

# Intraday Liquidity Flows

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## **Report of the Payments Risk Committee**

**March 30, 2012**

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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. The 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 US 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. On behalf of the PRC, we are pleased to provide the 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. This paper documents a broad view of the current landscape and brings together key information for the first time.

The Intraday Liquidity Flows report provides a unified view of the infrastructure that enables more than \$14 trillion of USD denominated payments and the associated \$9 trillion of cash needed to settle those payments to move through the financial system. Seventeen financial market utilities and two clearing banks participated in the study, 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 PRC believes that there is value in repeating this information collection and the supporting analysis periodically to evaluate the sufficiency of intraday USD liquidity to settle payments. The committee thanks all the institutions that participated in the study and supported this important industry initiative.

The report was prepared for the PRC by its working group. We are very grateful to the members of the working group and its chairman, Michael Kurlander, 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 without whose contributions this report would not have been possible.

Paul Galant  
Chairman, Payments Risk Committee  
Chief Executive Officer, Global Enterprise  
Payments  
Citibank, NA

Kurt Woetzel  
PRC Sponsor, Intraday Liquidity Project  
Head of Global Operations and Technology  
The Bank of New York Mellon

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### EXECUTIVE SUMMARY

Intraday liquidity is the life-blood of the global payments, clearing, and settlement (PCS) systems – it is absolutely critical for the health and survival of the infrastructure and, without sufficient liquidity, the infrastructure will simply not function properly, if at all. The recent financial crisis underscores this point, as new regulatory proposals related to the intraday liquidity requirements of the PCS infrastructures continue to emerge.

Recognizing the predominance of the US dollar (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, initiated a study in the first quarter of 2011 to analyze the current environment. The information in this paper may be particularly valuable to the risk management and operations/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 U.S. government securities clearance business. In addition to those two clearing banks (CBs), 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 off-shore central securities depositories
- Retail payment services

The FMUs & 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 2010. 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 & 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 & CBs is more than \$9.0 trillion.
- While USD settlement activity is greatest during U.S. business hours, there are important flows around the clock.
- FMUs & 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 2010, aggregate overnight balances held in Federal Reserve accounts averaged approximately \$1 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 focus regulators are putting on intraday liquidity in the clearing and settlement infrastructures, it is critical that the industry look for continuous improvement and refinement of liquidity management processes. Several initiatives that might influence intraday liquidity needs, including tri-party repo reform, changes to the Federal Reserve Payment System Risk policy and the move of over-the-counter (OTC) derivatives to clearinghouses, are underway. More broadly, changes to governmental policies or market practices over the longer term could affect 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. It is in the best interest of the FMUs & CBs and market participants to maintain and update this study to provide important information about the sufficiency of USD liquidity intraday to settle global payments and clearing infrastructures where and when needed.

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, over \$14 trillion worth of payments to and from individuals, institutions, corporations, governments and other enterprises are settled in USD worldwide. To complete these transactions, more than \$9 trillion flow throughout the financial system. In addition to being significant in size and quantity, USD payment flows can be complex, occurring across a network of interconnected but separate PCS systems. It is important to note, however, that while there are multiple settlement systems, ultimately the final funds flows occur on accounts held at the Federal Reserve Banks. 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.

Recognizing the value of a common understanding and additional transparency into the flows of USD, the PRC undertook a study beginning in early 2011 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 clearly our understanding of 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.

Given the dependencies across PCS systems, one must consider consequences of variations from routine: how changing rules, new deadlines, or early or delayed release of funds can ripple through the network and potentially alter day-to-day activities. This report is intended to be leveraged as a baseline and can be updated over time to facilitate analysis of future trends and ramifications of changes on daily USD payments and intraday liquidity flows.

#### Context

Events over the last decade, especially since 2008, have highlighted the need for continuous improvement and refinement in how financial institutions manage liquidity. Efforts to minimize risk, for example in OTC derivatives, have led to significant pressure from regulators and lawmakers for the industry to create financial market utilities, generally in the form of clearing corporations, whose purpose is to eliminate or substantially reduce counterparty-specific settlement risk. Using clearing corporations, 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, 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 clearing corporations 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

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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.

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. This dynamic highlights the interdependencies of the financial institutions that carry the actual settlement obligations and of the FMUs. Questions about system-wide intraday liquidity, its availability and the cost to those who require it, are clearly worthy of continued study and attention.

To document the primary flow of USD funds across the globe, the PRC contacted and gathered information from seventeen firms that provide utility services for the U.S. 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 system. Chart 1.1, below, lists the FMUs & 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**

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

### Methodology

The PRC asked for hourly statistics on intraday flows of USD for “normal” days and for the peak day during the 4th quarter of 2010.<sup>1</sup> *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 or early 2011, 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 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 imply. For instance, while the FX settlement sector presents information for CLS<sup>®</sup> Bank 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<sup>®</sup>) or Fedwire<sup>®</sup> Funds Service or may settle on the books of a commercial bank.<sup>2</sup> 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.

### Organization

This report is organized as follows: Section 2 discusses the network of FMUs & CBs and the aggregate hourly statistics collected during the study. Section 3 includes descriptions of the entities in each sector. Section 4 looks to the future and some likely drivers of changes to the patterns and interconnections observed in this study. Section 5 concludes with selected key takeaways from the study.

## SECTION 2: INTERDEPENDENCIES AND AGGREGATE USD ACTIVITY

By focusing on the role of and the network created by the FMUs & CBs that transfer funds and settle transactions between participants, this paper documents 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 & 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.

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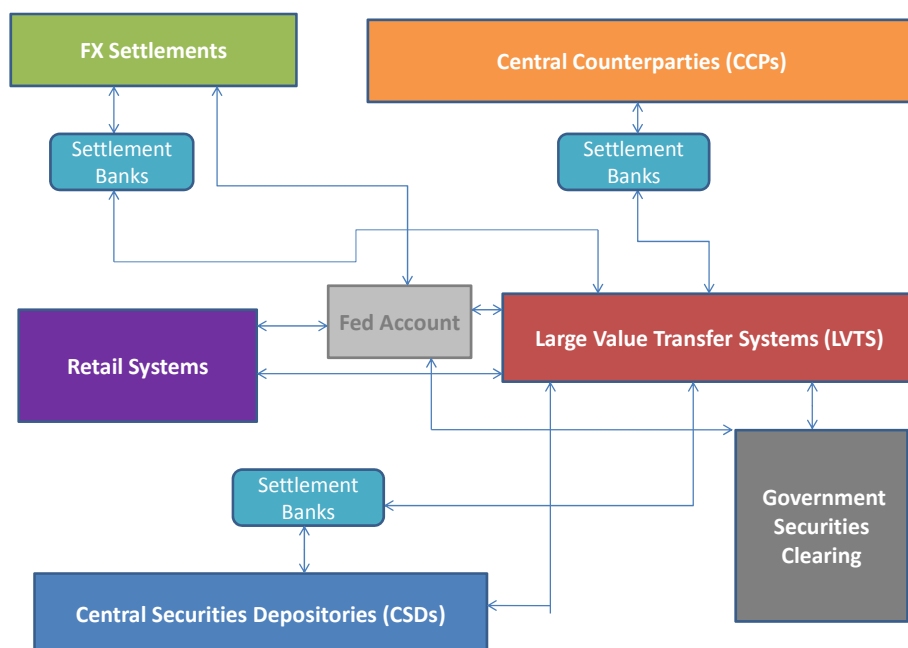
<sup>1</sup> Entities provided statistics on settlements and funding flows. These are described in Section 2 of the paper.

