infrastructures.

3 Which are SET-ICAP Securities Colombia, GFI Securities Colombia, and Tradition Securities Colombia.

4 Since 2012, SET-ICAP FX replaced *Integrados FX* as administrator of the SET-FX system. This change took place as the result of a corporate agreement between ICAP Colombia Holdings S. A. S., ICAP Latin America Holdings B. V., and the stock/securities exchange of Colombia (BVC), and aimed at rendering, in a joint manner to the Colombian capital market, administration services addressed to mixed foreign currencies and securities trading and registration systems.

5 GFI Exchange Colombia and Tradition Colombia.

In slot B of the diagram, the securities' clearing and settlement systems and their associated securities depositories are shown.<sup>6</sup> Entities resort to these infrastructures to settle the securities leg, foreign currencies and derivatives resulting from the obligations they incur in these markets. Among those relating to securities, the diagram includes the Central Securities Depository "Depósito Central de Valores" (DCV) administered by *Banco de la República*, solely for public debt securities; the Centralized Securities Depository of Colombia "Depósito Centralizado de Valores de Colombia S. A." (Deceval), for all types of securities both public and private; the Central Counterparty Risk of Colombia "Cámara de Riesgo Central de Contraparte de Colombia S. A." (CRCC) for standardized derivatives, both financial and for energy-related commodities, and non-standardized derivatives such as interest rate forwards, (OIS); and the Colombian stock exchange (BVC), for variable income securities.

Regarding currencies, it is worth highlighting the Foreign Exchange Clearing House of Colombia "Cámara de Compensación de Divisas de Colombia S. A." (CCDC), where exchange operations are settled in cash, as well as the CRCC, where compensation and settlement of standardized derivatives take place over the so-called "representative market rate" (TRM) and non-standardized Forwards (COP \$ /USD) Non Delivery.

Slot C shows the large-value payment system (CUD), which is the financial infrastructure's center, where the settlement of the cash leg of operations of both financial assets compensation and settlement systems and retail payment systems converge.

In slot D, retail-value payment systems are grouped together, comprising compensation and settlement of multilateral positions created by the use of debit cards, credit, checks, and electronic transfers.

Annex 1 includes a description that allows for the identification and understanding of the role played by financial infrastructures according to the markets they support.

Table 1 offers detailed information concerning the type of operations being channeled in each system and the daily average of transactions (in number and value) over the past two years. These figures reflect the magnitude of resources mobilized on a gross basis, a value that does not necessarily coincide with the flow of money used for the effective settlement of obligations incurred therein by the agents, either because they do not imply a money movement or because the systems employ net settlement mechanisms.

As already mentioned, the settlement of obligations of the other external systems<sup>7</sup> converges towards the large-value payments system (CUD), on account

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6 In Colombia, as in other countries, securities depositories (or central securities depositories) render services related to clearing and settlement of operations.

7 "External system" is defined by External Resolution 5 of 2009 of *Banco de la República's* Board of Directors (JDBR) as any system other than the large-value payments system, as well as

Table 1  
Financial market infrastructures in Colombia  
(main transactions by number and value)

	Daily Averages <sup>a/</sup>				Main Transactions
	Number of transactions		Value (thousand of millions of pesos)		
	2014	2015	2014	2015	
<b>Large-value payment system</b>					
<b>Large value</b>					
CUD	7,570	7,430	35,925	41,767	Settlement of cash leg of transactions cleared by the DCV, Deceval, BVC, CCDC, CRCC, and retail payment systems. Payment of cash leg of monetary transactions. Transfer of funds issued directly by the participants. Debits on accounts for items such as interbank clearing, sales tax, GMF, fees, among others.
<b>Clearing and settlement systems for financial assets</b>					
<b>Securities depositories</b>					
DCV <sup>b/</sup>	3,493	2,822	22,910	29,319	This corresponds to the transactions made on the primary market with government bonds (trusteeship), on the secondary market, and through <i>Banco de la República</i> monetary transactions.
Deceval <sup>c/</sup>	5,046	4,915	3,539	3,478	It includes transactions with government bonds, corporate bonds, and stocks on the primary and secondary market. It includes cash guarantees.
<b>Other securities clearing and settlement systems</b>					
BVC: variable income	2,663	2,389	201	164	Transactions with ordinary stocks, preferential stocks, subscription rights, and money market transactions (repos and temporary transfers of securities)
<b>Central counterparty risk clearinghouses</b>					
CRCC	282	404	710	1,042	Clearing and settlement of standardized financial and energy derivatives. Clearing and settlement of non-standardized derivatives. Clearing and settlement of collateral required for public debt sell/buy-back transactions. The daily value on average of these transactions handled by the Clearinghouse since October 7, 2015 has been COP 4.14 b.
<b>Clearing and settlement systems for foreign currency</b>					
CCDC <sup>d/</sup>	1,482	1,823	2,355	3,164	Purchases and sales of dollars between the foreign exchange market intermediaries on the cash market (t + 0, t + 1, t + 2, and t + 3).
<b>Retail payment system</b>					
ACH Colombia	556,449	611,228	2,536	2,877	Recurring payments related to payroll, pensions, suppliers, dividends, and, in general, the billing for purchases of all kinds of goods and services as well as automatic payments for these same items.
ACH-Cenit	47,586	44,743	671	723	Mainly remittances and payments from the nation to the territorial bodies.
Cedec and clearinghouses for checks	97,762	86,537	1,201	1,179	Checks for sales and purchases of goods, services, and settlement of obligations, etc.

a/ Averages calculated on the basis of the operating days for each infrastructure.

b/ Corresponds to the counter-value of the transactions cleared and settled in the DCV and which took place in the primary, secondary and monetary transactions markets. This includes delivery versus payment and free of charge as settled transactions.

In the sell/buy-back transactions, repos, and TTS transactions, the initial and return transactions are included.

c/ Corresponds to the counter-value wired by the investor for the acquisition of the security.

d/ Nominal values, Colombian pesos as counter-value of the transactions.

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

of transactions carried out by the financial intermediaries and other securities market agents, foreign exchange, derivatives and in national currency both large-values and small values. For 2015, the daily average of transactions settled therein amounted to COP \$41.7 billion (b), equivalent to 5.22% of the annual gross domestic product (GDP), followed by stock market operations (COP \$3.8 b); DCV with a total value of COP \$29.3 b, and Deceval, for COP \$3.5 b. These are followed in order of importance by the sum of the two Automated Clearing Houses (ACHs Cenit and Colombia) for COP \$3.6 b; the settlements of the cash leg of the transactions through the CCDC for COP \$3.1 b; the value of operations with derivatives being cleared and settled by the CRCC for COP \$1.04 b; the value of the interbank clearing of checks as settled in the Cedec system for COP \$1.17 b, and finally the operations on variable income securities carried out through the BVC, with a COP\$0.16 b daily average.

## B. LARGE-VALUE PAYMENT SYSTEM

### 1. General aspects and evolution

As of December 2015, in *Banco de la República's* large-value payments systems (CUD), 146 direct participants had deposit accounts. The number of participants for each type of entity is outlined in Table 2.

As for the evolution of figures, in Graph 1 and Table 3 it is possible to see the number and value of operations processed in the system. The average daily number of these operations (7,430) decreased by 1.85% in 2015 with respect to the previous year; nevertheless, the nominal value (COP \$41.7 b) increased by 16.2% as compared with that year. In real terms, the average daily value experienced a rise of 8.8%. In the annual aggregate, the value entered accounted for 12.7 times the Colombian GDP<sup>8</sup> in 2015, that is to say a daily average of around 5.22% of GDP, which means an increase as compared with the 4.75% of GDP in 2014.

Table 4 explains in detail the origin and description of transactions whereby debits are performed on the CUD system's deposit accounts. As can be observed, the settlement at the cash leg of investments, purchase-and-sales, sell/buy-backs and repos in the primary and secondary public debt through the delivery versus payment (DVP) mechanism accounted for 35.1% of the total value in 2015. Monetary policy operations pertaining to expansion repos and liquidity operations for the payment system (intraday repo) endorsed with public

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any other systems entailing clearing and settlement operations on securities, foreign currency clearing and settlement or futures, options and other financial assets, including central counterparty risk clearing houses, duly authorized by the competent body to operate in Colombia.

8 GDP values envisaged herein pertain to official estimations of the National Administrative Department for Statistics (DANE) with the new national accounts base 2005. For year 2015, the preliminary GDP value of COP \$800.84 b is considered as a reference.

**Table 2**  
Number of Participants by Type of Entity

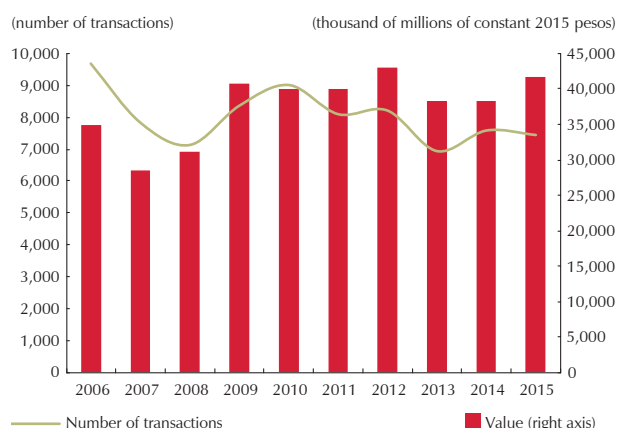
Type of Entity	Number of participants
Banco de la República	1
General Directorate of Public Credit and the National Treasury	1
Ministry of the Treasury and Public Credit: general royalty system	1
Banks	25
Commercial finance companies	19
Financial corporations	5
Pension and Severance Pay Funds	4
Brokerage Firms	20
Trust Funds	24
Insurance companies	15
Savings and Loan	2
Public financial entities	8
Financial cooperatives	5
Managers of social security information	6
Stock Market	1
Central Securities Depository	1
Foreign Exchange Clearinghouses	1
Central counterparty risk clearinghouses	1
Retail payment system (ACH: card networks)	3
Investment Management Companies	1
Foreign Exchange and Financial Intermediation Service Companies	2
<b>Total</b>	<b>146</b>

Source: Banco de la República (CUD).

debt securities accounted for 15.3%. By adding these figures, it is possible to establish that 50.4% out of the total operations in the CUD were carried out with public debt securities held in custody in the DCV. Monetary policy operations relating to interest-bearing or the so-called “re-

munerated” deposits accounted for 15.9%, of which 15.4% pertain to those by the Ministry of Finance, and 0.52% by other entities.

**Graph 1**  
Statistics on Number and Value of CUD Large-Value Payment System Transactions, daily averages



Source: Banco de la República (CUD).

Among direct fund transfers in the CUD<sup>9</sup>, which make up 33.6% of the total value of the operations, the following stand out: those with 9.0% of the transfers (money “uploads”) from credit institutions to other financial institutions in such a way that the latter are enabled to hold the necessary liquidity to meet the cash leg of their operations with securities; 4.2% from net multilateral clearing of the retail-value payment

9 This information is generated on the basis of the discretionary utilization of the transaction codes that each financial entity applies in the CUD system.

Table 3  
Number and Value of Transactions in the CUD System

Year	Number of transactions	Daily Average				Annual Value			
		Value		Average Transaction Value		(number of transactions)	(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(number of times the GDP)
		(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)				
2006	9,669	24,301	34,888	2.5	3.6	2,339,810	5,880,914	8,442,959	15.3
2007	7,820	21,031	28,567	2.7	3.7	1,900,305	5,110,643	6,941,843	11.9
2008	7,116	24,611	31,047	3.5	4.4	1,743,349	6,029,760	7,606,509	12.6
2009	8,343	32,912	40,703	3.9	4.9	2,019,118	7,964,630	9,850,156	15.8
2010	8,998	33,330	39,953	3.7	4.4	2,204,510	8,165,754	9,788,479	15.0
2011	8,083	34,676	40,074	4.3	5.0	1,988,418	8,530,296	9,858,169	13.8
2012	8,196	38,132	43,020	4.7	5.2	2,016,269	9,380,456	10,582,939	14.1
2013	6,925	34,543	38,231	5.0	5.5	1,689,588	8,428,598	9,328,298	11.9
2014	7,570	35,925	38,356	4.7	5.1	1,847,039	8,765,618	9,358,971	11.6
2015	7,430	41,767	41,767	5.6	5.6	1,805,454	10,149,449	10,149,449	12.7

Source: Banco de la República (CUD).

systems (3.4% ACH, 0.4% checks, and 0.4% card networks and ATMs); 3.0% pertaining to interbank movements; 2.2% made up by the settlement of the cash leg of investments, purchase-and-sales, and money market supported with corporate bonds (fixed income) and equities (variable income) settled through Deceval; 1.8% of transfers between administrators and custodians in order for the latter to perform collective investment fund operations; and 1.2% of net multilateral netting of the CCDC.

Finally, other direct fund transfers make up 10.6% of the total value channel by the CUD; and the remaining (1.6%) pertains, among other things, to the sum of operations that commercial banks transfer to the Government on account of tax collection; the settlement of purchase-and-sale of foreign currency out of the CCDC; cash provision through *Banco de la República's* treasury; the settlement of purchase-and-sale of equities in BVC, and the settlement both daily and at maturity of derivative contracts in the CRCC.

By comparing the total average daily values settled in the CUD for years 2014 and 2015 displayed in Table 4, it can be determined that the main concepts that explain the increase experienced in the transactionality of the system in about COP\$5.8 b pertain to the increase in the settled amounts of: expansion repos for COP\$2.5 b; creation and retrocession of sell/buy-backs with public debt for COP\$2.2 b; interest or “remunerated” deposits for COP\$1.04 b; COP\$0.747 b worth transfers for the performance of FIC operations through the custodians; increase offset, among others, by a reduction of COP\$1.5 b in the purchase-and-sale of public debt securities.



**Table 4**  
Origin and Transactions for which Deposit Accounts in the CUD System are Debited, number and value of transactions (daily averages in thousand of millions of pesos)

Transactions with Public Debt in the DCV <sup>a/</sup>	Year 2014		Year 2015		Year 2014		Year 2015	
	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value
					(percentage)			
<b>Primary market</b>								
Issuances <sup>b/</sup>	21	171.45	18	136.57	0.28	0.48	0.24	0.33
Payment of capital and returns <sup>c/</sup>	54	165.32	52	164.23	0.72	0.46	0.70	0.39
<b>Secondary Market<sup>d/</sup></b>								
Purchase-and-sales	1926	6,357.35	1484	4,816.76	25.44	17.70	19.97	11.53
<b>Money Market<sup>d/</sup></b>								
Sell/buy-backs	285	3,594.37	319	4,736.67	3.77	10.01	4.30	11.34
Reverse sell/buy-backs	285	3,584.12	318	4,719.71	3.76	9.98	4.29	11.30
Repos between financial institutions	1	9.54	1	28.58	0.01	0.03	0.01	0.07
Reverse repos between financial institutions	1	9.71	1	28.51	0.01	0.03	0.01	0.07
<b>(1) Total Transactions with Public Debt in the DCV</b>	<b>2,572</b>	<b>13,892</b>	<b>2,193</b>	<b>14,631</b>	<b>33.97</b>	<b>38.67</b>	<b>29.52</b>	<b>35.03</b>
<b>(2) Others in the DCV<sup>e/</sup></b>	<b>13</b>	<b>50.34</b>	<b>12</b>	<b>15.24</b>	<b>0.17</b>	<b>0.14</b>	<b>0.16</b>	<b>0.04</b>
<b>Total (1) + (2)</b>	<b>2,585</b>	<b>13,942</b>	<b>2,205</b>	<b>14,646</b>	<b>34.15</b>	<b>38.81</b>	<b>29.68</b>	<b>35.07</b>

Monetary Policy	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value
Expansion repos <sup>f/</sup>	57	3,026.40	60	5,537.20	0.75	8.42	0.80	13.26
Contraction repos <sup>f/</sup>	0.0	0.0	0	0.00	0.00	0.00	0.00	0.00
Remunerated deposits <sup>h/</sup>	71	5,580.36	55	6,620.99	0.94	15.53	0.74	15.85
<b>Total Monetary Policy Transactions</b>	<b>128</b>	<b>8,607</b>	<b>115</b>	<b>12,158</b>	<b>1.69</b>	<b>23.96</b>	<b>1.54</b>	<b>29.11</b>

Provision of liquidity in the payment system (Banco de la República)	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value	Number of transactions	Valor
Intraday repos <sup>i/</sup>	46	704.37	44	854.79	0.61	1.96	0.59	2.05
<b>Total Liquidity Supply Transactions</b>	<b>46</b>	<b>704.37</b>	<b>44</b>	<b>854.79</b>	<b>0.61</b>	<b>1.96</b>	<b>0.59</b>	<b>2.05</b>

Direct transfers from funds in the CUD <sup>j/</sup>	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value	Number of transactions	Valor
Debt securities (uploads and downloads of money) <sup>k/</sup>	539	3,843.89	520	3,776.13	7.12	10.70	7.00	9.04
Intraday interbank transactions	42	382.44	36	287.92	0.55	1.06	0.48	0.69
Reverse intraday interbank transactions	13	58.79	13	73.45	0.18	0.16	0.17	0.18
Overnight or longer-term interbank transactions	14	286.87	15	295.53	0.18	0.80	0.20	0.71
Reverse overnight or longer-term interbank transactions	14	282.66	15	289.46	0.19	0.79	0.20	0.69
Interbank transactions in the BBI	16	99.21	16	160.00	0.21	0.28	0.22	0.38

Table 4 (continued)

Origin and Transactions for which Deposit Accounts in the CUD System are Debited, number and value of transactions (daily averages in thousand of millions of pesos)

Direct transfers of funds in the CUD <sup>f/</sup>	Year 2014		Year 2015		Year 2014		Year 2015	
	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value
					(percentage)			
Reverse interbank transactions in the BBI	16	98.93	16	160.03	0.21	0.28	0.22	0.38
Currency exchange settled outside of the Clearinghouse	45	238.27	44	200.57	0.60	0.66	0.59	0.48
Taxes	102	432.65	98	447.40	1.35	1.20	1.32	1.07
Transfers to trustees to comply with CIF's transactions <sup>h/</sup>	0	0.00	105	747.00	0.00	0.00	1.41	1.79
Other transfers <sup>m/</sup>	1989	3,884.62	2325	4,411.67	26.28	10.83	31.29	10.56
<b>Deceval<sup>n/</sup></b>								
Issuances	57	176.41	69	190.91	0.76	0.49	0.93	0.46
Payment of capital and returns	184	204.98	219	234.31	2.44	0.57	2.95	0.56
Purchase-and-sales	138	209.05	115	184.54	1.82	0.58	1.55	0.44
Sell/buy-backs	46	49.10	55	51.84	0.61	0.14	0.73	0.12
Reverse sell/buy-backs	46	49.62	54	51.38	0.61	0.14	0.73	0.12
Repos	27	11.02	22	9.64	0.35	0.03	0.30	0.02
Reverse repos	27	11.21	22	9.54	0.36	0.03	0.30	0.02
Temporary transfer of securities	7	0.001	7	0.001	0.09	0.00	0.09	0.00
Change of depositor	345	191.70	316	177.02	4.56	0.53	4.26	0.42
Term transactions	3	0.23	4	0.18	0.05	0.00	0.05	0.00
<b>Total Deceval Transactions</b>	<b>882</b>	<b>903.33</b>	<b>884</b>	<b>909.37</b>	<b>11.65</b>	<b>2.51</b>	<b>11.90</b>	<b>2.18</b>
Colombian Stock Market (BVC) <sup>o/</sup>	15	44.02	9	23.12	0.20	0.12	0.12	0.06
<b>Central counterparty risk clearinghouse (CRCC)<sup>p/</sup></b>	15	10.98	13	23.85	0.20	0.03	0.18	0.06
<b>Foreign Exchange Clearinghouse (CCDC)<sup>q/</sup></b>	19	458.83	16	486.02	0.26	1.26	0.22	1.16
<b>Retail payment system<sup>r/</sup></b>								
ACH	110	1,270.54	96	1,399.31	1.45	3.54	1.29	3.35
Card and automatic teller machine networks	40	115.14	40	157.38	0.53	0.32	0.54	0.38
Checks (Cedec and delegated clearinghouses)	62	199.94	11	183.56	0.82	0.56	0.15	0.44
<b>Total Retail payment systems</b>	<b>211</b>	<b>1,585.63</b>	<b>147</b>	<b>1,740.25</b>	<b>2.79</b>	<b>4.41</b>	<b>1.98</b>	<b>4.17</b>
<b>Total Direct transfers of funds in the CUD</b>	<b>3,933</b>	<b>12,611</b>	<b>4,271</b>	<b>14,032</b>	<b>51.95</b>	<b>35.10</b>	<b>57.49</b>	<b>33.60</b>

Table 4 (continued)

Origin and Transactions for which Deposit Accounts in the CUD System are Debited, number and value of transactions (daily averages in thousand of millions of pesos)

Other transactions	Year 2014		Year 2015		Year 2014		Year 2015	
	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value	Number of transactions	Value
	(percentage)							
<b>Total Other Transactions<sup>s/</sup></b>	<b>878</b>	<b>60.22</b>	<b>795.33</b>	<b>75.59</b>	<b>11.60</b>	<b>0.17</b>	<b>10.70</b>	<b>0.18</b>
<b>Total Transactions Debited in CUD</b>	7,570	35,925	7,430	41,767	100.00	100.00	100.00	100.00

a/ Fund transfers in the CUD system originating from securities transactions in the DCV.

b/ Issuance of securities effectively means spending resources. Does not include: reinvestments in TDA, CERT, TES from court rulings, agricultural bonds, and those with constant value, etc.

c/ Corresponds to the money in the CUD that was effectively transferred due to capital maturity payments or yields from securities deposited in the DCV and excluding payments on *Banco de la República* investments.

d/ Does not include cross trades. This is where the originating entity and the receiving entity of the cash leg is the same financial institution.

e/ Deposit account debits due to charges for tariffs, sanctions and DCV commissions.

f/ Corresponds to the reversal of expansion repos. For the repo linkages, it only includes the net value and interest.

g/ Contraction repos.

h/ Remunerated deposits, includes the DGCPTN.

i/ Corresponds to the reversal of intraday repos. For the repo linkages, it only includes the net value and interest.

j/ Clearing and settling transactions from external systems or those handled by the account holder entities directly at their CUD stations.

k/ Fund transfers (money uploads) from leading banks to brokerage firms, trust companies, pension funds (termed clients) so that the latter have the necessary liquidity in their deposit accounts to fulfil the cash leg of their transactions with securities; the banks debit these funds ahead of time from the checking accounts of their clients.

l/ Money transfers made from the deposit accounts of institutions which manage collective investment funds (CIFs) to the deposit accounts of entities which hold said CIFs so that the latter comply with the settlement of the respective cash leg and satisfy the securities depositories (DCV-Deceval).

m/ Transfers of funds from Deceval to the lending institutions of the securities trades (delivery versus payment type). The initial transfers of the debtor entities to Deceval are discriminated in the areas that item n/ is made up of, transfers of funds from the ACH account, and from the network clearing systems to entities with a multilateral position in their favor in each clearing cycle. The initial transfers of the debtor entities to the ACH and the networks are in item r/, Operations numeral 10 article 879 of the tax statute, transfers between accounts in the same entity, transfers of funds from the account of the Foreign Exchange Clearinghouse to the FEMI with a multilateral position in their favor denominated in pesos (payment versus payment). The initial transfers from the FEMI with payments owed to the Foreign Exchange Clearinghouse are in item q/, loan disbursements, payment from issuers of securities, transfers of funds from the account of the Central Counterparty Risk Clearinghouse to the entities with a multilateral position in their favor denominated in pesos. The initial transfers from the entities with payments owed to the Central Counterparty Risk Clearinghouse are in item p/, acquisition-return of collateral. Transfers of money made from deposit accounts of entities which hold CIFs to the deposit accounts of the institutions which are managing these CIFs which is typically the result of the sale of securities or property rights.

n/ Payment of capital and returns as well as transfers of funds from the debtor entities to Deceval so that this deposit can guarantee the settlement of transactions under the delivery versus payment method. This also includes: purchase-and-sales, sell/buy-backs, repos and change of depositor of securities deposited in the Deceval.

o/ Net multilateral clearing and settlement of the cash leg in the trading of equities.

p/ Transfers of funds from the entities with payments owed to the Central Counterparty Risk Clearinghouse denominated in pesos so that this entity can guarantee the settlement of derivative clearing (daily settlement and upon the expiration of contracts).

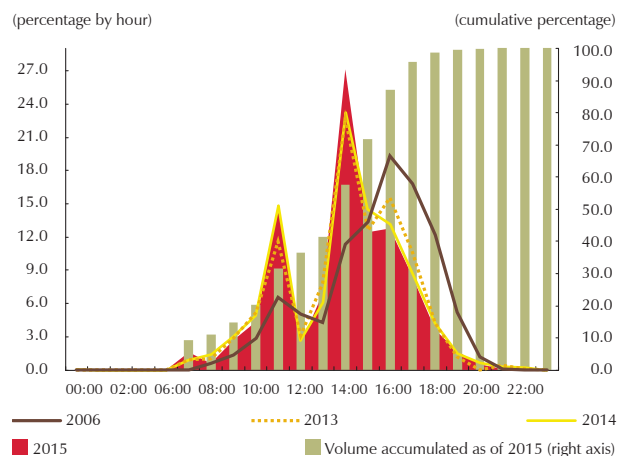
q/ Transfers of funds from the FEMI with payments owed to the Foreign Exchange Clearinghouse denominated in pesos so that this entity can guarantee the settlement under the payment upon payment method.

r/ Transfers of funds from the entities with a multilateral payments owed to the ACH and the Credibanco, Redeban, Servibanca and ATH networks so that they can guarantee the clearing and settlement of the electronic transfers and transactions using debit and credit cards and ATMs. Also includes check clearing and settlement.

s/ Provision of cash from the treasury of *Banco de la República* to financial entities holding deposit accounts, payment of services, commissions and fees, liens, and collection of the GMF.

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

Graph 2  
Distribution of Transactions in CUD by an Hour Range, in Value



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

## 2. Liquidity indicators in the CUD

A liquidity indicator in the payment systems is revealed in the concentration of payments taking place at given moments in the day. In this respect it is necessary to remember that Colombia is one of the few countries in the world where the common practice of the market is that trade negotiations about values (except for the purchase-and-sale of shares: t+3) and foreign currencies agreed in the course of a day are paid (settled) on the same date before the closing of the systems' services (technically known as: t + 0).

For 2015 (Graph 2), it can be seen that between 7:00 and 13:59 hours, 33.4% of the accumulated number of payments in the day had been settled. In the next four hours

(from 14:00 through 17:59 hours), a high concentration in the payment settlements can be observed (60% of the daily total) for a total of 94.1% before 18:00 hours.

The steep peaks of 23.2% for 2014 and 27.1% for 2015 settled by 14:00 hours were generated as a result of the liquidity-saving mechanisms in the securities and cash legs offered by the DCV.

### 3. Concentration indicators, operational efficiency indicators, and others

**Table 5**  
Number and Percentage of Participants in the CUD who Account for 70% of the Value of the Payments

Year	Number of participants	Percentage of participants
2006	20	13.8
2007	18	11.4
2008	16	10.3
2009	16	10.2
2010	16	10.3
2011	16	10.2
2012	16	10.0
2013	15	9.4
2014	14	9.3
2015	14	9.9

Source: Banco de la República (DSIF).

Table 5 presents estimates of the concentration level of payments made between direct participants in large-value payments (excluding some payments).<sup>10</sup> Taking 70% of total payments as a reference, the following is established: between 2006 and 2015 the concentration of entities has increased, passing from twenty to fourteen units, and the percentage of total participants encompassed in said reference passed from 13.8% to 9.2%.

For 2015, in particular, it can be seen that while 9.2% of the most active participants (fourteen entities) gave origin to 70.7% of the CUD payments (eleven banks: 56.9%; two brokerage firms: 8.3%, and a financial corporation: 5.4%), nearly 90.8% of the participants sent scarcely 29.3% of the total payments.

With regard to operational efficiency, the CUD remained in continuous service during 99.88% of the regular time schedule in 2015, meaning that occasional suspensions took place that affected the provision of service for a period of time equal to 0.12% of the total.

In Table 6 it is possible to see the timeline of the CUD system that illustrates, in one-hour time slots, the accumulated settlement percentages of operations for the most relevant items affecting deposit-account balance<sup>11</sup>, from the opening to the closing of the transfer service.

The operations that were settled with the benefit from liquidity-savings mechanisms and optimization of DCV operations are illustrated with brown-colored textboxes.

<sup>10</sup> The payments excluded are those coming from the General Directorate of Public Credit and National Treasure (DGCPTN) and Banco de la República.

<sup>11</sup> In previous versions of this Report, examples are illustrated for a proper reading of this time line.

Table 6  
Timeline for the Settlement of Transactions in CUD (daily averages for 2015)

	0:00	7:00	8:00	9:00	10:00	11:00
<b>Origin and Type of Transactions</b>						
<b>Transaction with Public Debt in the DCV</b>						
<b>Primary market</b>	Percentage of cumulative settlement in each time slot					
Issuances	0.00	0.00	0.00	0.19	0.86	10.05
Payment of capital and returns	73.47	73.47	74.85	76.71	80.08	83.63
<b>Secondary Market</b>						
Purchase-and-sales	0.00	0.00	0.00	0.64	2.72	20.44
<b>Money Market</b>						
Sell/buy-backs and repos between financial institutions	0.00	0.00	0.00	0.07	0.89	21.66
Reverse sell/buy-backs and repos between financial institutions	0.00	0.41	2.04	4.39	10.02	56.43
<b>Monetary Policy</b>						
Expansion repos	0.00	0.00	0.00	0.07	0.89	21.66
Reverse expansion repos	0.00	0.41	2.04	4.39	10.02	56.43
<b>Provision of liquidity in the payment system (<i>Banco de la República</i>)</b>						
Intraday repos	0.00	0.25	1.20	4.41	11.70	19.46
Reverse intraday repos	0.00	0.00	0.08	0.08	0.57	1.01
<b>Direct transfers from funds in the CUD</b>						
Debt securities (uploads and downloads of money)	0.05	5.23	6.58	9.92	13.74	18.89
Intraday interbank repos	0.00	0.00	3.50	48.24	52.35	58.34
Reverse intraday interbank transactions	0.00	0.04	0.04	0.04	0.04	0.35
Interbank overnight (or longer) repos	0.00	0.00	0.00	0.00	0.00	0.03
Reverse overnight or longer-term interbank transactions	0.00	0.00	0.00	1.18	3.37	8.60
Interbank repos: BBI	0.00	0.00	0.00	0.00	0.00	95.74
Reverse interbank repos: BBI	0.00	0.00	0.21	1.63	3.72	7.05
Taxes	0.00	0.00	0.62	44.91	99.37	99.95
Custodians	0.00	0.00	0.06	0.55	2.06	7.50
Currency exchange settled outside of the Clearinghouse	0.00	0.00	0.09	0.47	1.28	4.01
<b>Deceval</b>						
<b>Primary market</b>						
Issuances	0.00	0.00	0.00	0.01	0.82	4.11
Payment of capital and returns	0.00	0.00	1.11	2.63	2.66	5.30
<b>Secondary Market</b>						
Purchase-and-sales	0.00	0.00	0.00	0.10	0.58	2.82
<b>Money Market</b>						
Sell/buy-backs	0.00	0.00	0.00	0.02	0.40	1.94
Reverse sell/buy-backs	0.00	0.00	1.78	31.41	46.57	57.41
Repos	0.02	0.02	0.02	0.52	1.64	6.11
Reverse repos	0.00	0.00	3.11	63.03	77.01	85.26
Temporary transfer of securities	0.00	0.00	0.00	0.51	4.49	19.80
<b>Others</b>						
Change of depositor	0.31	0.31	0.31	1.79	6.83	16.83

Neutral effect of liquidity  
 Neutral effect of settled transactions with liquidity savings  
 Drainage effect of liquidity  
 Injection effect of liquidity

Source: Banco de la República (DSIF).

	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	Total value settled daily on average mm
Percentage of cumulative settlement in each time slot											
	18.38	32.19	52.79	71.21	90.21	99.21	99.99	100			COP 136.57
	88.14	93.20	100								COP 164.23
	21.77	25.15	57.07	77.18	93.95	98.87	99.85	99.99	99.99	100	COP 4,816.76
	23.45	29.43	72.25	86.60	96.00	99.44	99.96	99.99	100		COP 4,736.67
	57.31	59.64	81.76	93.67	98.81	99.80	99.97	100	100		COP 4,719.71
	23.45	29.43	72.25	86.60	96.00	99.44	99.96	100	100		COP 5,514.37
	57.31	59.64	81.76	93.67	98.81	99.80	100	100	100		COP 5,537.20
	25.98	32.55	55.53	75.17	89.29	96.37	98.22	99.99	100	100	COP 879.18
	1.37	2.15	7.24	14.76	33.87	75.47	95.65	99.87	99.96	100	COP 854.79
	21.66	24.54	31.00	43.79	61.30	77.41	90.59	99.76	99.97	100	COP 3,776.13
	64.99	73.22	86.03	90.17	95.82	98.82	99.89	100			COP 287.92
	12.46	27.00	36.74	43.84	63.50	90.86	99.35	100			COP 73.45
	0.15	0.41	2.65	16.57	57.07	91.07	99.50	100			COP 295.53
	10.99	16.08	31.97	55.83	84.85	98.59	99.95	100			COP 289.46
	95.74	95.74	99.87	0.00	100						COP 160.00
	8.39	15.55	94.03	95.38	99.79	100					COP 160.03
	99.97	99.98	99.98	99.99	100						COP 447.40
	12.74	17.38	26.01	41.76	63.60	85.80	98	99.92	100		COP 747.00
	7.05	11.86	20.53	42.40	77.68	95.49	99.20	100	100		COP 200.57
	5.74	7.89	10.54	22.91	51.16	87.33	98.54	99.97	100		COP 190.91
	6.42	6.48	14.86	35.08	84.41	98.31	99.84	100			COP 234.31
	7.45	14.47	30.21	50.98	76.25	93.39	99.46	99.98	100		COP 184.54
	4.83	10.06	23.99	51.59	80.67	95.89	99.40	99.98	100		COP 51.84
	62.97	68.09	76.42	89.66	97.75	99.80	99.98	100.00	100		COP 51.38
	14.40	21.90	42.03	66.33	87.95	97.59	99.67	99.99	100		COP 9.64
	88.32	91.44	94.68	96.66	98.74	99.29	99.88	99.97	100		COP 9.54
	28.69	37.37	54.70	70.89	80.18	92.57	96.60	99.96	100		COP 0.00
	25.49	32.43	38.23	49.55	71.35	93.19	99.48	99.87	99.94	100	COP 177.02

Table 6 (continued)  
Timeline for the Settlement of Transactions in CUD (daily averages for 2015)

	0:00	7:00	8:00	9:00	10:00	11:00
<b>Colombian Stock Market (BVC)</b>						
<b>Secondary Market: trading stocks</b>						
Entity pays debit position to the BVC	0.00	4.06	20.46	42.16	56.05	74.84
BVC pays credit position to the entities	2.57	2.57	2.57	2.57	2.57	2.57
<b>Central Counterparty Risk Clearinghouse (CRCC)</b>						
Entity pays debit position to the CRCC	0.00	97.74	98.20	98.68	99.26	99.36
CRCC pays credit positions to the entities	0.00	93.70	98.34	98.68		99.29
<b>Foreign Exchange Clearinghouse of Colombia (CCDC)</b>						
Entity pays debit position to the CRCC	0.00	0.01	0.80	1.56	3.56	6.28
CCDC pays credit positions to the entities	0.00	0.00	0.00	0.12	0.12	0.12
<b>Retail payment systems</b>						
ACH	0.0	0.8	1.3	3.7	7.6	19.8
Card and automatic teller machine networks	6.3	8.0	9.5	13.1	18.7	30.1
Checks (Cedec and delegated clearinghouses)	0.0	0.0	0.0	0.0	0.0	100
<b>Percentage of the number of transactions made per hour (not cumulative)</b>	0.00	9.40	1.50	3.80	5.50	11.40

Neutral effect of liquidity  
 Neutral effect of settled transactions with liquidity savings  
 Drainage effect of liquidity  
 Injection effect of liquidity  
 Source: Banco de la República (DSIF).

