

Intraday Liquidity Flows

Report of the Payments Risk Committee

November 16, 2016

Sponsored by the Federal Reserve Bank of New York, the Payments Risk Committee is a private sector group that includes senior managers from several major banks in the United States. The Committee identifies and analyzes issues of mutual interest related to risk in payment, clearing, and settlement systems. Where appropriate, the Committee seeks to foster broader industry awareness and discussion and to develop input on public and private sector initiatives. Current members of the Committee are Bank of America N.A., The Bank of New York Mellon, Bank of Tokyo-Mitsubishi UFJ, Citibank N.A., Deutsche Bank AG, Goldman Sachs, HSBC Bank USA, JPMorgan Chase, Morgan Stanley, State Street Bank and Trust Company, UBS AG, and Wells Fargo.

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FOREWORD

In early 2011 the Payments Risk Committee (PRC) initiated a study of the flow of United States dollars (USD) over the course of a business day across key payments, clearing, and settlement systems around the world. The study was designed to provide a better understanding of the magnitude of the flows and highlight the significant interconnectedness of this infrastructure. In early 2015, the PRC initiated the refresh of the 2011 study based on data from 2014. On behalf of the PRC, we are pleased to provide the refreshed results of this study—the Intraday Liquidity Flows report—to the public, in particular to the financial institutions that depend on payments, clearing, and settlement services that are the plumbing of the financial system.

The 2015 study provides a view of the infrastructure that enabled approximately \$14.8 trillion of USD denominated payments and the associated \$7.1 trillion of cash needed to settle those payments to move through the financial system in 2014. Seventeen financial market utilities and two clearing banks participated in the original study and this refresh, providing hour-by-hour statistics on the movement of USD into and out of their settlement accounts. The study describes the dependencies and interconnections across payments, clearing, and settlement systems. It highlights the importance of the underlying infrastructures and the value of continuous review of and improvements to liquidity management. In addition, the study underscores the influence that underlying economic conditions, regulatory mandates, and liquidity policies have on the pattern of hourly USD flows.

The committee thanks all the institutions that participated in the study and supported this important industry initiative.

We are very grateful to the members of the Intraday Liquidity Flow (ILF) task force, task force chairs, Jason Sutton and Fred Crosnier, and the PRC Working Group lead, Denise Sommerville, for their excellent work in preparing this report. The PRC also recognizes the contributions of the staff of the Federal Reserve Bank of New York and Office of Financial Research (OFR) for their input, guidance and support in the delivery of this report.

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EXECUTIVE SUMMARY

Intraday liquidity is crucial to the efficient functioning of the global payments, clearing, and settlement (PCS) systems. Without this liquidity the infrastructure will simply not function properly, if at all. The 2008 financial crisis underscores this point. New regulatory proposals related to the intraday liquidity requirements of the PCS infrastructures continue to emerge.

Recognizing the predominance of the USD in the payments, clearing, and settlement system, and the need for a common understanding and a transparent view into global USD payments and settlement activity, the Payments Risk Committee (PRC), a private sector industry group sponsored by the Federal Reserve Bank of New York, originally initiated a study in the first quarter of 2011 using 2010 data to analyze the current environment. In early 2015, the PRC initiated the refresh of the 2011 study. The information in this paper may be particularly valuable to the risk management, operations and/or technology professionals at banks, financial market utilities (FMUs), and at other payment and clearing system participants as a baseline against which to assess changes.

The study is based on payments data and associated USD values from seventeen global FMUs and the two financial institutions that are the primary service providers in the United States (U.S.) government securities clearance business. In addition to those two clearing banks (CBs), the seventeen FMUs representing the following sectors contributed information:

- Large-value cash and securities transfer systems
- FX settlement services
- Domestic and off-shore equity and derivatives clearing services
- Domestic and international central securities depositories
- Retail payment services

The FMUs and CBs, for the most part, provided information on intraday USD flows for a “normal” (or typical) day and for the “peak” (or highest-value) day during the fourth quarter of 2014. The individual entity statistics were consolidated to develop a 24 hour “follow the sun” map which charts the transaction and value flows both by specific financial services sector and in the aggregate across participating FMUs and CBs. The data captured in this study represent a substantial portion (but not all) of the total intraday flows of USD through the global payments, clearing, and settlement systems.

Key observations from this study include:

- The average daily aggregate value of flows through all reporting FMUs and CBs is more than \$7.1 trillion.
- While USD settlement activity is greatest during U.S. business hours, there are important flows around the clock.
- FMUs and CBs and their financial institution customers create an effective network recycling liquidity intraday and present varying degrees of interdependence.

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- Currently, there is ample USD liquidity to fund these settlement positions – during the fourth quarter 2014, aggregate overnight balances held in Federal Reserve accounts averaged approximately \$2.6 trillion.
- Notwithstanding the availability of sufficient liquidity, a number of changes that can affect liquidity are already underway and should be monitored to identify potential bottlenecks.

Given the interdependencies across the PCS systems and the increased focus on intraday liquidity in clearing and settlement infrastructures, it is critical that the industry look for continuous improvement and refinement of liquidity management processes. Since 2011 the PRC has observed that intraday liquidity needs have been influenced by an evolving payments market, tri-party repo reform, changes to the Federal Reserve Payment System Risk Policy and the move of over-the-counter (OTC) derivatives to clearinghouses. Additionally and more broadly, changes to governmental policies or market practices over the longer term are affecting the availability of intraday liquidity. Any or all of these changes may have a positive or negative impact on the ability of the industry to maintain effective and efficient settlement processes.

The conclusions and recommendations of this report do not necessarily represent policies of the institutions represented or views of the Federal Reserve System.

SECTION 1: INTRODUCTION

On a routine day in 2014, almost \$14.8 trillion worth of payments settled in USD worldwide. This is up from approximately \$13.6 trillion on a routine day in 2010. To complete these transactions, more than \$7.1 trillion flowed throughout the financial system. In addition to the significant dollar value and volume of transactions settled, USD payment flows can be complex, occurring across a network of interconnected but separate PCS systems. Many of these settlement systems are FMUs designed to reduce risk and financial institutions (usually banks) are involved in supporting the settlement process as well as serving as direct counterparties in the underlying transactions. It is important to note, however, that while there are multiple clearing and settlement systems, ultimately the final funds flows and final settlement occurs on accounts held at the Federal Reserve Banks.

Recognizing the value of a common understanding and additional transparency into the flows of USD, the PRC undertook this study to document the current state of daily USD flows. The results have been summarized in the following paper, representing the collective work of the PRC and its associated working group.

The goal of the analysis is to document the magnitude and timing of USD flows across normal and peak operating cycles, to shed light on the interrelationships of some of the large systems where most of the activity occurs, to identify particular points during each day when significant portions of payments occur and to assess the impact of upcoming changes to the PCS landscape. With this refreshed data the PRC now also have the ability to form comparisons and capture observations based on these comparisons against the original report.

Context

Events over the last 10-15 years, especially since 2008, have highlighted the need for continuous improvement and refinement in how financial institutions manage liquidity. Aided by pressure from regulators and lawmakers, the industry has created new financial market utilities, generally in the form of clearing houses and central counterparties (CCPs). Using CCPs, activities can be bilaterally or multilaterally netted among the participants to reduce multiple individual large settlement obligations into fewer net settlement obligations. These efforts broadly are intended to increase efficiency and transparency.

One consequence, however, of concentrating flows at FMUs, may be a need for additional intraday liquidity to be available to the entire system as well as to individual participants to settle payments to CCPs at specified times. Just as there is an expectation of growth in the value of settlement activity, the current landscape is one in which more of these types of organizations are being created, which will add to the payment obligations due at specified deadlines during the business day. In addition, offsetting cash receipts or other flows may not converge to the same deadlines.

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Firms that participate in large value payment systems make economic decisions on how to manage their liquidity intraday to meet their obligations. They must manage the tension among meeting scheduled obligations, preserving liquidity where a payment obligation is flexible, the down-stream effects of holding payments, and deciding where and when they will pay for liquidity. The decisions of paying institutions impact the liquidity of receiving institutions and could push more settlement activity to later in the day and closer to standard end-of-day deadlines or even cause gridlock. This dynamic highlights the interdependencies of the financial institutions that carry the actual settlement obligations and of the FMUs.

To document the primary flow of USD funds across the globe, the PRC contacted and gathered information from seventeen firms that provide utility services in USD for the wider financial system and from operations within two banks that provide certain specialized securities clearing services. All of these firms provide key PCS services. While these nineteen entities do not represent all of USD global activity, they do appear to handle the overwhelming value of USD transferred through the financial system¹. Chart 1.1, below, lists the FMUs and CBs that agreed to participate, grouped into six sectors by type of service provided or market served.

Chart 1.1: Selected USD Financial Services Providers by Sector

<i>Sectors by type of service provided</i>	<i>Name of entity</i>
Large-Value Transfer Systems	CHIPS
	Fedwire Funds
U.S. Government Securities Clearing and Settlement	Fedwire Securities
	FICC-GSD
	FICC-MBSD
	BNYM (Govt. securities only)
	JPMC (Govt. securities only)
FX Settlements	CLS
	Hong Kong USD clearing
Domestic and Off-shore Equity, Derivatives Clearing	CME
	ICE Clear Credit
	LCH.Clearnet Ltd.
	NSCC (settlement in DTC)
	Options Clearing Corp
Domestic and Off-shore Central Securities Depositories	Clearstream
	DTC
	Euroclear Bank
Retail Systems	EPN
	FedACH

¹ It is for this reason that not all USD processing entities have been included. E.g. ICE Clear US, ICE Clear Europe, LCH.Clearnet SA and LCH.Clearnet LLC have not been included in the clearing data.

Methodology

For purposes of this refresh, the PRC collected hourly statistics on intraday flows of USD for “normal” days and for the peak day during the 4th quarter of 2014.² *Normal* was broadly defined as a typical day and *peak day* as the highest value day during the quarter. (The latter is also referred to as a *high-value day* to distinguish it from *daily* peak hours.) Certain FMUs also provided statistics on the gross USD value of transactions settled within their systems. FMUs or CBs that could not readily provide information based on quarterly activity used other techniques, such as samples from shorter time periods in Q4 2014 or early 2015, to capture representative statistics. FMUs that process transactions in multiple currencies provided statistics on USD transactions only—not the USD value of transactions in other currencies. Federal Reserve and Office of Financial Research staff consolidated and analyzed the information to compile statistics for this report.

This report focuses on daily average and peak USD funding flows activity aggregated within and across six service sectors. Although each entity is grouped in a *sector*, the groupings are slightly arbitrary and not as pure as they may appear. For instance, while the FX settlement sector presents information for CLS Bank International (CLS[®]) and the Hong Kong USD clearing system, it does not capture all FX settlements because some of this activity may also take place via The Clearing House Interbank Payment System (CHIPS[®]) or Fedwire[®] Funds Service or may settle on the books of a commercial bank.³ Moreover, FX settlements are only one of several different types of payments settled in the Hong Kong USD clearing system, which also handles direct counterparty payments. In contrast, other groupings are more precisely definable. For example, The Depository Trust Company (DTC) settles an overwhelming majority of equity and bond transactions and the equity and derivatives clearinghouses capture the payment flows for these products in this report.

Report Organization

This report is organized into the following sections: Section 2 covers interdependencies across the network and provides summary context on flows, aggregate values and peak and average timing. Section 3 describes each entity. Section 4 captures conclusions from this report and Section 5 examines a 12-36-month forward view of the PCS systems.

² Entities provided statistics on settlements and funding flows. These are described in Section 2 of the paper.

³ CLS[®] (CLS) is a registered trademark of the CLS Bank, CHIPS[®] (CHIPS) is a registered trademark of The Clearing House Payments Company L.L.C., and Fedwire[®] Funds Service (Fedwire) is a registered service mark of the Federal Reserve Banks.

SECTION 2: INTERDEPENDENCIES AND AGGREGATE USD ACTIVITY

The paper focuses on the role of and the network created by the FMUs and CBs that transfer funds and settle transactions in USD between participants. These transactions continue to cover a substantial portion of the total flows of USD through global payments, clearing, and settlement systems. The statistics provided here document the significant amounts of USD that are transmitted through or used by FMUs and CBs on a daily and hourly basis. This information also illustrates the significant level of interactions needed for a payments, clearing, and settlement system to support a global economy in which USD transactions flow almost around the clock on a typical business day.

An Interconnected Network

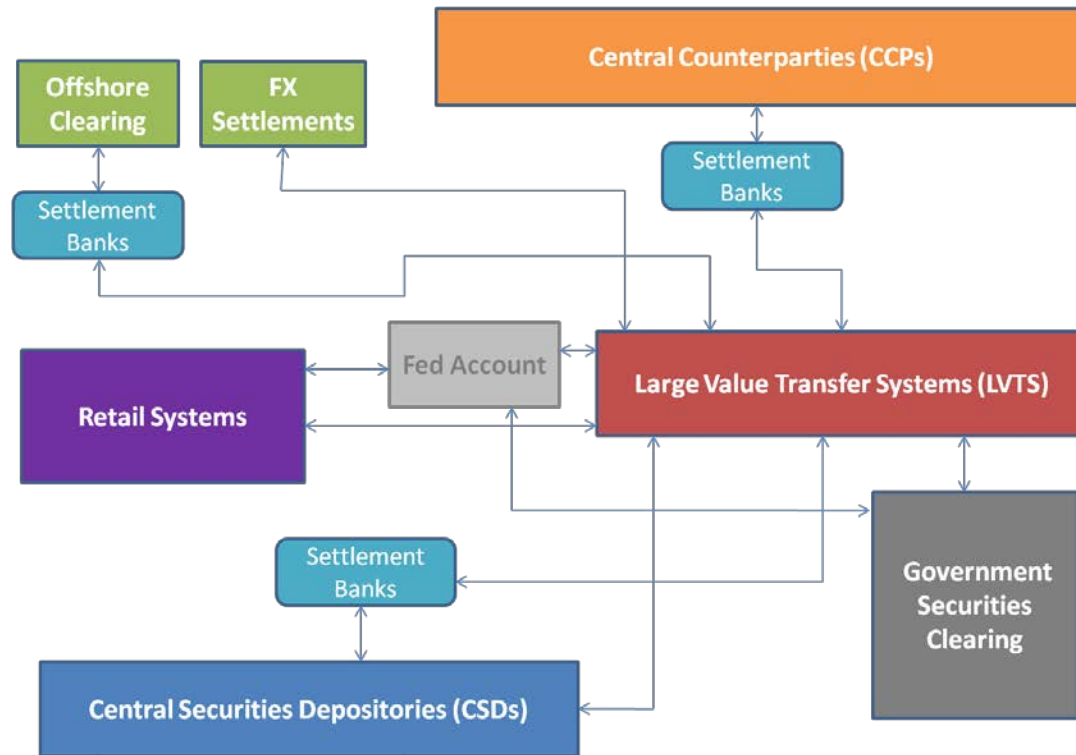
Chart 2.1 shows a stylized view of the USD payments, clearing, and settlement system. This illustration presents six types of entities, organized by their underlying purposes and connected by lines showing general flows of funds and securities: Large value transfer systems (LVTS), government securities clearing entities, FX settlement systems, central counterparties (CCPs), central securities depositories (CSDs), and electronic retail payment systems.