<sup>2</sup> CLS<sup>®</sup> (CLS) is a registered trademark of the CLS Bank, CHIPS<sup>®</sup> (CHIPS) is a registered trademark of The Clearing House Payments Company L.L.C., and Fedwire<sup>®</sup> Funds Service (Fedwire) is a registered service mark of the Federal Reserve Banks.

### 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 systems. In addition, the schematic includes two other types of entities: Federal Reserve Banks, shown as “Fed account,” and settlement banks. Transfer of value occurs when balances are transferred between entities that both have accounts with the same bank.<sup>3</sup> The Federal Reserve Banks provide this service for U.S. depository financial institutions, 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.

**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

<sup>3</sup> 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.

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 & 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 small number of 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.<sup>4</sup> 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.

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, 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.

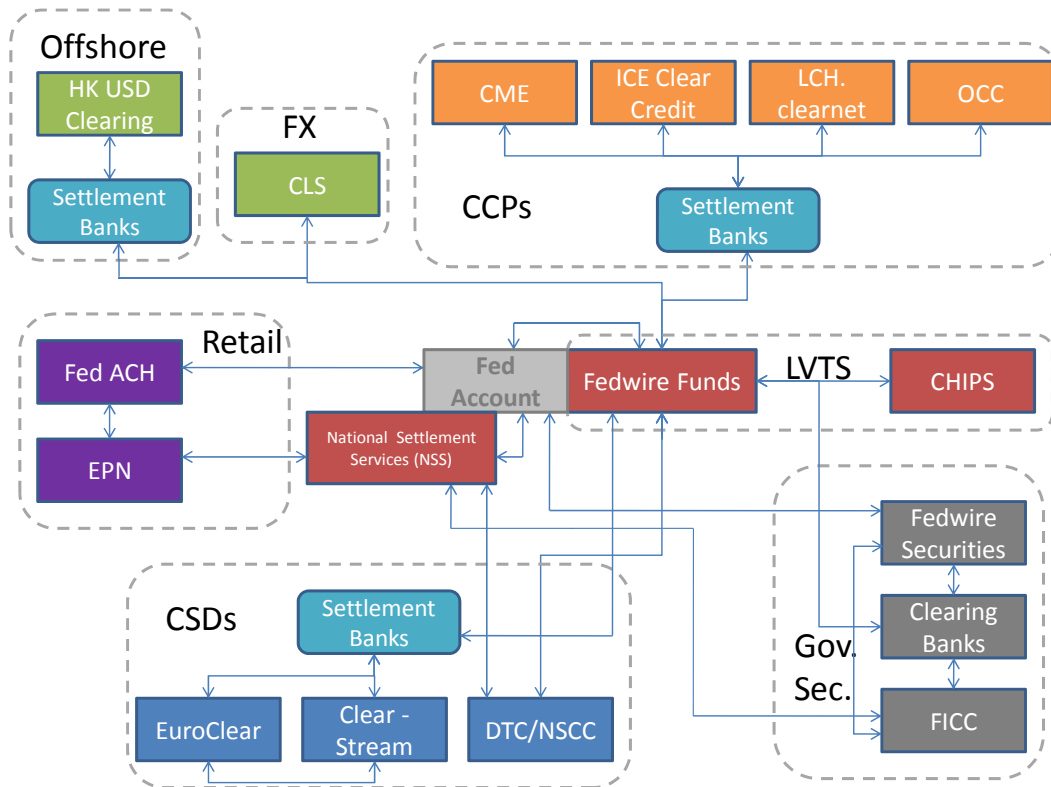
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<sup>4</sup> Some FMUs maintain settlement accounts at multiple settlement banks. They may consolidate the funds at one of the settlement banks during the day, known as the concentration bank. In principle, CHIPS may be used to transfer these funds as well as Fedwire.

**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 by 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.

**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 link, can arise because the entities perform similar functions or serve the same or

related markets. For example, CLS Bank settles almost 60 percent of all FX contracts.<sup>5</sup> 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 underlying business design or calendar events. Standardized days for futures contract settlements at CME and Class A settlement days at Fixed Income Clearing Corporation's Mortgage-Backed Securities Division illustrate the former, while pent-up flows on the days following holidays, mentioned by many systems, illustrate the latter. 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 the fourth quarter of 2010, aggregate overnight balances held in Federal Reserve accounts averaged about \$1.0 trillion. 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.<sup>6</sup> During the fourth quarter of 2010, daylight overdrafts incurred by depository institutions averaged about \$7 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.<sup>7</sup> 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

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<sup>5</sup> A 2010 study found that about 58 percent of all FX transactions and about 68 percent of FX transactions denominated in CLS eligible currencies settle through CLS. See <http://www.cls-group.com/SiteCollectionDocuments/CLS%20market%20share%20Feb%202011.pdf>.

<sup>6</sup> 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](http://www.federalreserve.gov/paymentsystems/psr_about.htm).

<sup>7</sup> 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](http://www.newyorkfed.org/research/economists/mcandrews/CHIPS_PolicyPaper.pdf))

settlement on their books; this credit permits a smoother flow of transactions, so that some level of shortfall may not materially delay FMU settlements.<sup>8</sup> Some FMUs also provide limited lines of credit that can be used to facilitate settlements.<sup>9</sup> And the U.S. government securities clearing banks routinely provide substantial amounts of intraday credit to facilitate clearing of tri-party repo transactions.<sup>10</sup>

### Payment Transactions vs. Funding Transactions vs. Funding Flows

Chart 2.3 compares the aggregate values of transactions settled within the participating FMUs & 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 *payment transactions*, *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: A CCP generally requires participants that owe money to the CCP (a “net debit” position) to send those monies to the CCP (in this example, \$10 billion). After the monies are received, the CCP pays out an equal amount of value to participants ending the settlement period in a “net credit” position (also \$10 billion). In this example, the payment transaction amount would be \$10 billion, the funding transaction would be \$10 billion, and funding flows would be \$20 billion (\$10 billion transferred from the net debit participants to the CCP and the \$10 billion transferred from the CCP to the net credit participants).