## C. CLEARING AND SETTLEMENT OF SECURITIES AND FINANCIAL DERIVATIVES

In this section, reference is made to other financial infrastructure components that clear and settle operations with securities and financial derivatives, and which, in turn, must interact with the large-value payment system in order to carry out the settlement of the cash leg of their transactions. These are the central securities depositories (DCV and Deceval), the BVC and the CRCC.

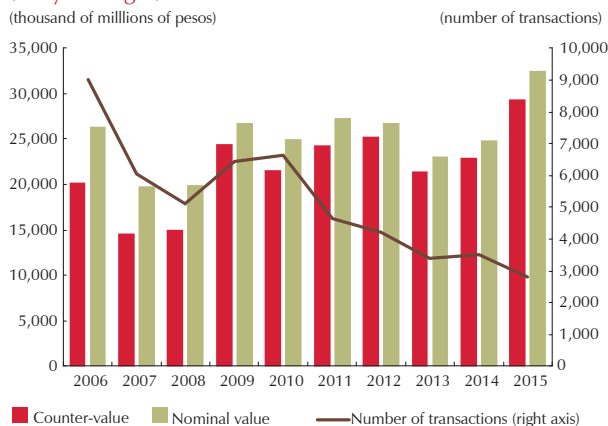
### 1. The Central Securities Depository (DCV)

Graph 3 shows the evolution of transactions settled by the DCV. Emphasis is to be made on the significant increase exhibited by the nominal value and the counter-value in the course of year 2015. Indeed, daily nominal averages for COP\$29.3 b, account for increases of 30.7% and 28%, respectively as compared with the previous year. However, the number of operations showed a negative variation of 19.2% when it shifted from 3,493 in 2014 to 2,822 in 2015.

In Table 7, operations processed in the DCV are disaggregated according to their origin. With relation to the primary market, which includes the placement of securities in different (forced, agreed, and auction-related) modalities, as well as the payment of yields and amortizations to principal carried

	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	Total value settled daily on average mm
	85.24	90.53	98.72	99.45	99.91	99.97	100	99.99	99.99	100	COP 23.12
	2.58	2.58	3.03	11.98	84.14	93.86	96.14	98.10	99.97	100	COP 23.12
	99.45	99.98	99.99	100							COP 23.85
	99.75	99.83	99.90	99.99	100						COP 23.85
	7.71	91.66	100								COP 486.02
	0.12	0.12	94.41	100							COP 486.02
	22.0	29.9	57.3	71.5	86.1	94.9	98.1	99.6	99.7	100	COP 1399.31
	34.6	39.7	57.2	71.5	86.6	95.3	98.5	99.3	99.5	100	COP 157.38
											COP 183.56
	4.90	4.90	16.20	14.30	15.20	8.70	3.10	0.80	0.30	0.10	

Graph 3  
Central Securities Depository – CSD (DCV), processed operations (daily averages)



Source: Banco de la República (DCV)

out by the issuers, it can be seen that, in 2015, both the nominal value (COP\$338 mm) and the counter-value (COP\$363.1 mm) declined by 23.1% and 12%, respectively, compared to the previous year. Likewise, the amount of operations stood at a daily average value of 99, registering a negative variation of 12.4%.

As far as the secondary market is concerned<sup>12</sup>, it can be observed that the nominal value and the counter-value increased in comparison with the previous year. Particularly for 2015, the nominal value of operations settled in the DCV for COP \$18.9 b and the counter-value for COP \$15 b *vis-à-vis* 2014, account for increases of around 14% and 5.1%, respectively. In contrast, the number of operations was reduced by 20.6% in the

same period by shifting from 3,170 to 2,516.

With regard to services rendered by the DCV to *Banco de la República*, which involve open market operations (OMO) and liquidity provisions to the large-value

<sup>12</sup> This market includes purchase-and-sales, delivery versus payment between participants, free-of-payment transfers, securities account transfer between securities accounts, as well as repos and sell/buy-backs with their respective retrocessions.



**Table 7**  
Daily Average Transactions Processed in the DCV, by service  
(thousand of millions of pesos)

Year	Primary market			Secondary Market			Monetary transactions		
	Number	Nominal value	Counter-value	Number	Nominal value	Counter-value	Number	Nominal value	Counter-value
2006	1,220	287.2	301.6	7,489	15,773.3	11,307.3	290	10,293.2	8,664.9
2007	1,135	301.4	324.1	4,688	10,535.8	6,816.0	233	9,004.7	7,493.2
2008	883	292.3	314.5	4,023	11,706.0	7,722.0	212	7,878.4	7,023.6
2009	278	368.9	355.8	5,925	18,568.2	16,172.8	219	7,891.4	7,888.7
2010	206	312.9	330.8	6,213	16,804.0	13,361.0	215	7,907.5	7,922.5
2011	172	342.6	367.0	4,197	14,250.7	10,927.0	263	12,702.3	12,979.7
2012	143	249.2	285.7	3,803	15,305.9	12,927.0	262	11,189.0	11,999.2
2013	128	346.1	370.7	3,048	14,152.6	12,120.1	229	8,548.8	8,962.6
2014	113	439.7	412.4	3,170	16,576.4	14,285.1	210	7,884.0	8,212.9
2015	99	338.0	363.1	2,516	18,902.5	15,013.4	207	13,292.5	13,942.6

Source: Banco de la República (DCV)

**Table 8**  
Total Securities Held by the DCV at the Closing of the Year  
(thousand of millions of pesos)<sup>a/</sup>

Year	Current	Constant
2006	98,906	141,993
2007	103,856	141,072
2008	114,221	144,089
2009	125,739	155,510
2010	142,327	170,606
2011	155,818	180,069
2012	160,443	181,004
2013	183,580	203,182
2014	202,604	216,323
2015	207,943	207,943

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

payment system, positive variations were registered as of the closing of 2015. With respect to the previous year, the amount associated with the nominal value for COP\$13.3 b, and the counter-value for COP\$13.9 b account for an increase of 69.2% on average. Notwithstanding this fact, the number of operations went from a daily average of 210 to a 207, which means a 1.1% contraction.

As for the custody service, Table 8 displays the total value of securities deposited as of the closing of every year since 2006, at current and constant prices.

Throughout 2015, the balance in custody in current Colombian pesos exhibited a 2.6% growth. Nine point six percent of this balance pertains to securities issued by the National Government and the rest can be explained by securities issued by the farming sector financing fund (Finagro) (3.4%). From the total issues

in force administered by the DCV, class B TES securities (includes monetary TES) continued to maintain their high relevance by showing a share of 95.9% of the total balance and 99.3% with respect to the National Government's internal public debt issues (Table 9).

With regard to the distribution of the balance in custody according to the type of entity, Graph 4 shows that pension and severance administration companies<sup>13</sup>,

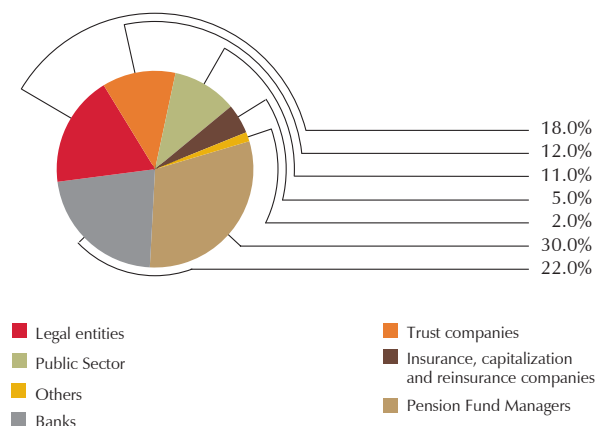
13 Includes pension liabilities and collective investment funds.

**Table 9**  
Balance of Securities Held by DCV at the Closing of 2015, Broken down by Issuer  
(millions of pesos)

Issuer	Balance	Percentage
<b>National Government</b>		
Class B TES	194,517,893	93.54
Monetary TES	4,924,174	2.37
Constant Value Bonds series B	1,255,640	0.60
Debt reduction securities	96,353	0.05
Constant Value Bonds series A	65,086	0.03
Solidarity for Peace Bonds	7,748	0.00
Security Bonds	116	0.00
CERT	82	0.00
<b>National Government Total</b>	<b>200,867,093</b>	<b>96.60</b>
<b>Finagro</b>		
Agricultural development Class B	3,790,527	1.82
Agricultural development Class A	3,285,623	1.58
<b>Finagro Total</b>	<b>7,076,150</b>	<b>3.40</b>
<b>General Total</b>	<b>207,943,242</b>	<b>100.00</b>

Source: Banco de la República (DCV)

**Graph 4**  
Total Balance Held by the CSD (DCV) by Type of Entity  
(December 2015)



Source: Banco de la República (DCV)

along with the banks, concentrate most of the holdings with nearly 52% (COP\$109.2 b). Legal persons are in the third and fourth places<sup>14</sup> with 18% (COP\$38.1 b), and trust companies<sup>15</sup> with a 12% (COP\$25.1 b). Then comes the consolidated public sector which includes both the financial and non-financial sectors as well as some enterprises of special nature with 11% (COP\$13.2 b). The remaining 6.4% is mostly composed by the holdings of insurance, reinsurance and capitalization companies with 4.9% (COP\$10.1 b).

As far as the DCV operational DCV indicators are concerned, the system was available to the participants during 99.86% of the time of the schedule established for service in 2015. With respect to the timing of settlement of transfer orders, Graph 5 allows to see that, before 17:00 hours, nearly 96% of

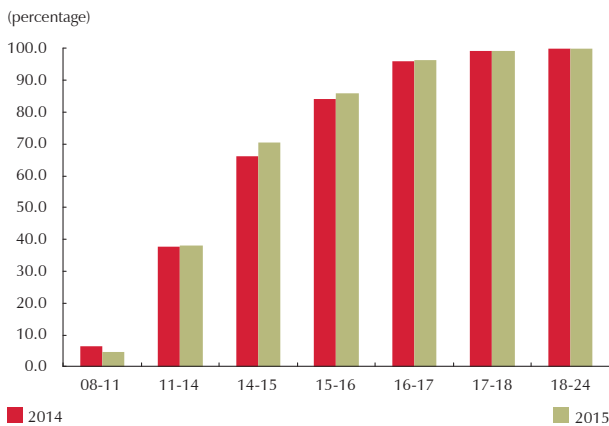
the operations had been settled.

Graph 6 disaggregates the activation mechanisms used in the settlement of operations received by the DCV in the last year. It can be perceived, for instance, that between 8:00 a.m. and 10:59 a.m., all participants activated their operations manually.

14 Includes foreigners, among others.

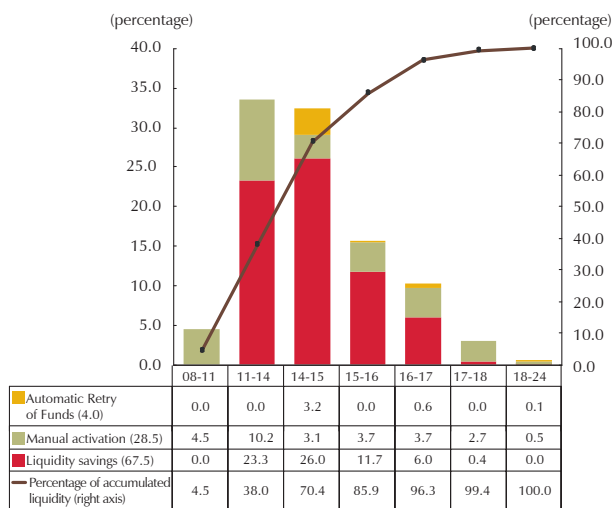
15 Includes trusteeships and collective investment funds.

**Graph 5**  
Settlement of Transfer Orders Received in the DCV by Time Frame



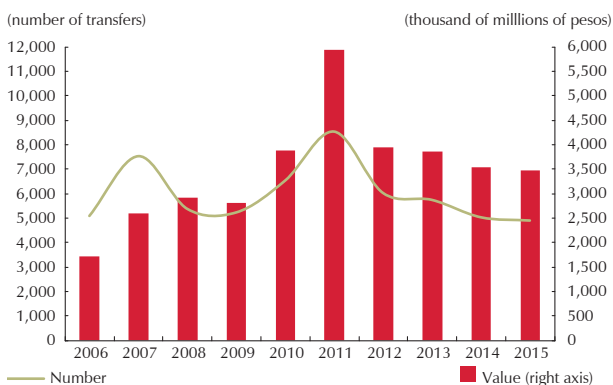
Source: Banco de la República (DCV)

**Graph 6**  
Distribution of the Transaction Activation Mechanism by Type, 2015



Source: Banco de la República (DCV)

**Graph 7**  
Statistics on Value and Volume of Deceval (daily averages)



Source: Deceval (management of securities)

Besides, the liquidity saving facility was used between 11:00 and 13:59; and, for the next time slots, the automatic retry of funds (“*repique automático*”) was added. Regarding the liquidity saving facility, the major contributor to the settlement of transactions makes its highest contribution during the cycle between 14:00– 15:00 hours. Thus, out of 100% of operations received by the DCV in 2015, 71.5% were automatically activated (automatic retry of funds and liquidity saving facility), and 28.5% by direct instructions from participants.

## 2. Centralized Securities Depository (Deceval)

Graph 7 and Table 10 exhibit the evolution of transactions carried out in the Deceval, which include primary market operations (fixed-income securities and variable incomes); secondary market operations (purchase-and-sale between depositors and free-of-payment transfer-transactions), and money market (repos, sell/buy-backs and temporary securities transfers (TTS)) with their respective retrocessions and cash collaterals. It can be observed that the average daily volume of transactions shifted from 5,046 in 2014 to 4,915 in 2015, while recording a negative variation of 2.59%. On the other hand, by the end of the year, the average daily value of transfers was likewise reduced when it shifted from COP\$3.53 b in 2014 to COP\$3.47 b in 2015 (-1.71% equivalent percentage variation).

As for the custody service, Table 11 presents the total securities deposited at the closing of each year since 2006, at current and constant prices.

Throughout 2015, the balance in current Colombian pesos in custody exhibited a 9.6% decrease. Table 12 shows that out of the total securities issued that are administered by the Deceval, equities (of ordinary and preference nature) are the securities with the largest percentage of participation (60.5%), followed by fixed-term deposit certificates (“CDT”) with 23.5%, and ordinary bonds with 9.3%. The share of the remaining instruments such as commercial papers and acceptances, among others, is 6.6%.

By grouping the balance in custody according to the class of security and the type of depositing

Table 10  
Deceval Statistics

Year	Volume (number of transfers)	Processed transfers							
		Daily Average		Average transfer value		Annual Value			
		Value (thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(millions of pesos)	(millions of constant 2015 pesos)	(number of transfers)	(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(number of times the GDP)
2006	5,103	1,719	2,468	337	484	1,234,906	416,095	597,364	1.08
2007	7,524	2,602	3,535	346	470	1,828,351	632,345	858,946	1.47
2008	5,388	2,920	3,683	542	684	1,320,128	715,288	902,336	1.49
2009	5,244	2,816	3,482	537	664	1,269,071	681,427	842,765	1.35
2010	6,536	3,881	4,652	594	712	1,601,310	950,766	1,139,672	1.74
2011	8,520	5,932	6,855	696	805	2,095,997	1,459,175	1,686,286	2.35
2012	6,032	3,944	4,449	654	738	1,471,831	962,331	1,085,656	1.45
2013	5,752	3,867	4,280	672	744	1,403,374	943,534	1,044,278	1.33
2014	5,046	3,539	3,779	701	749	1,231,272	863,508	921,977	1.14
2015	4,915	3,478	3,478	708	708	1,199,378	848,744	848,744	1.06

Source: Deceval (management of securities)

Table 11  
Total Securities Held by Deceval at the Closing of the Year<sup>a/</sup>  
(thousand of millions of pesos)

Year	Current	Constant
2006	93,883	134,783
2007	138,390	187,983
2008	142,619	179,914
2009	204,058	252,372
2010	281,767	337,752
2011	299,041	345,585
2012	362,513	408,970
2013	387,405	428,769
2014	421,697	450,250
2015	381,310	381,310

a/ Balances valued on the last working day of each year. In the case of variable income securities, the price value of each equity divided by the number of equities in trusteeship is used.

Source: Deceval (management of securities)

entity, it is stressed that in variable income securities (COP\$232.5 b), legal persons are in the first place with 30.0% (COP\$69.8 b), followed by brokerage firms with 24.3% (COP\$56.5 b) and banks with 18.5% (COP\$42.9 b). Then, the administrators of pension and severance funds follow with 12.6% (COP\$29.4 b), and trust companies with 12.4% (COP \$28.9 b). The remaining 2.2% (COP \$5 b) consists of entities such as financial corporations and insurance companies, among others (Graph 8, panel A). Additionally, in this market dematerialized issues accounted for 94.8% of the total securities, the physical issue 5.1%, and in other deposits 0.1%.

With respect to fixed-income securities (COP \$148.8 b), composed by CDTs (59.6%), bonds (31%) and other securities (2.8%), entities with the highest percentage participation are trust companies 36.2% (COP \$ 53,8 b), followed by pension and severance funds administrators with 26.1% (COP \$38.9 b) and banks with 10.8% (COP \$16 b). Brokerage firms follow with 10.6% (COP \$15.8 b) and insurance companies with 8.7% (COP \$42.9 b). Finally, special official institutions with 3.9% (COP \$ 5.8 b), and others with 3.7%

**Table 12**  
**Balance of Securities Held by Deceval at the Closing of 2015, Broken down by Monetary Specie**  
(millions of pesos)

Monetary Specie	Balance	Percentage
Common stock	201,057,705	52.73
Certificates of Deposit	89,658,388	23.51
Ordinary bonds	35,516,048	9.31
Preferred stocks	29,742,048	7.80
Corporate securities	9,731,795	2.55
Domestic public debt bonds	7,833,472	2.05
Mortgage Credit Securities	3,156,026	0.83
Pension bonds	1,735,731	0.46
Credit securities	1,445,512	0.38
Tax Refund Securities (TIDI in Spanish)	643,150	0.17
Treasury bonds (TES)	394,328	0.10
Real Estate participation securities	165,433	0.04
Colombian foreign debt securities	130,060	0.03
Structured mortgage bonds	85,073	0.02
Non-mortgage Credit Securities	14,945	0.00
Debt reduction securities (TRD)	236	0.00
Bank acceptances	30	0.00
<b>General Total</b>	<b>381,309,980</b>	

Source: Deceval (management of securities)

(COP \$5.6 b), of which legal persons, commercial financing companies, capitalization companies and financial corporations stand out (Graph 8, panel B). In this market, 99.1% correspond to dematerialized issues, 0.6% to physical issues, and 0.3% to other deposits.

Finally, in the total balance in the custody of Deceval, natural persons accounted for 8.6%.

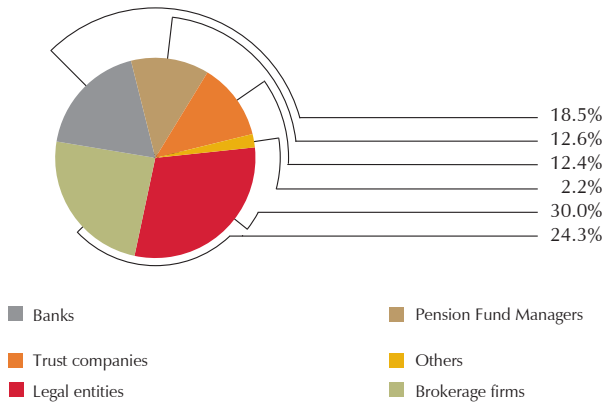
As regards the opportunity in the settlement of transfer orders in the large-value payment system, after having implemented a series of improvements during the year 2010 (like the automatic retry of funds and the automatic debit for most participants in the deposit), it was observed that for 2015 nearly 79.0% of operations were settled before 17:00. This result is satisfactory if it is considered that in the year previous to the implementation of these measures, in the same time period only about 59.0% of total operations were being settled (Graph 9).

### 3. Colombian Stock Exchange (“BVC”)

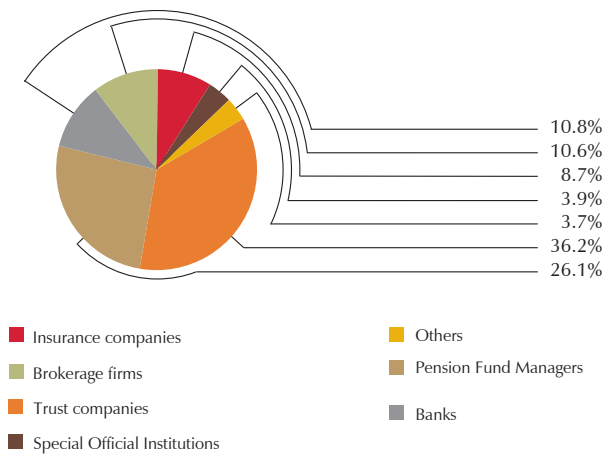
The BVC is an entity of private nature created on 3rd July 2001 as the result of the merger of the stock exchanges of Bogotá, Medellín, and Occidente. In the development of its task as a financial infrastructure, the BVC provides and administers

**Graph 8**  
Total Balance Held by Deceval by Type of Entity  
(December 2015)

**A. Variable income**

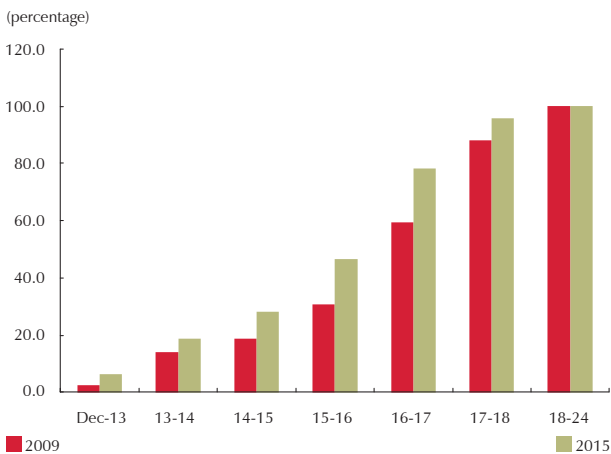


**B. Fixed Income**



Source: Deceval (management of securities)

**Graph 9**  
Settlement of Transfer Orders Received in Deceval by Time Frame



Source: Banco de la República (CUD).

electronic platforms that allow their participants to carry out offers to purchase and sell in the different markets. The market with the highest number of participants is the fixed-income market (106), followed by that of standardized derivatives with 33 and the variable income market with 20 participants. While in the fixed-income and standardized derivatives markets several types of entities take part (i.e. banks, trust companies, and so forth), the stock market is composed by brokerage firms only. As of the closing of 2015, the daily average amount negotiated in these three markets through the local stock exchange totaled COP \$ 5.4 b.

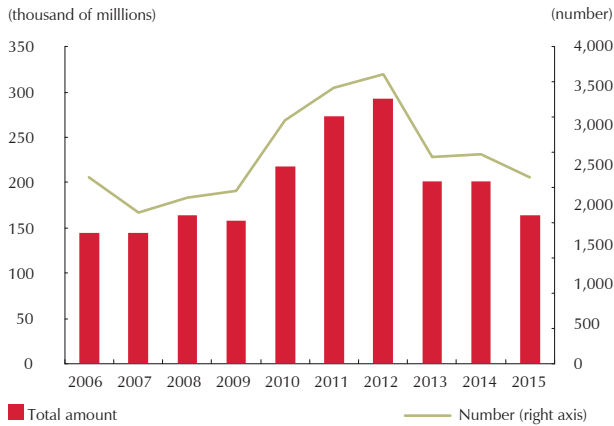
Particularly in the variable income market, the BVC manages both services associated with the trading system and those involving the key aspects of clearing and settlement. For this purpose, it uses its own developments along with the services provided by other infrastructures among which worth mentioning are Deceval (in the settlement of the securities and cash legs) and the large-value payment system of *Banco de la República* (cash leg's settlement). In all, the interaction of these entities shapes the financial infrastructure of the variable income market.

In the course of 2015, the evolution of transactions carried out in the stock market<sup>16</sup> exhibited a decrease in comparison with the previous year. Indeed, the daily amount averages, for COP \$164.2 mm, and of number of operations, for 2,653, accounted for negative variations of 18.3% and 10.9% with respect to those attained in the previous year (Graph 10).

Table 13 disaggregates the variable income operations carried out in the BVC, by type of operation. With relation to the spot market (i.e., purchase-and-sales) it can be observed that for 2015, the amount traded of COP \$134.3 mm daily average and the number of operations of 2,543 were reduced *vis-à-vis* the previous year by 18.8% and 10.0% respectively. Likewise, the repo market with variable income securities had a negative behavior where the daily average amount (COP \$27.9 mm) and number of operations (103)

<sup>16</sup> Includes cash operations, repos, and temporary transfer of securities (TTS).

**Graph 10**  
Transactions Processed by BVC  
(daily averages)



Source: Colombian Stock Market (BVC).

exhibited a drop of 16.9% and 28.0%, respectively. Regarding the market of loans of variable income securities (i. e.: TTS) which operates since year 2011, a negative behavior was also observed by recording a total operated amount of COP \$475.2 mm (COP \$1.96 mm daily average) throughout 2015 which, in comparison with COP \$494.4 mm (COP \$ 2.03 mm daily average) in 2014 means a 3.9% drop.

As already mentioned, the BVC uses both its own developments and a series of interconnections with other infrastructures for its clearing and settlement processes. Likewise, and according to the type of market, it employs different compensation models in order to make the exchange of assets easier (money in exchange for securities or vice versa) when appropriate.

In the spot market, for instance, the BVC carries out a gross settlement of the securities leg, which consists of settling transactions one by one. Nevertheless, given that the Deceval maintains the centralized custody of the variable income securities, the BVC provides instructions on a permanent basis to this infrastructure throughout the day in order that it, in turn, may carry out the relevant book entry. The amounts related with this process are part of the statistics of the respective securities depository described in the above sub-section.

As for the cash leg of these operations, in a parallel manner the BVC carries out a net multilateral compensation where, unlike the gross compensation, there is a unique position associated to all the purchase-and-sale transactions. Thus, once the participants are acquainted with that position vis-à-vis the market, the BVC, through the large-value payment system, collects the money of those with a net

**Table 13**  
BVC Statistics

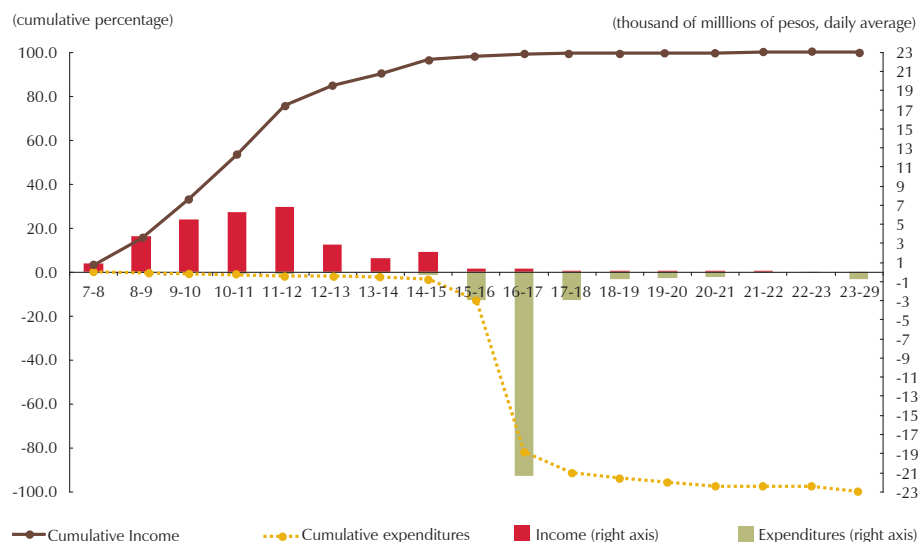
Year	Equity purchase-and-sales			Equity repos			TTS equities		
	Daily Average		Annual Value (thousand of millions of pesos)	Daily Average		Annual Value (thousand of millions of pesos)	Daily Average		Annual Value (thousand of millions of pesos)
	Number	Amount (thousand of millions of pesos)		Number	Amount (thousand of millions of pesos)		Number	Amount (thousand of millions of pesos)	
2009	1,956	104.9	25,376.8	494	53.2	12,872.8	n. t.	n. t.	n. t.
2010	2,975	151.3	37,058.8	479	66.8	16,354.4	n. t.	n. t.	n. t.
2011	3,251	162.6	39,993.7	661	110.5	27,181.4	1.0	0.2	43.6
2012	3,577	188.2	45,925.1	534	104.3	25,440.4	1.0	0.2	57.0
2013	2,758	167.5	40,881.6	180	34.2	8,352.1	2.0	0.3	84.2
2014	2,827	165.4	40,368.6	143	33.6	8,193.2	7.0	2.0	494.4
2015	2,543	134.3	32,497.1	103	27.9	6,754.3	7.0	2.0	475.2

n. t.: no TTS transactions  
Source: Colombian Stock Market (BVC).

balance to be paid by them (net buyers) in order to subsequently, and generally in the afternoon, deliver it to those participants having gained a net position in favor (net sellers).

Graph 11 shows the BVC dynamics of receipt and delivery of money in the clearing and settlement of spot operations for 2015. In the morning, the evolution of net buyers' money delivery to the stock exchange is observed, the highest peaks of which take place between 10:00-10:59 and 11:00-11:59 a.m. with a COP \$6.3 mm and COP \$ 6.8 mm daily average. As of 15:00 hours, the BVC carries out the delivery of money to net sellers where nearly 81.8% of the money (COP \$25.2 mm daily average) is received by the respective brokerage firms before 17:00 hours. It is important to stress that, as compared with the amount traded in the spot market, the amounts required by the BVC as a result of the multilateral clearing process signify savings of nearly 82.8% in the liquidity needs of their participants.

**Graph 11**  
Cash Payments in the Market for Equities in the Large-value Payment System  
(daily averages, 2015)

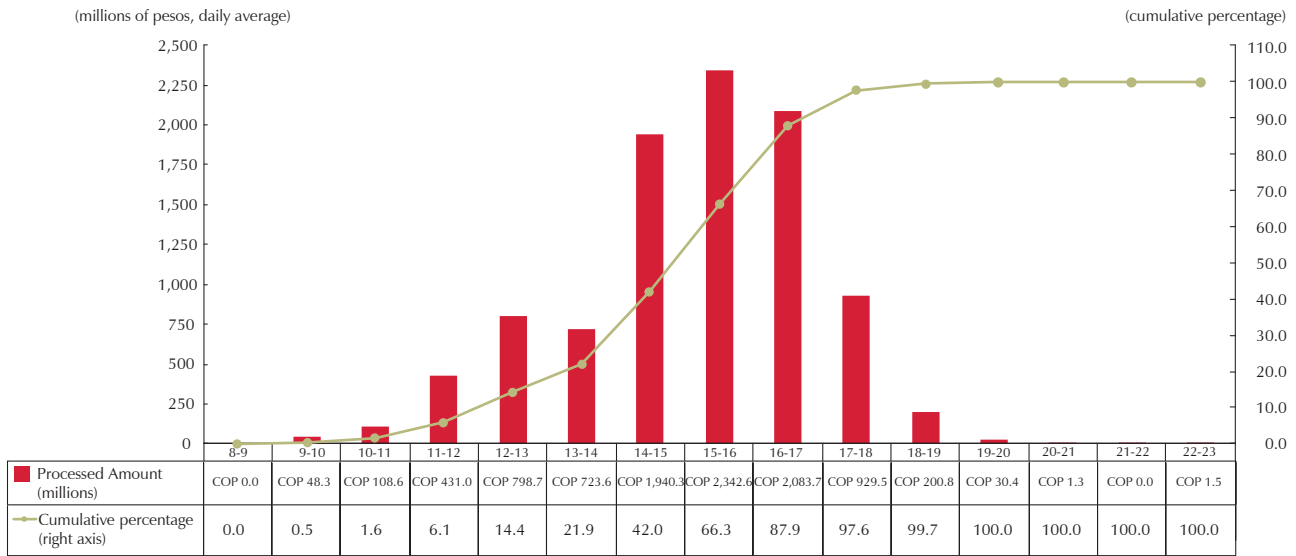


Source: Banco de la República (CUD).

In the other variable income markets (repos and TTS), the BVC administers the clearing and settlement of transactions. Nevertheless, the settlement of the securities leg and cash leg is carried out on a gross (trade by trade) basis in Deceval. In this manner, once the operation to be settled is passed through to Deceval, it takes care of carrying out both the relevant account entry and the necessary arrangements aimed at debiting the money. This occurs in the large-value payment system. Once the procedure has been completed, the BVC is notified of the final result. Graph 12 shows the evolution during 2015 of the dynamics of repo and TTS operations processed by Deceval using the large-value payment system.

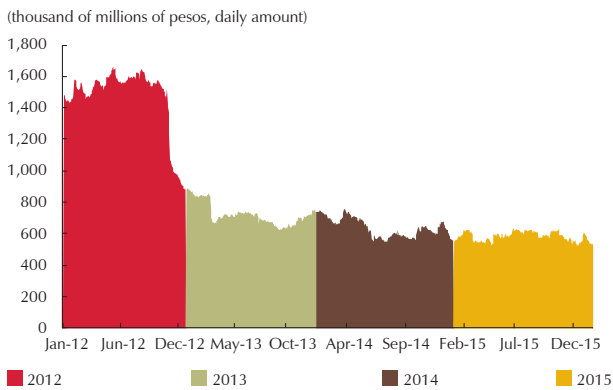


**Graph 12**  
Transactions Settled by Deceval Corresponding to the BVC Repo Market<sup>a/</sup>



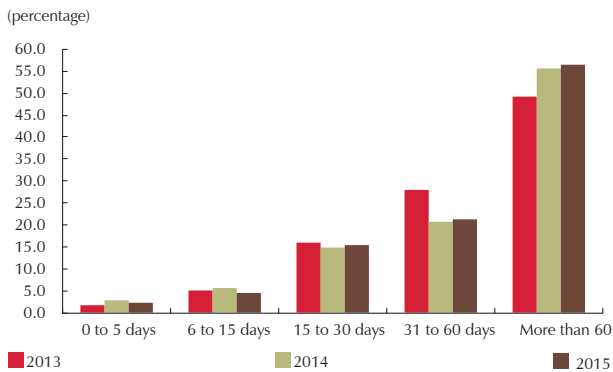
a/ Includes only the initial transaction.  
Source: Banco de la República (CUD).

**Graph 13**  
Repurchase Agreements on Variable Income Securities



Source: Colombian Stock Market.

**Graph 14**  
Repurchase Agreements on Variable Income Securities by Maturity date, 2013-2015



Source: Colombian Stock Market.