In addition, the schematic includes two other types of entities: Federal Reserve Banks, shown as “Fed account,” and settlement banks. Transfers of value, or book transfers, occurs when balances are transferred between entities that both have accounts with the same bank.⁴ The Federal Reserve Banks provide this service for U.S. depository financial institutions (including foreign banks with U.S. branches or agencies), and settlement banks provide a similar service for their customers, including banks, FMUs, and other financial institutions. The boxes represent the types of FMUs or CBs that transfer or settle USD value. The lines illustrate the USD flows and resulting interconnections among the entities.

⁴ See also Bech, Martin, and McAndrews, *Settlement Liquidity and Monetary Policy Implementation – Lessons from the Financial Crisis* (FRBNY, Economic Policy Review, March 2012)

<http://www.newyorkfed.org/research/epr/forthcoming/1202mart.html>, for additional description of the USD clearing and settlement network. The PRC thanks Morten Bech for his significant assistance in characterizing and illustrating the interconnectedness of this system and the role of settlement banks.

Chart 2.1: USD Clearing and Settlement Network



The arrangements that permit USD payments to move among the various entities participating in this study create an interconnected network. This network supports the clearing and settlement of most financial transactions, including cash payment orders, cash vs. securities transactions, and USD cash vs. other currency transactions. These transactions, in turn, support a full-range of purposes for moving cash: payments to settle business obligations among banks’ customers, payments to or from individuals, relocation of funds among entities (cash concentration payments), and settlement of banks’ own investments, to name a few.

Another reason for moving cash is to facilitate funding transactions by financial firms. Throughout the day FMUs and CBs move cash value to clear, net, offset, and/or settle financial market transactions based on proprietary rules. In the U.S., many payment and funding transactions are made through the Fedwire Funds Service (including its National Settlement Service (NSS)), a wholesale large-value payment system operated by the Federal Reserve Banks. Cash payments between banks are settled by offsetting entries on the books of the Federal Reserve Banks to the “Fed accounts” of participating U.S. banks. Hence, the Fed account is shown at the center of the network charts.

Some FMUs tend to focus on specific types of transactions, and they use proprietary rules to improve the efficiency of completing those transactions. For example, CHIPS and the Hong Kong USD clearing system settle payments. CSDs, CCPs, government securities clearers, and CLS clear and/or settle financial contracts. And, retail automated clearing house (ACH) payments services move cash between bank customers and is frequently used to settle the merchant portion of credit and debit card payments.

Once funds are received by the FMU or CB, the money is used to settle gross payments, netted payments, or other transactions consistent with entities' respective missions.

Settlement Banks and the Role they Play in Connecting FMUs

The CBs and a few FMUs have bank charters and, therefore, have direct access to Federal Reserve Bank accounts through which they receive and send funds from/to their participants. For those FMUs that do not have accounts at the Federal Reserve Banks, funding moves through commercial bank intermediaries known as settlement banks. Participants in these FMUs provide cash by routing Fedwire transfers to the Federal Reserve Bank account of the designated settlement bank for the benefit of the FMU.⁵ Once settlement according to an FMU's rules is completed, the accounts of cash receivers at the settlement banks are credited. Participants may then choose to leave the funds with the settlement bank or request that they be transferred to another institution, typically via Fedwire Funds transfers. It should be noted that new regulations under Dodd-Frank Title VIII enable the Federal Reserve to provide designated systemically important FMUs access to Federal Reserve accounts.

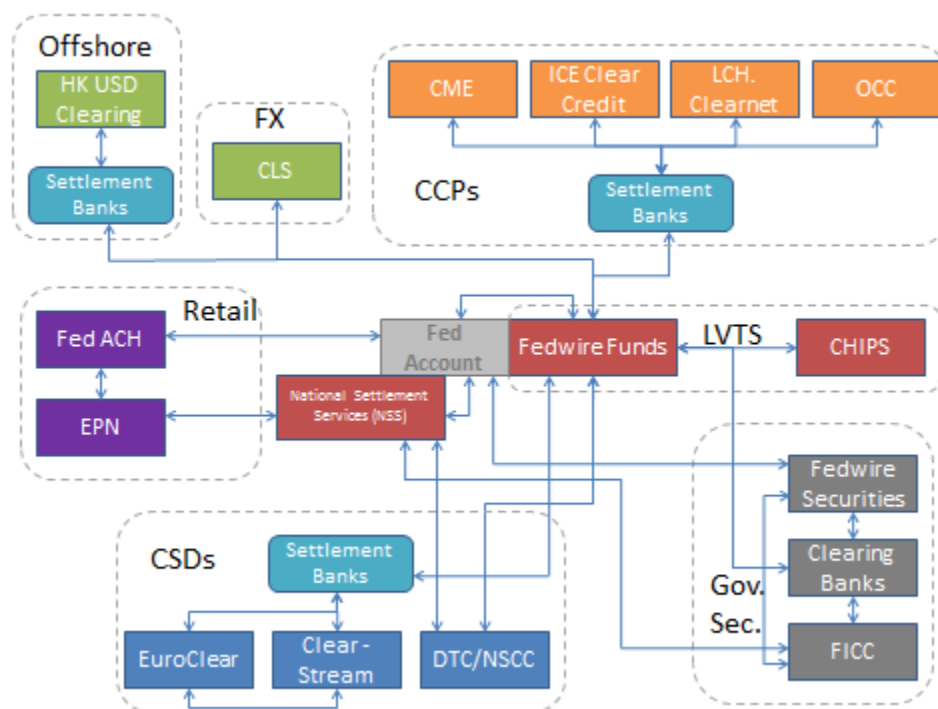
Transactions within a settlement bank are "on-us" transactions and outside the scope of this study. On a day-to-day basis, the funding of FMUs' accounts at settlement banks by their participants can be made either by transferring funds to the settlement bank or by an on-us transfer from a participant's account with the settlement bank. Operating rules for Chicago Mercantile Exchange (CME), ICE Clear Credit, LCH Ltd (LCH), and the Options Clearing Corporation (OCC) permit these FMUs to initiate debit and credit transactions from/to participants' accounts at settlement banks. To the extent that the transfers are wired in, the values are included in the Fedwire statistics reported in this paper.

Settlement Dependencies

Chart 2.2 shows the primary funding relationships among the nineteen entities participating in this study. It illustrates the web of interconnections and, sometimes, interdependencies among institutions. In some cases, settlement activity at one FMU is directly dependent on receipt of a funding transaction from another FMU. In these cases, interruption in one can trigger delay at the next. For example, CHIPS starts and ends each day with a zero balance. No CHIPS payments can be processed for a participant until that participant transfers its required initial funding to the CHIPS account with the Federal Reserve Bank of New York via the Fedwire Funds transfer. Settlements within CLS Bank also need to be triggered in this way by participants' daily Fedwire Funds transfers to the CLS account with the Federal Reserve Bank of New York.

⁵ Some FMUs maintain settlement accounts at multiple settlement banks. They may consolidate the funds at one of the settlement banks during the day, known as the concentration bank. In principle, CHIPS may be used to transfer these funds as well as Fedwire.

Chart 2.2: USD Clearing and Settlement Network, by entity



In general, direct dependency means that the downstream flows of funds depend on what happens before. Thus, availability of extra funds “upstream” can trigger earlier release of payments “downstream.” Similarly, operational and funding delays can have downstream ramifications. For example, an operational delay in Fedwire Funds services can delay settlement in CHIPS. A delay in receiving funds that are then retransmitted to an FMU or a delay in settlement at a CCP due to either operational or liquidity problems could also delay the use of those funds for other transactions.

In other cases, the relationships may be correlated but not necessarily directly linked. Correlation, and the impression of a direct link, can arise because the entities perform similar functions or serve the same or related markets. For example, CLS Bank settles 68 percent of all FX contracts (in CLS eligible currencies and products).⁶ Most of the remaining FX contracts with a USD component settle through CHIPS. Events that affect the USD FX market generally, for example triggers of high-value days could result in higher values of transactions on both services. However, operating problems on one system do not cause corresponding problems on the other.

In this study drivers for peak and normal activity varied considerably and were often associated with calendar events, such as pent-up flows on the days following holidays (mentioned by many systems) or underlying business design, such as standardized days for futures contract settlements at CME and Class

⁶ A 2012 study found that about 68 percent of all FX transactions denominated in the 18 CLS-eligible currencies settle through CLS. See <http://www.economist.com/news/finance-and-economics/21586540-cls-keeps-market-safe-settlement-risk-needs-add-more> and <http://www.cls-group.com/SiteCollectionDocuments/CLS%20market%20share%20Feb%202011.pdf>

A settlement days at Fixed Income Clearing Corporation's Mortgage-Backed Securities Division. The ramifications of these high-value days ripple through the network, following the interdependencies described above.

Role of Funding and Credit as “Grease” for the Network

Initiating funding transactions requires either cash balances or extensions of credit. This initial cash or credit can come from any of several sources and functions as “grease” to help smooth the movement of liquidity through the network.

Although not the only source of funds, Federal Reserve accounts provide access to both balances and credit. Thus, a bank wiring funds to an FMU at the beginning of the day may draw on balances held overnight in its Federal Reserve account. During December 2014, aggregate overnight balances held in Federal Reserve accounts averaged over \$2.6 trillion.⁷ If a bank does not have sufficient ready cash and it has been granted access to daylight overdrafts at its Federal Reserve Bank, it can use daylight overdrafts to support the transaction.⁸ During the fourth quarter of 2014, daylight overdrafts incurred by depository institutions averaged about \$1.3 billion in aggregate.

Outside of Federal Reserve accounts, other parts of the PCS system described here also rely broadly on funding balances and, in some cases, on extensions of intraday credit. The implementation of these arrangements varies. For example, CHIPS requires an initial “funding” that provides the grease that permits functioning of its settlement algorithm. Additional, “supplemental” funding during the day and “final” funding at the end of the day may be used to release and settle unresolved payment transactions.⁹ CCPs and CSDs also require that participants provide funds prior to defined settlement times, creating a balance that the FMU can draw on to effect settlements and send funds to participants with credit positions. Settlement banks may provide credit to the FMU participants to facilitate settlement on their books; this credit permits a smoother flow of transactions, so that some level of shortfall may not materially delay FMU settlements.¹⁰ Some FMUs also provide limited lines of credit that can be used to facilitate settlements.¹¹ And the U.S. government securities clearing banks routinely provide substantial amounts of intraday credit to facilitate clearing of tri-party repo transactions.¹²

⁷ Per the Federal Reserve Statistical Release H.4.1 Factors Affecting Reserve Balances.

⁸ See the Federal Reserve Board's Payment System Risk Policy for information about daylight overdraft lines of credit with Federal Reserve Banks at http://www.federalreserve.gov/paymentsystems/psr_about.htm.

⁹ McAndrews, Kuo and Sheets, *CHIPS Supplemental Funding Effects on Fedwire* (2009) measures effects of additional funding on release of transactions. (See http://www.newyorkfed.org/research/economists/mcandrews/CHIPS_PolicyPaper.pdf)

¹⁰ This study did not collect information on the size or availability of settlement bank credit, or on FMUs' use of such credit from clearing banks. The discussion here is conceptual.

¹¹ The CPSS-IOSCO standards include guidelines under which FMUs provide credit to members. See BIS publications at http://www.bis.org/list/cpss/tid_61/index.htm.

¹² See *New York Fed White Paper: Tri-Party Repo Infrastructure Reform* for a description of the use of intraday credit from the clearing banks to settle tri-party repo transactions. See also, <http://newyorkfed.org/tripartyrepo> for updates on plans to achieve the practical elimination of that credit.

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Gross Value Settled vs. Funding Transactions vs. Funding Flows

Chart 2.3 compares the aggregate values of transactions settled within the participating FMUs and CBs, the cash needed to effect these settlements, and the supporting amounts of funds that need to flow to and from each entity. These are also referred to as *gross value settled*, *funding transactions*, and *funding flows*, respectively, and correspond with the columns in this chart 2.3 from left to right. The following example illustrates how the respective values would be calculated: using FX settlements as an example, the green boxes show the sum of USD cash movements into and out of CLS and HK-USD clearing, the two FX settlement FMUs included in this study. Collectively, on a normal day in late 2014, these two FMUs settled about \$2.5 trillion worth of USD denominated financial contracts; they used \$19 billion of cash to effect these settlements; and \$36 billion in cash moved into and out of these two firms' accounts at their settlement agent (either a Federal Reserve Bank or a commercial bank).

Because of the basic design differences of FMUs, the relationships among these three values vary considerably. Some FMUs, such as CLS and CHIPS, offer internal processes specifically designed to conserve liquidity. Other FMUs, such as Fedwire Funds and Fedwire Securities, connect other FMUs on a real-time basis with immediate finality and, therefore, provide features other than liquidity conservation. One approach is not superior to the other; they are just different. The retail systems (FedACH® and EPN®) are batch settlement systems that debit and credit transfers of equal value among the bank accounts of payors and payees.¹³ Depending on their designs, FMUs can conserve cash liquidity and provide other efficiencies by standardizing rules and managing risks.

