FINANCIAL MARKET INFRASTRUCTURES and PAYMENTS

Warehouse Metaphor Textbook

Financial Market Infrastructures and Payments: Warehouse Metaphor Textbook by Ron J. Berndsen, edition 2019.
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List of Acronyms

All acronyms (and abbreviations) employed in this textbook can be found in the list below. One exception is the two-letter code for denoting countries and regions, this can be found at https://www.iso.org/iso-3166-country-codes.html). In the last column, **L,M,U,W** refers to the floor or floors within a Warehouse where the entry is predominantly relevant: **L**ower, **M**iddle, **U**pper floor or **W**hole Warehouse; **P** denotes a Pseudowarehouse. Legislation is denoted by L with the jurisdiction as subscript (L_{EU} or L_{ECB}).

Term	Explanation	Relevance
ACH	Automated Clearing House	L
API	Application Programming Interface	L
ATM	Automated Teller Machine	L
B2B	Business to Business	L
BCBS	Basel Committee on Banking Supervision	W
bn	billion (10^9)	
BIS	Bank for International Settlements	W
BRRD	Bank Recovery and Resolution Directive	W, L_{EU}
BCH	Bitcoin Cash	P
BTC	Bitcoin	P
BTG	Bitcoin Gold	P
BTCP	Bitcoin Private	P
C2B	Consumer to Business	L
C2C	Consumer to Consumer	L
CB	Central Bank	W
CET	Central European Time	W
CCP	Central Counterparty	U
CDS	Credit Default Swap	U
CeBM	Central Bank Money	M
CoBM	Commercial Bank Money	L

Term	Explanation	Relevance
CPMI	Committee on Payments and Market Infrastructures (CPMI is the successor of CPSS)	W
CPSS	Committee on Payment and Settlement Systems	W
CPU	Central Processing Unit	W
CLS	Continuous Linked Settlement	M
CRA	Credit Rating Agency	W
CSD	Central Securities Depository	U
CSDR	Central Securities Depository Regulation	U, L_{EU}
CSM	Clearing and Settlement Mechanism	L
DKK	Danish Krone	
DLT	Distributed Ledger Technology	P
DNB	De Nederlandsche Bank	M
DNS	Deferred Net Settlement	W
DvP	Delivery versus Payment	M,U
EBA	European Banking Authority	W
ECB	European Central Bank	W
EIOPA	European Insurance and Occupational Pensions Authority	W
e-money	Electronic Money	L
EMD	Electronic Money Directive	L, L_{EU}
EMI	Electronic Money Institution	L
EMIR	European Market Infrastructure Regulation	U, L_{EU}
EMV	Europay, Mastercard and Visa	L
EoD	End of Day	
EPTF	European Post Trade Forum	U
ERM	Exchange Rate Mechanism	
ESES	Euroclear Settlement for Euronext Securities	U
ESFS	European System of Financial Supervision	W
ESRB	European Systemic Risk Board	W
ESMA	European Securities and Markets Authority	U
EST	Eastern Standard Time	W
ETF	Exchange Traded Funds	U
EU	European Union	W
FMI	Financial Market Infrastructure	M,U
FoP	Free of Payment	U
FX	Foreign eXchange	M,U
G20	Group of 20 major economies	W
GB	Giovannini Barriers	U
GDP	Gross Domestic Product	W