Particularly in the carrying out of repo and TTS operations, the BVC requests guarantees to the participants involved in order to ensure compliance with the transactions. As a result of this task, the average amount of outstanding reverse repurchase obligations administered by the BVC stood at a daily average of COP \$582 mm. This value accounts for a reduction of 8.6% in comparison with the previous year when the amount of these obligations was COP \$637 mm (Graph 13).

Graph 14 groups the share of the daily average amount of outstanding repurchase obligations according to the term agreed upon. Unlike what had been occurring until 2013 when, among other things a generalized trend was noticed of brokerage firms for obtaining financing in terms of less than sixty days, from 2014 the agents kept, on average, more than half of their obligations over a period of over 60 days (56.4% in 2015). This suggests that there is a recent preference of brokerage firms and their clients for obtaining, in this market, financing at longer time frames (although less than one year).

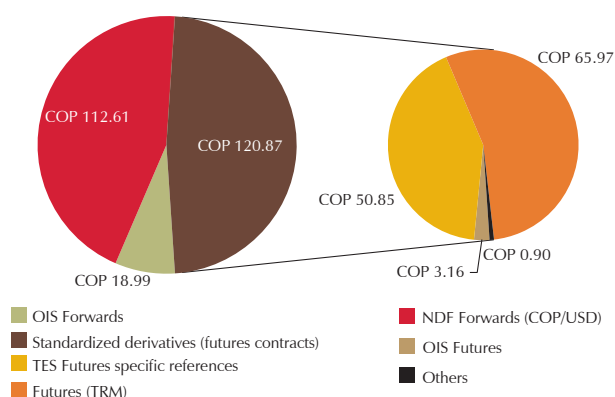
Since 2015, the BVC incorporated the custodians' model to the clearing and settlement chain of the fixed- and variable income markets. The implementation of this model enables market agents with the

possibility of meeting the conditions established in the Ministry of Finance and Public Credit Decree 1498 of 2013, whereby it is established that the collective investment funds (“FICs”) will have to delegate in an exclusive way on a custodian the activities dealing with value safeguard activity, clearing and settlement of transactions and administration of property rights. Currently, three custodians are linked with the Clearing and Settlement System of the Stock Exchange.

#### 4. Clearing of financial derivatives: the Central Counterparty Risk of Colombia S.A. (CRCC).

The value of the cleared and settled transactions throughout 2015 amounted to COP \$252.47 b, which accounts for an increase of 45.11% vis-à-vis the value of the 2014 operations. The share by type of product of the total proceeds of

Graph 15  
Participation in Billions of Pesos by Derivative Product  
(value of the transactions in 2015)



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

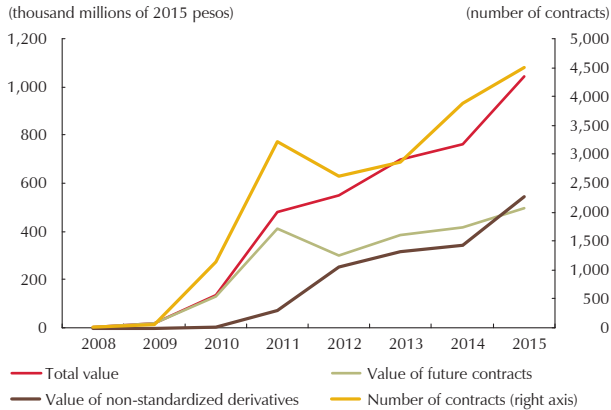
these operations was 47.88% (COP \$120.87 b) on standardized derivative financial instruments, and 52.12% (COP \$131.6 b) on non-standardized derivatives, which means an increase of 26.13% and 68.37% as compared to the previous year. The share by class of standardized future contracts in the total of this type of product was as follows: TES futures on specific references, 42.07% (COP \$50.85 b); TRM futures, 54.57% (COP \$65.97 b), OIS futures, 2.61% (COP \$3.16 b), and 0.75% (COP \$0.9 b) for other products among which futures on equities and indices can be found. For its part, the share within the non-standardized products was: Foreign currency forwards (NDF Col pesos/US dollars), 85.57% (COP \$112.61 b) and OIS forwards, 14.43% (COP \$18.99 b) (Graph 15).

Since October, the CRCC managed sell/buy-backs operations on a gross basis on public debt securities, reaching an accumulated value COP of \$466.09 b<sup>17</sup> at the closing of the year.

The number of future contracts cleared and settled in the CRCC shifted from 3,877 in 2014 to 4,491 in 2015 (neither includes NDF Col pesos/US dollars nor sell/buy-backs transactions). On the other hand, the total amount of operations accepted for netting in daily average shifted from COP \$710 mm in 2014 to COP 1,043 mm 2015. In this last figure, the daily average values of standardized and non-standardized derivatives were COP \$ 499 mm, and COP \$544 mm respectively (Graph 16).

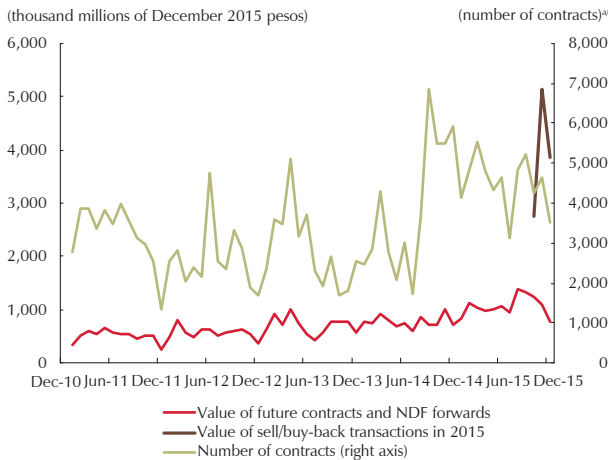
17 In this value, the setting up and retrocession flows of sell/buy-backs operations are taken into account.

**Graph 16**  
CRCC Transactions (daily average)



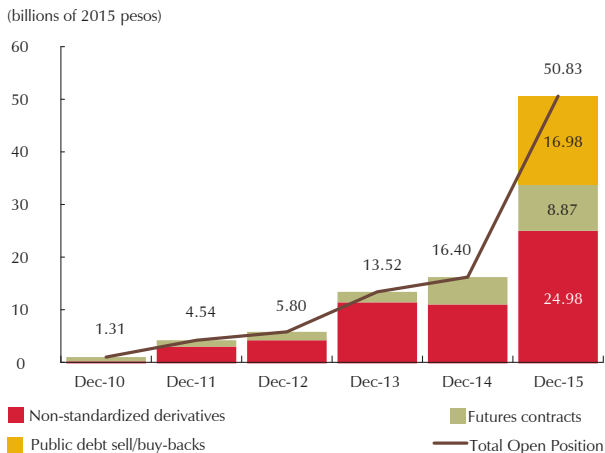
Sources: CRCC and Banco de la República (DSIF).

**Graph 17**  
Transactions in the CRCC (daily average)



a/ Not included in the NDF forwards nor in the sell/buy-backs  
Sources: CRCC and Banco de la República (DSIF).

**Graph 18**  
CRCC's Gross Open Position at the Closing of each Year



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

Additionally, the daily average value of sell/buy-backs transactions was COP \$4.16 b calculated from the date on which this type of operations began to be accepted.

By detailing the evolution of the CRCC operations for 2015, it can be observed that in August the highest daily average value accepted took place, reaching the amount of COP \$1.36 b on operations with netting, and in November for sell/buy-backs transactions with COP \$5.13 b. For the former, this behavior was in great part due to the increase in the clearing and settlement of future specific reference TES contracts and TRM futures (Graph 17).

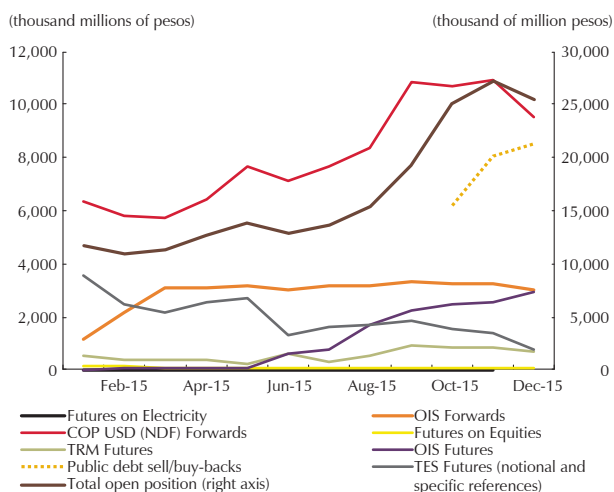
The value of gross open positions<sup>18</sup> at the closing of 2015 was COP \$50.8 b, this accounting for an increase of 189.66% with respect to the open position existing at the closing of the year 2014. The standardized derivatives closed the year with an open gross position of COP \$8.87 b (17.46%) and non-standardized derivatives with COP\$24.98 b (49.14%), and those open positions of sell/buy-backs operations on public debt securities beginning to be managed through the CRCC since October 2015 with COP \$16,98 b (33.4%)(Graph 18).

The behavior of the open position during 2015 presented an upward trend, except for the last month, when its total suffered a drop of 6.5%; this decline was mainly associated with the decrease of open positions in NDF forwards NDF and futures on specific-reference TES.

As for the evolution of open positions of the most representative product groups, in Graph 19 it is possible to see that those of products with an underlying asset BRI (bank reference index) grew on a monthly average rate throughout the year as follows: OIS futures 149%, and OIS forwards 12%, by attaining a share of 23.3% of the total open position for the

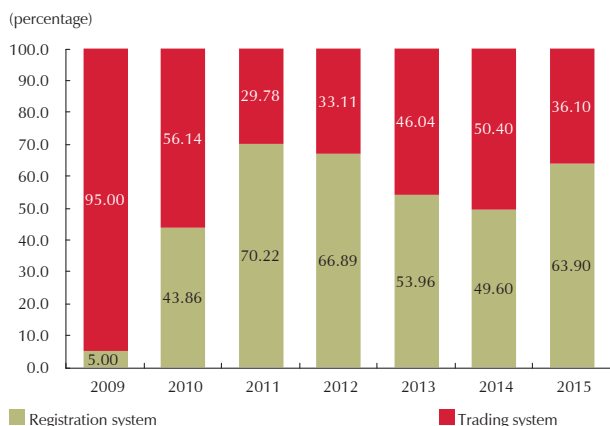
18 Both the buying and the selling position created by a same operation are taken into account. For example, by intervening in the buying operation of a TES futures contract, the open position for the CRCC shall be two contracts, because a participant has a long open position and another one has a short open position.

**Graph 19**  
Open Position by group of Derivative Products during 2015  
(considering only the buyer's position)



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

**Graph 20**  
Number of Standardized Derivative Contracts Received from the Registration or Trading Systems



Sources: CRCC and Banco de la República.

closing of the year. The open positions on sell/buy-backs with TES had an average monthly growth of 18.0%, while that of Non-Deliverable Forwards was 4.4% and, in contrast, the Specific Reference TES futures had an average monthly decrease of 9.5%.

With regard to the trading and registration systems having forwarded transactions towards the CRCC, non-standardized derivative operations during 2015 were totally received through the registration systems. 36.1% of the standardized derivative operations were incorporated by the BVC and Derivex trading systems, and 63.9% by means of their respective registration systems. Graph 20 reflects the evolution of the number of standardized derivative contracts carried out through electronic trading systems and registration systems.

As a consequence of the maturity and instrument risk compensation processes, efficiencies are generated in the guarantee requirements and, therefore, a possible lower liquidity requirement to the CRCC members. On daily average, during the year 2015, collateral requirements were reduced as follows: 43.71% for futures contracts on TES; 26.08% for future contracts on the Representative Market Rate “TRM”; 44% for Overnight Index Swap (OIS) futures, and 26.08% for currency forwards (NDF pesos / dollar). Liquidity savings are presented as lower requirements of cash or securities (daily guarantees) when there are purchases or sales of the same product at different maturities (for example, purchases of short-term TES futures contracts and sales of TES futures contracts in the medium

term), or when there are different positions in several underlying instruments correlated with each other (for example, TRM futures contracts and NDF dollar / peso sales).

Throughout 2015, the CRCC experienced three delays and one noncompliance of a third party, with no impact on the provision of the service, and where no guarantees were required.

The following can be found among the main changes introduced by the CRCC during 2015: 1) the incorporation of custodians into the clearing and settlement processes; 2) the expansion of the offer of services to clear and settle crude operations; 3) the acceptance and subsequent clearing and settlement of

sell/buy-backs transactions with public debt securities coming from the trading system SEN<sup>19</sup>, MEC transaction and MEC registration; 4) automation of the process of release of guarantees; (5) the clearing and settlement of transactions in non-standardized derivative financial instruments entered into by members with their third parties as foreign counterparties; and 6) the removal of the restriction of being a general liquidation member in order to be a counterparty to the repo operations with guarantees received in cash, thus expanding coverage to general and individual liquidation members.

Regarding the acceptance and gross compensation of sell/buy-back public debt operations, it is important to mention that this step represents a contribution to the mitigation of risks of the securities market and to the strengthening of certainty in the fulfillment of the operations. With the interposition of the CRCC between the original counterparties, these are benefited by the administration of guarantees, calls to margins, allocation of operating limits and open positions, and net of guarantees for compensation between maturities. Under normal conditions, the gross clearing and settlement of the sell/buy-backs transactions is still carried out directly in the central securities depositories, the securities leg of the transactions, and the cash leg through the CUD, working as it usually has. The daily clearing and settlement of guarantees is performed by the CRCC. However, in the event of default with the payment of the obligations of the members, the CRCC will be in charge of clearing and settling the operations and, through the execution of the guarantees, cover possible losses in the replacement of the assets.

#### D. FOREIGN EXCHANGE CLEARING HOUSE OF COLOMBIA (CCDC)

Among the 36 direct participants of the CCDC that were active during 2015, an average daily volume of 1,823 operations were settled, representing an increase of 23.1% as compared to the previous year's daily average. In gross value cleared and settled terms, the daily average amounted to USD \$ 1,164 million (COP \$3,163,720, mm)<sup>20</sup>, which represented a decrease of 1.3% in dollars and a 34.3% increase in pesos with respect to 2014 (Table 14 and Graph 21).

Average daily liquidity savings, as a result of net multilateral clearing, were 84.3%, 3.9 pp (percentage points) higher than in the previous year. The daily average for 2015 of the gross value of operations was USD \$1,163.8 million,

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19 On the initiative of the Ministry of Finance and Public Credit and through the DGCPTN, *Banco de la República* and the Central Counterparty Risk of Colombia S.A. carried out the studies and execution of the activities necessary for the CRCC to compensate, liquidate and to manage the counterparty risk of sell/buy-backs operations carried out in the first step of the secondary market of the program of market makers of public debt securities, as defined in Resolution 4161 of 2012 of the Ministry of Finance and Public Credit.

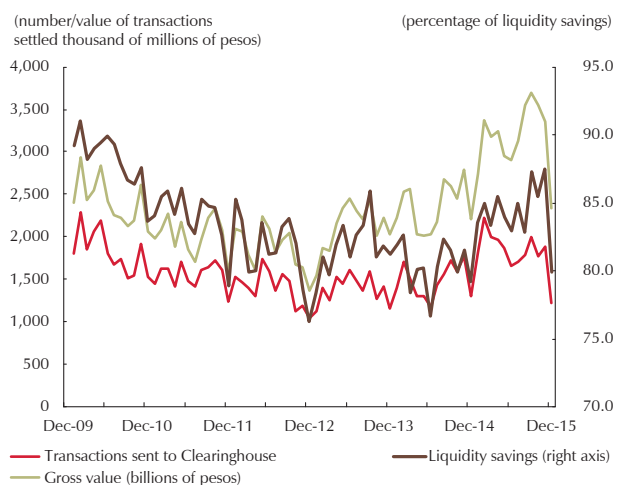
20 This value is expressed in current pesos.

Table 14  
Statistics of the Foreign Exchange Clearinghouse of Colombia S. A.<sup>a/</sup>

	Number of transactions (transactions sent to CCDC)	Daily Average		Liquidity savings (percentage)
		(millions of dollars)	Gross value (thousand of millions of December 2015 pesos) <sup>b/</sup>	
Average 2008	1,414	979.2	2,476.0	86.10
Average 2009	1,886	1,181.0	3,136.4	87.57
Average 2010	1,825	1,274.0	2,932.0	88.18
Average 2011	1,544	1,088.0	2,353.0	84.03
Average 2012	1,399	1,037.7	2,117.3	81.58
Average 2013	1,388	1,125.7	2,342.3	81.77
Average 2014	1,482	1,179.2	2,544.8	80.39
Average 2015	1,823	1,163.9	3,256.4	84.34
Ene-15	1,816	1,141.8	2,737.8	83.52
Feb-15	2,227	1,390.3	3,365.0	84.97
Mar-15	1,997	1,223.5	3,164.8	83.34
Abr-15	1,958	1,308.3	3,264.6	85.45
May-15	1,867	1,206.7	2,943.2	83.94
Jun-15	1,666	1,135.4	2,900.8	82.90
Jul-15	1,702	1,141.6	3,118.7	84.97
Ago-15	1,785	1,165.9	3,524.8	82.87
Sep-15	1,990	1,204.7	3,702.1	87.33
Oct-15	1,779	1,213.2	3,564.1	85.44
Nov-15	1,878	1,115.9	3,344.1	87.46
Dic-15	1,216	719.6	2,334.6	79.93

a/ Includes transactions on the spot market and next day t + 1, t + 2, and t + 3.  
b/ The pesos of the monthly values for 2015 correspond to current pesos.  
Source: CCDC S.A. and Banco de la República.

Graph 21  
Value, Volume, and Liquidity Savings in the Transactions of  
Foreign Exchange Clearinghouse of Colombia S. A.  
(daily averages)



Source: Foreign Exchange Clearinghouse of Colombia, S. A. and Banco de la República.

while the average daily net value was USD181.7 million.

From the point of view of risk mitigation mechanisms, during 2015 the CCDC maintained the required level of guarantees at 6.5% of the net selling position of each participant for the cleared and settled operations at t + 0. The direct participants constituted guarantees in favor of the CCDC on a daily average for USD \$94.6 m and COP \$107.14 mm. Quotas committed with their liquidity providers (LPs) in pesos were maintained at COP \$ 350 mm with six banks. Quotas in dollars increased by two million, reaching USD \$ 115 m committed to seven banks. This increase raised in the same proportions the maximum limit of the short position that the participants can have during the day.

The largest dollar-denominated liquidity provider accounted for 34.78% of total dollar credit lines by the end of 2015.

On the other hand, the CCDC experienced sixteen delay events<sup>21</sup> in fulfilling the payment obligations of some of its direct participants. Eleven of these corresponded to dollars, for a total value of USD \$121.27 m, and five in pesos, for a total value of COP \$ 153.31 mm. In the case of delays in US dollars it was necessary to use liquidity providers five times, for a total value of USD \$48.5 m. In addition to the delays in dollars, the first non-compliance event since its incorporation took place at USD \$0.65 m. However, neither delays nor non-compliance had an impact on the provision of the service and the payments execution of multilateral rights (Table 15).

**Table 15**  
Foreign Exchange Clearinghouse of Colombia S. A.:  
delays and non-compliances by participants of the CCDC during 2015

	Number of delays	Value of the delays	Number of uses of LP	Total cost of using LP	Non-compliances	Value of non-compliances
Dollars	11	USD 121,265,000	5	USD 48,555,000.00	1	USD 650,000.00
Pesos	5	153,307,150,700	0	0	0	0

LP: Liquidity Providers  
Sources: CRCC and Banco de la República.

Furthermore, during the year, the CCDC carried out two tests to validate the availability of credit lines with LPs, for a total value of USD \$ 20 m.

Among the events that affected the clearing and settlement of foreign exchange through the CCDC during the year of 2015, the following were highlighted: 1) the decision of the Board of Directors of *Banco de la República* to grant it access to FX-Swaps Foreign exchange clearing systems; 2) the change of the technological platform, establishing as main platform the system called Colombian Clearing and Settlement System (CCSS) to replace the Electronic Settlement Network (ESN) of Wall Street Systems Delaware, Inc .; 3) the acceptance of transfer orders related to foreign exchange next day<sup>22</sup> transactions and their subsequent clearing and settlement, from the date of negotiation; 4) compliance with the concentration limit of pre-approved credit lines with liquidity providers, defined by *Banco de la República* at 35% with a single supplier, and 5) linking the DGCPTN as a direct participant.

With regard to the acceptance of next day transactions from the date of their negotiation, it is important to mention that this service offers the market the

21 The regulation of the CCDC defines delay as the payment of the obligation, as a result of multilateral net balance, after the deadline (14:30 p.m. for 2015), provided that it does not exceed 8:00 a.m. of the day following the date of compliance.

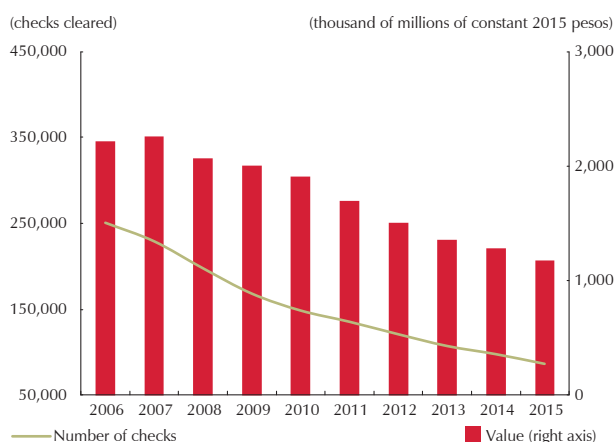
22 *Next day* is understood as spot currency operations, whose compliance date is t + 1, t + 2 or t + 3, where t is the trading date.

protection of operations through the principle of purpose from the date of negotiation, and the coverage of fluctuations of the exchange rate with the requirements of guarantees between the date of negotiation and compliance. The CCDC began operations' acceptance as of December 1, 2015 and by the end of the year gross daily balances were USD \$ 74.5 million, of which 97.3% were compliant at t + 1, 2.7% for operations at t + 2, and operations with compliance at t + 3 were not accepted. The gross value of these accounted for 10.3% of the cleared and settled cash transactions t +0. On the other hand, the methodology for calculating the necessary guarantees for these operations was defined as a full guarantee, corresponding to the one required to cover the variation in the exchange rate during the whole life of the operation, with the following percentages: t + 1 = 6.5%, t + 2 = 8.0%, and t + 3 = 8.0%. Additionally, it was determined the use of separate guarantees for the cash market t +0 and for the next day market.

## E. RETAIL PAYMENT SYSTEMS AND PAYMENT INSTRUMENTS

Retail-value payment systems have the function of clearing and settling the transactions executed through various payment instruments available in Colombia, among which the following are the most important: checks, credit and debit transfers from the ACH ( retail electronic payments), and credit and debit cards, among others. This section describes their main characteristics, value, and number of operations.

**Graph 22**  
Value and Number of Checks Cleared in Cedec and Check Clearinghouses.  
(daily averages)



Source: Banco de la República (Cedec).

### 1. Checks clearing house and the Cedec system of Banco de la República

#### a. Checks clearing system and Cedec

During 2015, 20.9 million checks were paid (a daily average of 86,537), which in value corresponds to 0.36 times the GDP (a daily average of COP \$1.17 b)<sup>23</sup>; less than the 60.5 million checks equivalent to 0.97 times the GDP recorded in 2006 (Graph 22 and Table 16).

In reference to the use of liquidity in 2015, it can be seen in Table 16 that a daily average of COP \$ 1.17 b was roughly offset; however, as a result of

23 These figures on the use of checks only consider interbank payments, that is, between customers of different financial institutions; therefore it does not include intra-bank checks, which do not go through the Checks clearing house. Statistics on intra-bank payments are exhibited in Table 17.



multilateral netting, COP \$183.56 mm was required to settle the obligations (Table 4), so that liquidity savings were 84.43%.

In the information reported by commercial banks with respect to intra-bank checks, in which the drawer and drawee share the same bank and therefore checks are not sent to Cedec or to the central clearing houses of the central

Table 16  
Statistics on Checks Clearing in Cedec and in the Check Clearinghouses.

Year	Number of checks (number of transactions)	Daily Average				Annual Value			
		Value		Average Transaction Value		(millions of checks)	(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(number of times the GDP)
		(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(millions of pesos)	(millions of constant 2015 pesos)				
2006	250,044	1,545	2,219	6.2	8.9	60.5	373,972	536,894	0.97
2007	228,546	1,665	2,262	7.3	9.9	55.5	404,645	549,634	0.94
2008	197,296	1,635	2,063	8.3	10.5	48.3	400,634	505,398	0.83
2009	167,967	1,625	2,010	9.7	12.0	40.6	393,212	486,300	0.78
2010	148,342	1,591	1,907	10.7	12.9	36.0	389,769	467,225	0.72
2011	135,334	1,467	1,696	10.8	12.5	33.3	360,922	417,105	0.58
2012	120,857	1,336	1,508	11.1	12.5	29.5	326,056	367,853	0.49
2013	107,239	1,226	1,357	11.4	12.7	26.2	299,225	331,165	0.42
2014	97,762	1,201	1,282	12.3	13.1	23.9	293,048	312,885	0.39
2015	86,537	1,179	1,179	13.6	13.6	20.9	285,374	285,374	0.36

Source: Banco de la República.

Table 17  
Comparison of Value and Number of Interbank Checks with Intra-bank Checks

Year	Interbank checks cleared <sup>a/</sup>		Intra-bank checks <sup>b/</sup>			
	Number (number of checks)	Value (thousand of millions of pesos)	Number (number of checks)	(as a percentage of the interbank checks)	Value (thousand of millions of pesos)	(as a percentage of the interbank checks)
2009	40,647,982.0	393,212.3	14,992,443	36.9	159,169.7	40.5
2010	36,343,795.0	389,768.8	13,992,620	38.5	164,547.8	42.2
2011	33,292,130.0	360,922.2	15,721,623	47.2	104,215.6	28.9
2012	29,489,131.0	326,056.0	13,362,676	45.3	98,033.5	30.1
2013	26,166,386.0	299,225.0	11,894,023	45.5	88,791.3	29.7
2014	23,853,920.0	293,047.9	13,745,083	57.6	109,281.5	37.3
2015	20,900,000.0	285,374.0	11,207,337	53.6	106,209.0	37.2

a/ Corresponds to the number and value of the checks cleared in Cedec and physical clearinghouses.

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

Sources: commercial banks and Banco de la República.

bank or to their Delegates, it is observed that by 2015 these represented 37.2% of the value and 53.6% of the total compensated in the interbank, with a decrease of approximately 2.81% in value and 18.46% in number compared to 2014 (Table 17).

*b. Concentration and operational efficiency indicators*

As of December 31, 2015, there were 27 entities related to the checks clearing process (Table 18). However, the trend in the concentration of operations observed from a long time ago is maintained, as shown by the indicator CR5, which represents the share in the net worth of the five largest participants, which went from 68.6% in 2006 to 72.1% in 2015, while the number of participants who offset 70% of operations went from seven banks in 2006 to five in the last year.

Table 18  
Cedec and Check Clearinghouses  
(participants and concentration)

Year	Total participants	CR5 indicator (percentage)	Number of Participants that clear 70% of value
2006	22	68.6	7.0
2007	18	66.4	6.0
2008	18	70.6	5.0
2009	18	68.8	6.0
2010	23	70.7	5.0
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

Source: Banco de la República (DSIF).

In terms of operational efficiency, during 2015 the Cedec had an availability of 99.72%; meaning that there were occasional suspensions that affected the provision of the service for a time equivalent to 0.28% of the total.

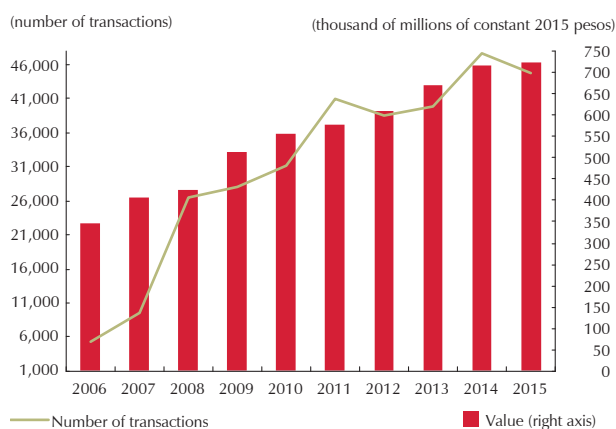
**2. Automated Clearing Houses (ACH)**

Two automated clearing houses operate in Colombia: ACH-Cenit (administered by Banco de la República) and ACH-Colombia, owned by commercial banks.

During 2015, more than 158.7 million transactions were offset in these two clearing houses, 7.7% more than in 2014 which, on average, pertain to 655,971 payment instructions (44,743 were processed in ACH-Cenit and 611,228 in ACH-Colombia) for a value equivalent to COP \$3.6 b (COP \$0.72 b in ACH-Cenit and COP \$ 2.87 b in ACH-Colombia). During 2015 the total value compensated jointly by these ACHs was of COP \$871,03 b; that is, 11.3% more than in 2014, which represented 1.09 times the nominal GDP of 2015.

a. *ACH-Cenit*

Graph 23  
Value and Number of transactions in ACH Cenit  
(daily averages)



Source: Banco de la República (Cenit).

Graph 23 and Table 19 show that, in ACH-Cenit more than 10.8 million transactions (44,743 average daily) were carried out between credit and debit transactions, with a gross value exceeding COP \$ 174.9 b (COP \$722.8 mm average daily); which, with respect to 2014, showed a 6.7% decrease in the number of operations and a 6.9% increase in value. The low liquidity savings (3.8% for 2015), resulting from netting of the ACH-Cenit net values, is due to the majority share of 84.56% that the DGCPTN and the General System of Royalties recorded in the value of the payments sent.

Within the total number of transactions, in 2015 the high participation in number (96.1%) and value (99.71%) registered in credit operations is highlighted.

With regard to debits, there was a 27.4% decrease in the number and a 17.8% increase in the value of operations compared to 2014 (Table 19).

In terms of operational efficiency, in 2015 Cenit had an availability of 99.56%; meaning that there were occasional suspensions affecting the service provision for a time equivalent to 0.44% of the total.

b. *ACH-Colombia*

In ACH-Colombia during 2015, between credit and debit transactions, 147.9 million transactions were carried out, for a gross value that exceeded COP \$696.1 b, which, with respect to 2014, shows an increase of 8.9% in number of transactions and 12.5% in value (Graph 24 and Table 20).

The ACH-Colombia liquidates the net values resulting from the compensation in five intraday cycles. Once net positions are calculated, participants with net debit positions transfer funds to ACH-Colombia's deposit account at *Banco de la República*, so that, at a later time, from their deposit account, they may

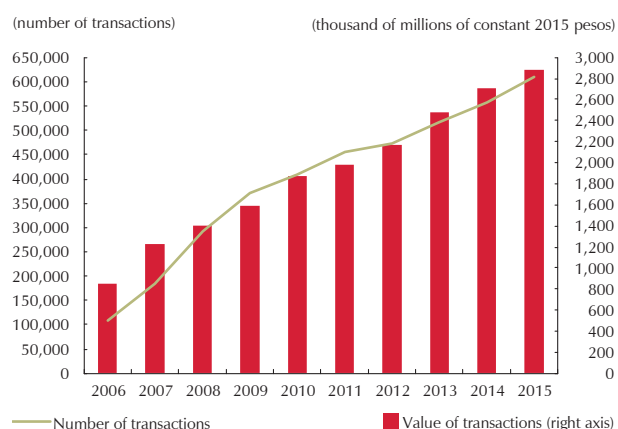
Table 19  
Statistics of the ACH Cenit Clearinghouse<sup>a/</sup>

Year	Daily Average				
	Number of transactions	Value		Average transaction value	
		(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(millions of pesos)	(millions of constant 2015 pesos)
2006	5,224	241.1	346.1	46.2	66.3
2007	9,646	299.0	406.2	31.0	42.1
2008	26,599	335.6	423.4	12.6	15.9
2009	27,967	415.6	514.0	14.9	18.4
2010	31,150	464.4	556.7	14.9	17.9
2011	41,005	500.4	578.3	12.2	14.1
2012	38,504	539.2	608.3	14.0	15.8
2013	39,852	607.0	671.8	15.2	16.9
2014	47,586	670.8	716.2	14.1	15.1
2015	44,743	722.8	722.8	16.2	16.2

Year	Annual total							
	Number of transactions			Value of transactions (thousand of millions of pesos)			Annual Value (thousand of millions of constant 2015 pesos)	Number of times the GDP
	Credit	Debit	Total	Credit	Debit	Total		
2006	1,261,895	2,235	1,264,130	58,310	34.7	58,345	83,763	0.15
2007	2,341,551	2,522	2,344,073	72,577	89.7	72,666	98,703	0.17
2008	6,497,852	18,899	6,516,751	81,818	403.4	82,222	103,722	0.17
2009	6,725,741	42,272	6,768,013	100,277	291.3	100,568	124,376	0.20
2010	7,587,763	43,912	7,631,675	111,993	1,781.5	113,775	136,384	0.21
2011	10,042,726	44,405	10,087,131	122,829	268.0	123,097	142,259	0.20
2012	9,378,640	93,385	9,472,025	132,504	129.0	132,633	149,635	0.20
2013	9,522,192	201,586	9,723,778	147,926	188.5	148,114	163,924	0.21
2014	11,035,981	574,941	11,610,922	163,238	429.0	163,667	174,746	0.22
2015	10,410,511	417,239	10,827,750	174,408	505.5	174,914	174,914	0.22

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

**Graph 24**  
Value and Number of Transactions in ACH Colombia  
(daily averages)



Sources: Asobancaria, Office of the Financial Superintendent of Colombia, and ACH-Colombia.

distribute to participants in net creditor positions. For all of 2015 the net value settled for COP \$ 170.4 b (COP \$ 704.3 mm average daily) was equivalent to 24.47% of the gross value, which represents a saving of 75.5% in liquidity.

As can be seen in Table 21, the CR5 concentration index, constructed as the sum of the five largest shares in the value of ACH-Colombia transactions, in 2015 was placed at 70.22% for credit operations, which is very similar to that for 2014 (70.24%), while for debit transactions the index reflects a fall of 4.35% from 92.1% in 2014 to 88.1% in 2015.

In Graph 25, it can be observed that the service of the Online Payments-PSE button exhibited an increase in the number of operations of 28% and in value of 20% with respect to 2014.