Chart 2.3: Estimated Gross Daily Activity Value vs. USD Needed to Effect Settlements, by Sector

Sector	Gross Value Settled		Funding Transactions ^a		Funding Flows ^b	
	2010	2014	2010	2014	2010	2014
Large Value Transfer Systems	3,953.0	5,047.9	2,426.1	3,451.9	2,378.2 ^c	3,398.7 ^c
FX Settlements	2,067.9	2,507.0	11.6	17.6	23.5	35.9
Central Counterparties ^d	NA	NA	5.2 ^e	9.2	10.7 ^f	18.5
Central Securities Depositories	1,101.7 ^g	1,986.9 ^h	55.8 ⁱ	94.7	129.5	194.0
Government Securities Clearing ^j	6,408.4 ^k	5,004.5	6,408.4	3,232.8	6,408.4	3,232.8
Retail Systems	159.8	251.1	159.8	251.1	159.8	251.1
Total	13,690.8	14,797.5	9,066.9	7,057.4	9,110.0	7,131.1

*All values in USD billions

^a Funding may occur through a Fedwire transaction or on the books of a commercial bank

^b Includes funding and defunding flows

^c Excludes known double counts of funding transactions for other FMU sectors;

^d Information on gross value of settled was not collected for CCPs

^e This information from the 2011 study was updated to more accurately reflect the value of funding transactions

^f This information from the 2011 study was updated to more accurately reflect the value of funding flows

^g Information on gross value of settled was not collected for some CSDs

^h A new baseline has been established for the 2014 report to more accurately reflect the gross value settled for CSDs

ⁱ One CSD provided net values of flows

^j Includes settlements on the books of the clearing banks including tri-party repo and internal FICC settlements

^k This information from the 2011 study was updated to exclude known double counting

¹³ FedACH® (FedACH) is a registered service mark of the Federal Reserve Banks, and EPN® (EPN) is a registered trademark of The Clearing House Payments Company L.L.C.

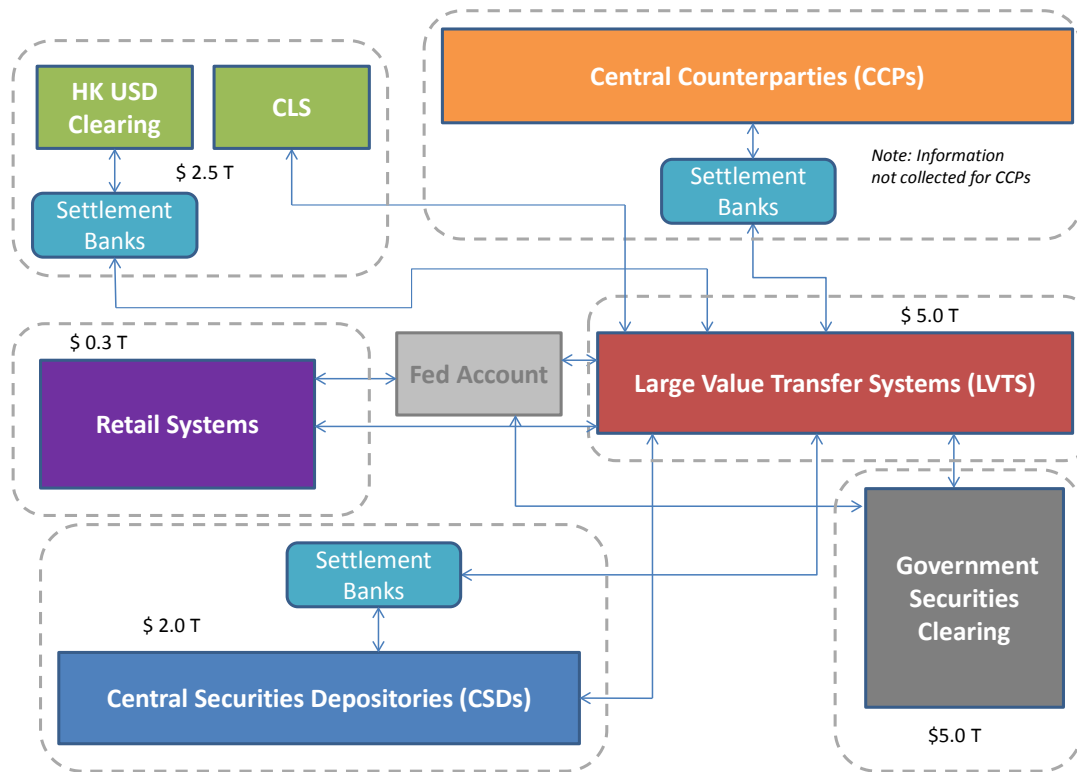
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Chart 2.4 merges the USD clearing and settlement graphic with normal gross daily value settled of USD by sector. These gross daily values, shown in USD trillions, reflect the aggregate values of transactions settled within the FMUs and CBs participating in this study. The aggregate values vary across the sectors, reflecting differences in the market segments served and the underlying design of the payment transactions. Sector-specific practices are explored further in Section 3.

Chart 2.4: 2014 Gross Daily Value Settled of USD Transactions, by Sector

Values in USD trillions

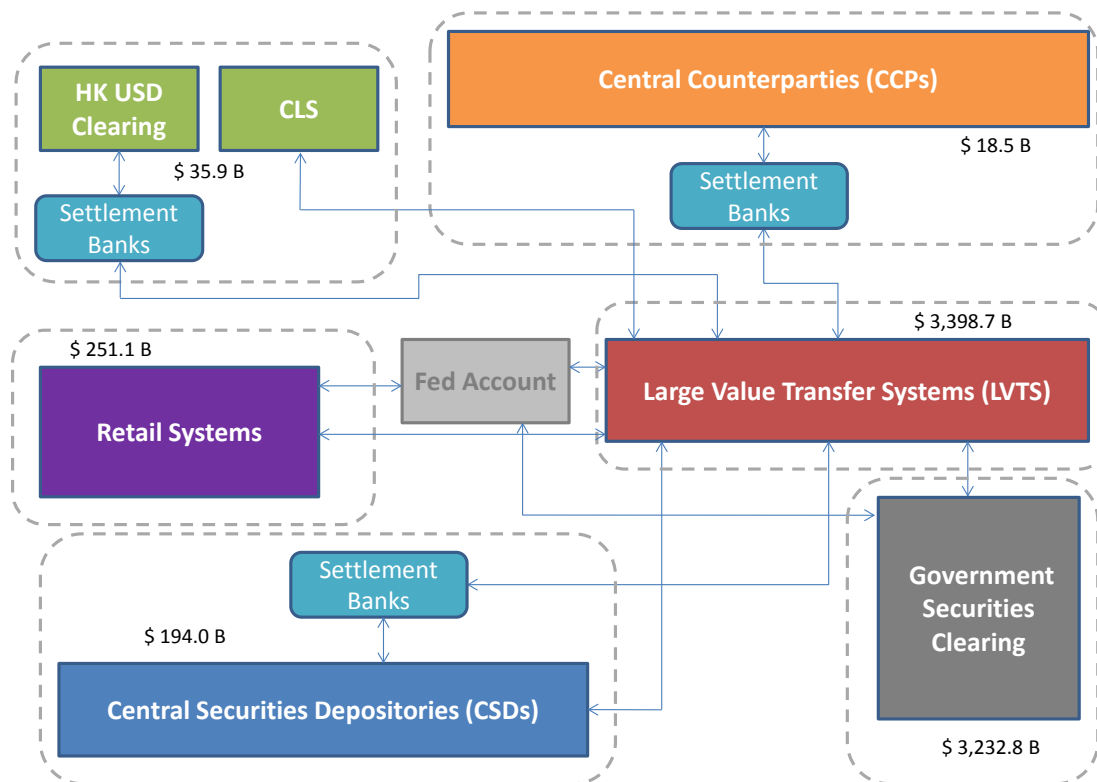


Funding Flows

The gross daily value settled statistics shown in Chart 2.4 focus on the transfers of value between payment system participants through or within particular FMUs and CBs. In contrast, Chart 2.5 applies the concept of funding flows—the amounts of funds that move into and out of each entity to complete settlements—to the USD clearing and settlement network illustration in Chart 2.2. Here, the values are denominated in USD billions and frequently demonstrate the results of bilateral and multilateral netting within those entities. The values in this chart correspond to the right-hand column in Chart 2.3. Using FX settlements as an example, the green box shows the sum of USD cash movements into and out of CLS and HK USD clearing, the two FX settlement FMUs included in this study. Collectively, on a normal day in late 2014, these two FMUs settled about \$2.5 trillion worth of USD denominated financial contracts; they used \$18 billion of cash to effect these settlements; and \$36 billion in cash moved into and out of these two firms' accounts at their settlement agent (either a Federal Reserve Bank or a commercial bank).

Chart 2.5: 2014 Global Daily USD Funding Flows, by Sector

Values in USD billions



Aggregate Hourly Activity

Thus far, the statistics in this paper have described gross value settled, funding transactions, and funds flows summed up to aggregates for a typical business day. In practice, funds are transferred, “flow,” and settle over the course of the day. Once a transaction has settled, the recipient can use the money received to fund a later transaction. Most of the monies that are “recycled” during a business day are transferred either through large-value transfers or on the books of a settlement or clearing bank. The size and wide-spread nature of this recycling is illustrated by statistics from the Fedwire Funds Service, which in aggregate transfers the value of the annual U.S. GDP in less than four days.

The hours during which the entities that participated in this study settle payments and the patterns—peaks and valleys—of those flows vary considerably. The number of active settlement hours varies because of the underlying design of firms’ settlement processes. Real-time or multi-batch flow systems have more hours that are active, compared to batch systems that settle transactions once or twice a day, but this does not imply that they settle relatively more or less value. Some systems operate virtually 24 hours and others for only a relatively short window. Daily peak settlement and associated funding transactions for the various entities occur at the opening of business, at the close of the business day, or somewhere in between. Drivers include internal funding deadlines as well as upstream and downstream flows from/to other system participants.

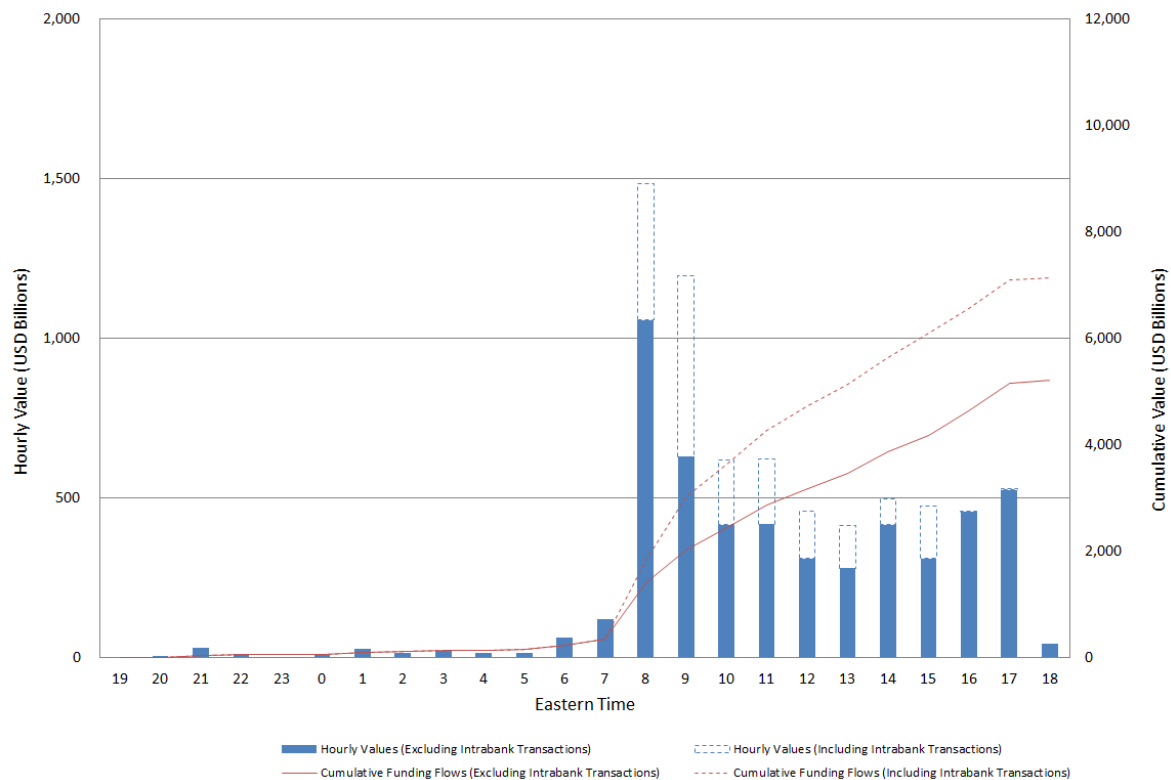
Intraday Liquidity Flows (ILF)

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Chart 2.6 shows consolidated hourly value of USD funding flows across all surveyed FMUs and CBs, providing a different breakdown of the same flows shown in Chart 2.5. The overall pattern is bi-modal, with relative peaks at the beginning and end of primary eastern U.S. business hours. Prior to 08:00 ET, the aggregate value of payment flows is fairly low, primarily reflecting activity in off-shore and cross-border systems. As the day progresses, funds values increase: during the 08:00-09:00 ET hour a number U.S. domestic entities open for business, and the morning peak includes a pick-up of domestic payments and settlement of government securities.¹⁴ Activity at the end of the day falls off after 18:00 ET as most U.S. markets and systems close for the day and once again the remaining activity is related to overseas systems.

In this chart, the solid blue bars represent funding flows between entities, while the dashed blue sections show the funding flows associated with government securities clearing that occurs within the CBs. The solid red line shows the cumulative flows over the day, excluding those within clearing banks. As various U.S. businesses open, funding activity picks-up and the cumulative flows climb steadily over the morning and afternoon hours. The dashed red line shows the cumulative funding flows, including those within clearing banks and between FMUs, reaching a high of over \$7 trillion.