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<sup>®</sup> and EPN<sup>®</sup>) are batch settlement systems that debit and credit transfers of equal value among the bank accounts of payors and payees.<sup>11</sup> Depending on their designs, FMUs can conserve cash liquidity and provide other efficiencies by standardizing rules, managing risks, and offsetting transactions many times their gross settlement values.

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<sup>8</sup> This study did not collect information on the size or availability of settlement bank credit, nor on FMUs’ use of such credit from clearing banks. The discussion here is conceptual.

<sup>9</sup> 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](http://www.bis.org/list/cpss/tid_61/index.htm).

<sup>10</sup> 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.

<sup>11</sup> FedACH<sup>®</sup> (FedACH) is a registered service mark of the Federal Reserve Banks, and EPN<sup>®</sup> (EPN) is a registered trademark of The Clearing House Payments Company L.L.C.



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

	Gross Value of Payment Transactions (USD billion)	Funding Transactions <sup>a</sup> (USD billion)	Funding Flows <sup>b</sup> (USD billion)
<b>Large Value Transfer Systems</b>	3,953.0	2,426.1	2,378.2 <sup>c</sup>
<b>FX Settlements</b>	2,067.9	11.6	23.5
<b>Central Counterparties<sup>d</sup></b>	5.8	7.4	12.5
<b>Central Securities Depositories<sup>d</sup></b>	1,101.7	55.8 <sup>e</sup>	129.5
<b>Government Securities Clearing<sup>f</sup></b>	7,646.0	6,408.4	6,408.4
<b>Retail Systems</b>	159.8	159.8	159.8
<b>Total for Participating Firms</b>	14,934.2	9,069.1	9,111.8

<sup>a</sup>Funding may occur through a Fedwire transaction or on the books of a commercial bank

<sup>b</sup>Includes funding and defunding flows

<sup>c</sup>Excludes known double counts of funding transactions for other FMU sectors

<sup>d</sup>Information on gross value of payments settled was not collected for some CCPs and some CSDs during the study

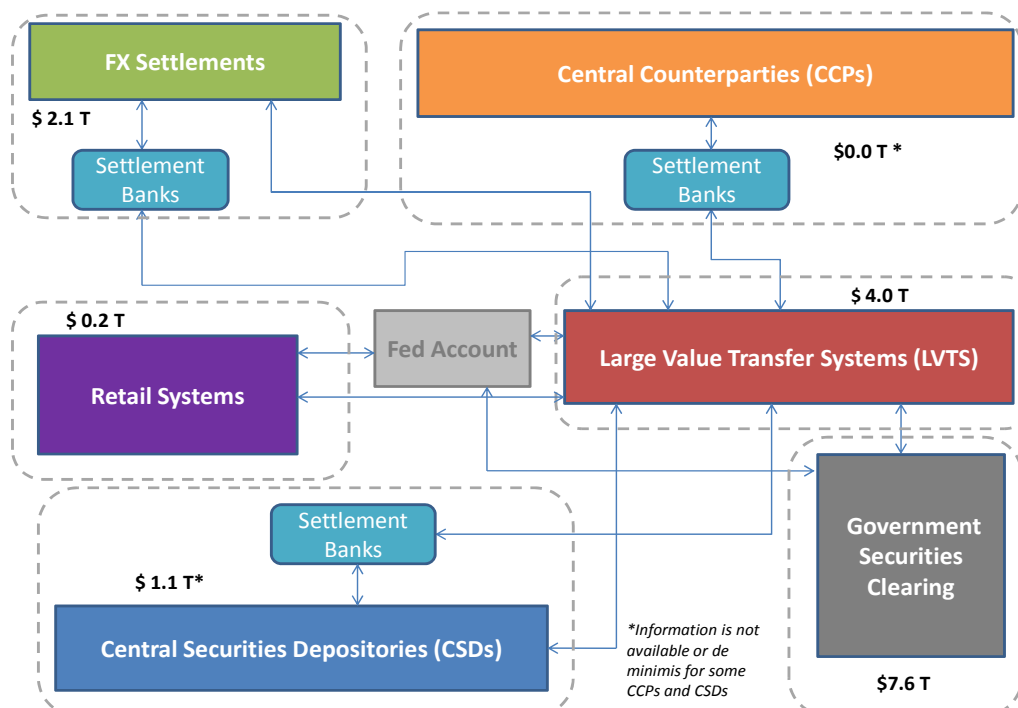
<sup>e</sup>One CSD provided net values of flows

<sup>f</sup>Includes settlements on the books of the clearing banks including tri-party repo and internal FICC settlements

Chart 2.4 merges the USD clearing and settlement graphic with normal gross daily values for payment transactions by segment in the left-hand column in Chart 2.3. These gross daily values, shown in USD trillions, reflect the aggregate values of transactions settled within the FMUs & 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: Gross Daily Value of Global USD Payment Transactions, by Sector**