**Table 20**  
ACH-Colombia Statistics

Year	Number of transactions	Daily Average				Annual Value			
		Value (thousand of millions of pesos)	Value (thousand of millions of constant 2015 pesos)	Average transaction value (millions of pesos)	Average transaction value (millions of constant 2015 pesos)	(number of transactions)	(thousand of millions of pesos)	(thousand of millions of constant 2015 pesos)	(number of times the GDP)
2006	108,319	596,1	855.7	5.5	7.9	26,213,261	144,248	207,091	0.38
2007	184,546	905,3	1,229.7	4.9	6.7	44,844,589	219,986	298,810	0.51
2008	292,086	1,112.0	1,402.8	3.8	4.8	71,560,987	272,437	343,678	0.57
2009	371,325	1,283.2	1,587.0	3.5	4.3	89,860,749	310,546	384,064	0.62
2010	407,587	1,558.2	1,867.8	3.8	4.6	99,858,818	381,754	457,618	0.70
2011	455,086	1,710.6	1,976.8	3.8	4.3	111,951,241	420,796	486,299	0.68
2012	471,629	1,920.7	2,166.9	4.1	4.6	116,020,691	472,495	533,064	0.71
2013	516,603	2,238.1	2,477.1	4.3	4.8	126,051,206	546,108	604,401	0.77
2014	556,449	2,535.9	2,707.5	4.6	4.9	135,773,574	618,750	660,634	0.82
2015	611,228	2,876.5	2,876.5	4.7	4.7	147,917,150	696,124	696,124	0.87

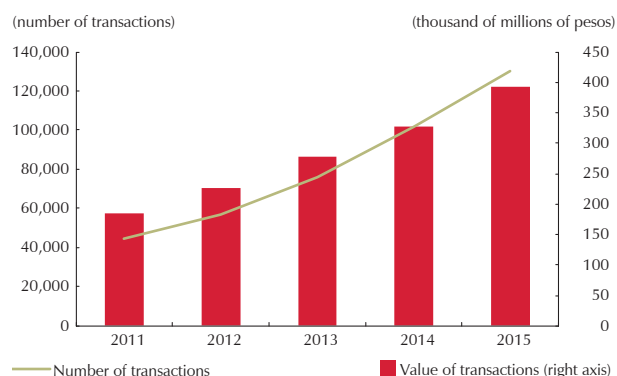
Sources: Asobancaria, Office of the Financial Superintendent of Colombia, and ACH-Colombia.

**Table 21**  
ACH-Colombia  
(participants in and concentration of the value of payments sent)

Year	Credit transactions			Debit transactions		
	Number of participants	CR5 indicator (percentage)	Number of Participants that account for 70% of value	Number of participants	CR5 indicator (percentage)	Number of Participants that clear 70% of value
2009	19	69.6	5	15	75.5	4
2010	19	70.1	5	15	72.6	5
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

Source: ACH-Colombia

**Graph 25**  
Value and Number of PSE Service Transactions  
(ACH-Colombia)  
(daily averages)



Source: ACH-Colombia.

In order to complement the statistics on the use of electronic funds transfer as a payment instrument, and with information submitted by commercial banks from 2010 to 2015, Table 22 shows the figures for intra-bank transfers<sup>24</sup>, in which the originator and receiver of the funds belong to the same bank and, therefore, are not compensated in the ACH.

By 2015 intra-bank transfers in number of transactions accounted for about 91.9% of the interbank, a different situation with respect to the value, given that intra-banking corresponded to 1.8 times the interbank ones.

**Table 22**  
Comparison of Value and Number of Interbank Transactions with Intra-bank Transactions

Year	Interbank transactions cleared <sup>a/</sup>		Intra-bank transactions <sup>b/</sup>			
	Number of transactions	Value (thousand of millions of pesos)	Number of transactions (number of transactions)	(as a percentage of the interbank transactions)	Value (thousand of millions of pesos)	(number of times the interbank transactions)
2010	107,490,493	495,529.2	74,964,949	69.7	1,436,046	2.9
2011	122,038,372	543,892.5	82,950,682	68.0	1,347,365	2.5
2012	125,492,716	605,127.9	70,701,523	56.3	1,005,437	1.7
2013	135,774,984	694,221.8	96,171,547	70.8	1,050,129	1.5
2014	147,384,496	782,417.0	112,103,184	76.1	1,025,864	1.3
2015	158,744,900	871,037.9	145,895,871	91.9	1,581,650	1.8

a/ Corresponds to the number and value of the transactions cleared in ACH Cenit and ACH-Colombia.

b/ Transfers that are settled within each financial institution and do not go through the ACH.

Sources: commercial banks and ACH.

With interbank and intra-bank data for both checks and transfers, it can be established that for 2015 transfers exceeded checks by 9.49 times in number of transactions and 6.3 times in value.

### 3. Payment instruments

Among the main instruments in the Colombian economy that allow the extinction of payment obligations in the market of goods and services are cash, cards (debit and credit), check, and fund transfers (debit and credit).

The instruments most used by natural persons are cash and cards. On the other hand, legal persons use more fund transfers and checks (Table 23).

Table 23  
Main Instruments of Payment in the Colombian Economy

Market	Instrument	Greatest use by type of person	
		Individual	Legal entity
	Cash	X	
	Debit Card	X	
Goods and Services	Credit Card	X	
	Check		X
	Transfers		X

Source: Banco de la República.

Of the previous payment instruments, the ones different to cash (banknotes and coins) are characterized by having an electronic process or by incorporating an electronic format (for example check) somewhere in the payment process chain. These instruments are used for the purpose of transmitting fund transfer orders from the account that a payer has in a financial institution to a payment beneficiary, for reasons such as the consideration of goods or services granted by the latter, or the transfer of resources in itself. Earlier versions of this Report outlined the detailed integration processes of the instruments in question with the clearing and settlement of retail payment systems.<sup>25</sup>

<sup>25</sup> See the 2015, 2014, and 2013 editions of the Payment Systems Report at: <http://www.banrep.gov.co/publicaciones-serie/2041>.

## Cash

To follow up on the use of cash as a payment instrument, *Banco de la República* applies a biannual survey. The most recent result was obtained in 2014, when, by number and value of transactions, about 90% of individuals indicated that they pay their monthly expenses of food, beverages, clothing, transportation, housing, public services, among others in cash. The merchants ratify these results and point out that the payment instrument preferred by its customers is cash. The results of this survey are detailed in the Payment Systems Report

of 2015. Another way to monitor cash usage is by analyzing the variable *circulation of banknotes and coins*, understood as an approximation to the potential use of this instrument in the economy, and not as a direct reference to payments made in cash.

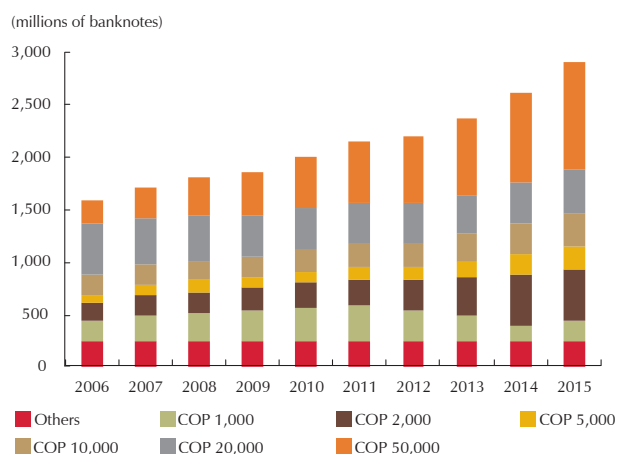
In order to identify the evolution of banknotes in circulation<sup>26</sup>, Graph 26 shows that in the period of 2006-2015 the number of pieces increased on average by 7.0% annually, reaching 2,905 million pieces in the last year.

By denomination, the banknotes of fifty and twenty thousand-peso (COP \$50,000 and COP \$20,000) represented close to 50%, followed by banknotes of two thousand-peso (COP \$2,000) with 17%, ten thousand-peso (COP \$10,000) 11%, and all other denominations, each one under 8.0%.

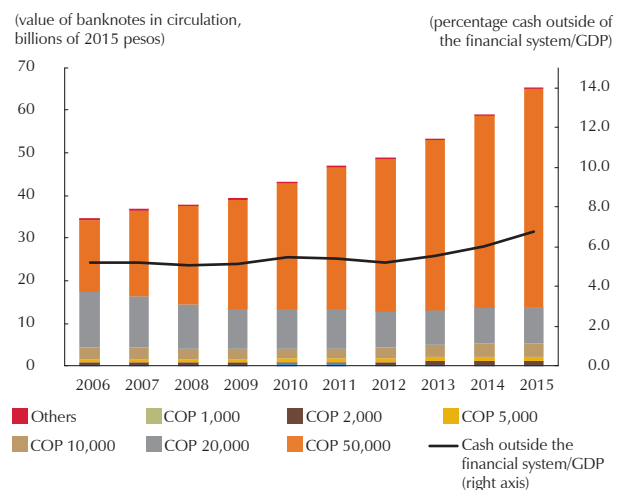
Graph 27 shows the evolution of the total value of banknotes in circulation for the period 2006-2015. In the same way as the performance of the number of pieces, the average growth of value in the period was around 7.0%, representing in 2015 a value close to COP \$ 65.1 b.

By denomination, in 2015 the fifty thousand-peso banknotes (COP \$50,000) represented 79% of the total value in circulation, the twenty thousand-peso banknotes (COP \$20,000) accounted for 13%, while each of the remaining denominations were below 5.0%.

Graph 26  
Banknotes in Circulation



Graph 27  
Value of Banknotes in Circulation vs. Cash Outside of the Financial System/GDP

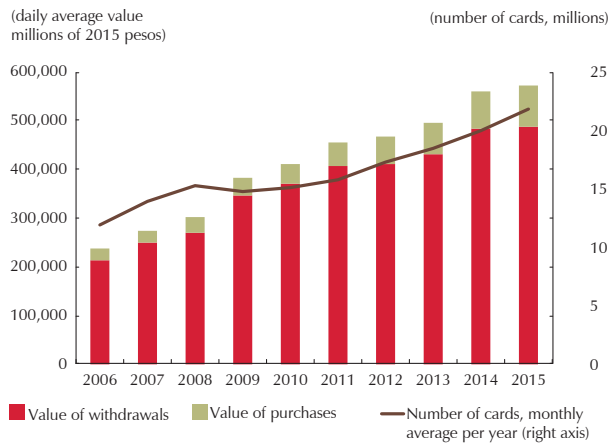


26 Given that in 2015, the value in circulation of banknotes represented 98.0% and coins represented the remaining 2.0%, only the development of banknotes is presented.

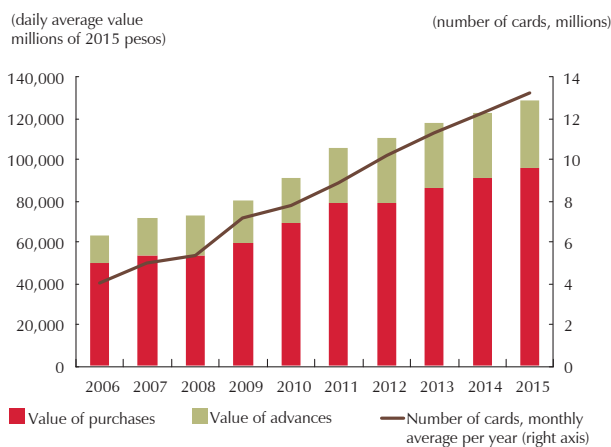


Graph 28

**A. Debit Card**  
(daily average value and number of cards)



**B. Credit Card**  
(daily average value and number of cards)



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

On the other hand, the effective ratio outside the financial system / GDP in the same period maintains an average of 5.49%, and presents an increasing trend during the last years.

**Cards**

The use of debit and credit cards has been increasing in a steady manner over the last decade (Graph 28). The monthly average of the number of debit cards in 2015 was 21.8 million, and their usage attained a daily average of COP \$ 570.7 thousand of millions, of which, the withdrawals accounted for 85% and purchases represented the remaining 15%.

In 2015 the monthly average of the number of credit cards was 13.1 million and their usage attained a daily average value of COP \$128.8 thousand of millions, with purchase operations around 74% and advances reaching 26%.

**Check**

Although the check has shown a downward trend during the last ten years, in 2015 inter and intra-bank checks as a whole represented a daily average gross pay value of COP \$1.61 b, a representative amount in the set of payments in the market of goods and services.

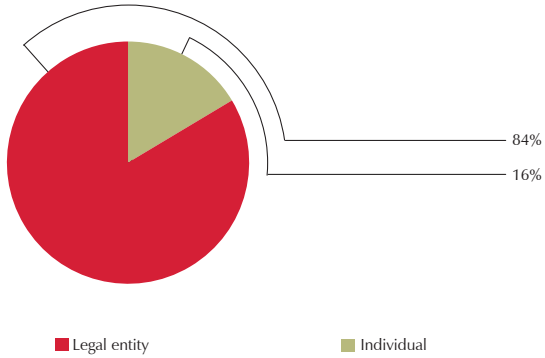
In Graph 29, with the information of most commercial banks it can be seen that, in value terms, 84% of checks is drawn by companies and the remaining 16% is used by natural persons. When analyzing by ranks the greater participation of checks drawn by companies (41%), pertains to individual checks in amounts up to COP\$ 50 m. Similarly, 63% of checks drawn by individuals amount to up to COP \$50 million.

**Fund transfers**

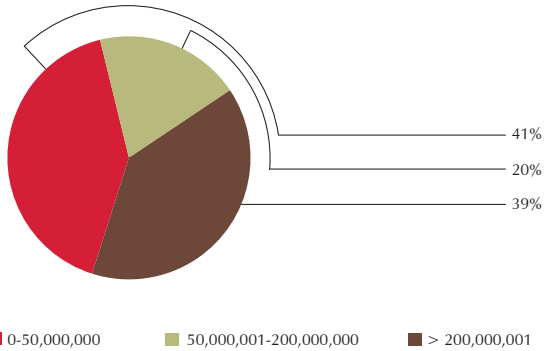
The use of credit and debit transfers has been increasing steadily over the last decade: in 2015 intra and interbank transfers as a whole reached a daily average gross value of COP \$ 10.1 b, becoming the electronic payment instrument most used in our country in the market of goods and services.

Graph 29  
Checks by issuer, 2015  
(thousand of millions of pesos)

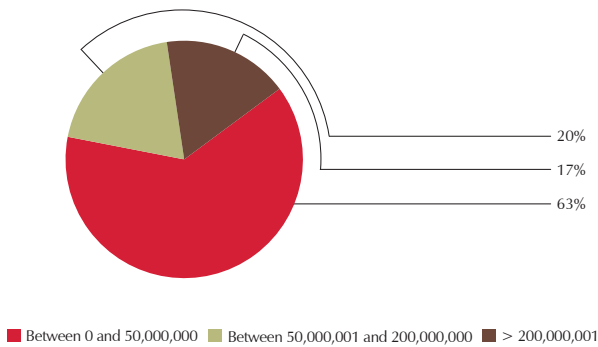
A. Total



B. Legal entity



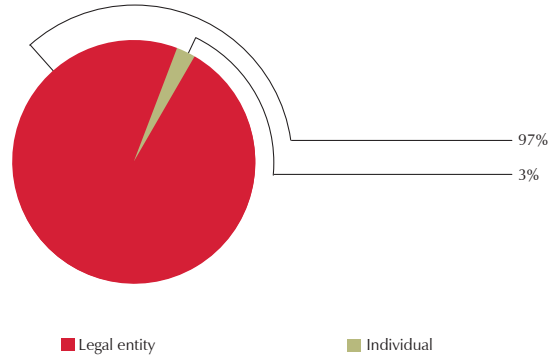
C. Individual



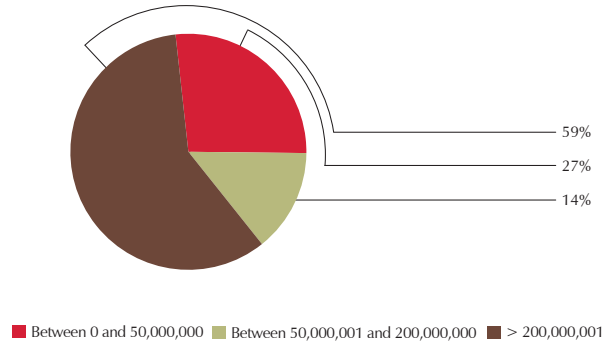
Source: commercial banks.

Graph 30  
Transfers by issuer, 2015  
(thousand of millions of pesos)

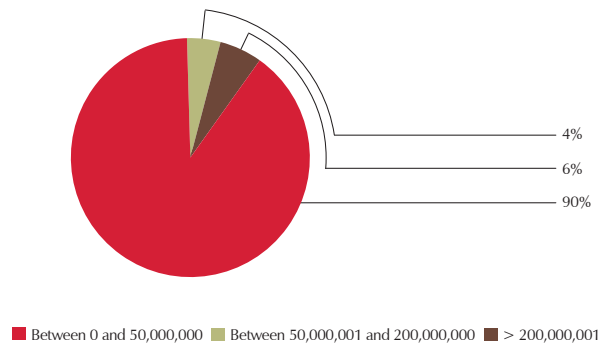
A. Total



B. Legal entity

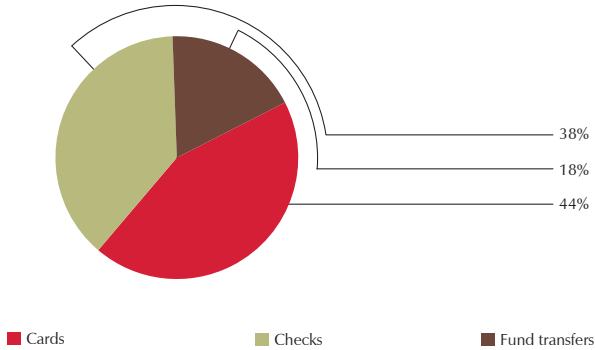


C. Individual



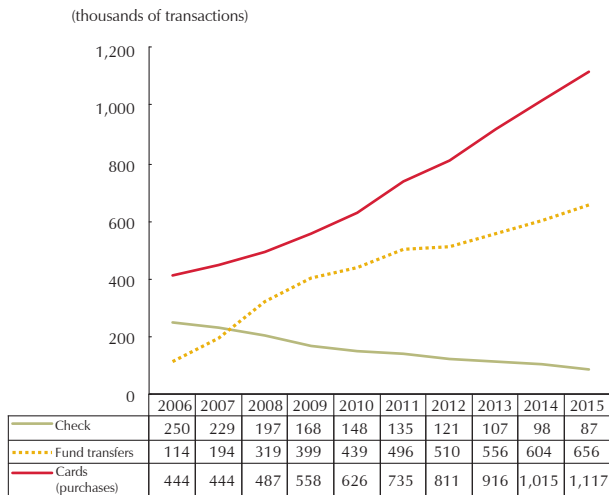
Source: ACH-Colombia.

**Graph 31**  
**Payment Instruments by Originator, Individuals, 2015**  
 (thousand of millions of pesos)



Sources: commercial banks, Office of the Financial Superintendent of Colombia, ACH-Colombia, calculations by Banco de la República.

**Graph 32**  
**Number of Transactions by Payment Instruments**  
 (daily average)



Sources: Banco de la República, ACH-Colombia, and Office of the Financial Superintendent of Colombia.

With the information provided by ACH-Colombia (COP \$ 2.8 b, daily average), 97% of the transfers are of business origin and only 3.0% are used by natural persons (Graph 30).

Fifty-nine percent of the transfers made by companies pertain to the range wider than COP \$ 200 million, and per natural person, 90% of transfers are below COP \$ 50 million.

By discriminating information solely for natural persons, Graph 31 compares which instrument enjoys higher preference within this population based on value. The results showing the following order: cards with 44% (purchases) followed by checks with 38%, while the remaining 18% pertains to electronic fund transfers.

### Comparative use of instruments with electronic processes: cards, checks, and fund transfers

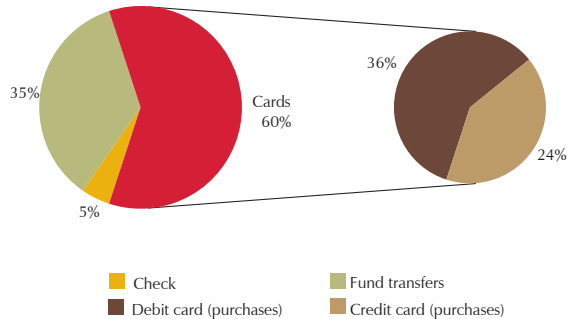
#### Number of transactions

The behavior in number of transactions of the different payment instruments is shown in Graph 32. The use of debit and credit cards (domestic purchases), as well as debit and credit transfers has been increasing steadily over the last decade. In the same period, the check shows a smaller number of transactions. For 2015, 1,117,000 daily<sup>27</sup> transactions were recorded on average by (debit and credit) cards, 656,000 by (debit and credit) fund transfers and 87,000 by check.

Graph 33 for 2015 presents the behavior of payment instruments by number of transactions. It is possible to observe that the participation of cards accounted for 60% (debit 36% and credit 24%), followed by (debit and credit) fund transfers with 35% and checks representing 5.0%.

27 For checks and fund transfers, data do not include intra-bank transactions.

**Graph 33**  
**Percentage Share in the Number of Transactions by Payment Instrument, 2015**  
 (daily average)

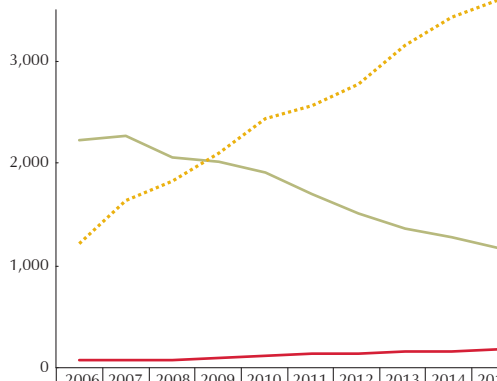


Year (thousands of transactions)	Checks	Fund transfers	Debit card (purchases)	Credit card (purchases)
2015	87	656	661	456

Sources: *Banco de la República*, ACH Colombia, and Office of the Financial Superintendent of Colombia.

**Graph 34**  
**Value of Transactions by Payment Instrument, 2015**  
 (daily average)

(thousand of millions of pesos in 2015)



Year	Check	Fund transfers	Cards (purchases)
2006	2,219	1,202	72
2007	2,262	1,636	79
2008	2,063	1,826	82
2009	2,010	2,101	97
2010	1,907	2,425	110
2011	1,696	2,555	127
2012	1,508	2,775	136
2013	1,357	3,149	151
2014	1,282	3,424	167
2015	1,179	3,599	179

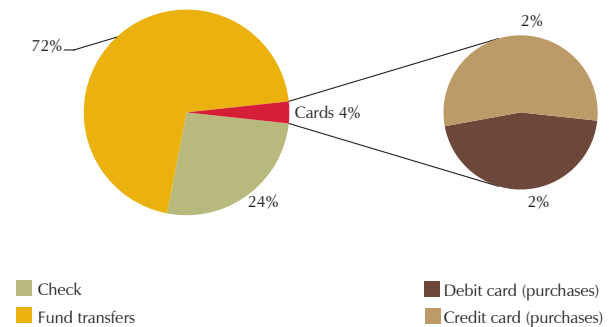
Sources: *Banco de la República*, ACH Colombia, and Office of the Financial Superintendent of Colombia.

**Value of transactions**

The behavior in value of the transactions observed in Graph 34, presents the same trends as in the number of operations: the check, with a descending behavior, and the fund transfers and the cards with an ascending one. However, the value of the fund transfers and the check far exceeds that of the cards. For 2015, in a daily average value<sup>28</sup>, (debit and credit fund transfers) accounted for around COP \$ 3.5 b, while for checks COP \$ 1.1 b and the cards used for purchases (debit and credit) COP \$ 179 mm.

In Graph 35, for 2015, the value of (debit and credit) fund transfers accounted for 72%, followed by checks with 24%, and cards with about 4.0% (1.67% debit and 1.93 % credit).

**Graph 35**  
**Percentage Share of Value of Transactions by Payment Instrument, 2015**  
 (daily average)



Year (thousand of millions of pesos)	Check	Fund transfers	Debit card (purchases)	Credit card (purchases)
2015	1,179	3,599	83	96

Sources: *Banco de la República*, ACH Colombia, and Office of the Financial Superintendent of Colombia.

## CASH AND THE USE OF ELECTRONIC INSTRUMENTS IN THE INTERNATIONAL CONTEXT

During the last decade, it is possible to observe in the international arena that both the availability of cash for payments and the use of other payment instruments in general have shown an increasing trend.

The cash in circulation/GDP ratio in 2014, and for the sample of countries in Graph A, averaged about 8.0%, where Japan is the country with the largest share with 20.1%, and Colombia with 7.5%, is below the aforementioned average. The only country in the sample that shows a downward trend is Sweden: in 2014 its participation was 2.1%, which is supported by its advance in electronic payments, due to public policy decisions and private sector momentum in that country<sup>1</sup>. On the other hand, the ratio of electronic payments to GDP (Graph A), i.e. those made mainly with fund transfer, check, debit and credit cards, in all countries of the sample, shows an upward trend. Mexico exhibit a growth of more than 150% during the last ten years, and in 2014 electronic payments accounted for 15.7 times the GDP. This indicator is similar to that obtained in the CPMI countries<sup>2</sup>, with 14.4, and the United States, where electronic payments accounted for 11.7 times GDP. In Colombia, electronic payments represented 1.5 times the GDP.

### Instruments and electronic payments

Payment instruments other than cash are fund transfers, checks, cards (debit and credit)<sup>3</sup> and the so-called e-money.<sup>4</sup> In Graph B can be seen that during the last

decade (2005 to 2014), in general, by number of operations the different payment instruments are used in the countries of the sample.

In the period under study, fund transfers have increased their participation in some countries such as the United States, Brazil, Colombia, and Mexico. The increase in cards usage is more generalized, as can be seen in all countries of the sample, except for Japan. In contrast, the check has decreased its participation in all the indicated countries, while the e-money only reflects an important contribution in Japan.

Graph C shows the participation by country of the value of the payment instruments: both fund transfers and cards grow in the period, although the participation of the latter is low. Also, it is possible to observe the loss in the contribution that the check makes during the last decade. Electronic money is not representative in the total value of payments with instruments other than cash.

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1 Sveriges Riksbank (2013). "The Riksbank's review of the retail payment market in Sweden," The Swedish Retail Payment Market, Riksbank Studies, June.

2 Australia, Belgium, Brazil, Canada, France, Germany, India, Italy, Japan, Korea, Mexico, Netherlands, Russia, Saudi Arabia, Singapore, Sweden, Turkey, the United Kingdom and the United States.

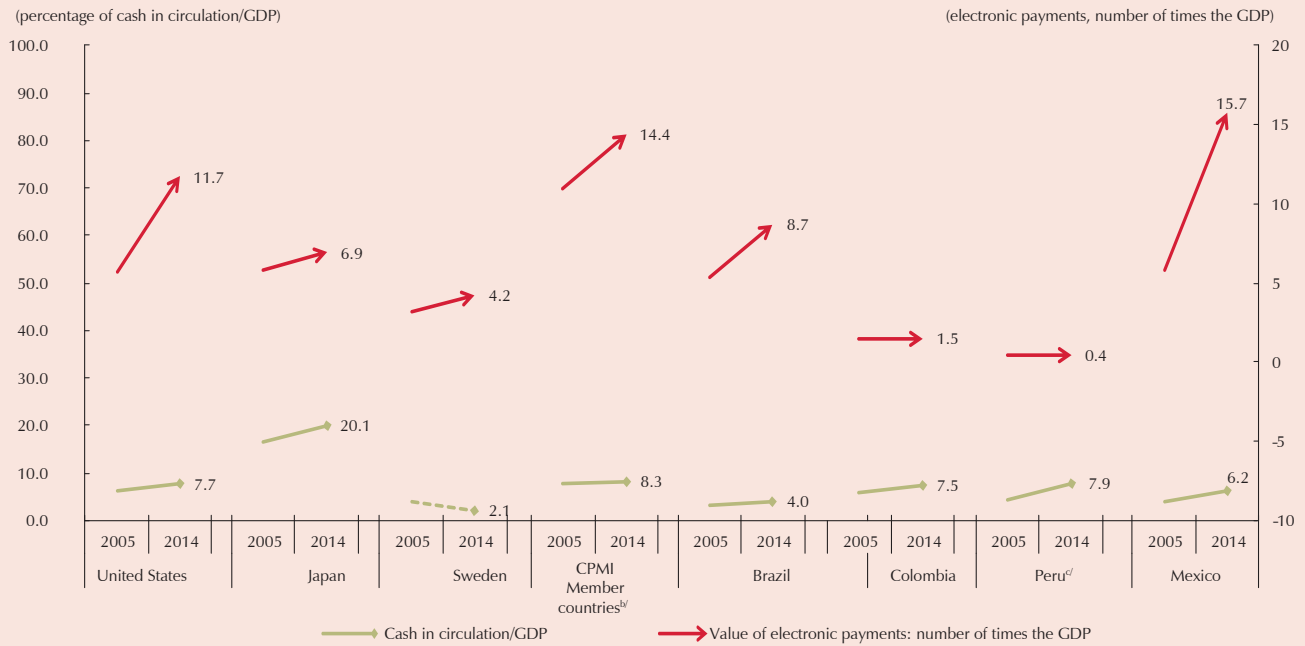
3 In Colombia, the statistics incorporate debit and credit card data. However, in other countries it is possible to add to the previous ones other valid cards in their territories, such as cards with delayed debit function, which allow the holder to charge their account, up to an authorized limit, but which do not offer installment credit and the total value of the debt incurred by a purchase is settled at the end of a period agreed in the contract.

4 These instruments have a balance with payment service providers (most of which are non-financial entities), and they

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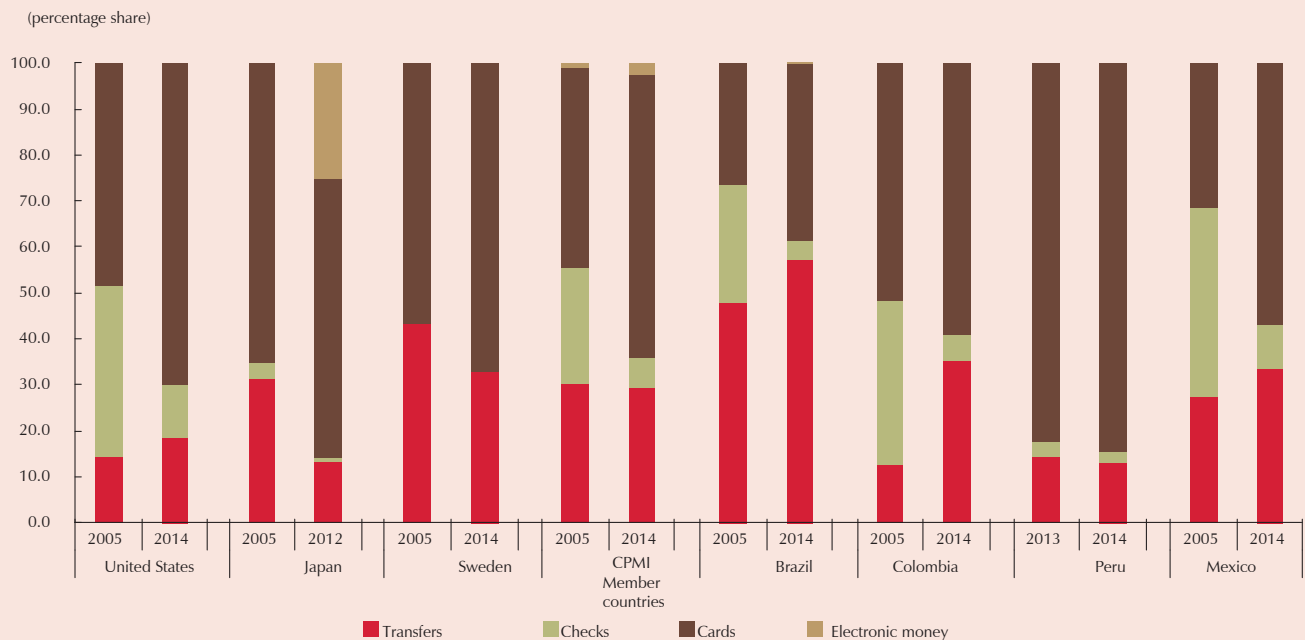
allow payments to be made on the Internet, or via mobile phones or prepaid cards - see CPMI, BIS, World Bank (2015). *Report on the Payment Aspects of Financial Inclusion 2015*.

**Diagram A**  
Cash in Circulation and Electronic Payments<sup>a/</sup> with Respect to the GDP



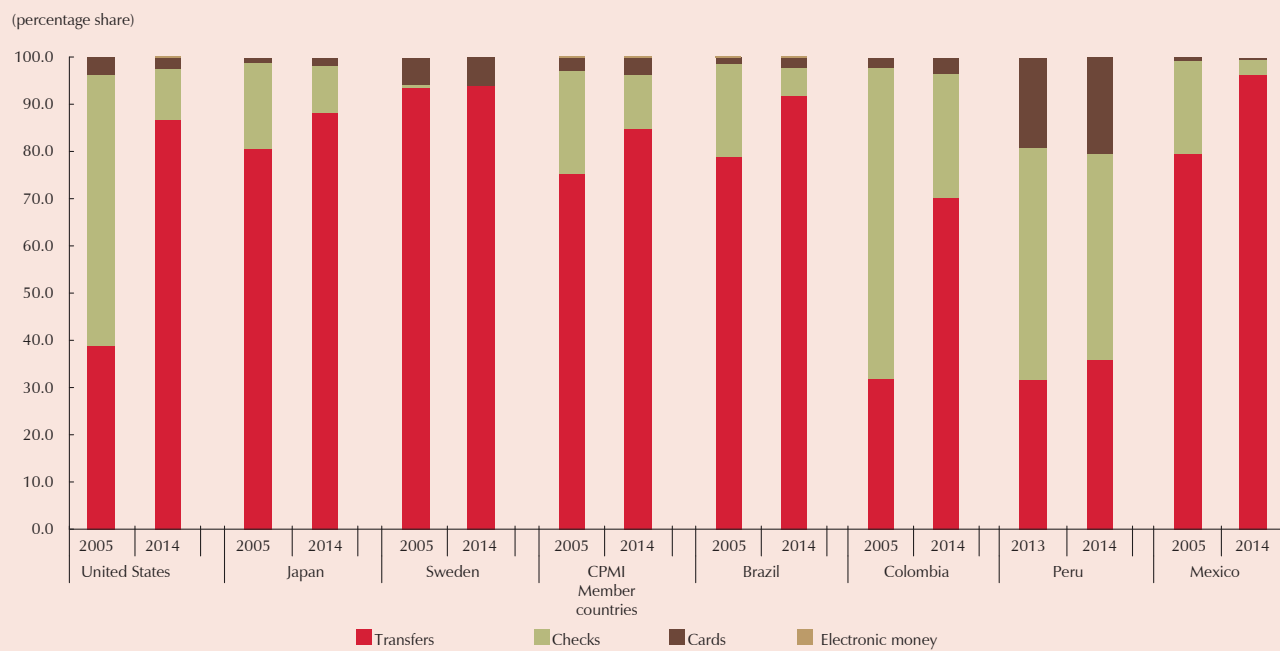
a/ Payments made with instruments: fund transfers, checks and cards. Although the check is originally on paper, its settlement involves an electronic component.  
 b/ Countries that are members of the Committee on Payments and Market Infrastructures (CPMI) correspond to the average of the available statistics in each indicator: For cash/GDP: Australia, Brazil, Canada, China (2005), Hong Kong SAR, India, Japan, Korea, Mexico, Russia, Saudi Arabia, Singapore, South Africa, Sweden, Switzerland, Turkey, the United Kingdom, the United States, and the euro zone.  
 For electronic payments: number of times the GDP corresponds to: Australia, Belgium, Brazil, Canada, France, Germany, India, Italy, Japan, Korea, Mexico, Netherlands, Russia, Saudi Arabia, Singapore, South Africa (2014), Sweden, Switzerland, Turkey, the United Kingdom, and the United States.  
 c/ Peru has information available for the “number of times that the value of electronic payments represents the GDP” indicator for the years 2013 and 2014.  
 Sources: BIS (tables of comparative statistics for 2009 and 2014) and Cemla (statistics on payment, clearing, and settlement systems in Latin America and the Caribbean, 1999-2014) and DANE, calculations by Banco de la República.