Term	Explanation	Relevance
IBAN	International Bank Account Number	W
ICSD	International Central Securities Depository	U
IMF	International Monetary Fund	
IOSCO	International Organization of Securities Commissions	U
ISO	International Organization for Standardization	W
LAN	Local Area Network	W
LEI	Legal Entity Identifier	W
LETS	Local Exchange Trading Systems	
LSM	Liquidity Saving Mechanism	M
LTCM	Long-Term Capital Management	
LVPS	Large-Value Payment System	M
MiFID	Markets in Financial Instruments Directive (1 and 2)	U,L_{EU}
MiFIR	Markets in Financial Instruments Regulation	U,L_{EU}
MS	Member State (of the EU)	
MTF	Multilateral Trading Facility	U
MPoR	Margin Period of Risk	U
MtM	Mark-to-Market	U
NCA	National Competent Authority (in a MS)	W
NFC	Near Field Communication	L
OBeP	Online Banking ePayments	L
OTC	Over-The-Counter	U
ORSIPS	Oversight Requirements for SIPS	M, L_{ECB}
Pn	$(n = 1, \ldots, 24)$ refers to an individual PFMI	W
PFMI	Principles for FMIs	W
PIN	Personal Identification Number	L
PISP	Payment Initiation Service Provider	L
POS	Point-of-Sale	L
PoW	Proof-of-Work	P
PSD	Payment Services Directive (1 and 2)	L, L_{EU}
PSP	Payment Service Provider	L
PvP	Payment versus Payment	M
RTGS	Real-Time Gross Settlement	M
RTO	Recovery Time Objective	W
SCA	Strong Customer Authentication	L
SCT	SEPA Credit Transfer	L
SCT INST	SEPA Credit Transfer Instant	L
SDD	SEPA Direct Debit	L
SDR	Special Drawing Rights	
SEPA	Single Euro Payments Area	L
SHA	Secure Hashing Algorithm	P

Term	Explanation	Relevance
SIPS	Systemically Important Payment System	M
SoD	Start of Day	
SRB	Single Resolution Board	W
SRM	Single Resolution Mechanism	W
SSM	Single Supervisory Mechanism	W
SSS	Securities Settlement System	U
SITG	Skin-In-The-Game	U
STP	Straight Through Processing	W
SWIFT	Society for Worldwide Interbank Financial Telecommunication	W
TARGET2	Trans-european Automated Real-time Gross-settlement Express Transfer (2nd generation)	M
TIPS	TARGET Instant Payment Settlement	M
TO	Transfer Order	M,U
T2S	TARGET2-Securities	M,U
VMGH	Variation Margin Gains Haircutting	U

Preface

The purpose of this introductory textbook on Financial Market Infrastructures and Payments is to provide the student with a structured way of learning about the fascinating multidisciplinary field of financial market infrastructures and payments. The organizing principle of this textbook is a metaphorical Warehouse. It has been used in my FMI-lectures in the Bachelor and Master Economics at Tilburg University since 2011.

This textbook has been written because a major goal of my Chair at Tilburg University, called Financial Market Infrastructures and Systemic Risk, is to disseminate this knowledge to the widest audience possible. I am deeply grateful to Lex Hoogduin and Sylvester Eijffinger for establishing the Chair and for their continuing support. The Chair is sponsored by De Nederlandsche Bank. The support is gratefully acknowledged.

I would like to specially thank Annemarie Hondius (DNB), Rob Koelman, Piet Mallekoote (Dutch Payments Association), Miriam Plooij (ECB), and Francisco Tur Hartmann (ECB) for helpful comments and suggestions on earlier versions. I would also like to thank students at Tilburg University, Erasmus University Rotterdam, Free University Amsterdam, and Hochschule der Deutschen Bundesbank (Hachenburg) for their "user acceptance testing" of this book. Any remaining errors are my own. Please send any comments and remarks you may have to r.j.berndsen@tilburguniversity.edu. I hope you enjoy the Tour through the Warehouse.

Ron Berndsen
October 2018

How to use this book

The organizing principle of this textbook is a metaphorical Warehouse created in 2011 [1]. The Warehouse contains all financial transactions of a currency and is divided in three floors. This should support the reader with a basic structure to add new elements to, during the learning process.

- Each chapter is briefly introduced by the Tour Guide who will guide you through the book.
- There is also Querious (in short Q), a curious person who asks all the questions.
- All tours except the introduction (Chapter 1) have a short summary in bullet-points. You can use this to check whether you have grasped the main points.
- Exercises have been prepared at the end of every tour to challenge you.
- There are many acronyms, so there is an alphabetical list to help you (see page *ix*).
- Important definitions are clearly marked and numbered in the text. If you need more background have a look at the CPMI interactive glossary of Payments and Financial Market Infrastructure terminology [2] on the BIS website.
- References to literature, such as [1] or [2] above, are simply numbered between brackets so as not to distract the reader too much. They are numbered in order of appearance and can be found in the Bibliography at the end of the book. For the interested reader who wants more background on Financial Market Infrastructures and Payments, the following books are suggested: [3], [4], [5], [6], [7].
- You are of course free to choose any sequence of chapters but it is recommended to read Chapters 2 through 4 in order of appearance. The following Tours are available to you:

The Grand Warehouse Tour Read Chapters 2, 3 and 4. You will visit the three floors of the Warehouse with your Tour Guide in a more or less logical order. After this tour you should have a thorough grasp of the Warehouse.