Values in USD trillions



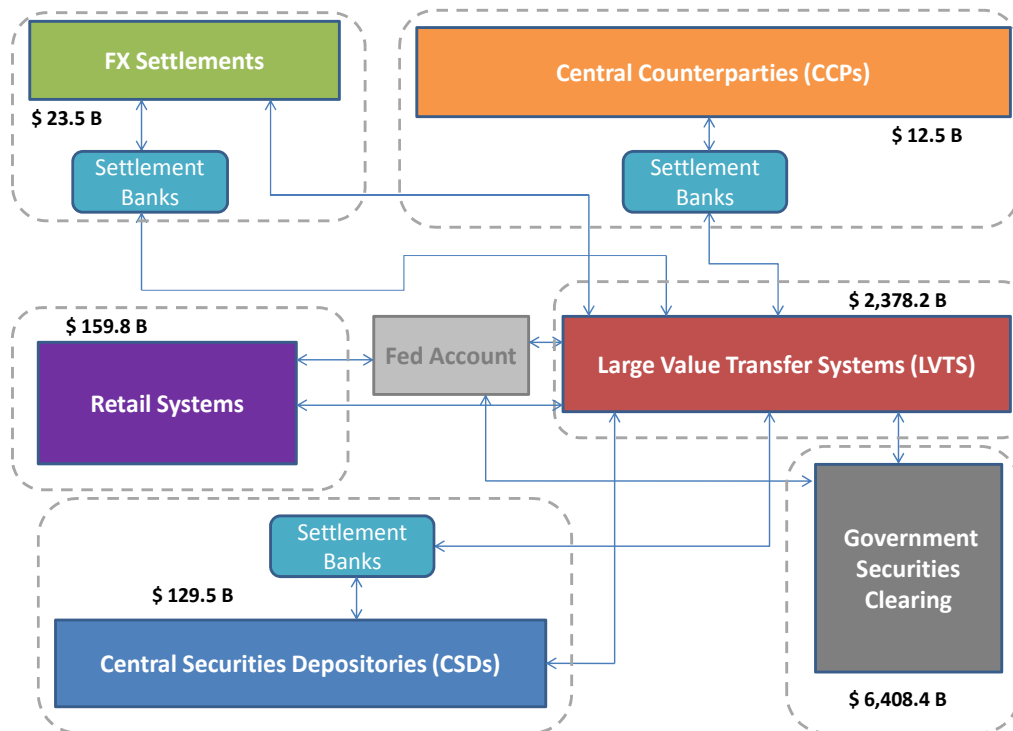
## Funding Flows

The gross daily settlement statistics shown in Chart 2.4 focus on the transfers of value between payment system participants through or within particular FMUs & 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 2010, these two FMUs settled about \$2.1 trillion worth of USD denominated financial contracts; they used \$12 billion of cash to effect these settlements; and \$24 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: Global Daily USD Funding Flows, by Sector**

Values in USD billions



### Aggregate Hourly Activity

Thus far, the statistics in this paper have described payment transactions, 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.

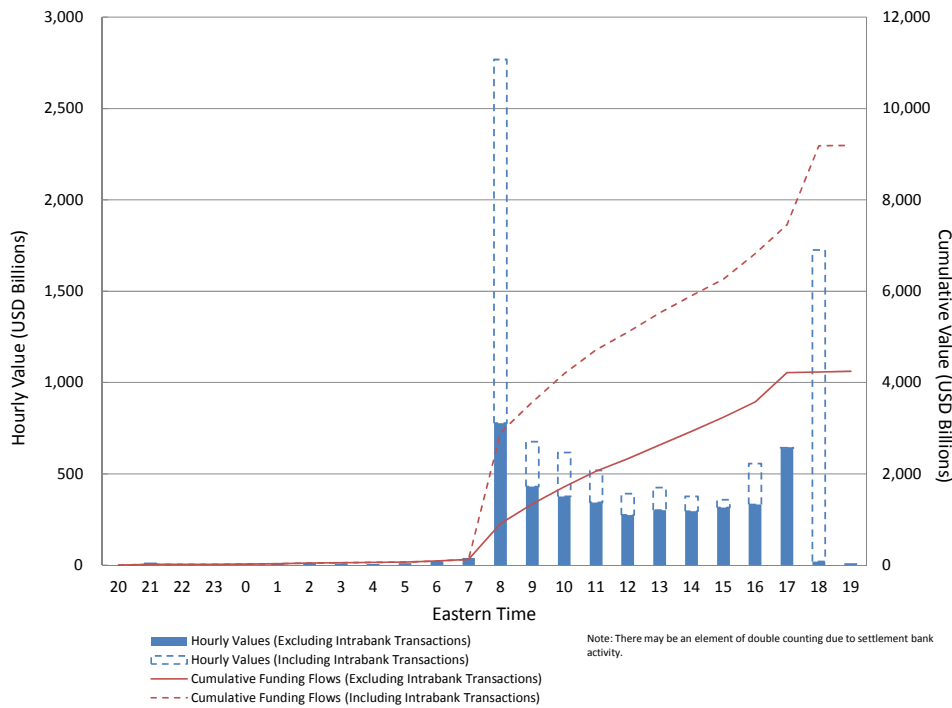
Chart 2.6 shows consolidated hourly value of USD funding flows across all surveyed FMUs & CBs, providing a different breakdown of the same flows shown in Chart 2.5. The overall pattern is bi-modal, with relative peaks at the beginning and end of primary eastern U.S. business hours. Prior to 08:00 ET, the aggregate value of payment flows are 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.<sup>12</sup> Mid-day, the aggregate flows average about \$380 billion per hour, and then increase somewhat in the late afternoon as the end of the regular business day approaches. 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. As various U.S. businesses open, funding activity picks-up and the cumulative flows climb steadily over the morning and afternoon hours, reaching just over \$4 trillion at the end of the day. The dashed red line shows the cumulative funding flows, including those within clearing banks and between FMUs, reaching a high of about \$9.1 trillion.

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<sup>12</sup> 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.