**Diagram B**  
Payment Instruments, Number of Transactions



Sources: BIS (tables of comparative statistics for 2009 and 2014), Cemla (statistics on payment, clearing, and settlement systems in Latin America and the Caribbean, 1999-2014), calculations by Banco de la República.

Diagram C  
Payment Instruments, Value of Transactions



Sources: BIS (tables of comparative statistics for 2009 and 2014), Cemla (statistics on payment, clearing, and settlement systems in Latin America and the Caribbean, 1999-2014), calculations by Banco de la República.

## Box 1 E-COMMERCE AND INNOVATIONS IN PAYMENTS

Retail e-commerce in Colombia has been increasing; it is defined as a commercial relationship by means of using data messages<sup>1</sup>; in other words, it is the buying and selling of retail-value goods and services, both in Colombia and abroad (imports and exports).

According to a study commissioned by the Colombian Chamber of E-Commerce (*Cámara Colombiana de Comercio Electrónico*) (CCCE), it is estimated that e-commerce in Colombia amounted to USD 9,961 million (b), a figure corresponding to 2.62% of GDP<sup>2</sup>, equivalent to COP \$ 19.9 billion (b).

For the same year, and according to a report on electronic transactions<sup>3</sup>, among the most commonly products purchased with the mechanism are: airline tickets and hotel reservations, coupons, electronic items, clothing and footwear. The payment instruments most employed for these purchases were: Credit cards (55%), cash (34%)<sup>4</sup> and debits in current and savings accounts (11%).

E-commerce worldwide in 2014 amounted to an estimated USD \$ 1.3 trillion, with China and the United States having a 55% share of the total. For Latin America in the same year, e-commerce amounted to USD \$ 38 b, with Brazil being responsible for 44% followed by Mexico with 12%, Argentina with 9%, and all other countries with the remaining 35%.<sup>5</sup>

Retail trade has shown payment innovations consolidated by means of technological development, for example the use of Internet, making communication and deals between sellers and buyers of goods and services easier. In general, the usage of new technologies has been showing an upward trend. In Colombia, eight out of ten people use the Internet and the penetration rate of mobile telephony is 108.3%.<sup>6</sup>

Currently, about 74% of micro, small and medium-sized companies (“Mipymes”) are connected to the Internet<sup>7</sup>, and the National Government’s goal is to promote increasing connectedness, with the purpose of fostering productivity and local competitiveness<sup>8</sup>. Mipymes<sup>9</sup> represented 95% of exporting firms and on average 5.6% of total exports in the last four years, reaching USD\$ 2,891 m<sup>10</sup> (total Colombian exports in 2014 amounted to USD \$54.795 m). Therefore, micro, small, and medium-sized companies have great potential in e-commerce.

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1 Act 527 of 1999: “Whereby the access and usage of data messages, electronic commerce and digital signatures is defined and regulated, and the certifying entities are established and other provisions are enacted”.

2 CCCE (2015). Study of electronic commerce in Colombia, hired by the CCCE to Price Water House Coopers.

3 *Portafolio* (2015). “Electronic commerce grew more than 40% in Colombia,” January 19.

4 The client makes an electronic purchase and receives a code with which s/he pays in cash at the collection center authorized by the seller.

5 e-marketer.com (2015). “Retail Ecommerce Sales Near \$50 Billion in Latin America” [online], available on <http://www.emarketer.com/Article/Retail-Ecommerce-Sales-Near50-Billion-Latin-America/1012744>; emarketer.com (2014). “Retail Sales Worldwide Will Top \$22 Trillion This Year” [online], available on <http://www.emarketer.com/Article/Retail-Sales-Worldwide-Will-Top-22-Trillion-This-Year/1011765>

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6 Ministry of Information Technologies and Communications and Ipsos Napoleon (2014): Study on digital consumption; Ministry of Information Technologies and Communications (2015). Information Technologies and Communications Quarterly Bulletin, first quarter.

7 National Consulting Center (2014): Description of Colombian MIPYMEs in relation to Information Technologies and Communications. Study commissioned by Bancoldex and Innpulsa. By number and value of operations, the payment channel most used in Colombia is Internet.

8 According to the Industry and Commerce Superintendent, in its *Management Report*, 2014, institutional commitments, based on the *Conpes* document 3620 of 2009: “Policy Framework for the Development and Promotion of E-commerce in Colombia,” have been brought forward and it is possible to consider than advances made in the legal definition of the different concepts such as electronic document, electronic invoice, digital signature, among others, will allow for a standardization of the different terms, thus optimizing the exchange in the communication that electronic commerce requires.

9 Procolombia (2015). Report on Foreign Trade of Colombian MIPYMEs, October. “The definition used to classify MIPYMEs [...] the variable average FOB value exported by each company as proxy of the income variable [...] companies were classified in the following manner:  
- Great exporting enterprise (GEX): Over US\$5 million.  
- Small and medium-size exporting Enterprise (PYMEX): between US \$500,000 and US \$5 million.  
- Exporting micro-enterprises (MEX): below US\$ 500,000.

10 Procolombia (2015). Report on Foreign Trade of Colombian MIPYMEs, October.



## Stages of the electronic retail payment process

Innovations in the payment process are characterized by being made in the first stages, that is, they involve new connections between channels and payment instruments. Therefore, it is worth noting that the stages through which electronic retail payments go through. In Diagram B1.1 a basic description of the electronic payment process in the goods and services market, or retail payments, is made, which begins with the buyer authorizing the seller (A) for the resources to be debited from his means of payment (savings account, current account or electronic deposit) or from his credit line, using different payment instruments.

The payment process begins by using one of the available payment instruments (B), which transmit orders of funds' transfer from the account held by a payer in a financial entity to a beneficiary, for reasons such as purchase of goods and services. Among the instruments are included: debit card, credit card, prepaid card, debit transfer and credit transfer.

In some cases, access devices are required (C) such as computers, landline phones, cellphones or tablets, which, attached to the selected instrument, allow for a connection with access channels (D), among which are the following: branches, ATMs, PIN terminal, Internet and land or mobile networks.<sup>11</sup>

After using the access channel, financial institutions providing services to both payer and recipient (E) have the payment information available, which at a later time is forwarded to retail payment systems.

The latter, by means of a multilateral clearing procedure (E), establish the credit or debit positions between the financial entities of payer and recipient, money that afterwards are settled to eventually accredit the resources in the recipient's account or deliver the corresponding funds.

## Innovations in retail electronic payments

According to the BIS<sup>12</sup>, international innovations in retail payment processing can be grouped by products as fol-

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11 In other cases, connection to the channel is obtained directly with the instrument itself, for example, when inserting a credit card in the PIN terminal without the need of a computer or another device.

12 Bank for International Settlements; Committee on Payment and Settlements Systems (2012). *Innovations and Retail Payments*, BIS.

lows: card, Internet, mobile network, electronic invoices and payments, and optimization of infrastructure and security. Given the different developments, it is possible to make the following summary on retail payment trends: 1) the payments market is dynamic, however, just a few innovations have had a substantial effect in the market; 2) most innovations have been developed for the domestic market of each economy, with only a few having international impact; 3) there is a widespread interest in the speed of payment processing; 4) financial inclusion promotes innovation in many countries, from the government or from the private sector (because of new business opportunities), and 5) the role played by new institutions in retail-value payments has markedly increased, due to technology always being in evolution and allowing access to areas where banks are not so competitive.

In Colombia, from the growth of electronic commerce, with commercial offers on the Internet, there is a service provided by an additional agent in the chain, known as a payment gateway<sup>13</sup>, which acts as an intermediary between the establishment and the payer, and which delivers the authentication for the transaction. Payment gateways perform functions such as: 1) transfer of clients' information to the financial infrastructure, with the ability to make connections from the merchant's webpage (gateway model), and 2) some payment gateways, besides transferring information, have a money collection function (merchant account).

Previously, service agreements are made between the payment gateway and the establishment, and the same takes place between the payer, the establishment, and payment gateway, and the infrastructure and financial entities. As observed in Diagram B1.2, with regard to the information flow, it is through the payment gateway that the business allows its clients to initiate payment with their instruments, such as credit card or electronic transfers, since payment gateways are the entry point for domestic and transnational payments, where information is transferred in two ways: 1) from the payer to the payment network or financial infrastructure and, 2) back to the payer with the response obtained, after the processing required by the network.

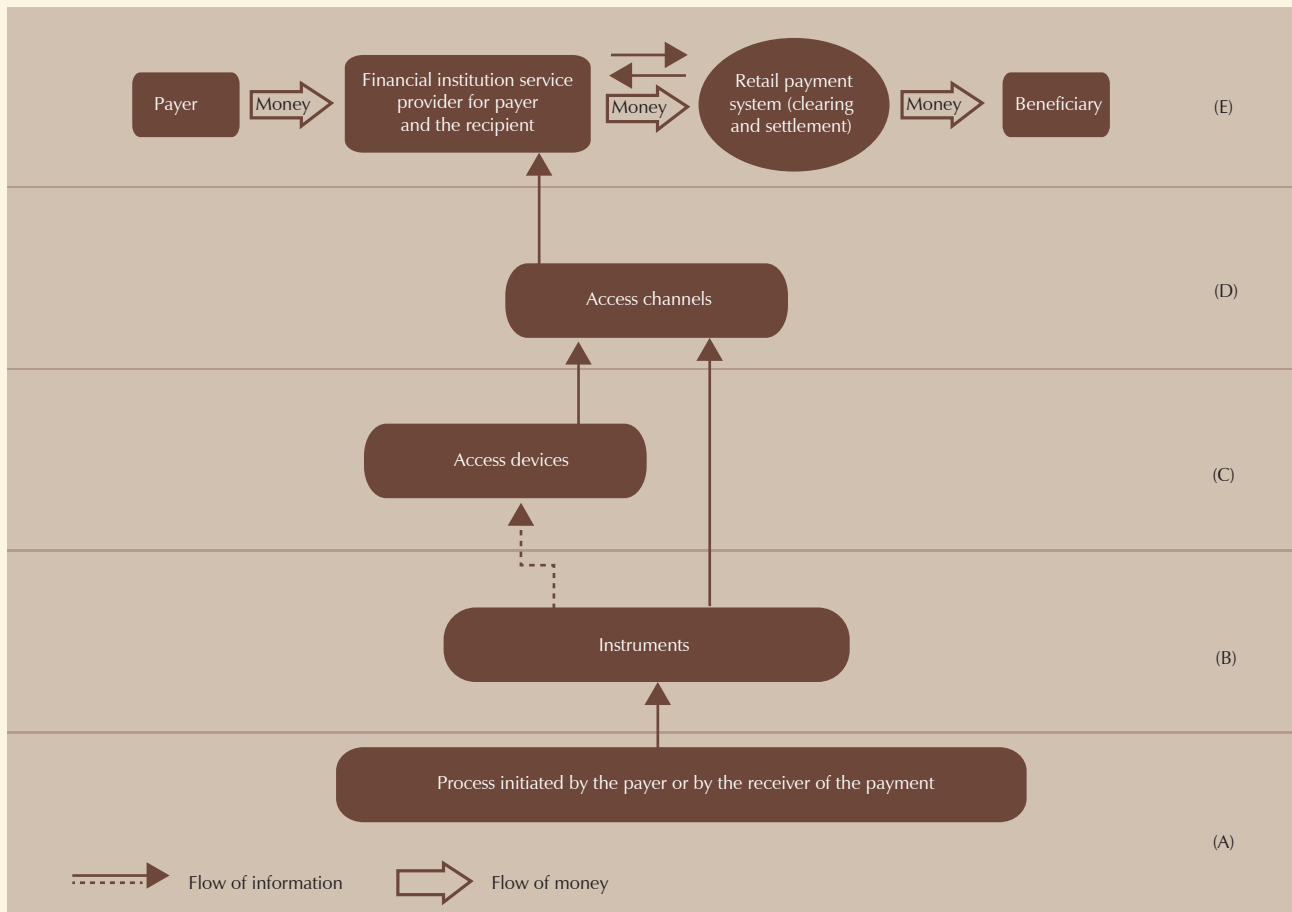
## International experience of the payment gateways' involvement in the payment process

An example of payment gateways in the international front is PayPal®; in the United States it is a non-banking entity providing domestic and international money

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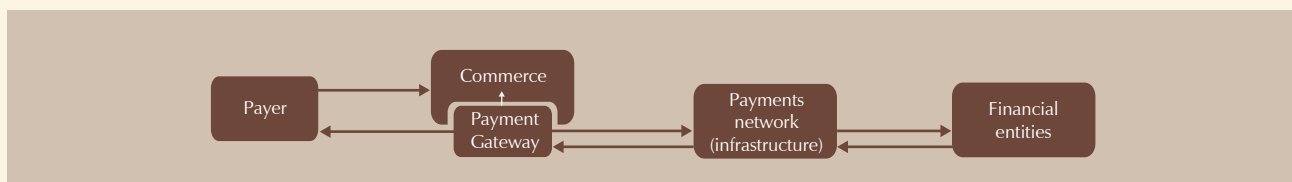
13 Office of the Industry and Commerce Superintendent (2014). *Comercio electrónico en Colombia*.

Diagram B1.1  
Flow of a Payment Process



Sources: BIS, adapted by Banco de la República (DSIF).

Diagram B1.2  
Agents in the General Payment Process in Electronic Trading



Sources: Banco de la República (DSIF).

services for clients making online purchases in businesses. Among the services rendered are: 1) information transfer for payment (buyer-seller), using payment instruments such as credit cards; 2) PayPal accounts (commonly known as PayPal balance, without being actual bank accounts); and 3) PayPal Working Capital, which is a commercial loan offered to the company's merchants, that pay off the loan in an automatic manner with a percentage of their daily sales.

In the beginning of the year 2015, Banco de la República's Financial Infrastructure Oversight Department conducted a survey with central banks, like Spain's and with different Latin American countries, with the purpose of learning about the participation of PayPal. With the results it is possible to conclude that:

Regarding the transfer of information, Paypal works as a payment gateway in most of the surveyed countries. Transnational payments resulting from electronic

purchases of goods and services are understood to be originated in PayPal and within the regulatory framework.

When PayPal provides domestic services it is established as an entity within the country, complying with norms and domestic licenses (like in Spain and Mexico). Also, it has made agreements with entities rendering financial services (Chile and Paraguay). In Brazil it is in the process of being authorized as a payment entity.<sup>14</sup> In Colombia, with the current foreign exchange system, residents can pay for international purchases with credit cards and monetize the sale of goods abroad through an intermediary in the exchange market or a clearing account.

### Conclusions:

As a whole, the availability of financial infrastructure enables the making of payments and has developed along with new technologies, allowing for a breakdown of the payment process in different stages and increasing the number of participants in the process.

Given the existing relationship between e-commerce and payment gateway agents, it is possible to conclude that innovations in retail payments are being made in Colombia.

The expansion in the process of payments establishes a need for evaluating this new cycle and, if necessary, for considering the enforcement of measures in benefit of the trust both the public and business have in the different payment instruments.

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14 Legal person with the following functions:  
a) Cash withdrawal and deposit of the payment accounts.  
b) Payment instructions.  
c) Managing payment accounts.  
d) Issuing payment instruments.  
e) Acquiring payment instruments.  
f) Remittances.  
g) Converting physical money to electronic money or vice versa. Using electronic money.  
h) Other activities relating to provide payment services, designated by the central bank of Brazil.

## Box 2

### EVOLUTION OF PAYMENTS AND LIQUIDITY SOURCES IN THE LARGE-VALUE PAYMENT SYSTEM

An integral part of monitoring the local financial infrastructure is understanding the behavior of each one of the participants (financial institutions: FIs) within the infrastructure of the financial market (FMI) as well as of all of them as a whole. The purpose here is to establish behavioral patterns (profiles), whose changes in time show signs that allow for the early identification and dimensioning of financial risks with systemic incidence, related to the clearing and settlement of operations in the local financial markets.

An essential element for constructing these profiles is the identification and quantification of liquidity sources used by each one of the participants in order to meet all payment obligations created, among others, by the purchases or sales of financial assets.

This Box analyzes the evolution in the use of different sources by the FIs as a strategy designed to meet their payments, in addition to how these payments have evolved in different periods. Information from the CUD large-value payment system is used, and the implementation of the figure of the role or figure of the custodian of collective investment funds (CIFs) in July 2015 is taken as a point of reference.

The selected periods comprise January 2014 through December 2015, as follows: 1) first semester of 2014; 2) second semester of 2014; 3) first semester of 2015, and 4) second semester of 2015. A daily average of payments is established for each one of the semesters, as well as the average amount of liquidity sources used to execute them.

The study and its results are constructed by type of financial entity selecting four of them, namely: 1) banks; 2) financial corporations; 3) brokerage firms and 4) trust companies that, when put them all together, constitute about 89% of the total payments made through the CUD system.

#### 1. Information of the large-value payment system (CUD)

The information held in the CUD is of the utmost importance, since this system is the central axis of the local financial infrastructure. The settlement of payment obligations of the other FMIs converges into it for transactions made by financial intermediaries and other agents of the stock market, currencies, derivatives, and direct transfers. Each FI has at least one deposit account in the

CUD with financial resources to meet its different incurred obligations.

The CUD operates with the Real Time Gross Settlement System (RTGS), which guarantees the immediate fulfillment of each money transfer order, subject to the condition that enough funds should be available in the payer's deposit account. This method is demanding, although it serves to mitigate the counterparty risk, due to the requirement of available funds in order for the transfer of resources to be carried out; and, for this reason it is relevant to identify and quantify the liquidity sources that each one of the participating FIs uses.

Among these sources are the following: 1) available balance in the CUD accounts; 2) access to the money market, with or without collateral; 3) access to the Central Bank's liquidity, and 4) use of the payment received from other participants (liquidity recycling or dynamic).<sup>1</sup>

The early or late meeting of obligations by the participants in the CUD during the time the latter offers the service<sup>2</sup>, is based on the costs in which these participants may incur, depending on what financing alternative they choose.

For example, when it comes to the provision of liquidity with collateral by the Central Bank (CB), the total cost corresponds to the sum of the opportunity cost of the frozen securities and the explicit cost at which the CB provides liquidity. The same calculation is generally used to estimate funding costs in the money market.

By contrast, funding based on payments received from other participants in the CUD (liquidity recycling or dynamic) does not imply any explicit costs; however, the timeliness in the reception of liquidity is subject to uncertainty, which could lead to payment delays (Bernal et al., 2012). Such delays may result in penalties due

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1 In this context, the terms liquidity recycling or dynamic, refer to payments made by some entities (outgoing payments) using liquidity received from other counterparties (incoming payments) as their sole source, in order to avoid drawing on the money market (with or without collateral) which implies greater costs, or to maintain their own balance in the account (which represents an opportunity cost, since the central bank does not remunerate any such account deposits).

2 The CUD system offers funds transfer and payment services from 7 a.m. to 8 p.m. every working day in the Colombian calendar.

to non-fulfillment of the time-critical payment schedule, reputational costs and loss of future deals because, in great measure it depends on the liquidity provided by counterparties (Becher et al., 2008).

## 2. Entry into force of the custodians figure for the CIFs

Seeking greater efficiency in the financing of long-term productive projects by way of a stimulus to investment and savings in CIFs (collective investment funds), the National Government issued Decree 1242 of June 14 of 2013 whereby it intends, in addition, to attain international standards with the use of the best practices in terms of management, administration, supervision, risk prevention, and comparable language as far as CIFs are concerned.

Among others, this decree corroborates that the only authorized institutions for the administration of CIFs are brokerage firms, trust companies and investment management firms that must act in a professional manner and with the diligence expected of a prudent and careful expert, in conformity with the investment policy of each CIF, while putting investors' interests above any others', including those of the managing firm, its stakeholders, administrators, employees, subsidiaries, parent company, and branches.

On the other hand, on July 15 of 2013 the Government issued Decree 1498 for the regulation of the custodian activity that has been defined as an exercise of the stock market whereby the custodian exercises care and vigilance over the securities and money resources in custody of the owner (the investor) in order to undertake operations with the securities in question. In the exercise of this activity, the custodian must at least ensure the safeguarding of the securities and the clearing and settlement of operations<sup>3</sup>, as well as the administration of the property rights ensuing from the securities.

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3 Clearing and settlement of operations: By means of which the custodian, according to what the investor or the one authorized to act on his or her behalf, takes part from the confirmation stage in the operation clearing process on securities that the client has validated, and performs the necessary work to their final settlement. This settlement involves the debit or deposit of money or securities from or to the client's account, as well as the orders required to make the payment associated with relevant operation, and other arrangements and formalities that may be applicable in order to carry out the operation. During all the time spent in the provision of its services, the custodian must keep in place mechanisms serving to protect, among others, the loss or damage risk due to the non-performance of transactions on securities other than aspects relating to the credit or counterparty risk.

The decree regulation establishes that only trust companies authorized by the Office of the Financial Superintendent of Colombia can act as custodians of securities; besides, it stipulates that firms that administer CIFs should engage custodian of the securities part of the portfolio they manage only institutions that, in accordance to the norm, can act as custodians of securities.

Although the decrees mentioned were issued in 2013, their entry into force did not take place until July 2015, and led to changes in the flow of clearing and settlement of CIF operations, basically consisting of trust companies now being responsible for confirming, clearing and settling CIF operations. Consequently, the administrators of these CIFs should in principle provide the money to the custodians directly in their CUD accounts, so that the securities depositories (DCV and Deceval)<sup>4</sup> can settle the cash leg and the securities leg in the accounts of the relevant custodians.

The custodians receiving the cash leg resulting from a sale or an equity right from a CIF, shall subsequently make the delivery of these resources to the relevant administrator by means of a direct transfer in the CUD.

## 3. Performance of payments and sources for the analyzed periods

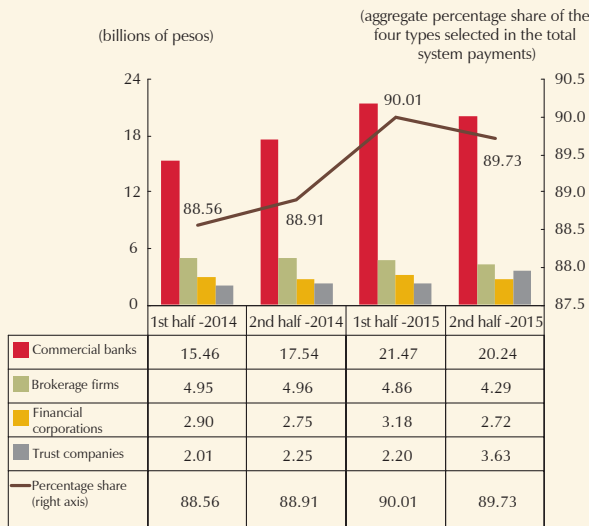
In this Box, the term *payment* refers to the entity that in the settlement of an operation delivers resources in money, and the term *source* to the entity receiving that money. For example, in a purchase of securities, the payment is made by the FI that bought the security (delivered the money) and the source is the FI that sold it (received the money). In a sell/buy-back of the money market, a payment is constituted for the entity that in the first part of the operation (the constitution) delivered the money and a source for the entity obtaining it.

In Graph B2.1 it is possible to see, by type of FI selected and for the periods considered, the average daily amounts and the share within the total of payments settled in the CUD, excluding those made by *Banco de la República* and the Public Credit and National Treasury's office (DGCPTN). Banks, financial corporations, brokerage firms and trust companies are identified as the most active types of FI in the settled value of payments, because they

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4 DCV: Central Securities Depository that, among other things, clears and settled public-debt operations. Deceval: Centralized Securities Depository that, among other things, clears and settles operations with private debt and shares.

**Graph B2.1**  
**Payments by Type of Entity**  
 (daily average during each half year)



Sources: Banco de la República.

together account for about 89% of the total paid on an average daily basis.<sup>5</sup>

As for the participation by type of entity in the average daily value of transactions in each of the six-month periods analyzed, it was established that: banks contributed 54.08%, 56.7%, 61.0% and 58.8%; brokerage firms contributed 17.32%, 16.0%, 14.0%, and 12.5%; financial corporation contributed 10.12%, 8.9%, 9.0%, and 7.9%, and trust companies contributed 7.04%, 7.3%, 6.0% and 10.5%.

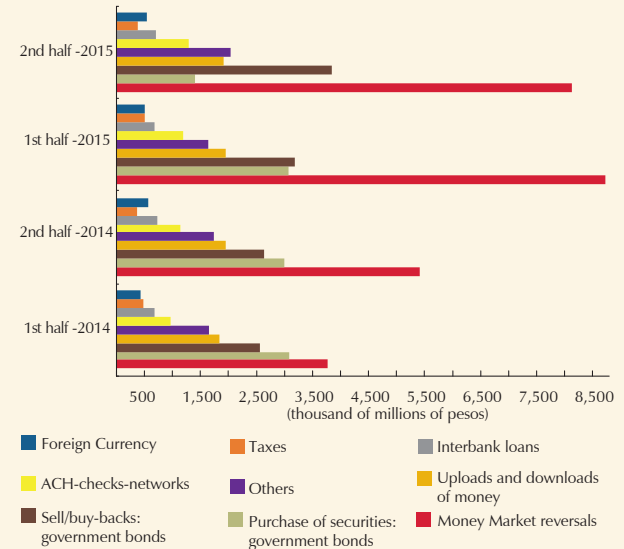
Since the entry into force of the custodian, trust companies occupy the third place in the total amount of payments transacted, displacing the financial corporations from that position.

In terms of payment (Graph B2.2), it is possible to establish that among the most relevant changes for banks, there is an increase in the use of liquidity in the money markets, where the liquidity obtained by monetary policy repos predominates, fueled by the increase in the quotas granted for expansion repos by Banco de la República<sup>6</sup>.

5 That is, 88.56% during the first half of 2014; 88.91% in the second half of 2014; 90% in the first half of 2015, and 89.73% in the second half of 2015.

6 On average, from the second half of 2014 to the first half of 2015, the central bank increased the one-day expansion repos by 60%; in addition, by 2015, it offered quotas with maturities of 30, 21, 14 and 7 days, not available in 2014.

**Graph B2.2**  
**Banks: Payments by Area**  
 (average daily value during each half year)



Sources: Banco de la República.

The payments of these obligations are reflected in the concept called retrocessions money market.<sup>7</sup>

In the second half of 2015 for this same type of entity, a decrease in purchases of public debt securities is observed, from a daily average of COP \$ 3.08 billion(b) in the first half of 2014 to COP \$ 1.4 b (2.2 times less). The decrease can be a consequence of the behavior of the domestic public-debt market, affected by several phenomena that caused volatility and affected the long segment of the curve, for instance<sup>8</sup>: 1) a 125 basis points (bp) increase in the benchmark interest rate, from December 2014 to December 2015, a decision taken by the Board of the central bank in order to contain inflation expectations in the economy. This rise in the rate drove up short-term credit, which generated devaluation in the TES in the same time period; 2) the announcement by the Ministry of Finance to issue TES with maturities of less than one year, which led to the devaluation of short-term securities due to the expectation of a greater offer in this type of financial assets; 3) an increase of Colombia's risk premium, which increased uncertainty, especially among foreign investors; 4) the expectation of a change in the Fed's

7 Operations of return of the liquidity obtained, plus payment of interest. In this Box, included within the concept of money market retrocessions are: retrocession of expansion repos, sell/buy-backs with public / private debt and equity repos.

8 Source: Fiducoldex. Semi-Annual Market Report, January 8, 2016.

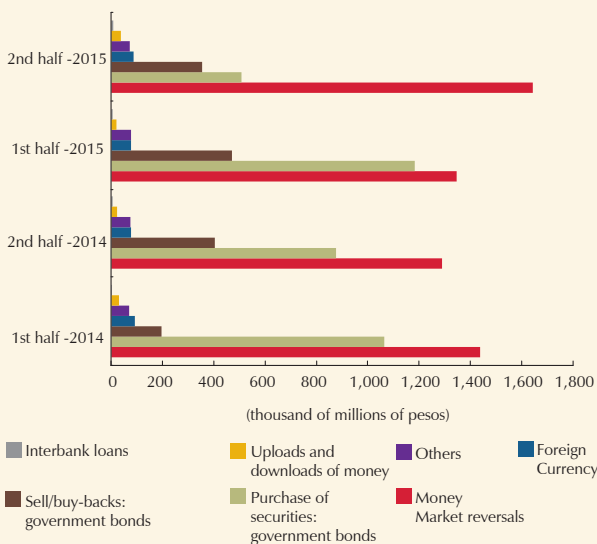
monetary stance, which pushed up the rates on emerging bonds, including the Colombian sovereign debt, by the increase in foreign credit; 5) uncertainty with respect to the international outlook, particularly China's lower GDP growth, which increased global risk aversion, generating further upward pressure on long-term bond rates; 6) the fall in oil prices raised concerns about the weakness of the Colombian foreign sector in the face of a deterioration in the nation's fiscal accounts; 7) devaluation of the exchange rate (peso / dollar), and 8) the increase in inflation expectations and the change in macroeconomic conditions that generated risk aversion, which in turn ended up causing devaluations.

Financial corporations displayed a similar behavior in the evolution of payments (Graph B2.3), because they increased their level of payments through money market retrocessions, and decreased purchases of public-debt securities.

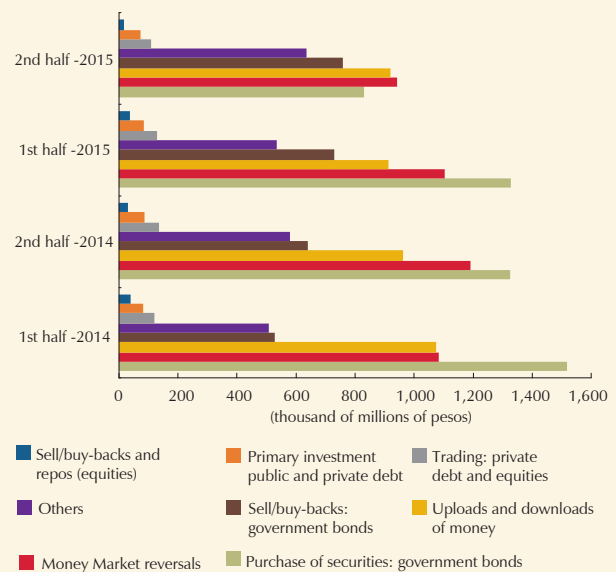
As for brokerage firms, their purchases of public-debt securities also decreased, albeit to a lesser extent than in the other two types; and the delivery of liquidity offered by them was increased by means of sell/buy-backs with public-debt (Graph B2.4).

For trust companies, the most significant change in the second half of 2015 was the transfer of funds between the administrators and custodians of CIF. This was due to the new flow mentioned already, needed to clear and settle this type of transactions, where it is currently essential that the CIF administrators transfer the liquidity

**Graph B2.3**  
Financial Corporations: Payments by Area  
(average daily value during each half year)



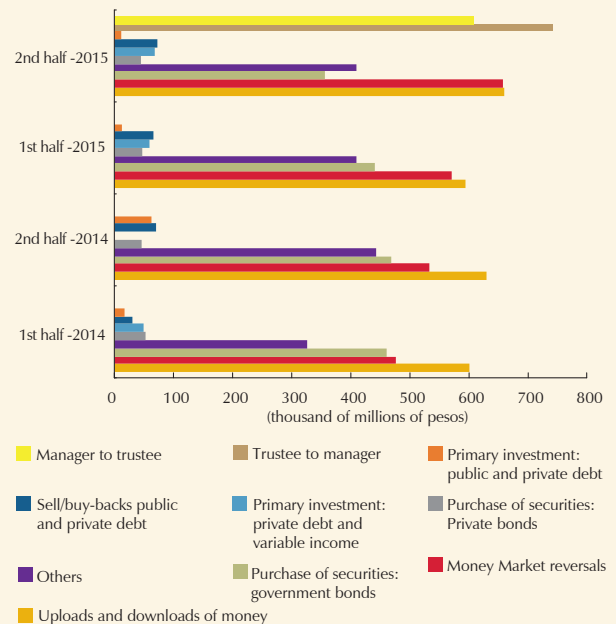
**Graph B2.4**  
Brokerage firms: Payments by Area  
(average daily value during each half year)



Sources: Banco de la República.

to the custodians, so that they can then complete, at the securities depository, the operations of their third parties in custody (Figure B2.5).

**Graph B2.5**  
Trust Funds: Payments by Area  
(average daily value during each half year)



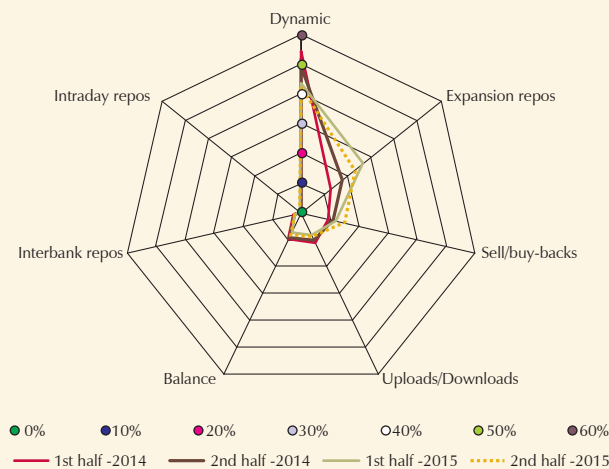
Sources: Banco de la República.

When analyzing the sources of liquidity by type of entity, it is observed that for the first half of 2015 banks increased the use of expansion repos and decreased their utilization by 3.6% in the second half of this year, a liquidity that was largely replaced by an increase in the use of sell/buy-backs with public-debt operations.

The above-mentioned 3.6% is supported not only in the lower quotas that the central bank granted in the second half of the year, but also in the incentive of lower costs that the FIs found in sell/buy-backs with public-debt operations for the same period (interest rate of up to 137 basis points below the repo rate).<sup>9</sup>

Banks also reduced the use of the dynamic and the opening day balance in the deposit account (Graph B2.6).

**Graph B2.6**  
Banks: Sources of Liquidity  
(average daily value during each half year)



Sources: Banco de la República.

Financial corporations increased their use of sell/buy-backs operations, particularly in the second half of 2015, and decreased their use of dynamic operations (Graph R2.7).

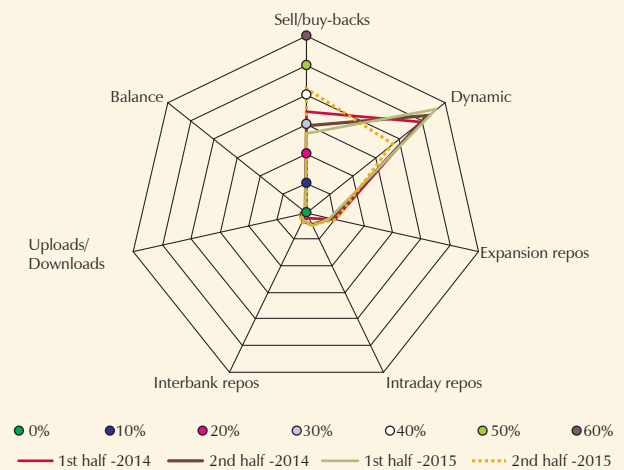
In the last two semesters, brokerage firms required further transfers<sup>10</sup> and, to a lesser extent, sell/buy-backs with public-debt operations; likewise, their use of the dynamic decreased slightly (Graph B2.8).

9 Banco de la República (2016). Financial Markets Report, January 2016.

10 Transfer of funds (uploads of money) from leading banks to brokerage firms and trust companies (called clients), so that the latter have the necessary liquidity in their deposit accounts to meet the cash leg, of their operations with securities: banks previously debit these monies from their clients' current accounts.