Methodology Read Chapter 5 if you want to understand the theoretical foundation of the Warehouse. You will go deep into the plumbing: the functional model of settlement, value and information.

Supervision If you have done the Grand Warehouse Tour you might wonder if anybody is looking after the Warehouse given the inherent risks involved. Turn to Chapter 6 to meet the supervisors of the Warehouse and the minimum standards that have been agreed on internationally.

Innovation Read Chapter 7 if you want to know what is new or expected soon in the euro Warehouse. You will visit the Innovation lab in the attic. Yes, that is the three-colored box on the roof of the Warehouse in Figure 1.1.

Cryptocurrencies Read Chapter 8 if you want to learn about Bitcoin and other cryptocurrencies. Is it money? Time will tell. In the meantime cryptocurrencies live in their own Pseudowarehouse.

Chapter 1

Introducing the Warehouse

Dear Reader. Welcome to the Warehouse! Let me introduce myself first. I am your Tour Guide. This chapter provides a quick tour of the Warehouse (free of charge) so you can familiarize yourself with its basic structure and building blocks. Enjoy.

1.1 Why Study the Warehouse?

As undergraduate students of Economics learn very early on, money has three functions: it serves as a unit of account, as a store of value and as a medium of exchange. They learn why money as an intermediate step is so much more useful than pure bartering. For example, the person who has a sheep but wants bread must search for someone with exactly the opposite need at the same time. This is referred to as the double coincidence of wants and it is roughly how the function of money as a medium of exchange is dealt with in the Bachelor Economics. Money as a medium of exchange in the sense of payments or financial market infrastructures is simply ignored. Too little attention is paid to this function in economics education; this is understandable, but not a good thing.

It is understandable because this function is largely carried out behind the scenes. It is embodied in a network that people use without further thought as long as it works, but which is very annoying when it does not. There are plenty of examples: an internet connection that is suddenly very slow, the

electricity network that shuts off the power for several hours or the point-of-sale terminal that refuses your debit card. Let's say that 99.9 percent of the time you can assume that the network will do what it is supposed to do. Furthermore, the service supplied by the network is basic in nature and, for this reason, not very exciting. Very few people regard the activity of making payments as an interesting one; the goods or services that are bought with it are an entirely different matter.

Nevertheless, it is not a good thing to pay too little attention to the other 0.1 percent of the time, because (financial) infrastructures that are affected by a severe disruption can have major implications for society. If money is temporarily unable to fulfill the function of medium of exchange, it will not be possible to transfer value in the economy or settle financial transactions. Alan Greenspan, former Chairman of the Federal Reserve Board of Governors, articulated this in his autobiography [8] as follows:

> "We'd always thought that if you wanted to cripple the U.S. economy, you'd take out the payment systems. Banks would be forced to fall back on inefficient physical transfers of money. Businesses would resort to barter and IOUs; the level of economic activity across the country could drop like a rock."

And then there is the possible financial crisis that has not happened yet. Consider a stock market crash like Black Monday (19 October 1987) or even the global financial crisis of 2007-2009 with the default of Lehman Brothers on 15 September 2008, as the largest US bankruptcy ever. That crisis will be referred to as the Lehman crisis in this book. Although those crises were severe, the financial infrastructure (or Warehouse as you will see) kept functioning on those days. But, what if the financial infrastructure does not work on one of "those days"? This provides ample reason why you should study this book and visit the Warehouse.