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

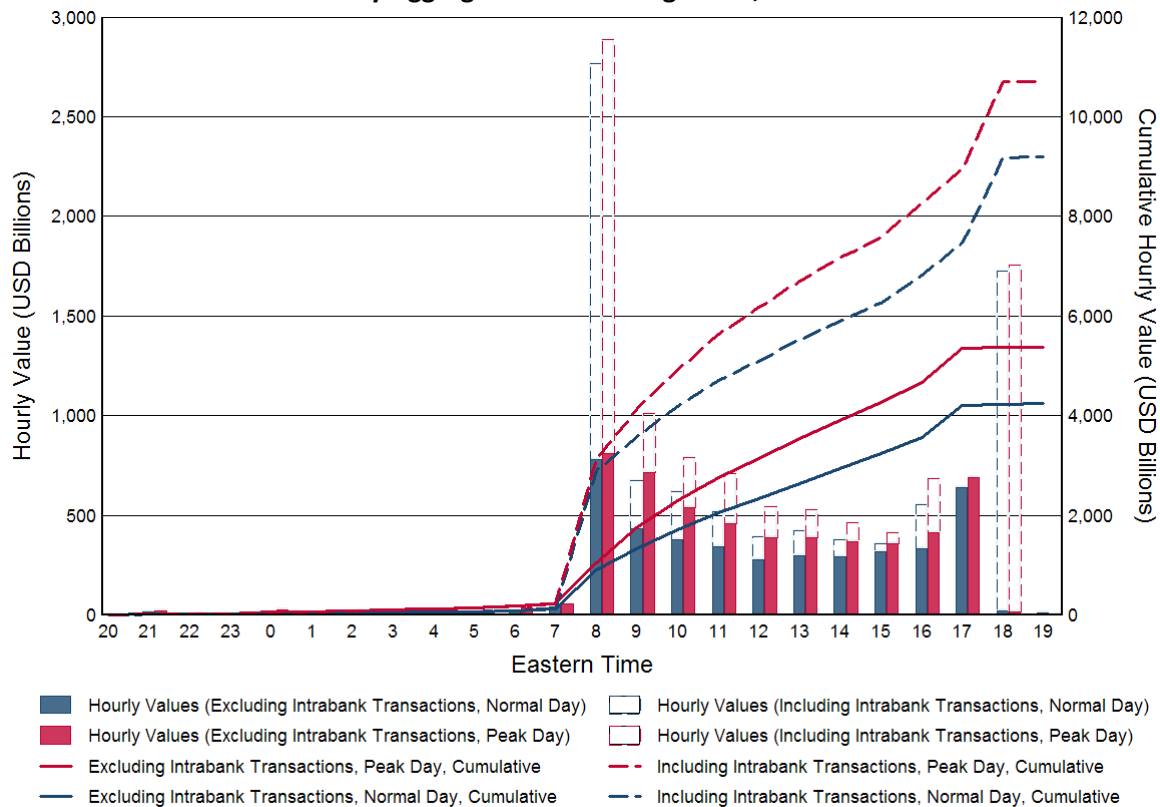


The PRC collected data on both normal and high-value day activity. Chart 2.7 compares the normal and peak aggregate and cumulative value of USD funding flows by hour. Each FMU & CB identified its peak day during the survey period based on when the value of funds flowing through its system was the highest. For this chart, the peak values for the component systems for each sector were added, although it is quite unlikely that all FMUs & CBs had the same peak day. As such, the peak activity data below represents an extreme scenario where all the FMUs & 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 later part of the business day. The cumulative aggregate flows across all FMUs & CBs on a peak day are over \$1.5 trillion more than those on a normal day, although this peak day represents an extreme scenario.

## Intraday Liquidity Flows (ILF)

Payments Risk Committee Report

Chart 2.7: Normal v Peak Daily Aggregate USD Funding Flows, YE 2010



There is considerable variation in the normal versus peak values and volumes by sector shown in Chart 2.8. The percentage variation in normal versus peak-day values ranges from a low of 11 percent for government securities clearing to over 280 percent for the equity and derivatives clearinghouses. The volume changes for peak days show a somewhat different pattern: At central securities depositories, the number of transactions was almost 280 percent greater than normal, while the number of transactions for FX settlements actually declined by about 2 percent, reflecting greater than normal netting efficiency. In general, variation in volumes is lower than the variation in value of funding flows of the FMU sectors, with the exception of central securities depositories.

**Chart 2.8: Normal v 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 (%)
LVTS	2,378.2	522.6	2,900.1	579.3	22%	11%
Gov Sec	6,408.4	150.2	7,085.0	175.8	11%	17%
FX	23.5	0.3	57.8	0.2	146%	-2%
CCPs	12.5	0.7	48.1	0.7	286%	9%
CSDs <sup>a</sup>	129.5	3.5	348.7	13.3	169%	278%
Retail	159.8	85.7	267.1	101.2	67%	18%

Note: To the extent that funding transactions take place through Fedwire Funds and/or settlement banks, there is an element of double counting that has not been eliminated.

<sup>a</sup> Clearstream volume data was not available

### 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.

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.<sup>13</sup> There were approximately 8,000 active accounts eligible to use Fedwire Funds as of December 2010. The Fedwire Funds is a real-time gross settlement system whereby transfer of money takes place from one bank to another based on entries to a 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 operates 21.5 hours each business day. Fedwire Funds transfers are 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.

<sup>13</sup> Depository institution customers for Federal Reserve Bank financial services are called banks in this paper.

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.<sup>14</sup>

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. In December 2010, CHIPS had 50 participants, including large U.S. banks and U.S. branches of foreign banks. CHIPS operates 20 hours each business day.

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, including the dollar payments resulting from foreign currency transactions (such as spot and currency swap contracts, out leg of CLS Inside/Outside swaps) and Eurodollar placements and returns to commercial transactions such as international remittances, corporate wire transfers and trade settlements.<sup>15</sup>

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

Government securities clearance (GSC) involves the receipt of U.S. Treasury and Agency securities vs. payment with the intent to deliver those securities within the same or next available settlement cycle. GSC services supports three primary product lines: buying and selling of securities (buy-sell), delivery-versus-payment (DvP) repos, and tri-party repos. GSC settlement mostly occurs through the Federal Reserve Banks' Fedwire Securities book-entry system or on the books of two clearing banks—Bank of New York Mellon (BNYM) and J.P. Morgan Chase (JPMC). Many of these transactions are facilitated by The Depository Trust & Clearing Corporation's (DTCC) Fixed Income Clearing Corporation, through its

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<sup>14</sup> See [http://www.federalreserve.gov/paymentsystems/psr\\_about.htm](http://www.federalreserve.gov/paymentsystems/psr_about.htm) for more information.

<sup>15</sup> Over 95% of cross-border USD payments outside of CLS Bank are completed through CHIPS.

Government Securities Division (FICC-GSD) and Mortgage-Backed Securities Division (FICC-MBSD). FICC-GSD provides netting and central clearing services for Treasury securities, while FICC-MBSD tracks and offsets trades of agency-issued mortgage backed securities. In addition, FICC's General Collateral Financing Repo (GCF-Repo<sup>®</sup>) service provides clearing and settlement services for interdealer transactions in the specialized tri-party repo market.<sup>16</sup>

U.S. government and agency transactions between two different banks settle on Fedwire Securities on a DvP basis, with the transfer of money from the buyer to the seller occurring simultaneously with the delivery of the securities from seller to buyer.<sup>17</sup> Transactions between entities that are both customers of the same clearing bank are generally effected on a book-entry (that is, on-us) basis at that clearing bank. Most of the transactions that flow through the Fedwire Securities service send securities from or to one of the clearing banks.

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

The key FX systems analyzed for this sector include Continuous Linked Settlement (CLS) and the Hong Kong USD clearing system. 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 is offered by CLS Bank International (CLS Bank). Owned by FX market participants, CLS operates the largest multi-currency cash settlement system to eliminate settlement risk in the FX market. As of June 2011, 60 settlement members settle transactions in seventeen eligible currencies.<sup>18</sup>

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 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, there are eighteen nostro agents to settle USD 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.

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<sup>16</sup> GCF-Repo<sup>®</sup> is a registered trademark of the Depository Trust and Clearing Corporation or its affiliates in the U.S.

<sup>17</sup> 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.

<sup>18</sup> CLS 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, and Mexican Peso.