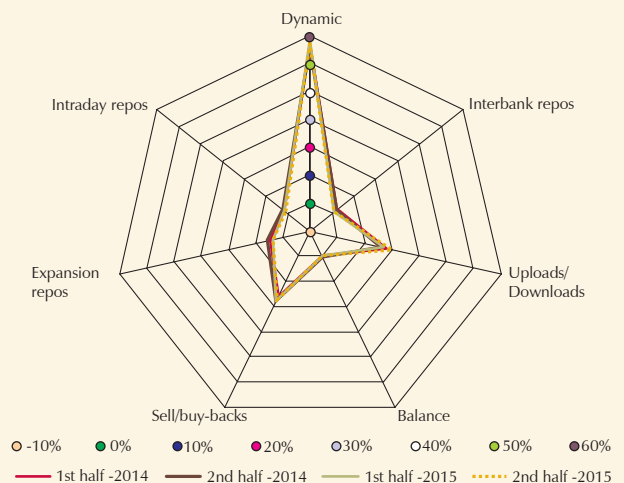
Trust companies depend to a greater extent on the transfer of resources from CIF-managing FIs, as they are currently responsible for confirming, clearing and settling the CIF operations of their custodians (third-party investors); in addition, they increased the use of the dynamic and decreased that of transfers and intraday repos with Banco de la República (Graph B2.9).

**Graph B2.7**  
Financial Corporations: Sources of Liquidity  
(average daily value during each half year)



Sources: Banco de la República.

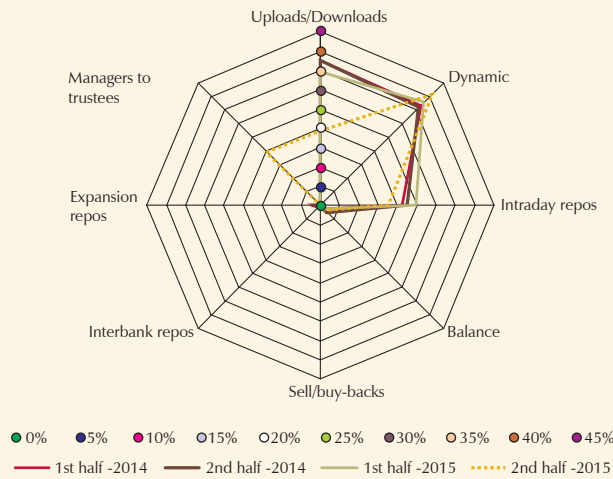
**Graph B2.8**  
Brokerage firms: Sources of Liquidity  
(average daily value during each half year)



Sources: Banco de la República.



**Graph B2.9**  
**Trust Companies: Sources of Liquidity**  
 (average daily value during each half year)



Sources: Banco de la República.

## Conclusions

Although the results are presented in aggregates by type of participants in the CUD, these can also be obtained by each FI, thus establishing a pattern of behavior (profile) revealing the individual strategy in the use of existing sources of liquidity to meet their obligations in the financial market. The continuous monitoring of this profile's evolution (for example, drastic changes in the use of a particular source and/or its main provider), is useful in order to have the timely capture of risk signals with systemic incidence.

It is important to acknowledge that when the FIs optimize their efficient use of liquidity sources, this process does not necessarily reflect well-being in the large-value payment system as a whole. In some cases, such as those FIs whose source of liquidity is predominantly the dynamic, their dependence has the disadvantage of being subject to uncertainty and, therefore, can result in delays in making their own payments. In addition, it is subject to opportunity mismatches between incoming and outgoing payments so that any tension that exacerbates those mismatches can lead to significant increases in intraday liquidity needs.

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### Box 3

## INTERNATIONAL DEBATE ON THE CAPITAL LEVEL OF CENTRAL COUNTERPARTIES

Central counterparties (CCPs) offer multiple benefits to the financial markets, including improved risk management practices, in particular counterparty and liquidity risks; the multilateral netting of operations and their contribution to the stability of markets through mechanisms of orderly settlement of positions in the event of default by any of their members. However, with the importance that these entities have been acquiring, due not only to the authorities' demand for some derivative products to be cleared and settled through them, but also to the increase in traded volumes, it is necessary to bear in mind the costs that this type of financial infrastructure represent for the markets and the stability of financial systems. In general terms, the main costs are related to the high concentration of risk and the possible systemic implications, were one of its main members to default or the CCP to be liquidated. The main benefits and costs of CCPs are summarized in Table B3.1.

Due to the growing and important role of CCPs in global financial markets, there is an ongoing debate in the

international community about the imperative need to give continuity to the service they offer, not only for the benefits described, but also for the impact a liquidation of one of these entities would have on the markets, participants and the financial stability of the jurisdictions where they operate and in which they are interconnected.

These concerns become particularly relevant in a crisis situation and in markets where only a single CCP operates. In such a case, it becomes a single point of failure placing all participants in the market and the system under risk, due to the lack of a substitute in the provision of a critical service within the value chain of the financial markets.

Among the market benefits that would be put at risk are: 1) mitigating counterparty credit risk and facilitating multilateral clearing of exposures through the legal or technical substitution of a high quality counterparty by many potential lower quality counterparties; 2) the

**Table B3.1**  
Benefits and Costs of the CCPs

Benefits	Costs
<p>Mitigation of risks by means of:</p> <ul style="list-style-type: none"> <li>• Multilateral Netting.</li> <li>• Improvement in risk-management practices.</li> <li>• Functioning as a protective barrier or filter that prevents spreading to other members and markets in the face of any member failing to comply.</li> </ul>	<p>A concentration of risks with a possible systemic impact due to the settlement of a CCP.</p> <ul style="list-style-type: none"> <li>• Possible losses in the settlement of transactions would have an impact on the liquidity of the CCP members and others linked to them.</li> <li>• Possible spread to other markets and financial institutions.</li> <li>• The lack of a substitute in the provision of the service could generate a setback in risk-management practices</li> </ul>
<p>Operational efficiency by means of:</p> <ul style="list-style-type: none"> <li>• Reduction in the number of settlement instructions processed.</li> <li>• Increase in processing levels without an interruption in operations (Straight Through Processing).</li> </ul> <p>Lower liquidity requirements for the members by means of:</p> <ul style="list-style-type: none"> <li>• Possible decrease in collateral requirements in comparison to those required bilaterally.</li> <li>• Possible lower collateral requirements due the correlations and clearing between assets.</li> <li>• Lower capital requirements due to exposure with respect to a CCP vs bilateral exposures.</li> </ul>	<p>Participation costs:</p> <ul style="list-style-type: none"> <li>• Demand for resources in terms of collateral and contributions to the established funds.</li> <li>• Costs of membership.</li> <li>• Operating Costs.</li> </ul> <p>Economic costs.</p> <ul style="list-style-type: none"> <li>• Temporary suspension of the market in view of the liquidation of a CCP.</li> <li>• Possible use of public resources to attempt to rescue a CCP if there are no substitutes.</li> </ul>
<p>Transparency:</p> <ul style="list-style-type: none"> <li>• Source of information on markets, especially on the over the counter transactions.</li> <li>• Ease of monitoring for the supervising authorities.</li> </ul>	

Source: Central Counterparties: Addressing their Too Important to Fail Nature - Froukelien Wendt- January 2015. Supplemented by Banco de la República.

reduction of collateral requirements as a result of exposure netting; 3) the reduction of a potential systemic impact in the event of default by any of its members, by maintaining adequate combinations of guarantees, liquidity and financial capital, or other resources, in order to face such an event without affecting other participants, and 4) the decrease in uncertainty surrounding a case of non-compliance by one of the members and the elimination of bilateral actions by participants as a result of having clearly defined procedures for dealing with such an event and having protections to offset and settle previously accepted obligations, among others.<sup>1</sup>

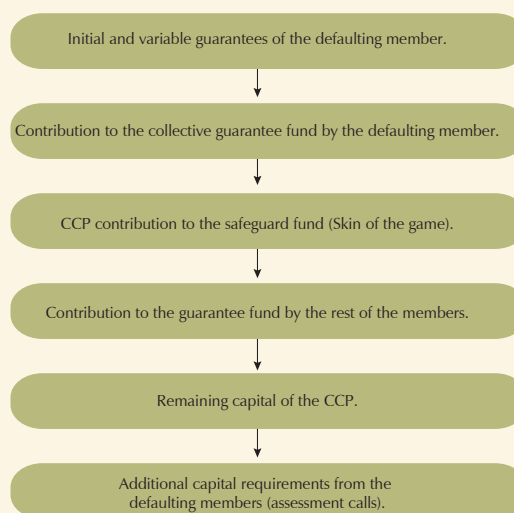
In this regard, financial authorities have the challenge of ensuring that CCPs have sound business management frameworks; sufficient financial resources to support non-compliance events of its members, and have viable recovery and resolution plans.

From the point of view of business risk, in accordance with the principles applicable to financial market infrastructures published in 2012 by the BIS, CCPs must identify, monitor and manage their general business risk and maintain sufficient net liquid assets financed with their net capital to cover possible general business losses, so they can continue to operate and provide services as a company in the event that such losses materialize. In addition, net liquid assets must be sufficient at all times to ensure a recovery or orderly cessation of their fundamental operations and services.

Faced with an adequacy of financial resources, the termination of a CCP could take place due to residual losses caused by the failure of its principal liquidating members exceeding its total capital. Diagram B3.1 shows, for example, how CCPs have their assets in two of the security rings: the first is the contribution to the safeguard fund or collective guarantee, and the second corresponds to an additional contribution in light of a depletion of resources in the rest of the security rings.

Given that the risks arising from clearing activities are largely covered by specific financial resources (margins and collective funds), CCPs must have financial resources of their own to ensure that they are adequately capitalized at all times in order to face credit, counterparty and market risks, as well as operational, legal and business risks, which are not already covered by specific financial resources. This would allow the CCP to carry out

**Diagram B3.1**  
Order in which CCP<sup>a/</sup> Security Rings are Used



a/ According to Wendt, 2015, the structure of the security rings varies from CCP to CCP and there is no single internationally defined structure. Sources: Banco de la República.

a restructuring or orderly winding up of its activities if necessary.

Some examples of capital requirements determining the optimal capital level of CCPs are presented below.

### European legislation

The European Banking Authority (EBA) has approved the draft regulatory technical standards on capital requirements for CCPs under the EMIR regulation (Regulation on OTC derivative transactions, central counterparties and trade repositories), which were adopted by the European Commission. The latter, by way of delegated regulation number 152 of the year 2013, defined technical standards related to the capital requirements of central counterparties. This regulation establishes capital requirements for the purpose of liquidating or restructuring a CCP and capital requirements to mitigate operational, legal, credit and market risks that are not covered by specific financial resources, such as margins and guarantee funds. In any case, the capital required for CCPs must be at least equal to the sum of the items described in Table B3.2.

In addition, the above mentioned regulation states that CCPs must have an initial and permanently available capital of at least EUR 7.5 million (about USD 8.5 m) and that the guarantee fund and other specific financial resources must allow the CCP to deal at any time with the default of at least the two main clearing members

<sup>1</sup> See: <https://ECC12site-ain.pbworks.com/f/The+Value+Proposition+of+Central+Counterparty+Clearing+Houses.pdf>

**Table B3.1**  
**Capital Requirements for CCPs that Operate in the European Union.**

Item	Calculation Method
Capital required for the purposes of settlement or restructuring	Gross monthly operating expenses multiplied by the number of months sufficient to ensure the orderly settlement or restructuring of its activities even under tight market conditions. The period shall be proposed by the CCP and authorized by the authority responsible.
Capital required for legal and operational risks.	The CCPs should calculate their capital requirements for operating risk, including legal risk, through the basic indicator approach or by means of the advanced measurement approaches provided for in Directive 2006/48/CE which defines the minimum proprietary fund requirements for credit institutions operational risk.
Capital required for credit and market risks that are not covered by specific resources.	The method of calculation should consider the risk weighting established by investment firms and credit institutions as the standard of reference.
Capital required for business risk <sup>a/</sup>	The capital requirements for business risk will correspond to the estimate approved by CCP and shall be subject to a minimum amount equivalent to 25 % of the gross annual operating expenses. Since the level of business risk largely depends on the individual situation of each CCP and may derive from factors such as inefficient procedures, an adverse market environment, an ineffective response to technological progress, or poor implementation of business strategies, capital requirements should be based on the CCP's own estimates subject to the approval of the authority responsible. A minimum level must be introduced in order to guarantee a prudent level of capital requirements.

a/ Business risk refers to the risk that a CCP assumes due to its efficiency and the possible change in the general conditions of its work which could jeopardize its financial situation as a result of a decline in its income or of an increase in its expenditures that leads to a loss that must be charged to its capital.  
 Source: European Commission regulation number EU-152/2013.

that it is most exposed to, in extreme but viable market conditions.

**The legislation in the United States of America**

On the one hand, the Board of Governors of the Federal Reserve in regulation HH <sup>2</sup>, with reference to the risk standards of the infrastructures designated by The Financial Stability Oversight Council, under title VIII of the Dodd-Frank Act as systemically important, mentions that such infrastructures should maintain liquid financial assets additional to the resources involved in the management of credit and liquidity risk, sufficient to cover the greater of the cost of implementing the plans to recover<sup>3</sup>

the CCP or the orderly liquidation plan of the business' general losses<sup>4</sup> and six months of current operating expenses. In addition, CCPs should review the calculations at least every two years and define rules and procedures in the event of insufficient resources.

With regard to credit risk management, this regulation defines that CCPs must have pre-funded financial resources that enable them to cover default by the first or the two main participants and their members<sup>5</sup> that would generate the largest exposures to CCPs in scenarios of market stress.

2 The HH regulation establishes two sets of risk management rules for certain infrastructures in the financial market: one for those operating a payment system and the other set for those operating a central securities depository or a central counterparty.

3 Recovery plans are the actions that a CCP has stipulated in its rules, procedures and contractual arrangements, seeking to deal with any mismatch, loss or lack of liquidity, whether

caused by a participant's default or other causes, with the aim of maintaining the service offer and avoiding systemic impacts.

4 This plan refers to actions to address the permanent cessation, sale or transfer of one or more of its critical business units or services, so that they do not generate impacts on liquidity or accentuate credit risk, affecting markets, participants, other FMs or adversely affecting financial stability.

5 It will depend on what the Federal Reserve System's Board of Governors defines.

On the other hand, the Commodity Futures Trading Commission (CFTC)<sup>6</sup>, under Title 17 of the US Federal Code of Regulations, establishes that the organizations that clear off derivatives must adequately identify and manage their overall business risks and maintain sufficient liquid resources to cover potential business losses that are not related to default with the obligations of their members, in such a way that the provision of the service is not interrupted. Therefore, financial resources will be considered sufficient if their value, at the very least, exceeds the sum of the values that: 1) would allow CCPs to fulfill their financial obligations with their liquidating members in the event of default by the member generating the greatest exposure in extreme but credible market conditions, taking into account that both affiliated entities and those under the control of a member shall be counted as one liquidating member for the purposes of this provision, and 2) would allow the institutions clearing derivatives to cover their operating expenses for a period of at least one year, calculated on an ongoing basis.

### Legislation in Brazil

The Central Bank of Brazil establishes the following limits on capital for the clearing and settlement service providers: 1) BRL 5 m (about USD 1.5 m), if it is responsible for a settlement system that is not considered of systemic importance, or 2) BRL 30 m (about USD 8.8 m), if it is responsible for a settlement system considered to be of systemic importance.

If the provider of clearing and settlement service operates more than one settlement system, the minimum equity limits mentioned must be the sum of the respective minimum limits required for the operation of each system. If the system provider of clearing and settlement services performs other activities, the capital requirements must be considered independent. These limits may be reviewed by the Central Bank every two years.

On the other hand, in accordance with Brazil's Payment Systems<sup>7</sup>, the Central Bank established 7 that securities clearing and settlement systems must have special assets invested in federal securities to ensure the continuity of service to market participants, for a minimum amount

of BRL 10 m (about USD \$ 3 m) for each of the systems deemed to be of systemic importance.

### The Colombian case

Decree 2555 of 2010 establishes that in order to request the creation of a central counterparty the minimum amount of capital that must be demonstrated (CCP) is COP \$ 19 mm of 2007. This amount must be permanently maintained by the CCP and must be adjusted annually with the consumer price index (CPI), provided by DANE. By 2015 the minimum capital requirements amounted to about COP \$ 28.9 mm (about USD \$ 9.6 m). This decree additionally provides that the regulations of the CCPs must have guarantees and other safeguards to ensure compliance with the operations, and in any case, these CCPs must maintain sufficient financial resources to support at least the non-compliance of the counterparty with which it holds the highest position, under extreme though possible market conditions.

### Challenges for authorities and CCPs

While it is evident that there is no single standard for defining capital requirements for CCPs or for an optimal level of their own financial resources at the international level, it is clear that an articulated work is needed between these type of entities and the respective authorities to define exercises that allow for the establishment of the levels required to ensure continuity of service and to avoid negative impacts on the financial stability of jurisdictions.

Regarding the establishment of an optimum capital level, it is key to establish, within the regulation of the CCPs, a requirement that not only contemplates a minimum capital of incorporation, but also includes requirements of business risk, recovery and resolution.

Accordingly, it is essential to jointly define periodic reviews of compliance with capital requirements, based on stress tests considering extreme scenarios and of market turbulence.

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6 Entity created to protect market participants and the public from fraud, manipulation, abusive practices and systemic risk relating to derivatives - futures and swaps - and to promote transparent, open, competitive and financially viable markets.

7 Circular 3057 of Central Bank of Brazil 7, in accordance with art. 5 of Law 10214, of March 27, 2001.

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## Box 4 SECURITIES LENDING MARKET IN COLOMBIA

As mentioned in the previous version of this Report, in general terms, a securities loan consists of a collateralized transaction between two participants. In particular, one of them temporarily transfers ownership to the other at the same time that the latter delivers other financial assets (for instance, money or other securities) in order to guarantee the operation. After the deadline, both parties receive the assets initially delivered. In addition, the original holder of the securities, by lending them, receives a monetary compensation. Likewise, when the receiver of the security has given money to the party granting the loan, the latter may recognize a return for such financial resources during the term of the operation. The way in which the payment of such return will be made (i.e.: rebates) shall be defined in the regulations of the loan programs, or agreed upon by the parties, as the case may be.

According to FSB (2012), the market of securities lending was one of the sources that allowed insurers such as AIG to obtain positions of leverage in the US mortgage securitization market<sup>1</sup>. In this sense, knowing the operation and essential characteristics of this type of operations represents a contribution to the understanding of the financial markets and their normal functioning, not only for the participants and the general public, but also for the different financial authorities, especially those involved in supervision, monitoring and financial risk tracking activities. In Colombian regulation, securities lending activity is characterized as a temporary transfer of securities, and is defined as an operation in which one party (the originator) transfers the property of some securities (object of the transaction) to the other (the receiver), with the agreement to retransfer them on the same date or at a later one.

According to the Colombian Stock Market (BVC), among the benefits motivating market participants to carry out this type of operations, are: 1) to increase profitability in the management of portfolios; 2) to facilitate the clearing and settlement mechanisms of

operations when there is a risk of default; 3) to execute arbitrage strategies that allow risk diversification and benefit from perceived differences in the price of related assets (i.e.: short sales), and 4) increase the turnover of assets and, consequently, market liquidity.

In Colombia there are two technological platforms through which temporary securities transfer operations can be carried out: the BVC and the Central Securities Depository (DCV) of *Banco de la República*: originators and receivers converge there to conduct their operations. However, due to the role each of these agents play in the market, their schemes differ in their functional design.

### 1. Characteristics of temporary transfer of securities (TTS)

Due to the characteristics of the Colombian securities market, the temporary loan of securities is typified as a financial transaction.<sup>2</sup> Unlike international practice, where securities lending is a supplementary service, the local securities lending market is a regulated activity.

In accordance with Decree 2555 of 2010, TTS operations are defined as:

[...] those where one of the parties (the “Originator”), transfers the ownership of some securities (the object of the transaction) to the other party (the “Receiver”), with the agreement of transferring them back on the same date or at a later date. In turn, the Recipient will transfer to the Originator the property of “other securities” (not subject to the transaction), or a sum of money of equal or greater value to the securities’ object of the transaction, or will deliver such sum of money or other securities as a collateral to a securities trading system or to a stock exchange supervised by the Office of the Financial Superintendent of Colombia.

In the specific case relating to the delivery of collateral, either to a stock exchange or to a trading system, the aforementioned decree states that:

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1 According to insurance sector authorities in New York State, much of the collateral received by AIG in securities lending operations was reinvested in financial instruments listed as triple A. However, about 60% of these instruments were investments in mortgage backed securities. In turn, 50% of these investments corresponded to debt of lower credit rating (including subprime). More information at [http://www.banking.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore\\_id=8ee655c8-2aed-4d4b-b36f-0ae0ae5e5863](http://www.banking.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=8ee655c8-2aed-4d4b-b36f-0ae0ae5e5863)

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2 Article 2.36.3.1.3., Decree 2555/2010 of the Ministry of Finance and Public Credit.

When money or “the other securities” are delivered as guarantee, the temporary transfer of securities must be carried out through securities trading systems or stock exchanges authorized by the Office of the Financial Superintendent of Colombia, where such guarantees for the performance of these operations are requested and the same are managed by the respective system or stock exchange, under the conditions of article 11 of Law 964 of 2005.

In addition, TTS operations have the following characteristics: 1) the maximum term of the operation is one year, beginning on the initial operation date; 2) the TTS object of the operation will generate the payment of a sum of money by the receiver, which will be calculated in accordance with the regulations of stock exchanges or securities trading systems, or agreed by the parties, as the case may be; 3) if, during the term of the transaction, the securities delivered generate returns or, in general, some kind of economic benefit, these benefits must be transferred to the initial holders of such assets; and 4) the receiver may have mobility restrictions if the securities are delivered as collateral to the operation. In case the asset corresponds to money, the recipient will be able to receive a financial return.

From the normative point of view, TTS in Colombia conforms to the international practice. In particular, it is an exchange of securities between two participants that can be done either directly between the interested parties or through an agent (e.g., trading system or stock exchange). In order to guarantee or support the operation, money or other types of securities can be delivered. Likewise, during the term of the operation, the initial holders of the assets enjoy the economic benefits that may be applicable.<sup>3</sup>

The regulations contemplate the possibility of carrying out the TTS operations in the counter market<sup>4</sup>. However, these must be registered in accordance with the instructions given by the Office of the Financial Superintendent of Colombia, and the securities intermediaries that enter into them must establish and deliver guarantees, with their own resources or with those of third parties, in favor of the stock exchange or a securities trading system.

As for the TTS that are carried out with agents, both the Colombian Stock Market (BVC) and the Central Securities Depository (DCV) of *Banco de la República* have a scheme implemented and currently in operation.

3 With respect to political rights, the parties involved may terminate the operation in advance

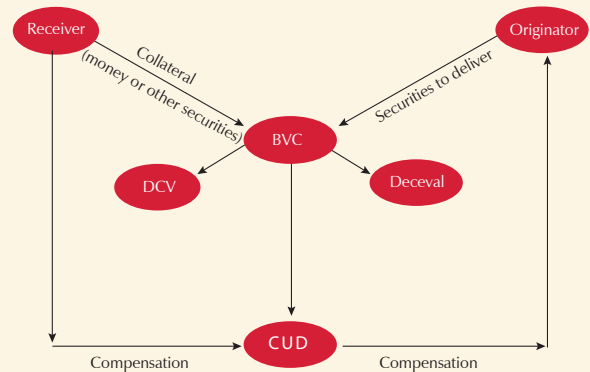
4 Decree 2555 of 2010, articles 2.36.3.1.3 and 2.36.3.2.6

However, due to the role played by each of these agents in the market, these schemes differ in their functional design. Below is a brief explanation of each.

### 1.1. Colombian Stock Market (BVC)

The TTS carried out in the BVC are aimed at increasing profitability in the management of portfolios and facilitating the mechanisms of operation clearing and settlement when there is a risk of default, among others. The scheme can be classified as an implementation of a securities lending program managed by a third party (i.e.: third party agent model), where its role is to put into contact, in this case through a transactional system, the parties interested in lending and borrowing securities. Once the transaction is closed in the trading and registration system, both the originator and the receiver deliver the securities object of the transaction and the associated guarantees to the BVC through Colombia’s Centralized Securities Depository (Deceval), the deposit account system (CUD) or DCV, depending on the case. Once the BVC has both legs of the operation, it proceeds to perform the exchange (Diagram B4.1).

Diagram B4.1  
Functional Model of BVC Temporary Transfer of Securities



Source: Banco de la República.

This functional design has the following additional characteristics: 1) although the originator receives the securities as guarantee, these are blocked in favor of the BVC and, therefore, cannot be involved in any subsequent operation; 2) the BVC manages the market and settlement risks with the Guarantee Administration System (SAG); however, both the compensation value and the management of economic rights are directly carried out by the parties; 3) no financial returns are generated for collaterals received in cash, and 4) the possibility of an advance of the operation (i.e., recall) is defined at its closing.



## 1.2. Evolution of TTS through the BVC

Graph B4.1 shows the evolution of the TTS operations traded at the BVC between January 2014 and December 2015. The decrease shown in both TTS on equities and on fixed-income securities is highlighted.

Thus, in the market for variable income TTS, from a monthly average of COP \$ 41.2 mm in 2014, COP \$ 39.6 mm were traded in 2015; while in the fixed-income TTS market COP \$389.2 mm were traded in 2014 compared to the monthly average of COP \$282.3 mm in 2015.

With regard to the equity market as a whole, TTS trading averaged 0.99% in 2014 and 1.21% in 2015, while in the

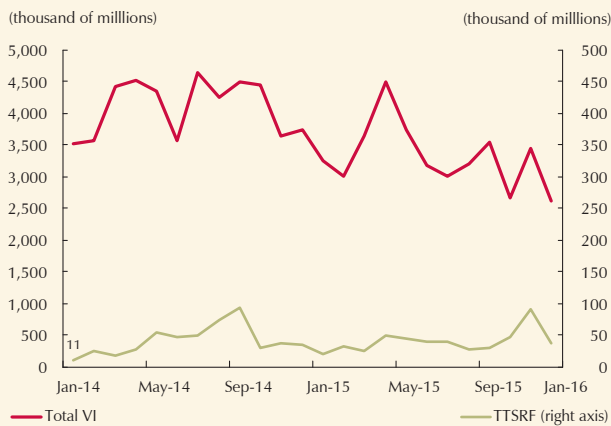
total fixed-income market traded through the BVC the TTS accounted for 0.47% in 2014 and 0.33% in 2015.

Regarding the distribution by type of traded securities during 2015, Graph B4.2 shows how 29 species of TTS on equities were traded, the most traded being Bancolombia's preferential shares, concentrating 34% of the total market (COP \$160 mm), followed by that of the Sura Group, with 11% (COP \$55 mm), Argos Group with 10% (COP \$46 mm), Ecopetrol with 8% (COP \$38 mm) and that of Aval Preferential shares with 7% (COP \$32 mm). The remaining 25 stocks consolidated 30% of the total market (COP \$ 144 mm).

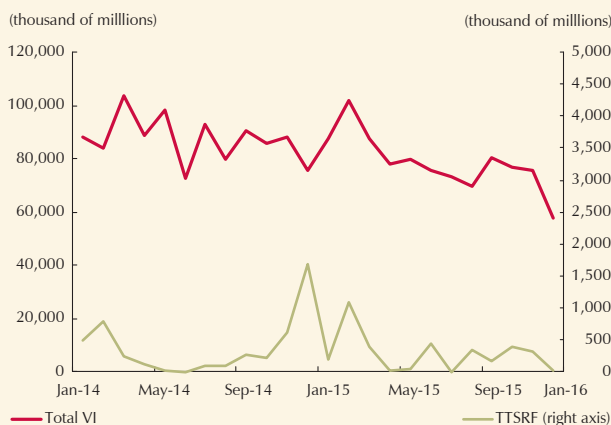
In relation to TTVs on fixed-income securities, only TES public-debt securities were traded during 2015, of which 85% (COP \$2.88 mm) corresponded to fixed-rate TES and the remaining 15% (COP \$506 b) to TES UVR.

Graph B4.1  
Change in the Temporary Transfer of Securities Operations  
TTS

### A. TTS on variable income securities (VI)



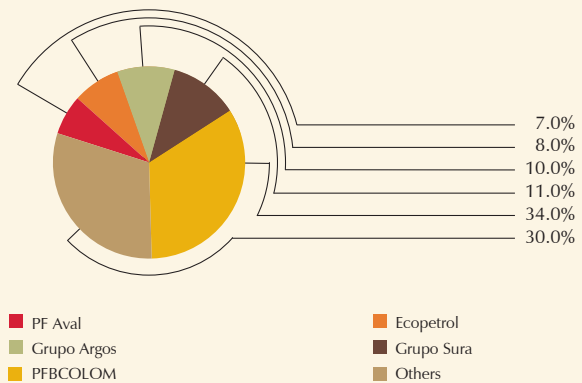
### B. TTS on fixed income securities (FI)



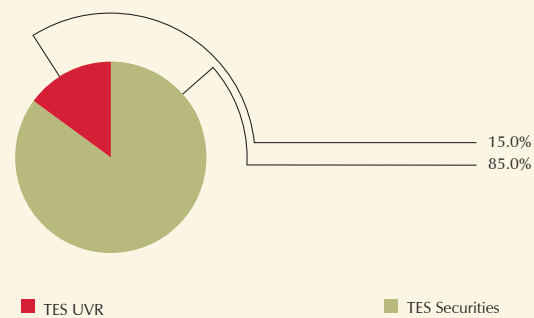
Source: Colombian Stock Market (BVC).

Graph B4.2:  
Temporary Transfer of Security Operations TTS, 2015,  
Breakdown by Type

### A. TTS on variable income securities



### B. TTS on fixed-income securities



Source: Colombian Stock Market (BVC).

It is important to mention that all transactions, for which the BVC acted as administrator of guarantees, were carried out through the trading system.

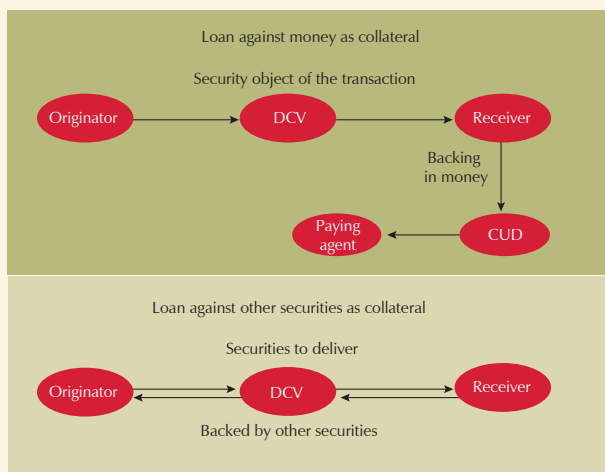
### 1.3. DCV Scheme

The securities lending program of the DCV is intended to mitigate possible default by participants who use the system to clear and settle transactions. For this reason, the motivations for its use are focused especially on reducing operational costs during the search for securities, speeding up compliance with pending transactions and increasing the liquidity of the payment system, among others.

To participate in the program, each participant must expressly request it. Additionally, it must inform both the portfolios that it is willing to lend, as well as the applicable limits according to its risk management policies (e.g. issuing limit). Likewise, it must inform the financial institution that will serve as payment or collection agent. The latter will apply for cases in which the receiver delivers money to support the operation; in particular, because the transaction is structured in such a way that the originator must pay a compensatory interest to the receiver.

There are two types of operations that are part of the securities lending program (Diagram 2):

Diagram B4.2  
Functional Model of BVC Temporary Transfer of Securities CSD



Source: Banco de la República.

#### a. Automatic operations

This modality attempts to automatically cover the missing or short positions in securities that the system identifies, at the end of the day. It is executed after the functional

closing of the depository and specifically attempts to cover transactions involving allowable emissions in the program, belonging to enrolled participants, with available quotas and sufficient assets.

#### b. On-demand operations

In this modality, the participant manually enters in the depository a request for the required security. Likewise, it establishes if it is willing to give cash to back the trade, once all the securities that have been made available for that purpose have been taken.

Each time a request is entered into the depository, the system tries to allocate and settle it. The operation is carried out when the system randomly encounters an originator with available securities and with sufficient reciprocal quotas with the receiver, provided the latter has securities or enough cash to support the operation.

The functional design provided by the depository has other features, such as: 1) it is a one-day operation (i.e.: overnight); 2) although the originator receives the collateral securities, they are blocked and, therefore, cannot be involved in any subsequent operations; 3) in case of delivery of cash as collateral, the originator will pay a remunerative interest; additionally, there are no restrictions on its use by the originator; 4) the DCV manages market and settlement risks; in addition, it performs all the debits and credits related with the operation, such as payment of remuneration, calculation of penalty percentages and calculation of interest payable when the receiver has delivered cash as collateral; and 5) the possibility of an advance of the operation (i.e.: recall) is not defined. However, the depository excludes those that during the term of the operation have stipulated a payment.

### 2. Evolution of TTS operations through the DCV

Although the Colombian Electronic Market (MEC), through its trading and registration system, allows TTS to be traded with public debt, these do not arrive as such (differentiated) to the DCV for settlement.

Particularly, only two trades of this kind have been registered in the DCV system, one in August and the other in October 2008. One possible cause that could explain the low expansion of this type of TTS is the use of other types of market operations to meet the demand for securities. As an example, and based on the information on the rates at which sell/buy-backs transactions are negotiated, it could be assumed that some of these trades are intended to meet the liquidity needs of some participants

and other to meet the demand for securities to cover short operations. Based on the above and the difference in the rates collected, it was estimated<sup>5</sup> that the average daily value of sell/buy-backs seeking the second objective was COP \$1.02 b during the year of 2015.

### Final Remarks

In the Colombian case, the BVC and the DCV offer TTS operations. Those of the BVC could be classified as an adaptation of a securities lending program managed by a third party (i.e.: third party agent model), where its role is to draw connect, in this case through a transaction system, the parties interested in lending and borrowing values. Those of the DCV were created by the securities depository with the purpose of reducing the probability of default of transactions that are carried out in the respective clearing and settlement system.

Although the regulation allows potential participants in the TTS market to carry out securities lending operations without resorting to these infrastructures, i.e. in the counter market, there is an obligation to register the transactions and to constitute guarantees in a securities trading system or a stock exchange monitored by the Financial Superintendency of Colombia. At present, all TTS operations are carried out through trading systems.

Albeit with different functional models and each one focused on meeting certain market needs and interests, both the BVC and the DCV TTS have the same purpose: to facilitate mechanisms so different participants in the securities market can temporarily lend and borrow various fixed-income and variable-income securities.

For the benefit of the evolution of this type of operations it is necessary to diagnose the possible aspects that could be delaying its development. Among the elements to be considered are: 1) to evaluate if there are excessive regulatory restrictions to conduct short sales; 2) to evaluate the creation of incentives for those investors who hold eligible securities (i.e. pension funds) within their long-term portfolios in order to obtain additional returns on the management of these portfolios; 3) to evaluate the convenience of not only lending securities through operations, but through a specialized service with the creation of loan programs offered by specialized agents (e.g. custodians), and 4) to analyze the reasons why the participants might prefer to use another product, such

as sell/buy-backs to cover their temporary needs for securities.

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5 The parameter defining whether the main factor was the demand for securities, were operations with rates lower than Banco de la República's intervention rate minus 25 bp.