1.2 What is the Warehouse?

The Warehouse of Payments and Financial Market Infrastructures (Warehouse for short) is a metaphor for the network that settles all kinds of non-barter transactions in an economy: paying for groceries in a shop (with cash or card) or the monthly rent, but also payments in bulk such as the monthly

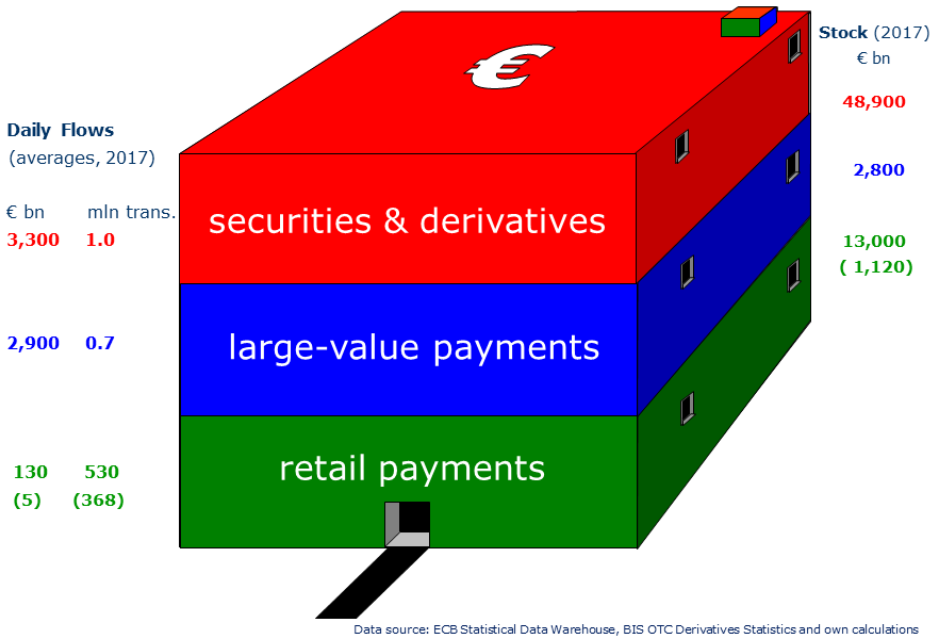

Figure 1.1: The Euro Warehouse

salaries paid by a major corporation to its employees. Other examples are the settlement of securities transactions done at the stock exchange, money market transactions or settlement of derivative contracts. In addition to housing the computer network, the Warehouse also contains the rules (what is a proper payment? and when is money legally transfered?) and the governance (who is in charge? and who is responsible if something goes wrong?). The Warehouse metaphor will be used as a common thread in this textbook.

Look at Figure 1.1. Three features stand out immediately. First, the large € symbol on the roof signals that you are looking at the euro Warehouse. This means that all transactions are denominated exclusively in euro. Each currency has its own Warehouse, so there is also a US dollar Warehouse, a Chinese Renminbi Warehouse, etc.

Second, let's talk figures. This is where the money is (literally) and a lot of it. Every working day the euro Warehouse turns over an amount of value of EUR 6,330,000,000,000 (or 6,330 billion) on average. This amounts to roughly 60% of the annual Gross Domestic Product (GDP) of the euro area,

every day. The daily turnover represents a flow variable and it measures the sum value of all money and financial assets that change ownership on a given day. The flow can also be measured in terms of the number of transactions. For the euro area the total number is 532 million transactions per day.

Third, it consists of three floors. On the ground floor the so-called retail payments take place. These are generally payments among and between consumers and businesses. The middle floor processes the large-value payments, mostly payments between banks. The upper floor contains everything an economy needs to complete transactions in financial assets and derivatives. These can be traded multilaterally on exchanges or agreed bilaterally between two parties (over-the-counter transaction). For each floor three main figures are given, two for the flow of transactions (measured in value and in number) and one for the outstanding stock of money and other financial assets (in value terms). If you add up the numbers of the three floors you arrive at the Warehouse totals mentioned above.

I see a person at the back raising his hand. May I introduce Querious to you. Please ask your question...