### 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. Transactions in four currency denominations may 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 The Hong Kong and Shanghai Banking Corporation. The system processes USD interbank and remittance payments that include FX transactions against several Asian currencies. Approximately 46 percent of total transactions are FX-related, and the remainder relate to interbank payments and remittances.

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

Four major domestic and offshore utilities actively clear and settle a large proportion of USD-denominated derivative transactions. They are 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 this paper, the market for derivatives clearing is growing, with the likely result that the number of entities that provide this type of service and the amounts settled could increase significantly.

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 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 IntercontinentalExchange 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.

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, 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., an independent clearing house 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, and euro and sterling denominated bonds and repos. LCH is principally regulated by the U.K. Financial Services Authority.

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

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 that they exist only as electronic records. The CSDs may also provide centralized comparison and clearing and settlement services.

The Depository Trust Company (DTC), established in 1973, is a wholly owned subsidiary of DTCC, which was formed in 1999. 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 (which typically involve money and securities transfers between custodian banks and broker/dealers), and for money market instruments. DTC and NSCC have a combined net funds settlement that is processed through NSS. In 2010 DTC settled securities valued at \$1.7 quadrillion and had over \$35 trillion securities on deposit.

NSCC, established in 1976, provides clearing, settlement, risk management, and central counterparty services. It guarantees settlement for certain transactions for broker-to-broker trades involving equities, corporate and municipal debt, American depository receipts, exchange-traded funds, and unit investment trusts. NSCC also nets trades and payments among its participants, reducing the value of securities and payments that need to be exchanged by an average of 98 percent each day. NSCC generally clears and settles trades on a T+3 basis.

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 more than 90 countries. Euroclear Bank, based in Brussels, is part of the Euroclear group of CSDs and settles transactions in more than 50 currencies and has processing links with CSDs in more than 40 markets worldwide. The Euroclear group, which also includes Euroclear Belgium, Euroclear Finland, Euroclear France, Euroclear Nederland, Euroclear Sweden and Euroclear UK & Ireland, settled the equivalent of more than €500 trillion in securities transactions in 2010, representing 150 million domestic and cross-border transactions, and held nearly €22 trillion in assets for clients.

Clearstream Banking Luxembourg is also an ICSD. It is a wholly owned subsidiary of Deutsche Börse that ensures that cash and securities are delivered between trading parties. Clearstream manages, safekeeps, and administers the securities that it holds on behalf of its customers. Over 300,000 domestic and internationally traded bonds, equities, and investment funds are currently deposited with Clearstream valued at over €10 trillion. Clearstream maintains relationships with around 2,500 customers in over 110 countries, and its global network extends across 50 markets.

### 3.6 Retail Systems (FedACH, EPN)

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.<sup>19</sup> The payments tend to be smaller than those carried by large value transfer systems, but 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).<sup>20</sup>

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), run 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 the 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.<sup>21</sup> 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

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<sup>19</sup> 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://frbervices.org/communications/payment\\_system\\_research.html](http://frbervices.org/communications/payment_system_research.html). These mechanisms—credit and debit 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.

<sup>20</sup> 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.

<sup>21</sup> 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.

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.

### **SECTION 4: SELECTED FUTURE CONSIDERATIONS**

As highlighted, there are key dependencies and correlations across the PCS systems. When considering this, the importance of continuous improvement and refinement of liquidity management on a systemic basis becomes apparent. Individual participants continually balance their liquidity against cost and client needs. In addition, this study illustrates the importance of giving attention to intraday liquidity across the PCS system. Certain patterns, for example late day concentrations, can present risks to many participants.

As the PRC analyzed current patterns of intraday USD payment flows, the committee recognized that it was important to also look forward and consider some of the changes taking place and potential reforms that could have an impact on the liquidity landscape in the future. Currently identifiable changes to the intraday liquidity patterns described in this paper include reforms to tri-party repo settlement, revisions to the Federal Reserve's Payment System Risk policy, requirements for clearing of OTC derivatives, and reductions in general liquidity availability.

#### **4.1 Tri-party Repo Reform**

In 2009, the PRC commissioned the Tri-Party Repo Infrastructure Reform Task Force (Task Force) to examine systemic risks in the tri-party repo funding market. For more information on the Task Force, see <http://www.newyorkfed.org/tripartyrepo/>. In 2010, the Task Force issued a set of specific recommendations, centered primarily around operational and technical enhancements. Key goals of these recommendations include the practical elimination of credit extended from the clearing banks to the U.S. dealer community, as well as increased transparency to market participants. Specific recommendations include eliminating the systemic need for a full unwind of securities back to dealers at the start of each day, settling maturing and new repo transactions simultaneously after 15:30 ET, and publishing key statistics on the composition of the U.S. tri-party repo market.

As these recommendations become fully implemented, U.S. tri-party cash investors will no longer have access to maturing cash at the start of the day. Additionally, cash investors are expected to send cash for new tri-party repo transactions prior to 15:30 ET under the Task Force recommendations. These changes could impact cash investors who rely on the availability of overnight tri-party cash to meet other intraday settlement obligations, or as a component of their liquidity risk planning. The aggregate impacts, however, are anticipated to be minimal to the overall liquidity and depth in the U.S. tri-party market. Analysis of the current market structure conducted by the Task Force in 2010 demonstrated the following: (1) a very large percentage of overnight cash rolls each day between a given dealer and cash investor; (2) of the remainder that does not roll, a significant percentage remains within the tri-party repo market; (3) of the remainder that leaves the tri-party repo market, a high percentage is not actually

## Intraday Liquidity Flows (ILF)

### Payments Risk Committee Report

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paid out until 14:00-16:00 ET. As dealers look to term out more of their tri-party repo funding, the notional value of daily tri-party repo payments could decline even further. The unwind time for maturing payments was pushed back to 15:30 ET in August 2011, and initial feedback suggests no adverse systemic impacts.

Under the Task Force recommendations, intraday credit extended by the clearing banks to dealers will be capped at 10 percent of the collateral a dealer finances in tri-party repo (also referred to as a dealer's "book"). As a result, dealers will need to much more closely monitor their projected and actual cash positions intraday. Technical advancements and improved operational tools developed by the clearing banks will help facilitate this change. Additionally, the delayed unwind of maturities allows cash from new financing transactions or other liquidity sources to be made available to facilitate the maturity process.