## II. THE COST-BENEFIT RATIO FOR TIERED ACCESS IN THE LARGE-VALUE PAYMENT SYSTEM<sup>29</sup>

Large-value payment system operators (LVPSs), generally central banks, should define the levels of access they provide in order to participate in their system and their liquidity facilities. The Bank for International Settlements (BIS), Principle 18 of “Principles for Financial Market Infrastructures” (BIS-CPSS, 2012), suggests that the participation of institutions and other financial market infrastructures (FMIs) in these LVPSs is broad and equitable, in order to stimulate competition, interoperability and efficiency of these systems. The cost-risk implied in the settlement of payments is decisive in the definition of the level of access that is granted in a system.

The trade-off between cost and risk that increases with the number of participants with access to a large-value payment system will depend on the architecture of settlement used, be it real-time gross settlement (RTGS) or deferred netting (DN). In deferred netting systems, the possibility of accumulating payment orders during the day helps reduce the number of transactions and helps benefit the participants with savings in the use of liquidity in the central bank. However, since the liquidation takes place at certain times, usually at the end of the day, there is no certainty that by then the payment orders will be settled. So if at that moment a participant fails to settle the orders already processed, they should be reversed, with the consequent risk of triggering breaches in other participants and the resulting systemic risk.

By contrast, in RTGS-type payment systems, where the individual settlement of payment orders is carried out by gross and real-time value, the greater

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29 Chapter based on Arango and Cepeda (2016).

liquidity requirements experienced by participants allow the final settlement to be achieved during the course of the day, without causing intraday exposures.

However, central banks can obtain the cost-risk allocation that they consider optimal, given the particular architecture of the LVPS they use, when defining criteria regarding access to their system in aspects related to the tariff scheme to be applied, the entities admitted to participate, the provision of liquidity to be granted, and the type of access to be granted. This last aspect refers to whether the access that is given to the participants is direct or tiered. Under tiered access, participants with direct access (DP) must send/receive their own payments and also those of their clients or indirect participants (IP).

In real-time gross settlement payment systems, the increased degree of tiered access could reduce liquidity needs for DPs by enabling them to benefit from their clients' payment flows. But it could also increase credit risk between IP and DP. The increased level of tiered access would at the same time increase the risk of concentration, because direct participants would send their payments and those of their clients, increasing the risk associated with their size (Too-big-to-fails, TBTF) or with their greater connectivity in the network of payments (Too-connected-to-fail, TCTF).

From the scarce literature available related to the estimation of the cost and risk by tiered access or tiering, the simulation analyses performed by Lasaoa and Tudela (2008) for CHAPS in the United Kingdom, and Arculus, Hancock and Moran (2012) for the RITS of Australia<sup>30</sup> are known.

With the help of the simulator from the Bank of Finland (BoF-PSS2), Lasaoa and Tudela (2008) estimate the liquidity needs and bilateral credit risk exposure between indirect and direct participants, which would be obtained by reducing the number of Participants with direct access in a system with a high staggering level such as CHAPS. By extrapolating their results to a system with lower tiering, the authors find that the benefit obtained by reductions in exposure to credit risk and concentration risk outweighs the slight increase in liquidity needs, and thus recommend extending direct access to a larger number of participants.

Arculus et al. (2012) find that the increase in liquidity needs in a payment system with less tiered access depends on its design. From the simulation results also obtained with the help of BoF-PSS2, the authors find that in systems where the liquidation modality is exclusively gross and in real time (pure RTGS), liquidity pressures increase, but they are reduced in an important way when these systems are complemented by liquidity-saving mechanisms. At the same time,

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30 These correspond to the large-value payment systems of the countries mentioned above and to the Clearing House Automated Payment System and Reserve Bank *Information and Transfer System* for RITS.

they identify that the broad direct access in the RITS system is justified by the low costs to access it.

With regard to the case of the CUD large-value payment system in Colombia, Arango and Cepeda (2016), using the same simulator, estimate the magnitude of the potential liquidity savings and increases in credit and concentration risks that would be obtained by allowing increased levels of tiered access. The work is complemented by a network topology analysis to identify changes in the structure of the network of transfers, basically with connectivity and centrality metrics, before successive increases in access scheduling.

### A. CUD, A BROAD DIRECT ACCESS SYSTEM

In Colombia, the large-value payment system CUD, of which *Banco de la República* is owner, operator and participant, is characterized by the use of a real-time gross settlement (RTGS) scheme, which is complemented by liquidity-saving mechanisms. Access to financial services provided by the central bank through payment systems and other components of the financial infrastructure is not available to all agents of the economy. In the case of Colombia, decisions on access and other aspects of the provision of these services by the central bank are in the hands of the Board of Directors of *Banco de la República* (JDBR). As a central component of the financial infrastructure, the CUD is directly interconnected with other infrastructures to allow the liquidation of the cash leg of the operations that these participants incur in these markets.

In this way, the range of entities that have access to deposit accounts to settle operations in the CUD comprises: 1) credit institutions and other financial institutions supervised by the Office of the Financial Superintendent of Colombia (SFC); 2) financial market infrastructures; 3) the nation: Ministry of Finance and Public Credit, and 4) operators of social security information, exclusively for the services provided by Cenit.

In 2015, the 146 institutions that participated in the CUD sent a daily volume of 7,430 transactions and a value equivalent to 5.2% of GDP. Within these participants, twelve credit institutions and two brokerage firms sent more than 70% of the value of payments.

The rate structure of the CUD, together with the liquidity facilities granted by the central bank as system administrator, generate enough incentives for financial institutions to opt for direct access.

One of the reasons that has contributed to explaining the why of broad access has to do with the interoperability that CUD maintains with other financial market infrastructures. Thus, in order to mitigate and eliminate risks in settlement and clearing, access has been extended to infrastructures participants in the

securities markets, currencies and other financial products, in order to guarantee the delivery-versus-payment of securities and the payment-versus-payment of foreign exchange.

## B. METHODOLOGY FOR THE ESTIMATION OF THE DILEMMA BETWEEN LIQUIDITY SAVINGS AND RISKS

Arango and Cepeda (2016) apply the methodology and simulation tool BoF-PSS2 used by Lasasosa and Tudela (2008) and Arculus et al (2012) to estimate the benefits for a month of transactions settled in the CUD (April 2014)<sup>31</sup>, measured in terms of liquidity savings, and contrast them with the costs, reflected in the credit and concentration risks, that would be obtained by increasing tiered access.

Panel A of Graph 36 illustrates the original network of payment transfers that was averaged over this month. In both Graph panels the participants are represented by circles or nodes, and the payment relationships by the arrows that connect them. Thus, in panel A, where no tiered scenario has been performed, the green nodes identify the participating candidates to send/receive their payments through correspondents distinguished by the red circles.

In order to define the scheduling scheme, the authors first estimate the percentage share that each of the 151 participating institutions recorded in the total value of payments sent and received. Based on this relative measure, they define the order with which they perform the tiered access of 132 participants with indirect access to a nucleus of direct participants made up of 11 participants that are maintained during the entire exercise.<sup>32</sup>

In each simulation scenario and cumulatively, participants with the lowest participation are assigned (as clients or IP) to those with greater participation, with whom they maintain the strongest bilateral relationship for the value of payments during the sample and who have not yet been assigned (as correspondents or DP). By way of example and as illustrated in panel B of Graph 36, in the final tiered scenario 132 of a particular day, payments sent and received by the 132 entities with the smallest participation (green nodes) will now be executed through their respective correspondents (red nodes). The basic assumption in this allocation scheme is that each IP will be connected to a single DP, which corresponds to the one with which it maintains a higher value of payments.

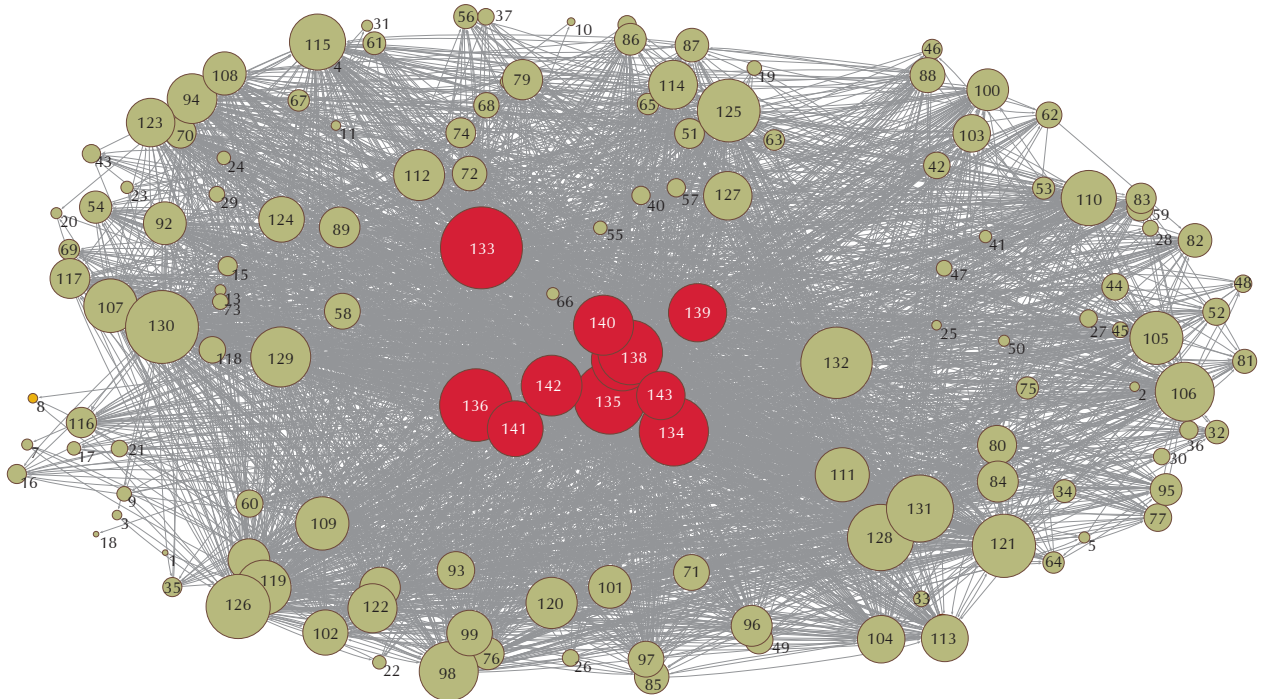
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31 They consider this month as representative, because it is the month that comes closest in value and volume to the monthly average of 2014.

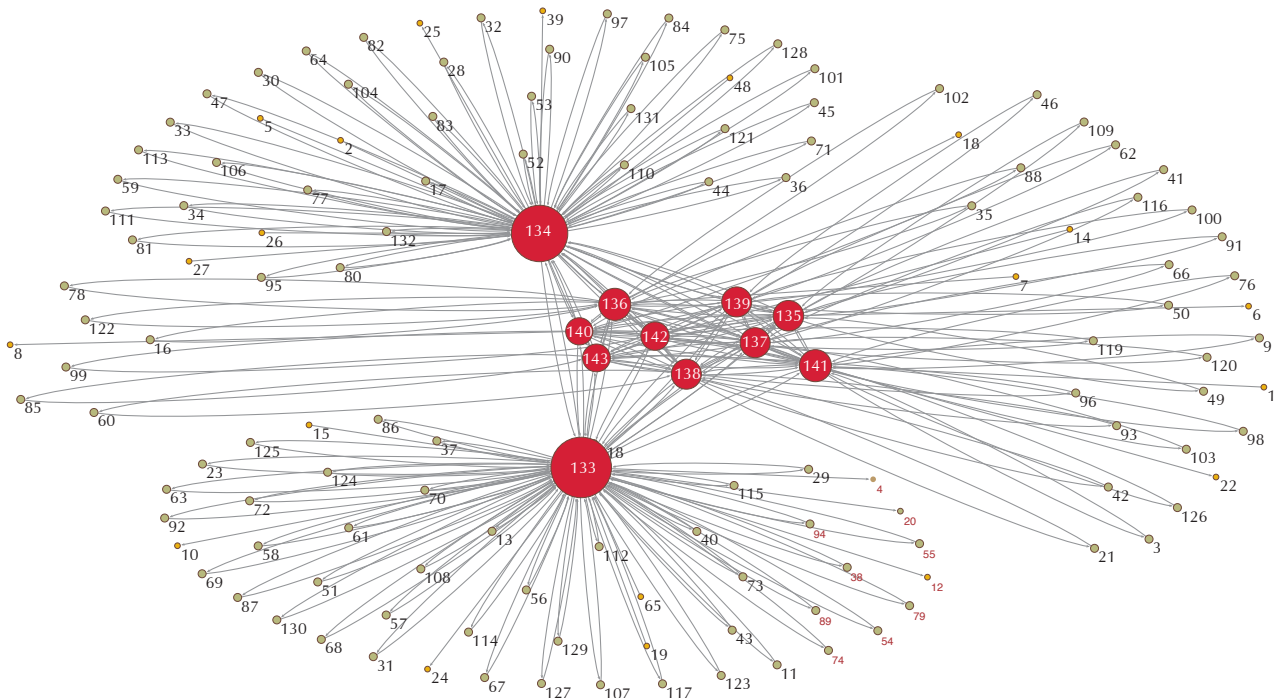
32 The eight entities that complete the total number of participants, by their nature, are not linked as clients of any DP and are six FMIs, the central bank and the General Directorate of Public Credit and National Treasury.

Graph 36  
Tiered Access to CUD

A. Original Network Scenario



B. Tiered Network Scenario 132



Source: Banco de la República (DSIF).



The estimation of liquidity savings is made in relation to the liquidity needs that each participant would face to settle under the RTGS modality and in the sequence of payments used for the original scenario, which is considered as a reference framework (or benchmark scenario).

Following the methodology proposed by Lasao and Tudela (2008), of the total savings of liquidity that direct participants benefit from, the authors manage to differentiate two types: those obtained by the possibility of combining their payments with their customers' payment flows (or pooling); and those resulting from the possibility of liquidating payments to or against clients in correspondent bank books (or internalization of payments).<sup>33</sup>

At the same time, the concentration risk is estimated in each tiered scenario by the participation in the value of the payments of each direct participant (red nodes), a value that increases as the indirect participants that are linked to it delegate their payments (shipments or receipts). The estimation of bilateral credit risk is made for both direct participants when exposed by the value of credits against defaults of their clients, as well as of clients when exposing their liquidity balances to the failure of their correspondent.

### C. RESULTS

To synthesize, and as it can be seen from the red path in Graph 37, Arango and Cepeda's results (2016) show that the CUD system could support for up to 90 entities, that were directly sending/receiving payments, to do so indirectly through correspondents with a direct access, without incurring in significant growth in the risk of concentration and in the exposure of counterparty risk between direct and indirect participants. However, when the tiered access level exceeds this number of indirect participants, credit and concentration risks grow in an exponential manner.

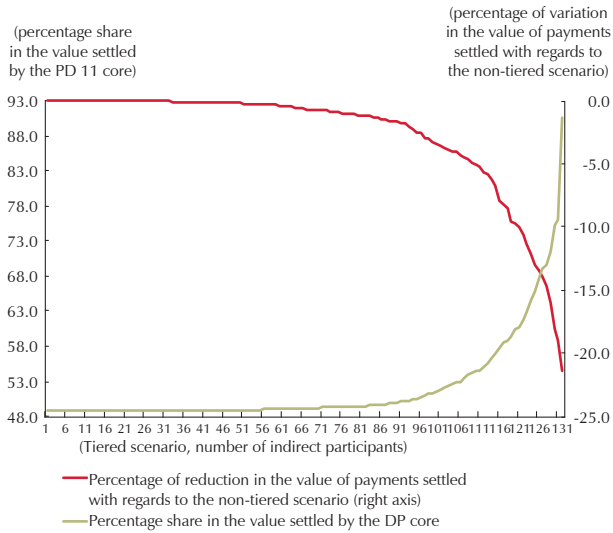
In the same Graph, the green trajectory shows that the percentage reduction in the value of the payments settled, relative to the benchmark scenario that would be obtained after successive stages of tiering, would exceed 20%, as a result of the combined effects of internalization and pooling.

On the other hand, the liquidity savings achieved with the tiering, relative to the necessary liquidity under the original scenario of full direct access, as seen in Graph 38, begin to become perceptible from the indirect linkage of one hundred entities, and reach a maximum of 13.4%, a saving that is not achieved in the scenario of maximum tiering (132 institutions). This result of reductions in liquidity savings with higher levels of tiering constitutes an anomaly in the monotonic cost-benefit relationship obtained in the works of Lasao and Tudela (2008) and Arculus et al. (2012).

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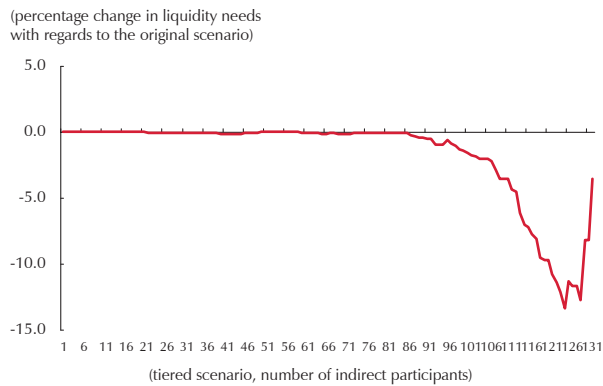
33 This process is performed for each of the 20 days, for the 132 scheduling scenarios, and in three versions: the original, the tiering, and an additional one to obtain the discrimination between the savings obtained by pooling and internalization of payments. The number of simulations they perform is  $20 * 132 * 3 = 7,920$ .

**Graph 37**  
Concentration Risk



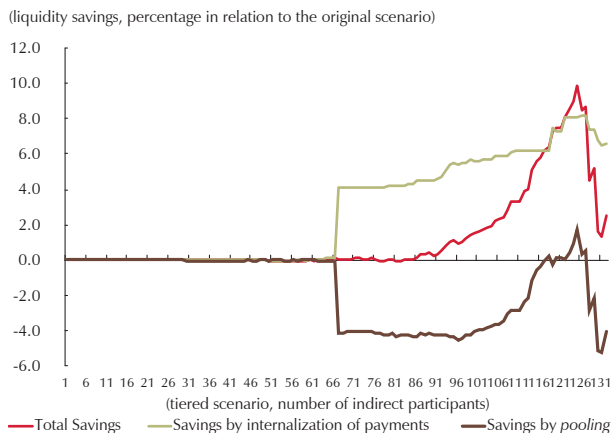
Source: Arango and Cepeda (2016).

**Graph 38**  
Liquidity Savings



Source: Arango and Cepeda (2016).

**Graph 39**  
Discrimination in Liquidity Savings



Source: Arango and Cepeda (2016).

At the same time, with respect to the discrimination of liquidity savings, the document shows that in the case of CUD these come mainly from the internalization of payments. Graph 39 allows us to appreciate the tension that is generated between the liquidity savings that the DP obtains by the mutual commitments with their clients in front of the greater demands of financial resources of some IP with flows of payments towards other DPs. Between the scenarios 67 and 84 of tiered access, such tension causes the total liquidity savings to be canceled.

Also, from this Graph it is possible to emphasize that as the level of tiered access increases, the liquidity needs of the DPs could increase (or the liquidity savings be reduced), a result that contradicts the monotonic relation that is reached in the works of Lasaosa and Tudela (2008) and Arculus et al. (2012).

With relation to the topological structure of the payment transfer network, which is transformed before the gradual tiered access, the document that is outlined distinguishes two networks: one formed only by the direct participants (red nodes in the Graph 36) and the total network, which considers all direct and indirect participants (red and green nodes).

From the analysis of networks, the authors conclude that the connectivity increases for the direct network, but reduces for the total. This fact is intuitive, because in the direct network a new phasing is captured both by the adoption by the DP of the relations that the clients maintained and by the elimination of the IPs, which reduces the number of potential relations between nodes. In the case of the total network this conclusion is achieved, because they are maintained as components of the network to clients or IP with a single relation to their correspondents or DP. With respect to the centrality, it is observed that as the escalation of access in the direct network increases, this is reduced to become more democratic by the similar levels of connectivity between DP. In the case of the complete network, this may present ups and downs depending on the relationships that each of the clients provides in successive tiered scenarios.

## D. CONCLUSIONS

From Arango and Cepeda (2016), the following conclusions can be reached regarding the CUD large-value payment system: 1) the monotonic relationship between counterparty risk and liquidity cost can be maintained up to certain levels of tiering and then it can be broken; 2) the results in the estimation of the cost-risk dilemma in a large-value payment system with tiered access strongly depend on the implicit assumptions in the allocation scheme between indirect and direct participants, and 3) the analysis from the simulation perspective contributes to the understanding of the advantages and disadvantages of modifying the level and form of access to the payment system. This contribution provides managers of payment systems with valuable elements to consider in determining the cost-risk combination that is optimal within the frontier of possibilities.

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### III. THE DILEMMA BETWEEN COUNTERPARTY RISK AND LIQUIDITY RISK IN MONEY MARKET NETWORKS<sup>34</sup>

The global financial crisis of 2007-2008 once again demonstrated that the relationship between liquidity risk and counterparty risk plays a key role in the functioning of the money market, one in which financial institutions exchange short-term liquidity. On that occasion, given the uncertainty in their counterparty's ability to pay (counterparty risk), financial institutions with liquidity surplus preferred to reduce their money market share. As a result, liquidity exchange among financial institutions declined sharply, and some faced the difficulty of securing the short-term funds needed to adequately service their operations and fulfill their payment obligations (liquidity risk). Faced with potential systemic risk, central banks intervened to supply the liquidity required by financial institutions for the normal and safe functioning of financial markets.

The dilemma between liquidity risk and counterparty risk in the money market is not a new issue, but it has become a more important issue after the most recent global financial crisis. An alternative to examine this dilemma is to use complex network analysis, from which other systems, including those corresponding to financial systems, have already been examined.

In this type of analysis, financial institutions participate in a network of interactions, which correspond to liquidity exchanges. The structure of liquidity exchange networks' connections can reveal how financial institutions face the risk of not borrowing (counterparty risk) and the risk of not finding counterparties willing to lend (liquidity risk). Based on the recent literature on the structure of

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34 Based in León and Sarmiento (2016)

financial networks and the optimization of complex networks (Ferrer i Cancho and Sole, 2003), as described in León and Sarmiento (2016), what follows is a description of the Colombian money market, and then the trade-off between counterparty and liquidity risks presented there, is interpreted.

## 1. The money market in Colombia

As in other money markets, the Colombian one can be divided into three types. The first belongs among financial institutions that exchange liquidity without collateral, in what is locally known as an interbank funds market. The second pertains to the relationship between financial institutions that exchange liquidity with collateral (e.g. equities, bonds). The third is between the central bank and financial institutions, which is done with collateral.

As shown in Table 23, both collateralized markets, between financial institutions, and between the central bank and financial institutions, are the most representative in the Colombian case. At the closing of the year 2015, 44.61% of liquidity exchanges in the money market corresponded to collateralized loans between financial institutions, while 51.18% were operations collateralized with sovereign bonds with the central bank. The remaining 4.21% were interbank funds (without collateral). Most collateralized loans between financial institutions (98.13%) corresponded to sell/buy-backs with sovereign bonds (TES) as collateral. Repos and sell/buy-backs with other collaterals (e.g., equities, private debt bonds) accounted for about 0.8% of the money market; the analysis conducted by León and Sarmiento (2016) discards this portion of the monetary market.

The Colombian money market has some particularities that have been highlighted in Martínez and León (2015), and León and Sarmiento (2016). For example, the contribution of the uncollateralized market is small. Only a fraction of financial institutions are involved in the interbank market, and those that do so are credit institutions. This can be interpreted as a signal of suboptimal

Table 24  
Types of Money Market Transactions

Type	Description	Contribution (percentage)
Collateralized	Sell/buy-backs with sovereign public debt securities	43.78
	Other sell/buy-backs	0.48
	Repos	0.35
	Open Market Transactions (repos with the central bank)	51.18
Non-collateralized	Interbank Funds	4.21

Source: Banco de la República.

exchange of liquidity, whereby the existence of negative externalities, in the face of default by a counterpart, induces financial institutions not to exchange liquidity with anyone (Castiglionesi and Wagner, 2013). This suggests that the network of the non-collateralized money market is of few participants, where the homogeneity of the latter must determine its type of connective structure.

In contrast, collateralized liquidity exchange between financial institutions is highly representative, both as a contribution to the total money market resources and by the number of participants. The market of sell/buy-backs with sovereign debt securities mixes a greater variety of institutions (e.g. credit institutions, brokerage firms, trust companies, etc.) of various sizes, types of business and risk profiles. In this sense, as has been documented for the United States (Allen et al., 1989), the availability of collateral to mitigate counterparty risk is an important determinant of access to liquidity in the money market. The number and heterogeneity of participants in the collateralized money market suggests that this network should be larger than the interbank market, and its connective structure should also differ from that.

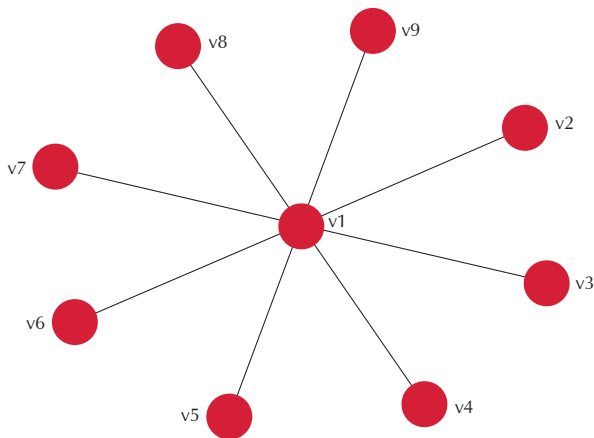
The network of liquidity exchange between financial institutions and the central bank is particular. The central bank is the dominant node, so that the monetary authority is the only possible counterpart for financial institutions, since those institutions cannot exchange liquidity among themselves. Since this network is a result of the normative and operational arrangement of the functions of the central bank, its structure must correspond with its missionary objectives. The structure of the open market operations network suggests that the central bank's liquidity can serve as the ultimate source of funding for the global financial crisis (Acharya et al., 2012, Temizsoy et al., 2015), when access to liquidity in the money market is interrupted as a result of uncertainty.

## **2. What does the network structure tell us about liquidity and counterparty risks?**

The structure of networks results from the interactions between their participants, who constantly and mutually make decisions and react to their individual behavior and that of others. As a result, the network structure reveals how participants seek their particular goals, and how this search generally conditions the system (Freeman, 1979).

For example, faced with the likelihood of contagion of a disease, participants in a system prefer to minimize risk away from possible sources of contagion, and may even prefer to refrain from interacting with others to avoid becoming infected. In the case of an air transport network, for example, airlines will try to reduce the cost of serving all their destinations. In both cases, should the ultimate goal be to minimize the cost of infecting (e.g., illness, death) or providing the service (e.g., operating expenses), the optimal structure tends to minimize

Graph 40  
Star-type Network



Source: León and Sarmiento (2016).

the connections between participants, which coincides with what is known as the star-type network, as exhibited in Graph 40.

Such a network is one that minimizes the number of connections between participants without being disconnected.<sup>35</sup> In this structure there is a participant (v1) or node that connects with all others, which are not connected to each other (v2, v3, ..., v9). In that sense, it is a network of maximum centralization, where a single node dominates the network by the number of connections and its intermediation position. Also, the density of the network, defined as the number of observed connections with respect to the number of potential connections<sup>36</sup>, is the lowest possible.

By minimizing the number of connections, the star-type network can offset the cost or risk of being connected to the system. In the case of an airline, when establishing a central-scale airport, or hub (v1), the operating cost is reduced, because serving all destinations does not require a large hub in each. In the case of a contagion network, maintaining a connection with a single participant minimizes the possibility of direct contagion. In the case of a network of loans between financial institutions, in view of the cost of monitoring their counterparties and in the event of non-compliance, participants will seek to maintain a limited and stable number of counterparties. This is what is known in the literature as loan relationships in the interbank market (Cocco et al., 2009, Afonso et al., 2013, Temizsoy et al., 2015), which is related to a suboptimal exchange level of liquidity (liquidity cross-underinsurance) - according to Castiglionesi and Wagner (2013); Castiglionesi and Eboli (2015)-.

In the extreme case of a lending network whose ultimate objective is to minimize exposures (without leaving financial institutions disconnected), the optimal structure is the star network, in which a single financial institution intervenes among all others. Thus, there is a direct relationship between density and exposure to counterparty risk, where a lower (higher) density coincides

35 An alternative is a circle or ring network, where the nodes connect sequentially. However, this structure is not in itself optimal compared to the star-type network, since the distance between nodes tends to be high. This type is not observed in financial networks.

36 The density (d) is calculated for non-directed networks as  $d = m / (n(n-1))$ , and as  $d = 2m / (n(n-1))$  for directed, where in the former the existence of a connection between two nodes is independent of the direction of the relation, while in the second it differs with respect to the direction of the connection. In both cases m is the number of connections observed in the network and n is the number of nodes. In the case of Graph 40, which corresponds to an unguided network, it is observed that  $n = 9$  and  $m = 8$ , so  $d = 0.22$ . By increasing the number of participants in a star-type network, the density tends to zero; for example, for an unguided star-type network with one hundred nodes the density is  $d = (2 \times 99) / (100 \times 99) = 0.02$ .

with a lower (greater) exposure to noncompliance with other money market participants.

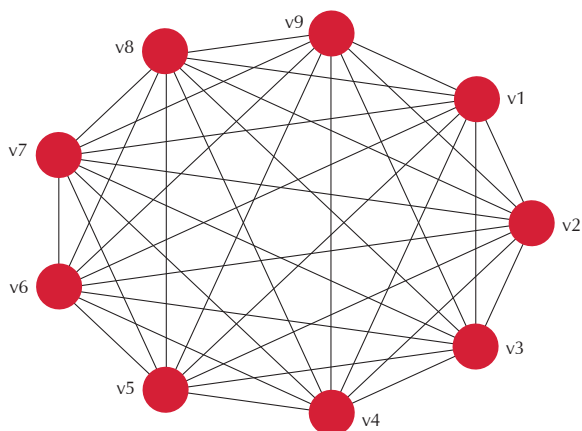
This type of network coincides with that formed around central counterparties, which are market infrastructures that precisely seek to mitigate counterparty risk. In this way, the cost of monitoring and counterparty risk is minimized. In any case, a star network, such as that resulting from the interposition of the central counterparts, is not without risks to the system, because it creates a strong dependence on the efficient and safe operation of the dominant node.

Conversely, if there are no costs associated with maintaining relationships with their counterparts, the structure of the network will tend to be complete, where the number of connections is as close as possible; that is, there is a tendency to form a dense network (intensely interconnected). For example, in the case of an air transport network, if the costs of maintaining operations at all destinations are negligible or non-existent, airlines will find it optimal to maintain direct routes between all possible destinations - passengers with nonstop flights and of shorter duration. A network of this type (Graph 41), where all nodes connect together, results in a minimization of the distance between the nodes that compose it, which tends, on average, towards a single connection between any pair of participants.<sup>37</sup> Also, this network is of minimal centralization, in which

there is no node that dominates the network by its number of connections or by its position among the other nodes.

Similarly, if a liquidity exchange network between financial institutions is exempt from monitoring and non-compliance costs, it is expected that these will be closely related to all their counterparts<sup>38</sup>. By relating to all (or almost all) available counterparts, the distance between financial institutions tends to the minimum (a connection). Thus, by maximizing the number of counterparties, the risks associated with the non-availability of counterparties to exchange liquidity are minimized for all participants; however, the risk that one financial institution is affected by the default of any other is the maximum. Thus, it can

Graph 41  
Complete Network



Source: León and Sarmiento (2016).

37 The average distance ( $l$ ) is calculated as the average of the geodesic distance (minimum distance) between all possible pairs of participants in the network; pairs of participants who cannot connect to the network are not considered in the calculation. This distance is measured in number of connections, where the average distance of a complete network is 1, while the average distance of a star network tends to 2 as the number of participants grows.

38 This can also happen when the negotiation between financial institutions is carried out on a platform that ensures the anonymity of the counterparties and the absence of credit quotas between them. In that case it is not possible to establish loan relationships, and the network structure will tend to a dense, random and homogeneous organization, as documented in the case of the Electronic Trading System (SEN) of public debt of *Banco de la República* (León et al., 2016).



be said that there is a direct relationship between the distance separating financial institutions in the network and exposure to liquidity risk, where a greater (smaller) distance corresponds to a greater (lesser) difficulty in obtaining counterparties with which to exchange liquidity .

The degree of similarity of the observed networks with respect to these two extreme cases, of maximum and minimum centralization, can indicate the way in which the participants and the system selected a combination of counterparty and liquidity risks. A network of financial institutions approaching the star would indicate that participants chose to minimize counterparty risk (density), while a full network would indicate that they chose to minimize liquidity risk (the average distance). Intermediate positions, between the star network and the full network, would indicate a particular combination of preference for those risks.

### **3. Counterparty and liquidity risks in the Colombian money market**

The main result presented in León and Sarmiento (2016) consists of a comparison of the main connective characteristics of the three networks that make up the money market, as well as the network resulting from their aggregation. Two parameters concentrate attention: the density of the networks and the average distance between network participants, which corresponds to the exposure to counterparty risk and liquidity risk, respectively.

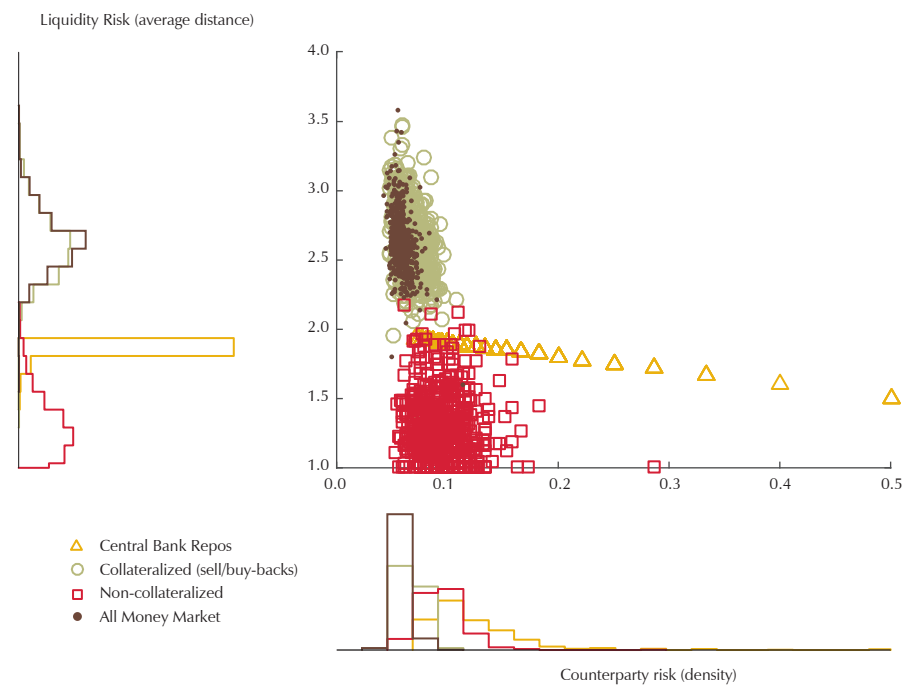
As mentioned, the case of a star network is one where the density is minimized, which corresponds to the number of connections observed as a proportion of the possible connections. In this case, when minimizing density, counterparty risk is the least possible, because there are no unnecessary connections that expose participants to each other (Castiglionesi and Eboli, 2015), and where the dominant node concentrates the exposures. Also, having liquidity through a single dominant node, the participants of this type of network are at an average distance close to two.