Chart 2.6: Normal Daily Aggregate USD Funding Flows, YE 2010



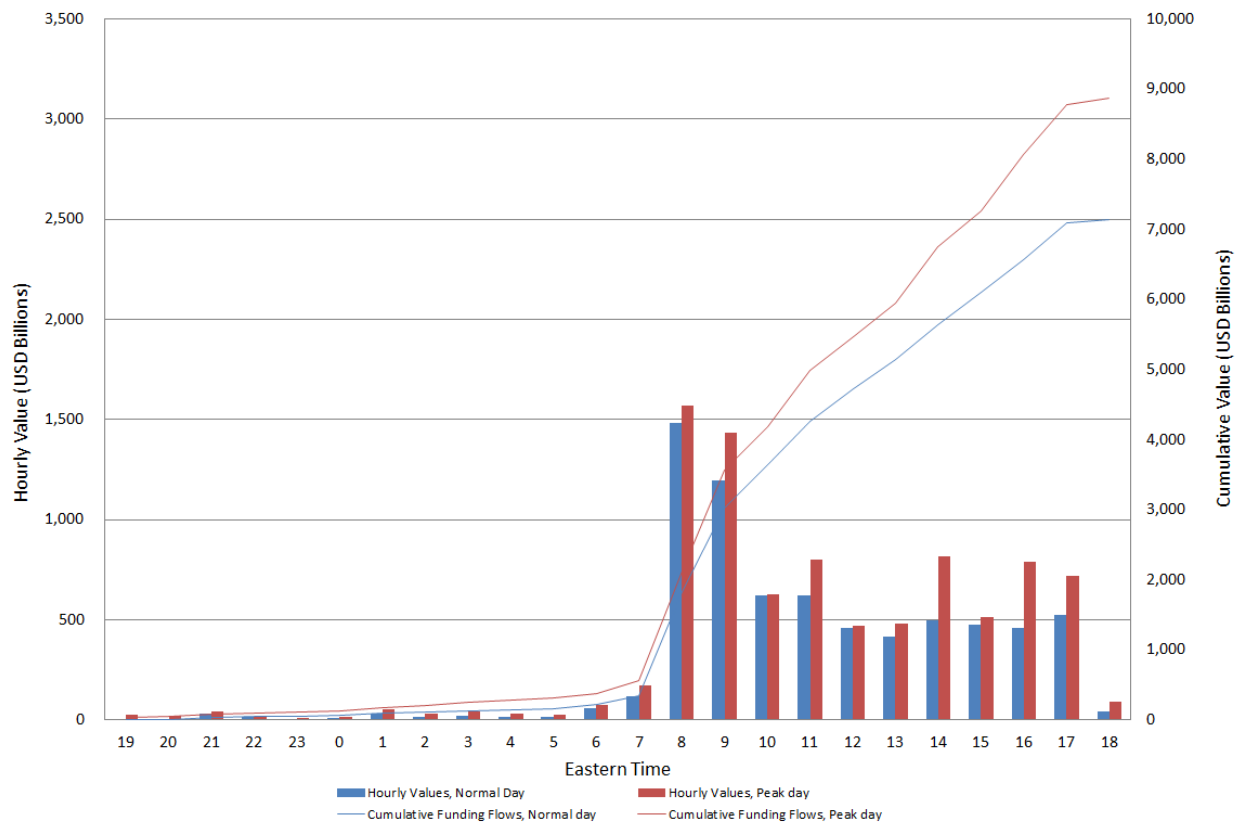
¹⁴ Government securities clearing, which includes activities of several FMUs and the two clearing banks, is described in Section 3.2. The flows during the study period reflect practices as of the end of 2010. In August 2011, the morning unwind of most tri-party repo transactions, which are part of the 08:00-09:00 ET daily peak in chart 2.6, shifted from 08:30 ET to mid-afternoon. These changes are discussed further in Section 4.1.

Intraday Liquidity Flows (ILF)

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The PRC collected data on both normal and high-value day activity. Chart 2.7 compares the normal and peak aggregate and cumulative value of USD funding flows by hour. Each FMU and CB identified its peak day during the survey period based on when the value of funds flowing through its system was the highest. For this chart, the peak values for the component systems for each sector were added, although it is quite unlikely that all FMUs and CBs had the same peak day. As such, the peak activity data below represents an extreme scenario where all the FMUs and CBs concurrently had peak flows. Prior to 08:00 ET, there is only a small difference between peak and normal aggregate flows. Differences begin to appear from 08:00 ET and seem more pronounced until 13:00 ET than during the latter part of the business day. The cumulative aggregate flows across all FMUs and CBs on a peak day are over \$2 trillion more than those on a normal day, although this peak day represents an extreme scenario.

Chart 2.7: Normal v Peak Daily Aggregate USD Funding Flows, YE 2014



Intraday Liquidity Flows (ILF)

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Chart 2.8: Normal versus Peak Daily Aggregate USD Funding Flows, by Sector, YE 2010

Sector	Normal Activity		Peak Activity		Change	
	Value (USD Billions)	Volume (Thousands)	Value (USD Billions)	Volume (Thousands)	Value (%)	Volume (%)
Large Value Transfer Systems	2,378.231	522.559	2,900.139	579.332	22%	11%
FX Settlements	23.465	0.251	57.771	0.247	146%	-2%
Central Counterparties ^a	10.719	0.674	44.309	0.732	313%	9%
Central Securities Depositories ^b	129.475	3.511	348.724	13.280	169%	278%
Government Securities Clearing	6,408.386	150.233	7,084.973	175.827	11%	17%
Retail Systems ^c	159.773	82,771.425	267.096	111,694.790	67%	35%

^a Volume data for one CCP was not available

^b Volume data for one CSD was not available

^c This volume data from the 2011 study was updated to more accurately reflect the volume of transactions

Chart 2.9: Normal versus Peak Daily Aggregate USD Funding Flows, by Sector, YE 2014

Sector	Normal Activity		Peak Activity		Change	
	Value (USD Billions)	Volume (Thousands)	Value (USD Billions)	Volume (Thousands)	Value (%)	Volume (%)
Large Value Transfer Systems	3,398.747	559.988	4,127.778	878.285	21%	57%
FX Settlements	35.886	0.266	63.013	0.286	76%	8%
Central Counterparties	18.489	1.099	50.395	1.300	173%	18%
Central Securities Depositories	194.024	4.451	614.090	12.881	217%	189%
Government Securities Clearing	3,232.819	140.829	3,678.128	255.574	14%	81%
Retail Systems	251.145	105,990.099	338.688	166,588.022	35%	57%

There is considerably more variation in the normal versus peak values and volumes by sector, as shown in Chart 2.8 versus Chart 2.9. The percentage variation in normal versus peak-day 2014 values ranges from a low of 14 percent for government securities clearing to 217 percent for the central securities depositories. The volume changes for peak days show a somewhat different pattern: At central securities depositories, the number of transactions was 189 percent greater than normal, while the number of transactions for FX settlements only increased by 8 percent.

SECTION 3: FINANCIAL MARKET SECTOR DESCRIPTIONS

The following section includes descriptions of the entities that participated in the study organized by sector.

3.1 Large Value Transfer Systems (Fedwire Funds Service, CHIPS)

Large value transfers, also often referred to as wholesale funds transfers, are carried through two services: the central-bank owned Fedwire Funds Service and the privately held CHIPS. Funds transfers on both entities are frequently referred to as wire transfers. Together they create the primary U.S. network for large-value or time-critical domestic and international payments.¹⁵

Fedwire Funds Service

Fedwire Funds is owned and operated by the Federal Reserve Banks. Depository institutions, as defined by the Federal Reserve Act, may open an account with a Federal Reserve Bank and are eligible to participate in Fedwire Funds transactions.¹⁶ As of 2014, there were approximately 7,900 active accounts eligible to use Fedwire Funds versus approximately 8,000 active accounts in 2010. The Fedwire Funds Service is a real-time gross settlement (RTGS) system whereby funds are instantaneously transferred from the Federal Reserve Bank (FRB) account of one participant to the FRB account of another participant via the Federal Reserve's highly secure electronic network. Settlement in *real time* means the payment transaction is not subject to any waiting period and the transactions are settled as soon as they are processed. *Gross settlement* means the transaction is settled individually, on a one-to-one basis without offsetting or netting with any other transaction. Settlement of funds is immediate, final, and irrevocable.

Fedwire Funds Service operates 21.5 hours each business day. Fedwire Funds Service is used to settle positions with other financial institutions (including banks, DTC, CLS, CHIPS), to buy and sell Federal (Fed) Funds, and to transfer payments for participants' customers.

When using Fedwire, a sending bank authorizes its Federal Reserve Bank to debit its account for the amount of the transfer and credit the same amount to the receiving bank's Federal Reserve Bank account. Subject to the Federal Reserve's Payment System Risk Policy, the Federal Reserve Banks can extend intraday credit to most Fedwire participants lacking sufficient balances to cover their payment instructions.¹⁷

CHIPS

CHIPS is owned and operated by The Clearing House Payments Company L.L.C., a bank-owned, private-sector company that operates several payment systems. As of 2014, CHIPS had 49 participants versus 50 participants in 2010. CHIPS operates 20 hours each business day.

¹⁵ <http://www.newyorkfed.org/research/epr/forthcoming/1202mart.html> for additional description of the USD clearing and settlement network

¹⁶ Depository institution customers for Federal Reserve Bank financial services are called banks in this paper.

¹⁷ See http://www.federalreserve.gov/paymentsystems/psr_about.htm for more information.

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Since January 2001, CHIPS has been a real time final settlement system that continuously matches; offsets individually, bilaterally, and multilaterally; and settles payment orders using the proprietary CHIPS Algorithm. All payments released from the CHIPS payment queue are final and irrevocable. Each CHIPS participant has a pre-established initial funding requirement to be transferred via Fedwire Funds to CHIPS' account at the Federal Reserve Bank of New York before 09:00 ET. CHIPS does not release any payment order that would cause a participant's position with CHIPS to fall below zero or to exceed two times of the initial funding requirement. Payment orders submitted to CHIPS that remain unsettled at the end of the day are tallied and CHIPS calculates a final funding requirement for each participant, if any, at 17:00 ET. Each participant with a final funding requirement must transfer the required funds, via Fedwire Funds Service, to the CHIPS account. At close, CHIPS then sends to each participant that had a positive final position a Fedwire payment instruction in that amount.

A significant volume of CHIPS payments relate to correspondent banking payment activity where international banks maintain accounts with many CHIPS participants. Payments transferred over CHIPS often relate to interbank transactions, and commercial transactions such as international remittances, corporate wire transfers and trade settlements.

Comparisons with 2010 Data

Below are contributing factors for changes since 2010 as referenced in the underlying data in section 2 of the paper:

1. General improvement in economic condition.
2. Continued large balances (over \$2.6 trillion as of December 2014) maintained by U.S. banks with their Federal Reserve Banks, which resulted in very little reliance on daylight overdrafts on the part of the U.S. banks offered by the Federal Reserve Banks. This ultimately allowed the U.S. banks to release time sensitive payments earlier in the day via the Fedwire Funds Service over CHIPS without much throttling;
3. Part of the large balances at the Federal Reserve Banks were maintained by foreign bank branches in the U.S. as they and their head offices prefer to earn 25 basis points (as of December 31, 2014) per annum from the balances from the Federal Reserve Banks. Those balances are transferred by foreign bank branches from their Federal Reserve Bank accounts to the head offices' accounts with their U.S. correspondent banks at the beginning of the day to release payments intraday and funds are returned to the branches' accounts with the Federal Reserve Banks at the end of each day;
4. The introduction of the Fed reserve repo program since the 2011 study which has contributed to cash movements later in the day;
5. The tri-party repo reform influenced changes in intraday liquidity flows. Cash may be sent in prior to 15:30 ET, although some cash from repos is still moving around 17:00 ET. A reduction in intraday credit lines offered by the clearing banks required participants to move more funds earlier intraday prior to the enforced 15:30 ET unwind to pay back principal and interest on maturing tri-party repos that do not roll. Additionally, the elimination of discretionary intraday credit which was provided by the agent banks to allow for earlier settlement of tri-party repos

caused settlements to occur later around 17:00 ET. More details on tri-party repos are covered in Section 3.2 U.S. Government Securities Clearing and Settlement;

6. Proceeds from large time deposits booked by custody clients are returned earlier in the day.

Potential Drivers of Future Change

The PRC expects to see a similar trend in gross value settled and funding flows over the foreseeable future mainly because large balances will continue to be maintained by banks in the U.S. with the Federal Reserve Banks; however, we note the following may cause intraday flows in LVTS to change:

- Large increases or decreases in interest rates (including negative interest rates) ;
- Major economic crises in the U.S. and around the world (with heightened volatility);
- Changes in liquidity related regulations including but not limited to Payment Risk Policy and Liquidity Coverage Ratio and other liquidity related regulatory requirements;
- Changes in regulations governing FMUs

3.2 U.S. Government Securities Clearing and Settlement (Fedwire Securities, Clearing Banks, Fixed Income Clearing Corp)

Government securities clearance (GSC) involves the exchange of U.S. Treasury and U.S. government-sponsored enterprises (Agency) securities typically for cash payment. Broadly speaking, GSC services support three primary product lines:

1. Buying and selling of securities (buy-sell) via Fedwire Securities or IntraBank Clearance¹⁸
2. Delivery-versus-payment (DvP) repos via Fedwire Securities or IntraBank Clearance¹⁹
3. Tri-party repos

GSC settlement mostly occurs either through the Fedwire Securities book-entry system or on the books of the two clearing banks—Bank of New York Mellon (BNYM) and J.P. Morgan Chase (JPMC). In addition, the Fixed Income Clearing Corporation (FICC), a subsidiary of Depository Trust and Clearing Corporation (DTCC), serves as the central counterparty between dealers through two units: the Government Securities Division (FICC-GSD) provides netting and central clearing services for U.S. Treasury and Agency securities while the Mortgage-Backed Securities Division (FICC-MBSD) provides netting and central clearing services of U.S. agency-issued mortgage backed securities. Finally, FICC's General Collateral Financing Repo (GCF-Repo[®]) service provides clearing and settlement services for interdealer transactions that utilize a tri-party mechanism.²⁰ Both GSD and MBSD are Central Counterparty Clearing Corporations which guarantee and novate matched trades.

¹⁸ Transactions between entities that are both customers of the same clearing bank are generally effected on a book-entry basis at that clearing bank (that is, "on-us," or intrabank clearance).

¹⁹ Delivery-versus-payment (DvP) repos, also known as specials, are transferred along with buy-sell securities transactions and are indistinguishable from them in the statistics available for this study.

²⁰ GCF-Repo[®] is a registered trademark of the Depository Trust and Clearing Corporation or its affiliates in the U.S.

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Fedwire Securities - The Federal Reserve Banks' Fedwire Securities Service is an electronic central securities depository. It is also a real-time gross securities settlement system that processed on average \$1.2 trillion of transfers every business day during 2014. The Fedwire Securities Service supports 18 domestic and international entities in the issuance of securities and the payment of principal and interest on outstanding securities, including the U.S. Treasury, Fannie Mae, Freddie Mac, and Ginnie Mae. The Fedwire Securities Service also provides securities account maintenance, transfer and settlement services to the issuers and approximately 5,500 depository institution customers as of year-end 2014.

Transactions involving U.S. Government and Agency Securities between two different Fedwire Securities participants (or interbank) settle on Fedwire Securities on a DvP (or free of payment) basis, with the transfer of money from buyer to seller occurring simultaneously with the delivery of the securities from seller to buyer. Participants also use Fedwire Securities to facilitate bilateral repo transactions.