A key future consideration for the U.S. tri-party repo market will be increased and improved payment netting. The Task Force has recommended, as a minimum standard to support the reforms, that cash investors develop the capability to net tri-party repo payments and receipts with a given dealer to curb the need to source liquidity to pay maturities only to see cash come back later in the day to settle newly-executed transactions. Additional improvements would increase the amount and level of netting, speed collateral allocation processing by the clearing banks, and implement a transparent rolling settlement cycle. These improvements should alleviate pressure on the ability to settle transactions and clear payments in the shortened post-15:30 ET settlement window.

As noted in the discussion on Chart 2.6, government securities clearing is extremely bi-modal, dominated by DvP repo transactions and the tri-party repo "unwind" between 08:00 and 09:00 ET and by the tri-party repo "rewind" after 18:00 ET. When fully implemented, the proposed reforms should significantly alter the tri-party repo part of the flows. Overall, the amounts should be at least halved, as the current unwind and rewind are melded into a single process. To the extent that term, open, and rolled transactions are not unwound at all, they should not trigger any funds flows, resulting in a still smaller daily peak during the new/future settlement time period. The recent change of shifting the morning settlement for many of these repos to mid-afternoon likely attenuated the daily morning peak somewhat.

#### **4.2 Changes to the Federal Reserve Payment System Risk Policy**

Revisions to the Payment System Risk Policy (Policy) were announced in December 2008 by the Federal Reserve Board and they went into effect on March 24, 2011. The revisions to the Policy aimed to improve intraday liquidity management and payments flows, which had shifted later in the day over the previous 25 years, and to help mitigate credit exposures of the Federal Reserve Banks from daylight overdrafts. The revised Policy explicitly recognizes the role of the central bank in providing intraday balances and credit to healthy depository institutions and makes greater use of collateral as a tool to help balance the benefits and risks of providing intraday balances and credit. The Policy encourages depository institutions to pledge collateral to cover daylight overdrafts by providing collateralized

daylight overdrafts at a zero fee and discourages the use of unsecured daylight credit by raising the fee for uncollateralized daylight overdrafts to 50 basis points.

Following the Policy's implementation, the level of daylight overdrafts incurred by depository institutions declined substantially. In Q2 2008, daily peak overdrafts averaged \$186.6 billion. In the quarter immediately following implementation, in Q2 2011, daily peak overdrafts had fallen to \$35.4 billion. Similarly, in Q2 2008, daily overdrafts averaged \$71 billion, and in Q2 2011 these had dropped to \$1.5 billion. In Q2 2011, just months after the collateralization option became available, 84 percent of the peak overdrafts and 93 percent of average overdrafts were collateralized. The impact of the revised Policy on payment flows is difficult to isolate, however, because high levels of liquidity in the banking system complicate the analysis. Under policies discussed further in Section 4.4, reserve balances held by depository institutions with Federal Reserve Banks rose from just over \$10 billion in June 2008, to more than \$1.5 trillion in June 2011.

### 4.3 Move towards Centralized Clearing of OTC Derivatives

The impact of the move of centralized clearing of OTC derivatives through CCPs should be considered in terms of its impact on liquidity withdrawal and timing. There are two areas to cite for future analysis of liquidity related to CCPs.

First, it will be useful to track the increase in liquidity that will be required to be lodged at CCPs intraday when the Dodd-Frank Act<sup>22</sup>, European Markets Infrastructure Regulation and the equivalent legislation in Asia take full effect. Initial margin, variation margin payments, and guarantee fund contributions will be substantial for OTC derivative products in the credit, rates, equities and FX space. In the case of central clearing of FX products, the required liquidity coverage is likely to be particularly large given the need to support physical settlement of contracts. In addition, unlike bilateral counterparty margin payments made in a less structured way during the course of a day, CCP margin payments are typically concentrated at a specific time in the day. As more products move to CCPs, the timing of intraday margin calls could create more concentrated flows than exist today.

Second, intraday liquidity issues can arise in dramatic fashion under default scenarios where CCPs will need to cover liquidity needs for the simultaneous failure of one, two or more clearing member families. An event such as this could result in a significant draw on liquidity from the market intraday. The decreasing availability of credit and the wrong-way risk inherent in drawing on committed liquidity facilities during periods of market stress would exacerbate the CCPs' demand for liquid deposits. The Committee on Payment and Settlement Systems (CPSS) and the Technical Committee of the International Organization of Securities Commissions (IOSCO)<sup>23</sup> are developing guidance for infrastructures supporting global financial markets, including CCPs, to be more robust and able to

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<sup>22</sup> The Dodd Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) is a federal U.S. statute that was signed into law on July 21, 2010. See, <http://www.gpo.gov/fdsys/pkg/PLAW-111publ203/content-detail.html>

<sup>23</sup> CPSS and IOSCO published a consultative report, *Principles for Financial Market Infrastructures*, in March 2011 and are expected to publish the final report shortly. More information at <http://www.bis.org/publ/cpss94.htm>

withstand financial shocks. This report, expected at the end of first quarter 2012, will include guidance on managing liquidity needs under normal and stressful conditions.

### 4.4 Reduction in General Liquidity Availability

Currently, there is substantial liquidity available in the banking system as evidenced by the very high reserve balances maintained by depository institutions with the Federal Reserve Banks. The size of reserves is determined by the size of the Federal Reserve's policy initiatives, such as the large scale asset purchases. As discussed in Section 2, the availability of liquidity from available reserves enables banks to fund payment transactions more readily and earlier than when funding draws on intraday overdrafts of Federal Reserve accounts.

In the future, the Federal Reserve could choose to reduce the amount of reserves available, with the possible knock on effect of reducing funds available for payments. However, because it can pay interest on reserves, the Federal Reserve can conduct monetary policy without needing to reduce the amount of reserves in the system. A central bank might make this choice for normal times because the approach can offer the important advantages to the payments system of reduced reliance on daylight credit and reduced operational risk associated with earlier-in-the-day payments movements.<sup>24</sup>

## 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 & CBs settle over \$14 trillion worth of payments, which requires movement of over \$9 trillion. 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 all settlements, the patterns of daily and hourly activity are likely indicative of total USD.

This study highlights three broad themes: (1) the complexity and interconnectedness of the FMUs & CBs and their financial institution customers create an effective network, (2) while more settlement activity occurs during certain parts of the day, it also occurs virtually around the clock and, (3) at least some portion of the hourly patterns and levels documented here are likely tied to current practices and economic conditions—and, in fact, this study recognizes that changes are already underway.

First, FMUs & 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,

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<sup>24</sup> See Keister and McAndrews, *Why are banks holding so many excess reserves*, Federal Reserve Bank of New York *Current Issues in Economics and Finance*, Volume 15, Number 8 (December 2009) at [http://www.newyorkfed.org/research/current\\_issues/ci15-8.pdf](http://www.newyorkfed.org/research/current_issues/ci15-8.pdf) for discussion of central bank options in establishing the level of reserves, and Bech et al, *Settlement Policy and Monetary Policy Implementation*, for analysis of liquidity on timing of intraday settlements.