Q: How do you measure the use of bank notes as they are passed on from person to person and as such are not recorded? Good question! The answer is: it is harder to quantify these flows in the euro Warehouse than it may seem. All figures come from the ECB Statistical Data Warehouse, available online. The easiest part to measure precisely is the outstanding stock of banknotes and coins because the Eurosystem only needs to keep track of the banknotes that are in circulation outside the banking system. Likewise, all electronic payments are relatively easy to measure because they are recorded by banks and infrastructures. The hardest part to measure is the flow of payments with banknotes among consumers and businesses because these are indeed not recorded. A common estimation method is to derive the daily value use of banknotes from withdrawals of automated teller machines (ATM's) and to use data of a panel survey in which participants are asked to keep a diary of their banknote usage [9],[10]. To conclude, the quantification of the Warehouse in Figure 1.1 is intended to give the stylized facts rather than attempting to be exact to the last euro.

The distribution of transactions over the three floors in terms of value and number exhibits a typical pattern: the largest flows measured in values are transferred on the middle and upper floor while the largest flows measured in numbers are transferred on the ground floor. This implies for example that the average transaction size on the middle floor is relatively high (hence the

name "large-value payments").

The three floors are also linked vertically in two ways. Firstly, a bank may provide services on all floors and hence connect them by its activities. Secondly, the middle floor contains the central bank within the Warehouse which usually provides payment services to the ground floor and to the upper floor.

Q: This is fine but what is the purpose of the Warehouse? Very good question. The purpose of the Warehouse is to eliminate all financial obligations that are due for settlement on a given date, called the intended settlement date. Usually that date is determined contractually by the two trading parties involved or is standardized according to market practice. It may be as short as the same minute in which the obligation to pay is created (paying in a store) or it may be a number of days in the future.

Definition 1 (Financial Transaction) *A one-sided financial transaction is the agreement to bilaterally exchange a good or provide a service against money. The party who bought the good or service (debtor) has the financial obligation and needs to pay the creditor on the intended settlement date.*
A two-sided financial transaction is the agreement to bilaterally exchange a financial asset against money (securities transaction) or a bilateral derivative contract (derivative transaction). The two financial obligations involved can be eliminated (discharged) by settlement on the intended settlement date.

Only financial transactions are relevant in the Warehouse, pure barter transactions are excluded. Two different kinds of financial transactions are distinguished (see definition 1). In a one-sided financial transaction only the financial leg of that transaction is relevant for the Warehouse. You should not care about the other, non-financial, leg while studying, though you probably do care in real life. In case of a two-sided financial transaction both legs are relevant for the Warehouse. There are many synonyms for debtor that are used: payer, originator, buyer or sender. Likewise for creditor: payee, beneficiary, seller or receiver. Note that the debtor in a one-sided transaction has the financial obligation to pay (or deliver in case of a security) and conversely the creditor is exposed to the risk of not being paid (settlement risk exposure). In a derivative transaction, it is usually not determined upfront who will be the debtor or the creditor as this may be dependent upon future price developments of the underlying asset. Nor is settlement in cash the only way to discharge the financial obligation.

Furthermore, the euro Warehouse is the most complex Warehouse in the world. This means that if you understand that Warehouse you can also learn

easily about Warehouses of the other currencies. The reason for the high complexity of the euro Warehouse is historical. The Warehouse itself dates from 1999 only (the start of the euro) but since infrastructure replacement and renewal is hard and costly, the existing domestic infrastructures of the individual countries are not yet replaced by pan-European infrastructures.

I hope that this short walk piqued your interest to further explore the Warehouse (see page *xvi* for tips on how to use this book).

Exercises of Chapter 1

1. What are the three main characteristics of a Warehouse?
2. What is the average transaction size in the euro Warehouse? And for each floor separately?
3. Which floor has the largest outstanding stock in value terms? Why?
4. For the middle floor (large-value payments) the average daily flow is larger than the outstanding stock. Assume that the stock doesn't change much over the year, what follows from all this?
5. Why is it easier to measure the outstanding stock of banknotes than to measure the number of transactions paid with banknotes?
6. What is the difference between a barter transaction and a financial transaction?
7. Draw a picture of a one-sided and a two-sided financial transaction. In terms of settlement risk, what is the crucial difference between a one-sided and a two-sided financial transaction?