Intrabank Clearance - Securities transactions between entities that are both customers of the same clearing bank are generally effected on a book-entry basis at that clearing bank (that is, "on-us," or intrabank clearance). Because no cash leaves the clearing bank with intrabank clearance, there is no liquidity impact to the clearing bank, which contrasts with transactions executed via Fedwire Securities, where cash must leave the clearing bank that can result in a liquidity impact for the settlement bank.

Intrabank clearance transactions involve internal accounts at either BNYM or JPMC and can include: (a) securities movements directly between the accounts of two dealers; (b) securities movements between a dealer and FICC; or (c) securities movements between a dealer and custodian. Given the concentration of clearance at two banks (BNYM and JPMC), there is ample opportunity for intrabank activity. In fact, as illustrated in charts within this section, the average daily value of intrabank clearance transactions exceeds that settled DvP on Fedwire Securities.

Tri-party repo - A repo transaction is the sale of a security together with an agreement for the seller to buy back the security at a later date. The seller is effectively the borrower of cash. The buyer, or provider of cash, receives the security as collateral to protect against default by the seller.

Buyers are primarily money market mutual funds, custodial banks investing cash collateral on behalf of their securities lending clients, and other asset managers. Sellers are typically broker-dealers that are seeking to finance other transactions and securities settlements.

In a tri-party repo transaction, a third-party clearing bank provides settlement and collateral management services to the seller and the buyer. The clearing bank maintains control of the securities that are subject to the repo transaction and processes the payments from the seller to the buyer. The advantages of tri-party repo over bilateral repos include the ability to rely on the infrastructure of the clearing agent to handle various processes such as securities custody, asset servicing, collateral valuation, and tools to allocate collateral efficiently. On the other hand, bilateral repos, despite the additional infrastructure required for processing, allow for the handling of specific collateral needs

(mainly “specials,” which are securities with exceptionally high demand instead of the use of general collateral for tri-party repo) and also greater flexibility around maturity timing.

Tri-party repo transactions generally occur in two forms: one day (“overnight”) or term (i.e. longer than one-day). Overnight transactions can mature the following day, or upon the agreement of the borrower and investor, rolled-over for additional time.

Tri-party Repo Reform - Tri-party repo reform describes a multi-year effort of risk reduction initiatives, which have been phased-in through a series of operational and technological changes and improvements. There are comprehensive reports on the topic of tri-party repo reform, including the 2012 report from the Task Force on tri-party repo infrastructure.²¹ An overview of two crucial changes related to tri-party reform follows:

- *Non-maturing trades will not unwind*

Prior to July 2011, clearing banks would “unwind” all transactions by the opening of Fedwire Securities and “rewind” term, rolling, and new transactions at the end of the business day. This process required the Clearing Banks to extend intraday credit to the Dealers from 8:30 ET in the morning until all collateral allocations were finalized and “locked up,” in the evening.

Since the previous study, the morning unwind has been eliminated, and tri-party repo trades mature starting at 15:30 ET. In addition, term trades were no longer unwinding daily. The delayed unwind of maturities allows cash from new financing transactions or other liquidity sources to facilitate the maturity process.

- *Capped and committed intraday credit*

Secured credit for the maturation of tri-party repo trades from clearing banks is now capped at 10% of a dealer’s notional tri-party book. In addition, the credit provided to dealers comes in the form of committed lines of credit. Previously, the clearing banks offered uncommitted and potentially unlimited lines of credit to dealers. The possibility that a clearing bank would either unexpectedly remove credit to a dealer or absorb a significant amount of credit risk from a distressed dealer were key factors in the transition to transparent, committed (and capped) lines of credit for tri-party repo.

Another driver of the move to capped and committed lines of credit included the desire to create incentives for both the clearing banks and dealers to utilize more efficient technology and operating procedures, thereby reducing the need (and related costs) for intraday credit.

In addition to the two items described above, numerous operational changes have been implemented including enhanced integration of GCF-repo with tri-party repo settlement, improved due diligence and stress testing by cash investors, the introduction of collateral substitution capabilities, and new

²¹ https://www.newyorkfed.org/medialibrary/microsites/tripartyrepo/pdf/report_120215.pdf

technological interfaces to enable better tracking and information exchange throughout the business day—particularly before the unwind occurs. The process of auto-substitution has enabled cash (or an eligible security) to be replaced in term trades without a full unwind taking place. Regulatory and market practices have also evolved such that dealers rely less upon short-term funding and also hold larger amounts of high quality liquid assets. Exuberance

Comparison with 2010 Data

Chart 3.2.2: Comparisons for USD Funding Flows for Government Securities Clearing

The tri-party repo funding transactions and funding flows data for 2014 only include the cash movements related to the daily unwind. By contrast, the 2010 data includes the entire tri-party repo market, “unwind” of all transactions by the opening of Fedwire Securities and “rewind” of term, rolling, and new transactions at the end of the business day, in the funding transactions and funding flows data even though most of the unwinds and rewinds took place within the clearing bank and did not result in external cash movements. The updated methodology for the 2014 data more closely follows the cash movement related to the tri-party repo unwind.

Potential Drivers of Future Change

1. Federal Reserve Repurchase Agreement Program (“Reverse Repo” or “RRP”)

Currently, one of the primary late-day flows relates to the RRP—an open market operation in which the New York Fed sells a security to an eligible counterparty with an agreement to repurchase that same security at a specified price at a specific time in the future. Maturities for the RRP may be either overnight or for a specified term.²²

Several factors will determine the impact of the RRP on intraday liquidity flows as the overall level of interest rates rise. Regulatory requirements such as the Supplementary Leverage Ratio (SLR) could result in tighter balance sheet management from banks and fewer outlets for cash investors looking to place excess cash. A key remaining question is how banks and dealers will adapt to the Basel III leverage ratio; currently, there are several practices across foreign banks including calculating the denominator based on the average of month-end totals each quarter, or using just the quarter-end balance sheet “snap shot” of on-balance sheet assets, which causes active management by banks and dealers of cash balances and repo activity around month- and quarter-ends. Domestic banks manage their SLR denominator based on an average of daily balance sheets for each quarter. With foreign banks/dealers focusing on the size of their balance sheets around month- and quarter-end, they may look to decrease participation in the tri-party repo market around statement dates. As such, it’s possible that the RRP may continue to see large flows on month- and quarter-end dates.

²² https://www.newyorkfed.org/markets/rrp_faq.html

2. Liquidity in Trading U.S. Government Debt

There have been reports of potentially decreased liquidity for trading debt securities, including U.S. Treasuries. Potential reasons include diminished market making activity from broker-dealers as they seek to reduce the inventory of securities on their balance sheets as well as the rise in high-speed electronic trading. On October 15, 2014, sharp moves in the yield of U.S. Treasuries shocked some market participants, leading them to deem that a “flash crash” had occurred.²³

3. Increases in Government Debt Outstanding

The amount of U.S. government debt outstanding has continued to increase, and with additional budget deficits likely, the outstanding debt balance would continue to grow. The higher debt levels may eventually lead to additional intraday flows related to government securities.

4. Other implications from non-cleared OTC derivative-margin rules

Given derivatives rules that require initial margin to be collected on certain transactions, will we see increased movement of high-quality securities like Treasuries and Agencies to meet these margin calls?

3.3 Foreign Exchange Settlements (CLS Bank, Hong Kong USD Clearing System)

The FX systems analyzed for this sector include CLS Bank International (CLS Bank) and the Hong Kong USD clearing system.²⁴ Additional offshore USD clearing systems operate across the globe including those in India, Colombia, and Brazil. The Hong Kong system provides an example of the type of services they provide.

Continuous Linked Settlement

Settlement for CLS eligible currencies is offered by CLS Bank. Owned by FX market participants, CLS operates the largest multi-currency cash settlement system to eliminate settlement risk in the FX market. In June 2011, 60 settlement members settle transactions in 17 eligible currencies. As of December 2014, 62 settlement members settle transactions in 17 eligible currencies.²⁵

CLS receives, validates, and matches FX settlement instructions and calculates a multilateral net funding requirement for each settlement member across all CLS-eligible currencies. CLS provides payment versus payment (PvP) settlement for FX transactions in eligible currencies in central bank funds. A PvP

²³ https://www.treasury.gov/press-center/press-releases/Documents/Joint_Staff_Report_Treasury_10-15-2015.pdf

²⁴ See <http://www.newyorkfed.org/research/epr/forthcoming/1202mart.html> for detailed systems descriptions.

²⁵ CLS Bank holds a U.S. banking charter and settles transactions in the following currencies: US Dollar, Euro, UK Pound, Japanese Yen, Swiss Franc, Canadian Dollar, Australian Dollar, Swedish Krona, Danish Krone, Norwegian Krone, Singapore Dollar, Hong Kong Dollar, New Zealand Dollar, Korean Won, South African Rand, Israeli Shekel, Mexican Peso, and, as of 2015, the Hungarian Forint.

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mechanism in a foreign exchange settlement system ensures that a final transfer of one currency occurs if and only if a final transfer of the other currency also takes place. Currently, eighteen member banks provide Nostro services in U.S. dollars for CLS settlement members. In addition to its FX settlement service, CLS also offers cash final settlement for some traded financial products beyond FX. Most other USD settlements for non-CLS settled FX transactions are completed either on a net or gross basis and settled through CHIPS.

Hong Kong USD Clearing System

The Clearing House Automated Transfer System, or CHATS, is a real time gross settlement system for the transfer of funds in Hong Kong. It is operated by Hong Kong Interbank Clearing Limited, a private company jointly owned by the Hong Kong Monetary Authority and the Hong Kong Association of Banks. Currently, transactions denominated in the following four currencies can be settled using CHATS: Hong Kong Dollar, Euros, US Dollar and Renminbi.

USD CHATS has been operating since August 2000, settling on the books of HSBC Hong Kong. The activities that are processed through the system are Commercial and Treasury payments, including FX transactions against several Asian currencies. The percentage of FX related transactions increased from approximately 46% in 2010 to approximately 53% in 2014.

Comparisons with 2010 Data

The increase in value FX Settlements since 2010 as referenced in the underlying data in section 2 of the paper could be attributed to several factors:

- (1) The number of foreign exchange transactions increase during a crisis. The Euro Crisis (including the Greek Crisis), which occurred between the 2011 study and this refresh, caused volatility in the foreign exchange market;
- (2) Part of the increase is a result of a gained market share with existing CLS settlement members while adding new Third Party participants²⁶;
- (3) The introduction of the USD/CAD same day settlement as part of CLS Bank's existing product suite in September, 2013.
- (4) DvP arrangements: In 2010, HK USD CHATS was connected to three Securities market infrastructures. Since then, it has established three separate DvP links with the Global Tripartite Repo System operated by Euroclear Bank, J.P. Morgan and Clearstream respectively for cross-border collateralized lending and borrowing.
- (5) Pvp arrangements: In 2010, there were a total of five FX arrangements. As of 2014, the number increased to six with the addition of USD/Baht Pvp link between USD CHATS in HK and BAHTNET of Thailand

Potential Drivers of Future Change

- Volatility in FX markets as a result of cross currency interest rate fluctuations and a crisis could increase gross value settled and funding flows more than what we observed in the past;

²⁶ 2014 CLS Annual Report: www.CLS-group.com/MC/annualreport2014/Documents/CLS_Annual_Report_2014.html

- If CLS introduces additional eligible currencies, currency pairs for same day settlement and new products/services, we will continue to see an increase in gross value settled in CLS and may lead to a decrease in funding flows if there is additional netting attributable to the new products;
- Given the de-risking activities by the U.S. banks, the perceived compliance hurdles of processing payments through U.S. banks, and the regional or local banks' attempt to better utilize liquidity in the same time zone, additional payment values could migrate to off-shore USD Clearing systems;
- An increase in the number of international USD clearing systems that operate across the globe.

3.4 Equity, Derivatives Clearing (Chicago Mercantile Exchange, ICE Clear Credit, Options Clearing Corp, LCH.Clearnet)

Context of System

Four major domestic and offshore utilities actively clear and settle a large proportion of USD-denominated derivative transactions. Covered in this report is data from the Chicago Mercantile Exchange Inc. (CME), Intercontinental Exchange's ICE Clear Credit, the Options Clearing Corporation (OCC), and LCH.Clearnet Limited (LCH). As discussed later in Equity and Derivatives Clearing comparison section, the market for derivatives clearing has grown significantly during the 2010-2014 timeframe.

CME Group Inc. owns and operates large derivatives and futures exchanges in Chicago and New York City, as well as online trading platforms. It also owns the Dow Jones stock and financial indexes. CME-owned exchanges trade futures and options based on interest rates, equity indexes, foreign exchange, energy, agricultural commodities, rare and precious metals, weather, and real estate. CME Clearing (a division of CME) monitors and processes more than one billion futures and options on futures trades each year, worth more than \$1,000 trillion, and ensures the financial integrity of each transaction. CME Clearing additionally provides clearing services for over-the-counter foreign exchange contracts, credit default swaps, and interest rate swaps. CME Group Inc. is a listed, publicly traded company regulated by the U.S. Commodity Futures Trading Commission.

Formerly known as ICE Trust, ICE Clear Credit is a subsidiary of the Intercontinental Exchange that operates exchanges, trading platforms, and clearing houses serving global markets for agricultural, credit, currency, emissions, energy and equity index markets. ICE Clear Credit, located in Chicago, is a central clearing facility for North American credit default swaps. The clearing house is subject to direct regulation and supervision by the U.S. Commodity Futures Trading Commission and the U.S. Securities and Exchange Commission, as well as oversight of the Federal Reserve.

The OCC is the largest clearing organization in the world for options contracts, operating under the jurisdiction of the U.S. Securities and Exchange Commission and the U.S. Commodity Futures Trading Commission, as well as under oversight of the Federal Reserve, given the OCC's designation as a systemically important FMU. OCC issues and clears U.S.-listed options and futures on a number of underlying financial assets including common stocks, currencies, and stock indexes. OCC is jointly

owned by five of its participant exchanges and governed by a Board of Directors, most of whose members are drawn from OCC's clearing members.

LCH.Clearnet Ltd., located in the U.K., is a subsidiary of the LCH.Clearnet Group Ltd., a clearing house group, currently majority-owned by the London Stock Exchange Group serving major international exchanges and platforms, as well as a range of OTC markets. It clears a broad range of asset classes, including securities, exchange traded derivatives, commodities, energy, freight, interest rate swaps, credit default swaps, non-deliverable FX Forwards, and euro and sterling denominated bonds and repos. LCH is principally regulated by the Bank of England under the European Markets Infrastructure Regulation (EMIR).