In the case of a complete network, in which all the participants are connected to each other, the density is maximum: any failure in the network will affect all the participants directly. In this case, given that all participants are at the shortest possible distance (a connection), liquidity risk is minimized: each has the possibility to exchange liquidity with all other participants in the network.

The combinations of average density and distance of each of the money market networks on each of the observed days reveals how the trade-off between counterparty risk and liquidity risk was resolved. As shown in Graph 42, each type of network in the money market has a combination of density and particular distance.

With respect to the two networks composed of financial institutions only (not collateralized and sell/buy-backs with sovereign bonds), it is evident that the combinations of density and average distance shown by interbank funds market networks show a smaller distance and a greater density. At first glance, this result seems contradictory: although there is no collateral to mitigate counterparty risk, financial institutions establish more connections with each other and, as a consequence, are closer. However, the result is consistent with the characteristics of the non-collateralized money market, which is made up of a small group of credit institutions (on average 17) that enjoy access to the facility of last resort lender of the central bank, which are generally larger than the other financial institutions, and may (in some cases) be considered of systemic importance.

Graph 42  
Combinations of Counterparty and Liquidity Risk



Source: León and Sarmiento (2016).

In this sense, given the homogeneity and small number of participants, the network of the interbank funds market reveals that its members are willing to have a higher level of exposure to the counterparty risk (higher density), and in turn obtain a greater facility to exchange short term funds (less average distance). But, consistent with the concept of suboptimal exchange of liquidity, most financial institutions are excluded from this market.

On the contrary, the network that corresponds to the market of sell/buy-backs with public debt securities has a combination of density and average distance

according to the great diversity of financial institutions involved there. On average, there are 42 financial institutions of all types (credit institutions, trust companies, brokerage firms, etc.), with different sizes and different risk profiles. Therefore, the results suggest that, despite the use of collaterals to mitigate counterparty risk, institutions prefer to establish fewer connections between them, resulting in a greater distance between them; that is, institutions choose less exposure to counterparty risk (i.e. lower density) and greater exposure to liquidity risk (i.e., greater distance), which can also be considered a signal of suboptimal liquidity exchange. In addition, this result suggests that in the Colombian case, as in other markets (King, 2008; Gorton and Metrick, 2012), the counterparty risk is significant, despite the use of collateral (Martínez and León, 2015).

The network that corresponds to the open market operations of *Banco de la República* is consistent with expectations: its star-type structure has an average distance close to two connections, whose density varies visibly. The variability in density is due to the fact that the number of financial institutions that access the resources of the central bank varies significantly over time. Due to its connective structure, this network, dominated by the central bank, would allow money market institutions to reduce their distance (reduce liquidity risk) in the event that the markets of interbank loans and sell/buy-backs with public debt securities do not work properly.

By adding the three networks that make up the money market, the complete network is obtained, something that in the literature can be defined as the multiplex of the money market. This reveals that the connective structure of the money market, as a whole, more closely resembles the market of sell/buy-backs with public debt.

If the contribution of each market to the total were to be taken into consideration in this analysis, this result would not be surprising. However, the present considers the connective structure only, i.e., the connections (without weighting) between the participants. The reason for this interesting result is, in any case, simple: the money market as a whole combines a great variety of financial institutions of different sizes, risk profiles, liquidity needs, and considerations of systemic importance, so that their connections are rather few (low density) and the possibility of exchanging liquidity is limited. As in other cases of aggregation of financial networks in a multiplex (León et al., 2016), the existence of a small group of financial institutions with more homogeneous and more intense interrelations tends to determine the heterogeneous structure of the market as a whole; that small group tends to be important (very connected) in all networks, and aggregation reinforces that fact.

#### 4. Main conclusions

From the exercise proposed by León and Sarmiento (2016) to examine how money market networks solve the dilemma between counterparty risk and liquidity risk, some findings and challenges can be highlighted. First, the importance of basic measures of network analysis to examine and compare the structure of the system in question: in this case, density and average distance revealed how each type of money market network achieves the balance between counterparty risk and liquidity risk, according to their intrinsic characteristics (e.g.: use of collateral, number of participants, etc.).

Second, consistent with the literature (King, 2008, Gorton and Metrick, 2012, Martínez and León, 2015), León and Sarmiento's findings suggest that the use of collaterals fails to mitigate the risk of counterpart altogether. However, similar to the case of the United States (Allen et al., 1989), in Colombia its use facilitates the access to liquidity to a greater variety of financial institutions.

Third, the network perspective allows us to interpret the central bank's role in the money market in a complementary way. For example, in the case of the most recent global financial crisis, the efforts of the central banks of developed countries can be interpreted as reducing the gap between financial institutions (liquidity risk), which increased as a consequence of the reluctance of some institutions to maintain the connectivity of the money market network in an environment of uncertainty over counterparty risk. This interpretation of the role of central banks in the crisis agrees with that of Acharya et al. (2012) and Temizsoy et al. (2015).

Some of the challenges mentioned by León and Sarmiento are the need to consider other variables as determinants of the structure of money markets. Variables such as the robustness of participants, differences in risk profiles, liquidity needs, among others, can help to complement the understanding of the differences between the different networks that make up the money market. Also, it is a challenge to include the variables of network analysis in models that seek to explain the cost of money in money markets. Another challenge is to consider the recent implementation of the central clearing and settlement of the market of sell/buy-backs with public debt securities in the local central counterparty; once there is sufficient historical information, it will be possible to verify whether the trading of short-term funds with collateral changed by introducing a central counterparty. Finally, in relation to the network analysis approach, it will be useful to consider the weightings of connections between financial institutions.

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## IV. ILLIQUIDITY CONTAGION IN THE INTERBANK MARKET<sup>39</sup>

The DebtRank methodology (Battiston et al., 2012) is a contagion simulation model that recursively measures the impact that cessation of payments (default) of a financial institution might generate in the capital buffer of the other institutions that make up the interbank network. In other words, DebtRank measures the contagion of solvency problems that could arise in response to the decline in the solvency position of a particular financial institution. This methodology makes it possible to quantify the systemic importance of each financial institution based on its potential contagion effect on other financial institutions' solvency position.

Individual illiquidity contagion is defined as one that can generate a decrease in the short-term liquidity of the other institutions in the interbank market. This section presents a modified version of the DebtRank methodology, originally proposed by Battiston et al. (2012), to measure the impact that a financial institution's default could have on the liquidity of the Colombian interbank network, as presented in León, et al. (2015).

Even though the Colombian interbank market represents only 4.11% of the money market (the sell/buy-backs contribute with 52.22%, the repos with the central bank 43.38% and other repos 0.29%), its study is deemed to be relevant since it will allow a better understanding of the interaction between the participants in this market, and the potential risks likely to arise.

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39 Based on León, et al. (2015).

## A. THE DEBTRANK ADVANTAGES

Traditional centrality measures, such as degree centrality (i.e.: number of connections), and strength centrality (i.e.: intensity of connections) are important local measurements in a network and therefore not suitable to assess global impact measurements (of the system). In addition, according to Soramäki and Cook (2013), these are not easily interpretable in matters of financial contagion, so they are not appropriate for determining the contagion effect of illiquidity that is intended for evaluation. The feedback centrality measures are very powerful for measuring the individual systemic importance (Brin and Page, 1998; Kleinberg, 1998; Soramäki and Cook, 2013), but they do not allow us to express the size of the contagion in economic terms.

The DebtRank methodology solves the limitations of the mentioned methodologies, because it is a global measure that allows quantifying the impact generated by the contagion in a convenient way. In particular, this methodology makes it possible to quantify the total economic value of the contagion in the affected financial network and, consequently, to obtain an economic interpretation, which makes it superior to the other alternatives so far available. An important part of this is that this measure has two specific characteristics: on the one hand, it prevents the same financial institution from affecting the system more than once, as with centrality measures (such as PageRank); this characteristic allows for the precise quantification of contagion effect's economic value. On the other hand, it has the advantage of not only including situations in which cessation of payments spreads to others in the form of insolvency, but also to those that are affected by a decrease in their solvency. The DebtRank methodology also allows us to determine the systemic importance of each financial institution from the severity of the impact of the initial default on the solvency of the system.

## B. A MODIFIED DEBTRANK VERSION TO MEASURE THE CONTAGION BY ILLIQUIDITY

A modified version of the DebtRank methodology, originally proposed by Battiston et al., is used to measure the contagion effects that a (selected) financial institution's default may cause in the short-term liquidity position of the other institutions (2012).

Its implementation requires defining a network of exposures between financial institutions with data from the Colombian interbank market, where financial institutions are interrelated through their uncollateralized (unsecured) loans. Thus, the information corresponding to the interbank network is organized in a non-symmetric square matrix, with elements that indicate the relationships (connections) that exist between each pair of financial institutions. Consistent with this definition, there should be no nonzero elements on the diagonal of the

matrix, because it is not possible to have a credit relation of a financial institution with itself.

In addition to the connection matrix, the DebtRank methodology requires initial conditions to make it operationally possible. The initial liquidity position, defined as the short-term liquidity of a financial institution, is affected in a linear fashion, assuming that a participant's default will reduce that position according to the exposure between both institutions. In this way, if the payment value that the affected participant stopped receiving prevents it from making its own payments, this could generate a chain of defaults that would affect other participants in the network. If, on the other hand, the initial default does not prevent the affected entity from making its payments, there will be defaults in other participants, but its short-term liquidity position will have weakened and, consequently, the whole system will be affected.

Thus, in response to the initial-payments default of the selected financial institution, its effects on the other participants in the interbank market are evaluated. These may result: not stressed (*U*), stressed (*D*) or inactive (*I*). The unstressed state (*U*) corresponds to the case in which a particular financial institution continues to be able to repay its interbank loans, while the other two cases (*D* and *I*) represent participants who cannot pay their loans: the first (*D*), because it was affected by the illiquidity shock, and the second (*I*), because it had previously entered into default.

The effects that the cessation of payments could generate on the other participants of the network are monitored until it is possible to determine the final status of each of them, whether they are classified as inactive or not stressed.

As a result of this methodology, it is possible to determine the economic value of the contagion and the systemic importance of each participant. The first of these results is measured as the difference between the liquidity of the system at the end of the contagion dynamic and the moment in which the first liquidity shock was observed. The individual systemic importance can be established from the percentage share that each financial institution has within the measure of stress of the whole system. Thus, the participants of greater systemic importance will be those that generate greater stress in the short-term liquidity position of the other participants.

### C. MAIN RESULTS

In the implementation of this methodology, bilateral exposures were used in the interbank market, which León et al. (2016) calculated using the Furfine algorithm (Furfine, 1999). As a proxy for the short-term liquidity position, we used the liquidity risk indicator (LRI) that the Office of the Financial Superintendent of Colombia calculates based on the information that financial institutions



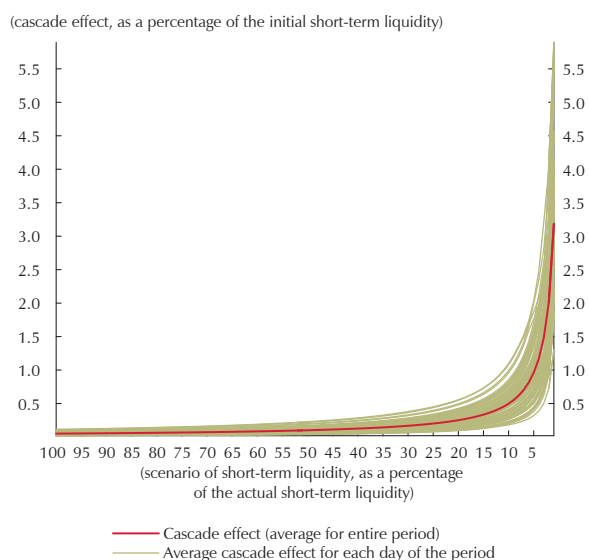
report to it on a weekly basis. In this way, the analysis period includes ninety weekly observations represented by the Friday of each week, between April 5, 2013 and December 26, 2014.

Some preliminary exercises showed that the contagion effects of assuming a drop in the short-term liquidity position of a particular financial institution are considerably low and therefore not significant. This coincides with other exercises performed for other economies (Upper, 2011; Battiston et al., 2015). For this reason, 100 liquidity scenarios were constructed in the interbank market to assess how the contagion effects vary in response to generalized reductions in the system's short-term liquidity. The base scenario is defined as the one in which the liquidity of the system remains unchanged. For the next scenario, it is assumed that the liquidity of all participants is reduced by 1%, and for subsequent scenarios it is assumed that it continues to accumulate similar decreases until the last scenario (100), when the decrease in liquidity of the system would reach the maximum possible reduction (99%). The dynamics of contagion by illiquidity is analyzed for each of the proposed scenarios.

### 1. Contagion effects

As expected, average contagion increases as more extreme generalized illiquidity scenarios are considered (Graph 43). For the base scenario, a slight average

Graph 43  
Average Illiquidity contagion



Note: The green lines represent the average percentage drop in the short-term liquidity position for each scenario. The red line is the average of the 90 lines.  
Source: Banco de la República.

contagion effect is observed, given that the short-term liquidity of the system is reduced in very low proportions (between 0.00% and 0.11%). Among the remaining scenarios, the highest average contagion would reduce the liquidity of the system by 5.90%; however, this result corresponds to a scenario of extreme illiquidity, which assumes a 99.0% fall in the short-term liquidity of the participants in the interbank market.

Although the average contagion effects generate interesting results, they may not be appropriate for the heterogeneous distribution of connections (non-collateralized credits) and the weights represented by the network of financial institutions. For this reason, we also considered the maximum contagion effects for each of the proposed scenarios.

The results of assessing the maximum contagion are in close correspondence with those obtained from the average measures. The maximum contagion also increases as they are considered scenarios of greater illiquidity of the system. For the base scenario, a slight drop in short-term liquidity (between 0.00% and

1.21%) is observed, while for the remaining scenarios the largest reduction in the liquidity of the system (45.78%) is obtained considering the maximum possible illiquidity for the system (99.0%).

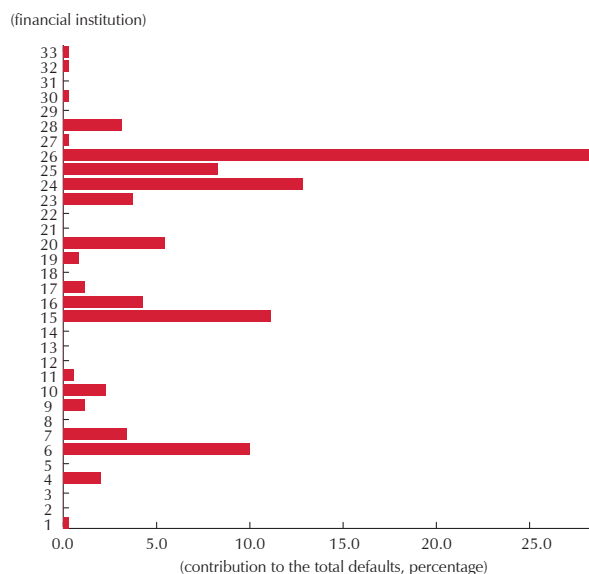
Thus, for the period considered and the proposed illiquidity scenarios, the results indicate that the proportion of financial institutions that would default is particularly low (0.86%), since in only 1,197 of the 138,900 possible cases this result could be observed.<sup>40</sup>

In summary, when assessing both the fall in the short-term liquidity position and the number of institutions entering into default, the results indicate that the effects of contagion are low and that they correspond to (unlikely) situations of extreme illiquidity. Therefore, it is not possible to affirm that these might represent a threat to the system's stability.

This absence of contagion caused by illiquidity has also been observed in previous studies, such as that by Upper (2011), who considered the past financial crisis, and found that most bank crises occurred after shocks that simultaneously affected several banks, and not from domino effects of idiosyncratic failures (as posed by DebtRank).

## 2. Systemic importance of financial institutions

Graph 44  
Individual Contribution to the Total Number of Defaults



Source: Banco de la República.

Based on the above results, it is possible to deduce the systemic importance of each participant, under the premise that institutions that have a greater contribution will be systemically important: 1) to the fall in total short-term liquidity, and 2) to the total number of defaults caused by the contagion.

According to the first criterion, financial institution 26 is the most systemically important because it has the highest contribution (14.2%) to the contraction in short-term liquidity. But if we consider the second criterion, financial institution 24 is the most systemically important (21.2%), followed by institutions 11 and 17, whose shares in the total number of defaults were 17.6% and 11.0%, respectively (Graph 44).

The conclusions that are obtained from these two criteria (a drop in short-term liquidity, and total number

40 The number of observations (138,900) arises from the product between the number of days (Friday) that represents each week (90), the number of scenarios proposed (100), and the number of financial institutions that had loans in the interbank market.

of cessations of payment caused by contagion) on the individual systemic importance are concentrated in few financial institutions; however, because these results depend on the occurrence of (unlikely) extreme illiquidity events, they cannot be considered as totally conclusive.

### 3. Conclusions

The contagion effects generated by illiquidity situations for the Colombian interbank market are analyzed by the implementation of a modified version of the DebtRank methodology. As it was to be expected, the results show an increase in the number of entities that fall into default as a greater contraction in the system's short-term liquidity is assumed. However, the contagion effects are low and, therefore, it is considered that they would not affect the stability of the financial system. Possible extensions in this area could include assessing the impact of contagion on solvency and liquidity (Müller, 2006), and the joint analysis of these impact measures with probabilities to obtain a measure of risk (Tabak, et al., 2013; Poledna et al., 2015).

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# ANNEX

## Annex 1

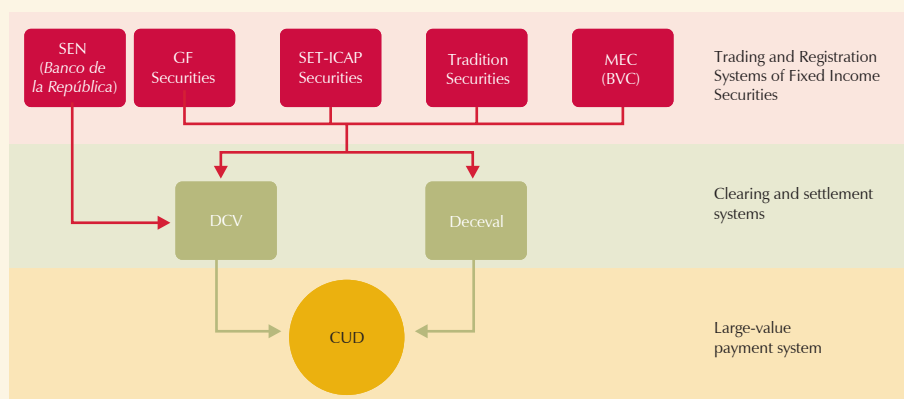
### Infrastructures and financial markets

The description below allows identifying and understanding the role of infrastructures in terms of the markets they support. For this purpose, they have been grouped into markets for fixed-income, equities, currencies, and derivatives. Likewise, aspects relating to the retail payment system are extended.

#### Fixed income

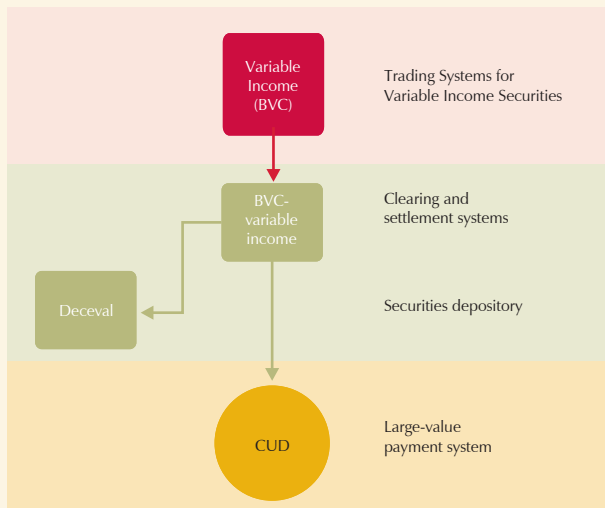
Diagram A1.1 shows the infrastructures that provide trading, clearing and settlement services for this market. The flow starts at the top with the trading and registration systems, where participants, with the use of automatic matching mechanisms (SEN and MEC) and voice and data systems (SET-ICAP Securities, GFI and Tradition), carry out their operations. In each one of them the seller must notify the system administrator of the deposit where the values are kept to then be delivered in order that the settlement process may be carried out. The securities leg is met with the account entry of the change of entitlement or ownership in favor of the buyer, and the cash leg with the transfer of funds to the seller through the CUD, the large-value payment system.

Diagram A1.1  
Flow of Operations in the Fixed Income Market



Source: Banco de la República (DSIF).

Diagram A1.2  
Flow of Operations in the Variable Income Market



Source: Banco de la República (DSIF).

## Variable Income

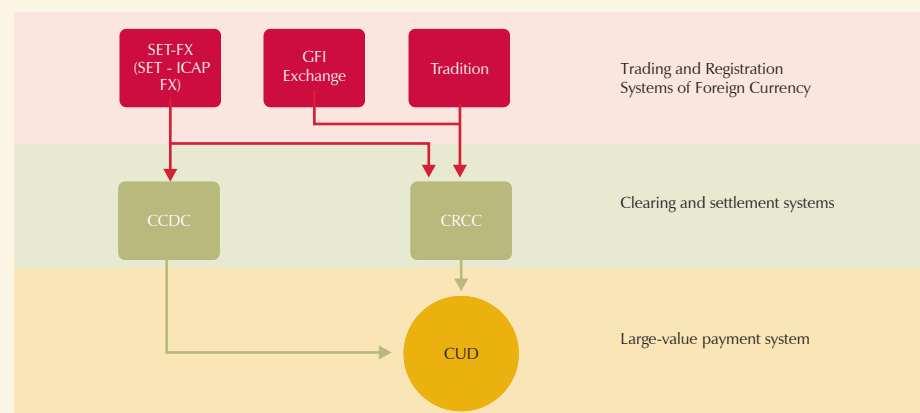
The BVC manages the value chain of the equity market existing in Colombia, from trading to clearing and settlement. For this purposes it uses own developments and systems belonging to other interconnected infrastructures.

As seen in Diagram A1.2, the flow starts in the trading system where the participants concur to make offers on the available values. After closing the operations, these are confirmed and supplemented with the necessary information required for their clearing and settlement. At this point, the BVC uses external systems for securities and cash legs. It uses Deceval for the former, and the large-value payment system CUD for the latter.

## Foreign currencies

SET-ICAP-FX, GFI and Tradition manage the securities trading and registering systems of operations of the Colombian foreign exchange market, the former through a matching system where participants voluntarily decide what offers they are willing to accept, and the latter privately receive, through voice and data systems, the offers relating to each participant's currency offers and subsequently disseminate them to the rest of the market. The operations obtained in these systems are sent to the authorized clearing houses to complete the clearing and settlement process (Diagram A1.3).

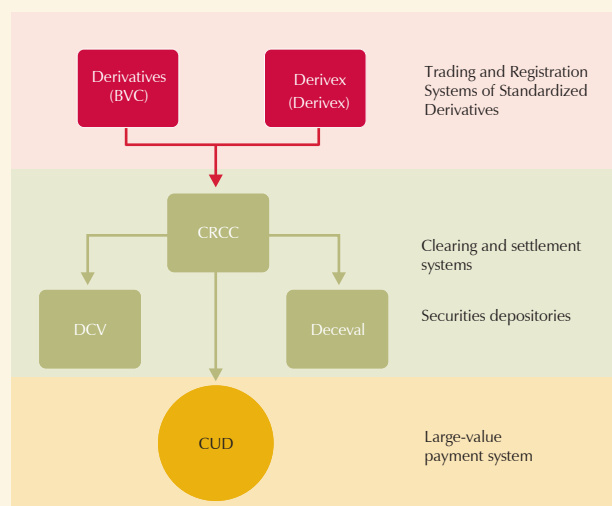
Diagram A1.3  
Flow of Operations in the Foreign Currency Market



Source: Banco de la República (DSIF).

Currently, CCDC processes spot and next day transactions from SET-ICAP-FX, the latter on the respective date of compliance. In addition, the CRCC in the quality of central counterparty offsets and clears NDF dollar/peso operations of all authorized systems. Nowadays, however, all of these operations are Standardized Derivatives Market Flows Received from SET-ICAP-FX.

Diagram A1.4  
Flow of Operations in the Standardized Derivatives Market



Source: Banco de la República (DSIF).

### Standardized derivatives

The BVC and Derivex manage the trading and registration systems of the standardized derivatives market. Diagram A1.4 shows that the operations carried out in these systems are sent to the CRCC for clearing and settlement.

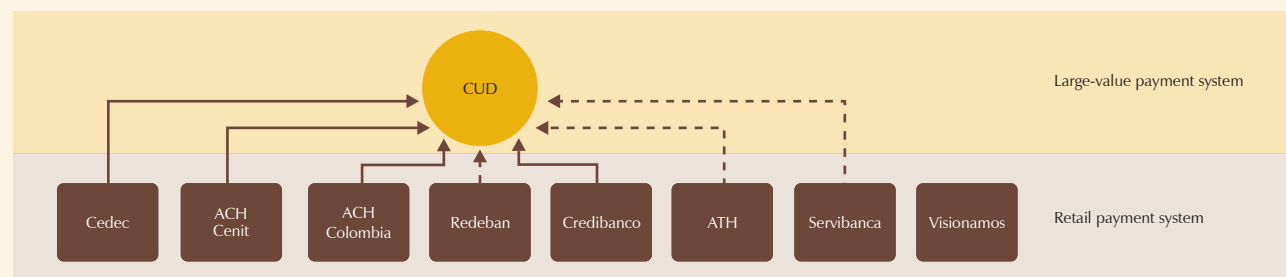
From that point on, the CRCC as the central counterparty performs the novation of operations, in this manner becoming a seller for every buyer and a buyer for every seller. Subsequently, it generates its participants' obligations (clearing) and it proceeds to settle them in the large-value payment system- CUD.

When the settlement involves the delivery of the underlying asset, the CRCC uses the securities depositories (DCV and Deceval) in order to receive the securities from the net debtors and deliver them to the net creditors.

### Retail-value payments

In Diagram A1.5, the following are represented: the Electronic Clearing System for checks, administered by *Banco de la República* which provides the check clearing service and other payment instruments at the national level; the automated electronic payments clearing houses (ACH, ACH-Cenit managed by the

Diagram A1.5  
Flow of Retail Payment System Operations



Source: Banco de la República (DSIF).



central bank, and ACH-Colombia which processes electronic payment orders and the transfer of funds or retail-value collection originated by the related entities in the name of their clients, either individuals or legal entities with current or savings accounts; and the Credibanco, Redeban, ATH and Servibanca networks, that process transactions with debit and credit cards (backed by international franchises) carried out in ATMs and commercial establishments.

Credibanco has its own deposit account in the large-value payment system, and for that reason it directly manages, clears and settles its operations in the resources of that account; the other networks do not have an account in *Banco de la República*<sup>1</sup>; in this sense, they only clear their operations, while the administration and settling of the same are carried out by a commercial bank in the deposit account opened in its name in the Central Bank.

In addition, it operates the *Visionamos* network that belongs to the solidarity economy sector and processes card transactions covered by the participating cooperatives or international franchises.

Although each entity performs a specific function within the structure of payment systems, ultimately a significant proportion of the obligations generated by its participants in the clearing processes are mostly settled in the CUD large-value payment system.

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<sup>1</sup> Dotted lines in Diagram A1.4 allude to the fact that these networks of ATMs and cards do not have their own deposit account in the CUD system of the central bank.

# RECENT DOCUMENTS FROM THE FINANCIAL INFRASTRUCTURE OVERSIGHT DEPARTMENT

## **The Cost of Collateralized Borrowing in the Colombian Money Market: Does Connectedness Matter?<sup>1</sup>**

**Constanza Martínez and Carlos León**

Traditional measures of risk, such as financial leverage, size, and indebtedness of financial institutions, have shown themselves to be inadequate predictors of the cost of collateralized borrowing in the money market. However, by including the connectivity between participants within the estimates, given the existence of operations that denote relationships in multiple directions, it is observed that the borrowing cost in this market depends not only on traditional measures of risk, but also, of its spatial (network) effects. This document shows, using the Spatial Durbin model (SDM), that there are spillovers among Colombian money market participants, making that a decrease (increase) in the borrowing cost of collateralized loans to one of the participants, spread to the other market participants.

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<sup>1</sup> Accepted for publication in the Journal of Financial Stability (doi:10.1016/j.jfs.2015.10.003). Published in *Borradores de Economía*, No. 803, *Banco de la República*, 2014. ([http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be\\_803.pdf](http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_803.pdf)).

## Assessing Systemic Importance with a Fuzzy Logic Inference System<sup>2</sup>

Carlos León, Clara Machado, and Andrés Murcia

This paper offers and compares fuzzy logic and principal component analysis methodologies, and is used with three new indicators of systemic importance seeking to capture the size, connectivity and substitutability of local financial institutions as the main determinants of the impact they can cause in the economy as a result of their malfunction. These indicators are based on balance sheet information (adjusted asset size), sell/buy-backs market exposures on public debt instruments, and transactions in large-value payment systems. Both methodologies, with very different approaches, coincide in that credit institutions are the most systemically important financial institutions in the local financial market, where the importance of two of them stands out. Other relevant results have to do with the presence of a brokerage firm and a pension fund within those institutions of systemic medium importance, as well as the heterogeneity in the distribution of the chosen indicators and the resulting systemic importance indices.

## Reaction Functions of the Participants in Colombia's Large-value Payment System<sup>3</sup>

Constanza Martínez and Freddy Cepeda

In the large-value payment system, the payments flow can be affected by temporary disruptions caused by different types of failures. In response to these failures, the entities that take part in the system may decide to collaborate, or not, in sending payments to their counterparts, which is known in the literature as reaction functions. These functions measure the entities' willingness to pay, once they receive payments from other entities. This paper provides an empirical analysis of how cooperative have been the financial institutions (banks, brokerage firms and trust companies) that participate in Colombia's large-value payment system, taking into consideration four specific incidents. The results have indicated the presence of considerable differences in the reaction exhibited by the different types of participants. In particular, these suggest that the entities' willingness to pay (marginal propensity to send payments) depends on the type of incident, as well as on the type of entity and its role in the market.

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2 Published in *Intelligent Systems in Accounting, Finance & Management*, vol. 23, no. 1-2, pp. 121-153, 2015 (<http://onlinelibrary.wiley.com/doi/10.1002/isaf.1371/abstract>). It is a revised version of the document published in *Borradores de Economía*, No. 800, *Banco de la República*, 2013 ([http://www.bankrep.gov.co/sites/default/files/publicaciones/archivos/be\\_800.pdf](http://www.bankrep.gov.co/sites/default/files/publicaciones/archivos/be_800.pdf)).

3 Published in *Borradores de Economía*, No. 875, *Banco de la República* 2015 and in *The Journal of Financial Market Infrastructures*, vol. 4, No. 2, 2015.

## **Identifying Interbank Loans, Rates, and Claims Networks from Transactional data<sup>4</sup>**

**Carlos León, Jorge Cely, and Carlos Cadena**

Based on information from the CUD large-value payment system, based on the Furfine algorithm, it is possible to identify loans without collateral between financial institutions, as well as their cost and term. When comparing the inferred loans with those that financial institutions reported periodically to the Office of the Financial Superintendent of Colombia, it is concluded that the implemented algorithm performs well and its results are robust to changes in its configuration. Being able to count the loans thus inferred is useful for comparison and monitoring purposes, while allowing the study of non-collateralized exposures between and among financial institutions.

## **Short-Term Liquidity Contagion in the Interbank Market<sup>5</sup>**

**Carlos León, Constanza Martínez, and Freddy Cepeda**

This document uses a modified version of the DebtRank methodology to recursively measure the contagion effects caused by the default of a selected financial institution. The contagion for illiquidity is evaluated as the fall in the short-term liquidity of the financial institutions that make up the interbank Colombian network. The results indicate that its negative effects are concentrated in few financial institutions. However, their total systemic importance is still to be confirmed, mainly because these are mostly conditional on the occurrence of unlikely events of generalized illiquidity, as well as the subsidiary contribution of the interbank market to the local money market.

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4 It will be published in *Lecturas de Economía*, vol. 85, 2016. Published in *Borradores de Economía*, No. 881, *Banco de la República*, 2015 ([http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be\\_881.pdf](http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_881.pdf)).

5 Published in *Borradores de Economía*, No. 920, *Banco de la República*, 2015 [http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be\\_920.pdf](http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_920.pdf).

## **Equity Markets' Clustering and the Global Financial Crisis<sup>6</sup>**

**Carlos León, Geun-Young Kim, Constanza Martínez, and Daeyup Lee**

This paper investigates the similarity of relationships existing between eighty stock indices of different countries of the world, as well as the hierarchical structure that results from these relationships for the years that preceded and followed the global financial crisis of 2008. The methodology used in this document is known as agglomeration clustering, and belongs to a set of methodologies known as unsupervised learning. The hierarchical structure resulting from this exercise reveals that there is an agglomeration principle of geographic nature, from which some countries are abstracted as a result of differences due to well-defined idiosyncratic shocks. It was also found that the principle of geographic agglomeration became stronger after the global financial crisis.

## **Liquidity and Counterparty Risks Tradeoff in Money Market Networks<sup>7</sup>**

**Carlos León and Miguel Sarmiento**

Based on the basic measures of network analysis (density and average distance), this document seeks to identify how financial institutions resolve in an aggregate way the dilemma between access to sources of financing (liquidity risk) and to maintain exposures to risk of default (counterparty risk) in the Colombian money market. For this purpose, loans between financial institutions, with and without collateral, and operations between financial institutions and the central bank with collateral are considered. The results show that in each type of market there are particularities that condition how financial institutions as a whole solve this dilemma. For example, it emphasizes that the use of collateral allows a wider access for dissimilar types of financial institutions, but such access is far from being homogeneous and smooth. On the contrary, the absence of collateral results in limited access to credit establishments, but more homogeneous and smooth. When considering the money market as a whole, it is found that it provides a broad but not homogeneous access, resembling the collateralized market.

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<sup>6</sup> Published in *Borradores de Economía* No. 937, *Banco de la República*, 2016 ([http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be\\_937.pdf](http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_937.pdf)).

<sup>7</sup> Published in *Borradores de Economía* No. 936, *Banco de la República*, 2016 ([http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be\\_936.pdf](http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_936.pdf)).

## Non-monotonic Tradeoffs of Tiering in a Large-value Payment System<sup>8</sup>

Carlos Arango and Freddy Cepeda

Although international authorities promote access to large-value payment systems to be comprehensive and equitable, the question as to their suitability is still in place. In the case of real-time gross settlement (RTGS) systems the tiered access level, or tiering, could be determined by the dilemma between the potentially high liquidity needs facing a large community of direct participants and the low counterparty credit risk, resulting from the uncovered bilateral credit exposure assumed by a small number of indirect participants with second-tier access and their correspondent banks. From the simulation analysis approach, existing literature has identified that by increasing the tiered access level, a monotonic relationship between growing liquidity savings and increasing credit risk exposure is evident. In contrast, for the case of the Colombian RTGS system, such a monotonic relationship between savings-risk could be maintained up to a certain level of tiering, after which marginal tiered participants could cause that relationship to break; that is, liquidity needs can increase without additional risk reductions.

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<sup>8</sup> Published in *Borradores de Economía*, No. 946, Banco de la República, 2016. ([http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be\\_946.pdf](http://www.banrep.gov.co/sites/default/files/publicaciones/archivos/be_946.pdf))

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