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government securities clearing, domestic and off-shore securities depositories, and retail payments settlements. As characterized in Section 2, these FMUs & 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 funds flow 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 & 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 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.

The Payments Risk Committee believes 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. The global and dynamic nature of payments shown here demonstrates the importance of the underlying infrastructures. The committee recommends repeating this study periodically to evaluate the sufficiency of intraday USD liquidity to settle payments via these infrastructures.



**APPENDIX 1: Glossary of Terms**<sup>25</sup>

<b>Automated Clearing House (ACH)</b>	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.
<b>Batch Processing</b>	The transmission or processing of a group of related payment instructions.
<b>Central Counterparty (CCP)</b>	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 corporation.
<b>Central Securities Depository (CSD)</b>	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.
<b>Clearance</b>	The process of transmitting, reconciling, and in some cases, confirming payments orders or financial instrument transfer instructions prior to settlement.
<b>Clearing Corporation (aka Clearinghouse)</b>	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.
<b>Clearing House Interbank Payments System (CHIPS®)</b>	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.
<b>Committee on Payment and Settlement Systems (CPSS)</b>	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.

<sup>25</sup> Sources used for the definitions include publications of the CPSS and IOSCO.

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<b>Continuous Linked Settlement</b>	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.
<b>CLS Bank International</b>	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.
<b>Correspondent Bank</b>	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.
<b>Custodian</b>	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.
<b>Daily Settlement</b>	The completion of settlement on the day of value of all payments accepted for settlement.
<b>Daylight Credit</b>	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.
<b>Daylight Overdraft</b>	A negative position in an institution's Federal Reserve account.
<b>Dealer</b>	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.
<b>Delivery-vs-Payments system (DvP)</b>	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.
<b>Depository Institution</b>	An institution that holds funds or marketable securities, usually under a specific agreement.
<b>The Depository Trust &amp; Clearing Corporation (DTCC)</b>	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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<b>The Depository Trust Company (DTC)</b>	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.
<b>Dodd-Frank Act</b>	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.
<b>Fedwire</b>	An electronic transfer system developed and maintained by the Federal Reserve System, enabling financial institutions to transfer funds and book-entry securities nationwide.
<b>Fedwire Funds Service</b>	Owned and operated by the Federal Reserve, the Fedwire Funds Service provides a real-time gross settlement system in which funds transfers can be initiated from more than 8,000 eligible accounts. These funds transfers 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.
<b>Fedwire Security Service</b>	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.
<b>Finality</b>	An irrevocable and unconditional transfer of payment which occurs during settlement.
<b>Financial Market Utility (FMU)</b>	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 Infrastructures (FMI).

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<b>Fixed Income Clearing Corporation (FICC)</b>	A subsidiary of The Depository Trust & 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.
<b>Foreign Exchange Settlement Risk (aka Herstatt Risk)</b>	The potential loss of principal associated with settling transactions sequentially instead of simultaneously.
<b>Funding Transaction</b>	Movements of cash value to clear, net, offset, and/or settle financial market transactions.
<b>Funds Transfer</b>	A series of transactions, beginning with the originator's payment order, made for the purpose of making payment to the beneficiary of the order.
<b>Funds Transfer System</b>	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.
<b>In/Out Swap (I/O swap)</b>	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.
<b>International Organization of Securities Commissions (IOSCO)</b>	An international organization comprised of securities market regulators.
<b>Intraday Credit</b>	See Daylight Credit.
<b>Intraday Liquidity</b>	Funds which can be accessed during the business day, usually to enable financial institutions to make payments in real time.
<b>Large-Value Payments (LVP)</b>	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.
<b>Large-Value Transfer System</b>	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.
<b>Liquidity Risk</b>	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.
<b>Multilateral Netting</b>	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.

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<b>National Securities Clearing Corporation (NSCC)</b>	A wholly owned subsidiary of The Depository Trust & 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.
<b>National Settlement Service (NSS)</b>	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.
<b>Net Debit Cap</b>	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.
<b>Nostro Agent</b>	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.
<b>Payment</b>	A transfer of value.
<b>Payment Order</b>	An instruction to a bank to pay or to cause another bank to pay a fixed or determinable amount of money to a beneficiary.
<b>Payment System</b>	The mechanism—the rules, institutions, people, markets, and agreements—that make the exchange of payments possible.
<b>Payment-vs-Payment (PvP)</b>	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.
<b>PSR Policy</b>	The Federal Reserve's Payment System Risk policy.
<b>Queuing</b>	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.
<b>Real-Time Gross Settlement (RTGS) System</b>	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.
<b>Repurchase Agreement (aka Repo)</b>	A contract to sell and subsequently repurchase securities at a specified date and price.
<b>Retail Payments</b>	Small-dollar payments made in the goods and services market.

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<b>Settlement</b>	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.
<b>Settlement Bank</b>	A central bank or private bank used to effect money settlements for FMU members.
<b>Settlement date</b>	The date on which the parties to a transaction agree that settlement is to take place.
<b>Settlement Finality</b>	When the sender's obligation to pay its receiving bank is discharged.
<b>Systemic Risk</b>	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.
<b>Wholesale Payments</b>	Large-value payments used primarily in the financial markets.

### APPENDIX 2: Members of the Working Group

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

Chairman	Michael Kurlander
Bank of America	Robert Clark Edward Ritter
Bank of New York Mellon	Joel Feazell Vincent Gesuele
Bank of Tokyo Mitsubishi-UFJ	Thomas Amato
Citibank	Gregory Fell William Park
Deutsche Bank	Steven Weinstock
Goldman Sachs	Joyce Lee Frank Tota
HSBC	John Ciccarone
JP Morgan Chase	Michael Albanese Roy DeCicco Alies van den Berg
Morgan Stanley	Valerie Gavora Graeme McEvoy
State Street	Beth Finn
UBS	Barry Tebbutt
Wells Fargo	Yoko Horio
Federal Reserve Bank of New York	Michele Braun Karen Brifu Alexa Herlach Radhika Mithal Lawrence Radecki

Significant contributions were also made by Alice Shen (Formerly with the Federal Reserve Bank of New York, now a student at the University of Pennsylvania), Morten Bech (Bank for International Settlements), Parinitha Sastry (Federal Reserve Bank of New York), and staff at the Federal Reserve Board of Governors.