Comparison with 2010 Data

Chart 2.3 shows a large increase in funding flows between 2010 and 2014, which correlates to the growth in the volume of cleared swaps at the CCPs. The Dodd Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act)²⁷ required certain classes of credit default and interest rate swaps to be cleared by CCPs. Much of the growth was fueled by the implementation of these requirements. 2014 was a high-growth year for both Interest Rate Swaps and Credit Default Swaps in the U.S. as measured in both cleared swap volume and open interest.²⁸ The large growth in the value of funding flows reflects the increase in margin flowing between participants and CCPs to cover the increased flow.

Potential Drivers of Future Change

Volumes and open interest in cleared swaps will drive increases in the value of intraday funding flows. Additional products required to be cleared and back loaded into CCPs will drive those volumes. The timing of the flows will continue to be driven by margin deadlines required by the CCPs. If volumes level off in particular products, market volatility may cause more peak flow activity as intraday margin calls can be significant in volatile markets and clearing members need to keep additional liquidity on hand to meet requirements. Any changes in margin requirements would also affect the average and peak data. Changes in rules regarding the segregation of collateral for clients may affect clearing member liquidity. Additionally, the intraday flows do not include auxiliary costs and flows such as concentration limit increases, and increased capital charges as this study is specific to the cost of cleared flow, not the overall liquidity impact of clearing to the market.

3.5 Central Securities Depositories (Depository Trust Company [including National Securities Clearing Corp], Euroclear, Clearstream)

Context of System

A CSD is an organization holding securities in certificated and/or uncertificated (dematerialized) form, to enable book-entry transfer of securities. Physical securities may be immobilized or dematerialized so

²⁷ <http://www.gpo.gov/fdsys/pkg/PLAW-111publ203/content-detail.html>

²⁸ <https://fimaf.fia.org/articles/cleared-otc-volume-increased-2014>

that they exist only as electronic records. The CSDs may also provide centralized comparison and clearing and settlement services. An international CSD (ICSD) settles trades in securities such as Eurobonds²⁹ usually through direct or indirect links to local CSDs.

Depository Trust Company (DTC) Overview

The Depository Trust Company (DTC) was established in 1973 and is the central securities depository subsidiary of DTCC. DTC was created to reduce costs and provide clearing and settlement efficiencies by immobilizing securities and making book-entry changes to ownership of the securities. DTC provides securities settlement for its affiliated National Securities Clearing Corporation (NSCC) for settlement of institutional trades, involving money and securities transfers between custodian banks and broker-dealers, and provides for the settlement of issuances and asset services of equities, warrants, rights, corporate debt and notes, municipal bonds, government securities, asset-backed securities, depository receipts and money market instruments.

Virtually all equity, corporate debt and municipal debt trades transacted on the New York Stock Exchange, NASDAQ, regional exchanges and electronic communication networks are processed through NSCC's Continuous Net Settlement (CNS) service with settlement processed through DTC. DTC has been designated by the Financial Stability Oversight Council as a systemically important financial market utility.

DTC also provides securities settlement for money market instruments (MMIs). MMIs are one of the largest asset classes in terms of value settled by DTC; issuance is supported on a same-day basis. DTC and NSCC have a combined net funds settlement processed through the Federal Reserve's National Settlement Service (NSS), facilitating the end-of-day net funds settlement related to the intraday processing of valued DTC transactions.

DTC operates on a fully collateralized basis, mitigating credit risk for DTC and its participants. Using collateral and net debit cap risk management controls, DTC's settlement system provides sufficient liquidity to complete system-wide settlement even if its largest single participant affiliated family of participants were to fail to settle. The system is linked to international clearing agencies, which provide delivery-versus-payment in the case of CDS, or free-of-payment settlement for other international links. In 2010 DTC settled securities valued at \$117.5 trillion and had over \$36.5 trillion securities on deposit, compared to 2014 where DTC settled securities valued at \$113.7 trillion³⁰ and had over \$46.4 trillion securities on deposit.³¹

DTC has been a leader in the U.S. financial services industry in their efforts to streamline securities settlement services and reduce risk. DTC has worked closely with industry stakeholders to help drive the dematerialization of physical certificates; DTC has seen an 81% drop in the number of physical

²⁹ Eurobonds - <https://en.wikipedia.org/wiki/Eurobond>

³⁰ 2014 DTCC Annual Report, page 8 - <http://www.dtcc.com/annuals/2014/index.php>

³¹ 2014 DTCC Annual Report, page 38 - <http://www.dtcc.com/annuals/2014/index.php>

certificates held in their vault since 2003.³² More recently, DTC implemented Settlement Matching. The Settlement Matching initiative grew out of DTCC's enterprise-wide efforts to dramatically reduce reclaim risk and promote intraday settlement finality, aligning with the recommendations of global organizations including the Committee on Payment and Market Infrastructures of the International Organization of Securities Commission (CPMI-IOSCO). Since project inception in 2013, DTC has removed approximately \$525 billion of risk from the settlement system³³; transactions that no longer pose reclaim risk to DTC, its clients, or the financial service industry.

The National Securities Clearing Corporation (NSCC) Overview

The National Securities Clearing Corporation (NSCC) was established in 1976 and is a wholly-owned subsidiary of the Depository Trust and Clearing Corporation (DTCC) and provides clearing, settlement, risk management, central counterparty services, and guarantee of completion for virtually all U.S. broker-to-broker trades involving equities, corporate and municipal debt, American depositary receipts, exchange-traded funds and unit investment trusts. It is regulated by the Securities and Exchange Commission³⁴ and supervised by the Federal Reserve Board of Governors³⁵. NSCC has been designated by the Financial Stability Oversight Council as a systemically important financial market utility, and generally clears and settles trades on a T+3 basis. NSCC nets trades and payments among its participants, reducing the value of payments that need be exchanged by an average of 98% each day.³⁶

Euroclear Bank SA/NV Overview

Euroclear Bank SA/NV is an international central securities depository (ICSD) that provides settlement and related services for cross-border transactions involving domestic and international bonds, equities, funds and derivatives to financial institutions located in 90 countries. The Brussels office of Morgan Guaranty Trust Company of New York (Morgan Guaranty) founded the Euroclear System in December 1968. Euroclear Bank, while no longer owned by Morgan Guaranty, remains based in Brussels. Euroclear Bank is part of the Euroclear group of CSDs and settles transactions in 51 currencies and has processing links with CSDs in 46 markets worldwide. The Euroclear group, which also includes Euroclear Belgium, Euroclear Finland, Euroclear France, Euroclear Nederland, Euroclear Sweden and Euroclear UK and Ireland (all local CSDs), settled the equivalent of more than €500 trillion in securities transactions comprising of Eurobonds, equities, funds and derivatives in 2010, representing 150 million domestic and cross-border transactions, and held nearly €22 trillion in assets for clients.³⁷ Euroclear, via its local CSD, offers Target2 Securities (T2S)³⁸ settlement. In May 2014, Euroclear and DTCC established a joint

³² 2014 DTCC Annual Report, page 38 - <http://www.dtcc.com/annuals/2014/index.php>

³³ 2014 DTCC Annual Report, page 36 - <http://www.dtcc.com/annuals/2014/index.php>

³⁴ <http://dtcc.com/about/businesses-and-subsiaries/nscc>

³⁵ https://www.federalreserve.gov/paymentsystems/over_pssystem.htm

³⁶ <http://www.dtcc.com/about/businesses-and-subsiaries/nscc.aspx>

³⁷ Euroclear Annual Report August 2015, page 3 – <https://www.euroclear.com/en/about/Our-business/annual-report/annual-report-2014.html>

³⁸ Target 2 Settlement (T2S) is a new European securities settlement engine which aims to offer centralized delivery-versus-payment (DvP) settlement in central bank funds across all European securities markets. This provides a single settlement platform for securities settlement of central bank monies. See <https://www.ecb.europa.eu/paym/t2s/about/about/html/index.en.html> for additional context.

venture to deliver a collateral processing infrastructure to improve efficiency and mitigate risks by offering straight through processing to the settlement of margin obligations and address collateral mobility and allocation at a global level.

Clearstream International Overview

Clearstream International, a Luxembourg-based ICSD, was formed in January 2000 through the merger of Cedel International and Deutsche Börse Clearing. Clearstream ensures that cash and securities are delivered between trading parties, and manage, hold, and administer the securities that it holds on behalf of its customers. As a central securities depository (CSD) based in Frankfurt, Clearstream provides post-trade infrastructure for the German securities industry. Clearstream maintains relationships with around 2,500 customers in over 110 countries, its network extends to the international market and 55 domestic markets³⁹, and it offers T2S settlement. Over 300,000 domestic and internationally traded bonds, equities, and investment funds are currently deposited with Clearstream. Securities held under custody in Clearstream's international business as an ICSD increased by 10% from EUR 6.5 trillion in December 2014 to EUR 7.1 trillion in December 2015⁴⁰ while securities held under custody in the German CSD increased by 4% from EUR 5.7 trillion in December 2014 to EUR 6.1 trillion in December 2015⁴¹. For 2015, the full-year average of the value of assets under custody held on behalf of customers reached EUR 13.3 trillion compared to EUR 12.2 trillion in 2014 - an increase of 9%.⁴²

Comparison with 2010 Data

Differences in the way the data was collected prevents comparisons between 2010 and 2014. However changes in value may likely be attributed to significant enhancements made during this time period by both DTC and NSCC. Since 2010, DTC has made several changes that have helped facilitate increased intraday settlement payment withdrawals of eligible principal and income payments, as well as reversals of SPP wire payments. This included the introduction of the "Push Profile", enabling participants to establish a standing withdrawal request, expansion of the withdrawal request deadline and an awareness campaign, along with enhanced reporting tools, to educate participants on withdrawal options. Other enhancements, primarily driven by risk reduction concerns, may have also influenced liquidity changes. In March 2013 DTC expanded its Largest Provisional Net Credit risk control from a single issuer credit to the two largest issuer credits. This change decreased potential credit and liquidity risk resulting from intraday reversals of completed transactions in an MMI refusal to pay event. Also, provisional credits are no longer withheld when an MMI issuer funds its maturity obligations; these two changes offset each other with minimal participant impact.

³⁹ <http://www.clearstream.com/clearstream-en/about-clearstream/who-we-are>

⁴⁰ Deutsche-Borse Group Financial Report 2015, page 51 – http://deutsche-boerse.com/dbg/dispatch/en/listcontent/gdb_content_pool/imported_files/public_files/10_downloads/12_db_annual_reports/2015/Annual_Report_2015.pdf

⁴¹ Deutsche-Borse Group Financial Report 2015, page 51.

⁴² Deutsche-Borse Group Financial Report 2015, page 51

Additionally, in 2014, NSCC implemented a Supplemental Liquidity Deposit (SLD) to the NSCC Clearing Fund as well as other risk management tools, which required its members to provide additional liquidity to cover exposure during certain period

Potential Drivers of Future Change

Industry initiatives related to settlement timing and finality are expected to significantly impact Central Securities Depositories over the next two years: The Depository Trust and Clearing Corporation, in conjunction with industry support, plans to shorten the U.S. settlement cycle from the current three day cycle (T+3) to a two day settlement cycle (T+2) in Q3 2017. Industry benefits will include reduced credit and counterparty risk, lower liquidity needs, operational improvements, and harmonization with other global markets. In addition, DTC will make structural changes to its Money Market Instrument (MMI) product to achieve funding certainty, eliminating the potential for reversal prior to settlement. Potential settlement delays due to funding are expected to be offset by the concurrent elimination of the Largest Provisional Net Credit (LPNC2) risk controls. MMI implementation phases will occur between Q4 2016 and Q1 2017.

Additionally, the February 2015 implementation of pre-settlement matching, utilizing DTC Receiver Authorized Delivery risk management control, allows participants to pre-match and approve all incoming deliver order and payment order transactions prior to settlement. This change helped mitigate DTC's potential credit exposure, and improved settlement finality and transaction transparency for participants and their clients. The liquidity implications of these changes, while minimal overall, may have impacted individual participant liquidity practices differently.

It should be noted that in 2015, beyond the data of the data collected for this refresh, the DTCC raised additional capital through the issuance of common shares to its existing shareholders and the issuance of preferred shares to non-participant institutional investors. The new capital raised through the issuance is expected to satisfy new regulatory capital requirements and may drive future noteworthy change.

3.6 Retail Systems (FedACH, EPN)

Context of System

The automated clearing house (ACH) is an electronic network designed to transfer large numbers of payments efficiently. The ACH is used for a wide range of purposes, including business-to-business, consumer-to-business, business-to-consumer, and Federal benefits payments. Examples include vendor payments, payroll, Social Security, and credit and debit card settlements between merchants and card-issuing banks.⁴³ The payments tend to be smaller than those carried by large value transfer systems, but

⁴³ Statistics about retail payment mechanisms not covered in this study are provided in "The 2010 Federal Reserve Payments Study: Noncash Payment Trends in the United States: 2006 – 2009," available at http://frbsservices.org/communications/payment_system_research.html. These mechanisms—credit and debit

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they are not necessarily low-value transfers. The rules and regulations that govern the ACH network are established by NACHA (National Automated Clearing House Association), the U.S. Treasury Department, and the Consumer Financial Protection Bureau (CFPB).⁴⁴

ACH payment transactions are initiated by banks and routed through ACH operators to be sorted, cleared, delivered to other banks, and settled. The ACH network is served by two operators: the Electronic Payments Network (EPN), operated by the bank-owned The Clearing House, and FedACH, operated by the Federal Reserve Banks. Each ACH operator serves as an intermediary among participating financial institutions, sorting files received from the banks that originate ACH transactions and sending files to banks receiving the ACH transactions, calculating the resulting cash flows needed to support these transactions, and initiating the funding transactions. Settlements for ACH transactions all occur on the books of the Federal Reserve, either through their National Settlement Service (NSS) or by debits and credits to banks' Federal Reserve accounts.

The ACH is the only U.S. payment type that supports both credit (push) transactions and debit (pull) transactions.⁴⁵ As a result, ACH debit transaction and ACH credit transaction files transmit two different sets of payment instructions that are not intended to be offsetting. Originating depository financial institutions deliver both debit origination and credit origination files to the operators. The ACH network is a batch processing payment system, generally with next day settlement. Same day settlement for certain debit origination transactions commenced in 2010, and credit origination files may be delivered two days before the settlement date.

Comparison with 2010 Data

The settlement statistics in section 2 were provided by FedACH and The Clearing House. Both provided the average daily gross dollar value and transaction volume for all debit origination and credit origination files submitted through their respective infrastructures for the 4th quarter 2010 and 4th quarter 2014. There have been significant increases in the gross value settled since 2010. Driving these increases has been a growth in commercial tax payments (which means larger dollar transactions) and greater utilization of ACH by governmental agencies such as FDIC and OCC. In the consumer arena, check conversions have actually fallen since fewer checks are being written, but there have been increases in the volume of web debits, telephone payments, peer to peer and health care payments.

cards, and various evolving electronic payments—are not separately discussed here because they typically settle through the ACH, settlement banks, and Fedwire Funds' National Settlement Services, already discussed. Settlement for checks is diffused and declining and, therefore, is less likely to trigger the significant intraday flows that are the focus of this paper.

⁴⁴ At the time of this study, certain regulations, including Regulation E, that cover ACH transactions were administered by the Federal Reserve Board of Governors. During July 2011, responsibility transferred to the Consumer Financial Protection Bureau.

⁴⁵ By analogy: Wire transfers are also credit or “push” transactions, in which the entity holding the value to be transferred initiates a transaction to deliver value to a recipient. Debit card and check payments are debit or “pull” transactions, in which the participant receiving the value initiates a request for payment.

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Potential Drivers of Future Change

The Federal Reserve continues to make adjustments to the intraday posting times for ACH activity that affect bank liquidity. On July 23, 2015 the morning posting time for FedACH debit transactions moved to 08:30 ET from 11:00 ET. This change also aligned FedACH debits with the same posting time as EPN debits. Due to large balances being held at the Federal Reserve by large commercial banks, this change did not have a significant impact to the intraday liquidity position.

The Federal Reserve announced on December 17, 2015 their willingness to open their NSS as early as 21:00 ET for next day business. Settlement agents will be challenged to effectively monitor their early morning intraday account positions since the intraday monitoring tool that the Federal Reserve Banks provide (i.e., the Account Management Information system) will not reflect that activity until about 04:00 ET. If EPN begins using the earlier time, their ACH posting times will once again no longer coincide with FedACH posting times.

Future developments that will affect Retail payments include “Same Day ACH” and Faster Payments. Both will likely result in more intraday settlements and increased volumes of transactions and dollars.

SECTION 4: SELECTED FUTURE CONSIDERATIONS

With Intraday Liquidity Flow key dependencies and correlations exist across the PCS systems. These interdependencies require continuous improvement and refinement of liquidity management as participants are continually balancing their liquidity availability against cost and client needs. Changes to liquidity flows in the PCS system can drive risk to PCS participants. Additionally, reform change may also impact the liquidity landscape in the future. The authors of this paper believe changes to regulations, payment patterns and blockchain technologies, Common Securitization Platform (CSP)/Single Security, Housing and Government-Sponsored Enterprise (GSE) Reform, and Regulation on Settlement and Central Securities Depositories have the most likely potential to impact this analysis in the future. These items should be considered for future updates to this analysis.

4.1 Ongoing Changes in the Regulatory Environment

There are significant regulatory directives on various fronts focusing on intraday liquidity preparedness, both for banks and financial market infrastructures. While the initial push for banks came from a 2013 paper⁴⁶ issued by the Basel Committee on Banking Supervision, Dodd-Frank Act, the Comprehensive Liquidity Analysis and Review, Supervision and Regulatory Letter 14-1 on Recovery and Resolution Preparedness and further Recovery and Resolution guidance have all been very clear that banks must have detailed capabilities around monitoring and managing intraday flows, as well as being prepared to address any market, systemic or individual stresses.

For FMIs, the Principles for Financial Market Infrastructures (PFMIs) as published by CPMI and the Technical Committee of the International Organization of Securities Commissions (IOSCO) in 2012⁴⁷, introduced an updated regulatory framework, containing new and more demanding international standards for payment, clearing and settlement systems, designed to ensure that the infrastructure supporting global financial markets is more robust and well placed to withstand financial shocks. Although preceding versions of the PFMIs paid some attention to (intraday) liquidity, the PFMIs provided additional focus, with Principle 7 fully focused on Liquidity Risk, mandating FMIs to effectively measure, monitor and manage its liquidity risk, including its use of intraday liquidity.

A number of future regulatory changes that have yet to be fully implemented have the potential to impact intraday liquidity management. For internationally active banks, the Net Stable Funding Ratio (NSFR), defined as the amount of available stable funding relative to the amount of required stable funding, could have an impact on pricing and availability as it is gradually implemented over the next several years (full implementation target is 2018). SEC Money Market Reform, targeted for institutional prime and municipal money market funds, will require new disclosures, stress testing, and floating net asset values (NAVs). Intraday liquidity markets could be impacted as changes to these funds are fully implemented in October 2016.

⁴⁶ BCBS, *Monitoring tools for intraday liquidity management*, April 2013; <http://www.bis.org/publ/bcbs248.htm>

⁴⁷ CPMI IOSCO, *Principles for Financial Market Infrastructures*, April 2012; <http://www.bis.org/cpmi/publ/d101a.pdf>

On the FMI side, the European Securities and Markets Authority (ESMA) finalized rules to allow EU-based CCPs to allow one-day customer gross margining for CCPs covered under their rules (EMIR). In order to allow the one-day margining for customers, these CCPs must introduce an intraday margining cycle, something not widely adopted yet in the EU, and likely to introduce new intraday liquidity requirements into the EU CCP ecosystem.

The regulatory guidance continues to evolve and while the current low interest rate environment has allowed many of us to work towards compliance with meeting adequate liquidity buffers; it will be interesting to observe systemic flows in a different rate environment. Today, most, if not all banks can minimize systemic risk issues of late day concentrations or tightly managing real-time intraday liquidity given the resources currently available. However, the future question is how that will be fared against the regulatory directives to maintain intraday stress buffers and preparedness.

4.2 Changes to Institutional Payment Patterns

The changes in payment patterns in the PCS systems since 2010 have not been dramatic and this is easily explained by the fact that it is a comparison of two relatively liquid periods among PCS participants. As most banks can probably attest, in intraday liquidity terms periods prior to both 2010 and 2014 when banks' money desks were more closely managing balances and managing to lower reserves are dramatically different than periods after 2010 and 2014. Similarly, industry consolidation, again, already observed in the 2010 patterns as well as 2014, has led to fewer, larger and generally more liquid clearing banks. As such, there is an increased concentration of membership in the major FMUs. Again, the interesting analysis would occur in a less liquid and/or stressful environment with potentially fewer providers.

While the above considerations are the primary items to review for discussion in future installations of this white paper, there are other less mature items to be considered. For example, blockchain technologies (e.g., Bitcoin, etc.) and payment disruptors (e.g., Venmo, etc.), while small in size, scope and impact to intraday liquidity flows today, are areas seeing explosive change and worth researching and investigating for impact in future refreshes of this document.

4.3 Common Securitization Platform (CSP)/Single Security

The CSP consolidates many of the outdated back-office systems used by Fannie Mae and Freddie Mac in the mortgage securitization process into a common platform to be used by both GSEs. Fannie Mae and Freddie Mac, under the guidance of the Federal Housing Finance Authority, continue to make progress toward issuing a single MBS security that would have features similar to that of the current Fannie Mae MBS. The goal is to improve overall liquidity of Fannie Mae and Freddie Mac securities, which currently are not interchangeable with one another.

4.4 Housing and Government-Sponsored Enterprise (GSE) Reform

The potential impacts of possible GSE reform for Fannie Mae and Freddie Mac vary widely, with correspondingly different implications for Fedwire Securities. The GSE legislative reform options

discussed to date have differed in a number of respects, including factors that may influence whether securities issued by any newly created entities would remain eligible to settle on Fedwire.

4.5 Regulation on Settlement and Central Securities Depositories

The implementation of the EU Regulation on Settlement and Central Securities Depositories, also known as CSDR, could foster a reduction in intraday credit, as it impose new capital requirement on CSDs for the extension of intraday credit and limits criteria for collateral against which credit can be extended.

SECTION 5: CONCLUSIONS

Providers of payments, clearing, and settlement services for USD operate as independent but interconnected entities to create a virtual global network. Over the course of a typical business day, FMUs and CBs settle almost \$14.8 trillion worth of payments, which requires movement of over \$7.1 trillion daily during 2014. The role and size of USD in the global economy is well known, and this paper augments that information by documenting the distribution of fund flows through the business day. This paper focuses on the hourly settlement of transactions through financial market utilities and clearing banks, and although this does not include 100% of all USD settlements, the patterns of daily and hourly activity are likely indicative of total USD.

The 2011 study highlighted three broad themes, which still hold true today

- (1) The complexity and interconnectedness of the FMUs and CBs and their financial institution customers create an effective network;
- (2) Although more settlement activity occurs during certain parts of the day, it also occurs virtually around the clock and;
- (3) Some portion of the hourly patterns and levels documented are likely tied to current practices and economic conditions—and, in fact, this study recognizes that changes are already underway.

First, FMUs and CBs provide an important infrastructure for the USD financial system, supporting large value transfers, foreign exchange settlements, domestic and off-shore equity and derivatives clearing, government securities clearing, domestic and off-shore securities depositories, and retail payments settlements. As characterized in Section 2, these FMUs and CBs connect into the U.S. banking system. Collectively these entities provide core infrastructure—the pipes and plumbing—for the U.S. economy. The complexity of the interconnections, with multiple paths through the banking system and multiple service providers illustrated in chart 2.1, demands resilience and flexibility.

Second, the USD payments, clearing, and settlement system is global, active, and is virtually always open for business. Some of the fund flows documented in this study are tied to specific FMU requirements such as pre-scheduled settlement and margin call deadlines. These rules-based practices were described in Section 3. The timing of many other transfers is flexible, driven by factors that can vary by day, business needs, and a payor's funds availability. Thus, funds flows exhibit patterns but are also dynamic. The ability to move funds in real or near-real time and the availability of credit from various sources promotes the active flow of funds available to settle both payments and FMU and CB settlement obligations.

Third, Section 4 showed that the aggregate hourly patterns of USD funds flows are subject to change. Change can be driven by general economic conditions, FMU rules, public regulations, and market practices. Changes in needs, rules, and actions at individual FMUs or CBs would be reflected in alterations to the aggregated flows. And, some changes—including some already in the works—might

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be sufficiently significant on their own to influence the overall pattern should this study be repeated. For example, during the period of this study, substantial amounts of funds were typically available to start transactions flowing at the opening of FMUs' business day (because of the Federal Reserve's current policy stance and banks maintaining high overnight balances). The available liquidity undoubtedly was a factor in the current hourly profile. Some part of the hourly pattern of funds flows will change in concert with underlying economic conditions and liquidity policies.

Other motivators of change include reform of settlement practices for a particular part of a market (such as changes that have begun to be implemented for tri-party repo transactions), policy changes (such as the Federal Reserve's recent acceptance of collateralized overdrafts in lieu of fees), and regulatory imperatives (such as the Dodd-Frank mandate for centralized clearing of derivative transactions). As these and other changes are considered and put into practice, understanding the implications for funds flows during the day will become more important. The information in this paper may be particularly valuable to the risk management and operations/technology professionals at banks, FMUs, and at other payment and clearing system participants as a baseline against which to assess changes.

Since 2010, there have been a number of developments that could likely impact future liquidity. Some of these have and some of these have not impacted liquidity based on the 2014 data:

- Tri-party Repo Reform – The extensive reform of the tri-party repo market has produced significant operational improvements and enhanced risk management even as the size of the tri-party repo market (as measured by daily average outstanding collateral value) has remained relatively unchanged from 2010 to 2014.
- The changes to the Federal Reserve's collateralized overdraft policy and the potential reduction of general liquidity availability – although these were considered developments with potential future impact on liquidity flows, the reality has learned, given the general liquidity availability, that this has not yet impacted the intraday liquidity flows;
- Mandatory clearing of derivatives - the 2014 data shows a large increase in funding flows compared to 2010, which correlates with the growth in the volume of cleared swaps at the CCPs. The Dodd-Frank Act required certain classes of credit default and interest rate swaps to be cleared by CCPs, and hence, much of the growth was fueled by the implementation of these requirements.

Additionally, some other developments were noticed:

- The large balances maintained by U.S. banks with their Federal Reserve Banks resulted in very little reliance on daylight overdrafts. This ultimately allowed the U.S. banks to release time sensitive payments earlier in the day.
- On the retail side there have been significant increases in the gross value settled since 2010. Driving these increases has been a growth in commercial tax payments (which means larger dollar

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transactions) and greater utilization of ACH by governmental agencies such as FDIC and OCC. In the consumer arena, check conversions have actually fallen since fewer checks are being written, but there have been increases in the volume of web debits, telephone payments, peer to peer and health care payments. Credit origination examples include social security, direct deposit payroll and annuity payments. Debit origination examples are auto-debit insurance premiums and mortgage payments.

While the themes from 2010 continue to be relevant and important, the 2014 study identified several new and notable themes:

(a) flows continue to shift due to environmental (including but not limited to macroeconomic and regulatory) changes outlined in this paper and over time more shifts which could be positive or negative, are likely to occur and as they do, tracking the drivers will be important to understand the impacts on liquidity flows;

(b) the enormous amounts of available systemic intraday liquidity are unprecedented and it is thus unclear whether some historical concerns such as late day concentrations and timing spikes are being masked by the post-2008 trend of large available balances held by banks with the Federal Reserve Banks;

(c) related and possibly overlapping with the prior issue is the low interest rate environment along with certain regulatory requirements to hold certain levels of high quality liquid assets and their availability which does not provide incentives for reducing balances at the Federal Reserve Banks;

(d) significant regulatory pressure on banks driven by the BCBS, the Dodd-Frank Act and SR 14-1 to insure more than adequate intraday liquidity and short term liquidity buffers as well as the implementation of intraday liquidity reporting requirements may also influence behavior. It is currently unclear how a different rate environment would change behaviors among banks, however it is considered to be likely that measuring, monitoring and managing intraday liquidity can only become more important in a different rate environment.

The Payments Risk Committee continues to believe that documenting the current PCS activity and describing some of the underlying sources of change provides useful information to the public and, in particular, the financial institutions that use payments, clearing, and settlement services, especially given the evolving regulatory environment and with it, banks' building upon intraday liquidity programs. We have seen numerous historical moments when changes to one or many variables in the settlement process have caused shifts in timing and concentrations.

APPENDIX I: Glossary of Terms⁴⁸

Automated Clearing House (ACH)	A type of payment system designed to allow corporations and consumers to reduce or eliminate the use of paper checks when making routine high-volume, low value payments. ACH systems process large volumes of individual payments electronically. Typical ACH payments include salaries, consumer and corporate bill payments, interest and dividend, and Social Security. ACH providers in the U.S. include Federal Reserve and EPN which is owned by The Clearing House.
Batch Processing	The transmission or processing of a group of related payment instructions.
Central Counterparty (CCP)	An entity that is the buyer to every seller and seller to every buyer of a specified set of contracts, e.g. those executed on a particular exchange or exchanges. A CCP is a type of clearing cooperation.
Central Securities Depository (CSD)	A facility (or an institution) for holding securities that enables securities transactions to be processed by book entry. Physical securities may be immobilized by the depository or securities may be dematerialized (i.e., so that they exist only as electronic records). In addition to safekeeping, a central securities depository may perform comparison, clearing, and settlement functions.
Clearance	The process of transmitting, reconciling, and in some cases, confirming payments orders or financial instrument transfer instructions prior to settlement.
Clearing Corporation (aka Clearinghouse)	A central processing mechanism through which financial institutions agree to exchange payment instructions or other financial obligations (e.g. securities). The institutions settle for items exchanged at a designated time based on the rules and procedures of the clearing corporation. In some cases, the clearing corporation may assume significant counterparty, financial, or risk management responsibilities for the clearing system.
Clearing House Interbank Payments System (CHIPS)	An electronic funds transfer system that transmits and settles payment orders denominated in U.S. dollars. CHIPS enables banks to transfer and settle domestic and international payments more quickly with electronic bookkeeping entries. CHIPS is owned and operated by The Clearing House Payments Company L.L.C.
Committee on Payments and Market Infrastructures (CPMI) (formerly CPSS)	A committee of the BIS that serves as a forum for central banks to monitor and analyze developments in domestic payment, clearing and settlement systems as well as in cross-border and multicurrency settlement schemes.

⁴⁸ Sources used for the definitions include publications of the CPMI and IOSCO.

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Continuous Linked Settlement	A process enabling simultaneous foreign exchange settlement across the globe, eliminating the settlement risk caused by delays arising from time-zone differences by using a payment vs. payment mechanism.
CLS Bank International	CLS Bank is a multi-currency bank, holding an account for each settlement member and an account at each eligible currency's central bank, through which funds are received and paid. Technical and operational support is provided by CLS Services, an affiliate of CLS Bank. CLS Bank is based in New York and is an Edge Corporation bank supervised by the Federal Reserve.
Correspondent Bank	A bank that holds deposits for other banks and performs services, such as check clearing. The deposit balance is a form of payment for services.
Custodian	An entity, often a bank, that safekeeps securities for its customers and may provide various other services, including clearance and settlement, cash management, foreign exchange, and securities lending.
Daily Settlement	The completion of settlement on the day of value of all payments accepted for settlement.
Daylight Credit	Credit extended for a period of less than one business day; in a credit transfer system with end-of-day final settlement, daylight credit is tacitly extended by a receiving institution if it accepts and acts on a payment order even though it will not receive final funds until the end of the business day. Also called daylight overdraft, daylight exposure and intraday credit.
Daylight Overdraft	A negative position in an institution's Federal Reserve account.
Dealer	A firm that enters into transactions as a counterparty on both sides of the market in one or more products. OTC derivatives dealers are primarily large international financial institutions—mostly commercial banks but also some securities firms and insurance companies— as well as a few affiliates of what are primarily non-financial firms.
Delivery-vs-Payments system (DvP)	A system that ensures that the final transfer of one asset will simultaneously occur if, and only if, the final transfer of another asset (or other assets) occurs.
Depository Institution	An institution that holds funds or marketable securities, usually under a specific agreement.
The Depository Trust and Clearing Corporation (DTCC)	The holding company for a group of operating companies providing securities clearance, settlement, custody and information services. Subsidiaries include The Depository Trust Company (DTC), National Securities Clearing Corporation (NSCC), Fixed Income Clearing Corporation (FICC), and DTCC Solutions LLC, as well as certain joint ventures including Omega LLC.

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The Depository Trust Company (DTC)	DTC is a wholly owned subsidiary of DTCC. Established in 1973, it was created to reduce costs and provide clearing and settlement efficiencies by immobilizing securities and making “book-entry” changes to ownership of the securities. It provides settlement services for NSCC trades and for institutional trades, which typically involve money and securities transfers between banks and broker/dealers that are its participants. DTC is a state member bank of the U.S. Federal Reserve System, a limited-purpose trust company under New York State banking law and a clearing agency registered with the Securities and Exchange Commission.
Dodd-Frank Act	A federal statute formally known as The Dodd-Frank Wall Street and Consumer Protection Act was signed into law on June 21, 2010 by President Obama. The Act, by definition, was established to promote U.S. financial stability by improving accountability and transparency in the financial system, to end "too big to fail", to protect the American taxpayer by ending bailouts, to protect consumers from abusive financial services practices, and for other purposes.
FedACH	Suite of services provided by the Federal Reserve to give institutions an efficient, low-cost batched payment process/system which enables the electronic exchange of debit and credit transactions through the Automated Clearing House (ACH) network.
Fedwire	An electronic transfer system developed and maintained by the Federal Reserve System, enabling financial institutions to transfer funds and book-entry securities nationwide.
Fedwire Funds Service	Owned and operated by the Federal Reserve, the Fedwire Funds Service provides a real-time gross settlement system in which more than 8,000 participants initiate funds transfers that are immediate, final, and irrevocable when processed. Participants that maintain a reserve or clearing account with a Federal Reserve Bank may use the service to send payments to, or receive payments from, other account holders directly. Participants use the service to handle large-value, time-critical payments, such as payments for the settlement of interbank purchases and sales of federal funds; the purchase, sale, and financing of securities transactions; the disbursement or repayment of loans; and the settlement of real estate transactions.
Fedwire Securities Service	Owned and operated by the Federal Reserve, the Fedwire Securities Service provides a real-time, delivery-versus-payment (DvP), gross settlement system that allows for the immediate, simultaneous transfer of securities against payment. It also provides participants with the ability to maintain multiple securities accounts segregated for their own use or their trust operations.
Finality	An irrevocable and unconditional transfer of payment which occurs during settlement.

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Financial Market Utility (FMU)	The infrastructures that facilitate the clearing and settlement of monetary and other financial transactions, such as payments, securities, and derivative contracts, including derivatives contracts for commodities. Also known as Financial Market Infrastructure (FMI).
Fixed Income Clearing Corporation (FICC)	A subsidiary of The Depository Trust and Clearing Corporation (DTCC), FICC is an industry service organization, designed to operate on a not-for-profit basis, whose primary purpose is to ensure orderly settlement in the fixed income securities marketplace. FICC operates through two divisions: one, the Government Securities Division, serves the U.S. government securities market, while the other, the Mortgage-Backed Securities Division, supports the mortgage-backed securities market.
Foreign Exchange Settlement Risk (aka Herstatt Risk)	The potential loss of principal associated with settling transactions sequentially instead of simultaneously.
Funding Transaction	Movements of cash value to clear, net, offset, and/or settle financial market transactions.
Funds Transfer	A series of transactions, beginning with the originator's payment order, made for the purpose of making payment to the beneficiary of the order.
Funds Transfer System	A formal arrangement based on private contract or statute law, with multiple memberships, common rules and standardized arrangements, for the transmission and settlement of money obligations arising between the members.
Gross Domestic Product (GDP)	The broadest quantitative measure of the total economic activity specific to a nation. Often represents the monetary value of all goods and services produced within a nation's geographic borders over a specified time period.
Interest on Excess Reserves (IOER)	The interest rate paid on a reserve which is determined by the Federal Reserve Board. This rate is equal to the top of the target range for the federal funds rate and provides the Federal Reserve Bank, specifically the Federal Open Market Committee with a tool for conducting monetary policy.
In/Out Swap (I/O swap)	An In/Out swap comprises two equal and opposite FX transactions that are agreed as an intraday swap. One of the two FX transactions is input to CLS, in order to reduce each member's net position in the two currencies. The other is settled outside CLS.
International Organization of Securities Commissions (IOSCO)	An international organization comprised of securities market regulators.
Intraday Credit	See Daylight Credit.
Intraday Liquidity	Funds which can be accessed during the business day, usually to enable financial institutions to make payments in real time.

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Large-Value Payments (LVP)	Payments, generally of very large amounts, which are mainly exchanged between banks or between participants in the financial markets and usually require urgent and timely settlement.
Large-Value Transfer System (LVTS)	A type of wholesale payment system used primarily by financial institutions in which large values of funds are transferred between parties. Fedwire and CHIPS are the two large-value transfer systems in the U.S.
Liquidity Risk	The risk that a counterparty (or participant in a settlement system) will have insufficient funds to meet its financial obligations as and when expected, although it may be able to do so in the future.
Money Market Instrument (MMI)	Vehicles used to trade in the money markets over the counter. Vehicle examples include T-bills, commercial paper, repos, federal funds, etc.
Multilateral Netting	An arrangement among three or more parties to net their obligations. In settlement systems of this type transfers are irrevocable, but are only final after the completion of end-of-day-settlement.
National Automated Clearing House Association (NACHA)	A non-profit membership association charged with overseeing the Automated Clearing House (ACH) system, which operates the largest electronic payment network in the world.
National Securities Clearing Corporation (NSCC)	A wholly owned subsidiary of The Depository Trust and Clearing Corporation (DTCC). It is a central counterparty that provides centralized clearance, settlement and information services for broker-to-broker equity, corporate bond and municipal bond, exchange-traded funds and unit investment trust (UIT) trades in the U.S.
National Settlement Service (NSS)	A multilateral settlement service owned and operated by the Federal Reserve Banks. The service is offered to depository institutions that settle for participants in clearinghouses, financial exchanges and other clearing and settlement groups. Settlement agents acting on behalf of those depository institutions electronically submit settlement files to the Reserve Bank. Files are processed on receipt, and entries are automatically posted to the depository institutions' Reserve Bank accounts. Entries are final and irrevocable when posted.
Net Debit Cap	The maximum dollar amount of daylight overdraft an institution is permitted to incur in its Federal Reserve account. The exact dollar amount is a multiple—determined by the Federal Reserve—of an institution's capital.
Nostro Agent	A nostro agent is a bank that provides a nostro account for its customer. A nostro account is an account held by a customer bank on the books of another bank acting as a service provider.
Payment	A transfer of value.
Payment, Clearing and Settlement	The process components integral to the payments system.
Payment Order	An instruction to a bank to pay or to cause another bank to pay a fixed or determinable amount of money to a beneficiary.

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Payments Risk Committee (PRC)	A Federal Reserve Bank of New York committee established as an industry forum to assess and analyze payments functions, trends and risks.
Payment System	The mechanism—the rules, institutions, people, markets, and agreements—that make the exchange of payments possible.
Payment-vs-Payment (PvP)	A mechanism in a foreign exchange settlement system which ensures that a final transfer of one currency occurs if and only if a final transfer of the other currency or currencies takes place.
PSR Policy	The Federal Reserve’s Payment System Risk policy.
Queuing	A risk management arrangement whereby transfer orders are held pending by the originator/deliverer or by the system until sufficient cover is available in the originator’s/deliverer’s clearing account or under the limits set against the payer; in some cases, cover may include unused credit lines or available collateral.
Real-Time Gross Settlement (RTGS) System	A category of payments system. A system is said to operate in real-time if each payment is processed as it is initiated—which provides immediate finality—rather than in batch. This serves to reduce Herstatt Risk. Gross settlement refers to the settlement of each transfer individually rather than netting. Fedwire uses a real-time gross settlement system.
Repurchase Agreement (aka Repo)	A contract to sell and subsequently repurchase securities at a specified date and price.
Retail Payments	Small-dollar payments made in the goods and services market.
Reverse Repurchase Program (RRP)	AKA ‘Reverse Repo’ is a transaction conducted by the Open Market Trading Desk at the Federal Reserve Bank of New York where a security is sold to an eligible counterparty with an agreement to repurchase that same security at a specified price at a specific time in the future. The difference between the sale and repurchase implies a rate of interest paid by the Federal Reserve in the transaction.
Settlement	The final step in the transfer of ownership involving the exchange of securities or payment. In a banking transaction, settlement is the process of recording the debit and credit positions of the parties involved in a transfer of funds; in a financial instrument transaction, settlement includes both the transfer of securities by the seller and the payment by the buyer. Settlements can be "gross" or "net." Gross settlement means each transaction is settled individually. Net settlement means that parties exchanging payments will offset mutual obligations to deliver identical items, at a specified time, after which only one net amount of each item is exchanged.
Settlement Bank	A central bank or private bank used to effect money settlements for FMU members.
Settlement date	The date on which the parties to a transaction agree that settlement is to take place.
Settlement Finality	When the sender’s obligation to pay its receiving bank is discharged.

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Supplementary Leverage Ratio (SLR)	The ratio of a banking organization's tier 1 capital to its total leverage exposure including all on-balance sheet exposures and many off-balance sheet exposures.
System Open Market Account (SOMA)	The primary purpose of SOMA is to assist the Federal Reserve Bank of New York in carrying out open market operations and foreign exchange interventions.
Systemic Risk	The risk that the failure of one participant in a transfer system, or in financial markets generally, to meet its required obligations will cause other participants or financial institutions to be unable to meet their obligations (including settlement obligations in a transfer system) when due. Such a failure may cause significant liquidity or credit problems and, as a result, might threaten the stability of financial markets.
Target2 Securities (T2S)	A new European securities settlement engine which aims to offer centralized delivery-versus-payment (DvP) settlement in central bank funds across all European securities markets.
United States Dollar (USD)	The U.S. Dollar is the currency of focus for which the Intraday Liquidity Flows paper is written.
Wholesale Payments	Large-value payments used primarily in the financial markets.

APPENDIX II: Members of the 2011 Working Group

This report was produced for the Payments Risk Committee by its Working Group, whose members are listed below.

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Deutsche Bank	Steven Weinstock
Goldman Sachs	Joyce Lee Frank Tota
HSBC	John Ciccarone
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APPENDIX III: Members of the 2015 Working Group

This report was written for the Payments Risk Committee by its Working Group members listed below.

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