Debt, Leverage and Money Markets in Times of Crisis

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Contents

Acknowledgements **III**

List of Figures **V**

List of Tables **VII**

Preface **1**

1 Household Debt, Deleveraging Needs and Unemployment **7**

1.1 Introduction ... 8

1.2 Overview of Related Literature ... 9

1.3 Theoretical Framework ... 11

1.4. Empirical Evidence ... 14

1.4.1 Description of the data ... 14

1.4.2 Empirical analysis ... 18

1.4.3 Robustness ... 20

1.5 Conclusion ... 24

2 Mortgage Debt and Unemployment over the Business Cycle **25**

2.1 Introduction ... 26

2.2 Theoretical Channels ... 29

2.3 Empirical Evidence ... 34

2.3.1 Description of the data ... 34

2.3.2 Identification ... 36

2.3.3 Results ... 40

2.3.4 Robustness ... 42

2.4 Conclusion ... 48

3 Repo Markets, Monetary Policy and Collateral Shortage **51**

3.1 Introduction ... 52

3.2 Organizing Framework ... 54

3.2.1 The hierarchy of money 54
3.2.2 The three key players of the repo market 56
3.2.3 Primary dealers 57
3.2.4 The segmentation of money markets 60
3.3 Stylized Facts about the Repo Market 65
3.3.1 The primary dealer statistic 66
3.3.2 Matched and open books 67
3.3.3 Identification 72
3.3.4 Results 74
3.4 Collateral Scarcity 77
3.4.1 Cyclical collateral scarcity 78
3.4.2 Structural collateral scarcity 85
3.5 Conclusion 94

Bibliographie **97**

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Jonas Schlegel, Munich in September 2018

List of Figures

Figure 1.1: Provincial debt-to-income ratios and unemployment 18

Figure 2.1: The macroeconomic environment in Spain and the US 26

Figure 2.2: Mortgage loans created via endogenous money creation 32

Figure 2.3: Relations between debt and unemployment for selected provinces 36

Figure 2.4: Equity shares for selected provinces 45

Figure 3.1: A stylized repo market 59

Figure 3.2: The mechanism of the FED's ON RRPs 61

Figure 3.3: Volumes of the FED's ON RRP facility 63

Figure 3.4: The repo-subfloor spread 64

Figure 3.5: Repo and other money-like volumes in the US 65

Figure 3.6: Repos with treasury bonds as collateral 67

Figure 3.7: Open book separted by underlying collaterals 69

Figure 3.8: Open book separated by duration of the repo 70

Figure 3.9: Absorbed risks by primary dealers 71

Figure 3.10: Proxies for balance sheet costs and financial stress 72

Figure 3.11: Intensity of ON RRPs in the ON treasury market 82

Figure 3.12: Collateral with reuse allowance of selected PDs 87

Figure 3.13: Aggregated collateral with reuse allowance 88

Figure 3.14: Hypothetical change of collateral volumes since 2003 89

Figure 3.15: Aggregated reused collateral 92

List of Tables

Table 1.1: Identification of tradable and non-tradable economic activities 16

Table 1.2: The effects of household debt to unemployment growth 19

Table 1.3: Detailed analysis of non-tradable sector unemployment 20

Table 1.4: Structural differences in debt levels among provinces 22

Table 1.5: Savings banks and the credit crunch hypothesis 23

Table 2.1: Identification of non-tradable economic activities 35

Table 2.2: Effects of mortgage debt on non-tradable unemployment 41

Table 2.3: Robustness checks 43

Table 2.4: Stable effects over the business cycle 47

Table 3.1: Effects on the overall repo volume 74

Table 3.2: Effects on the repo volume with treasury bonds as collateral 75

Table 3.3: The Repo-EFFR spread as a proxy for cyclical collateral scarcity 79

Table 3.4: Quarter End Dummies as proxies for cyclical scarcity 81

Table 3.5: ON RRPs as a proxy for cyclical scarcity 83

Table 3.6: Proxies for cyclical scarcity 84

Table 3.7: Correlations between repo volumes and collateral with reuse allowance 91

Table 3.8: Correlations between repo volumes and reused collateral 93

Preface

> *„Economics provides many of the stepping-stones and analytic tools to address the big public issues of our time. What it doesn't provide is definitive, universal answers. Results taken from economics proper must be combined with values, judgments, and evaluations of an ethical, political, or practical nature. These last have very little to do with the discipline of economics, but everything to do with reality*." (Rodrik, 2015, p. 114)

General thoughts

I started my bachelor studies in economics in October 2008, around one month after the collapse of Lehman Brothers. I still remember one specific moment during my first days in Frankfurt, Germany. I was waiting for the subway and, as it is often seen at subways stations, best and worst performers of the day of the German stock index (DAX) were shown on a screen.

I clearly recall how the value of Volkswagen AG shares increased by more than 100% during that day. Investors had short sold Volkswagen AG as they expected declining share prices. While these expectations would have been right for the other 29 members of the DAX, Porsche AG increased its share on Volkswagen AG and argued that they hold additionally high volumes of options, which would have decreased the free float of Volkswagen AG to less than 10%. Accordingly, short seller tried to settle their positions. As markets at that time have been highly illiquid, the stock price of Volkswagen AG skyrocketed from around 200 € to more than 1000 € per share, which made Volkswagen AG the most valuable company of the world for one day.

Why did this influence me as a macroeconomist? Because usually when you are trained as a macroeconomist, you learn to look at the fundamentals of an economy like consumption, savings and real interest rates where households appear as forward-looking decision makers. These fundamentals determine a stable path of the economy, where for instance changes in

expectations allow the economy to deviate from this path. But if a company like Volkswagen AG with more than 329,000 employees and more than 6.2 million sold vehicles in 2007 increases its market capitalization by more than 500% in a couple of days, there is something going on which goes beyond fundamentals.

It is undeniable that the last ten years have changed the minds of economists and politicians and made them more susceptible to potential spillovers from the financial system. Today, it is almost impossible to find an economist who completely questions the relevance of debt and the financial system for the economy. Highly important contributions have been made on (government) debt sustainability, financial frictions, and the procyclicality of debt.

Having been influenced by the work of Minsky (1982, 2008), I would go even further: I believe that there is no normal state of the economy where the financial system appears as a well-functioning intermediary, which from time to time is disturbed by turmoils. For me, the financial system, at least since the financialization took place in the late seventies (see, e.g., Krippner (2005)), is at the core of economies. Just because the financial system is not in a crisis, it does not mean that the financial system is not shaping the current state of the economy.

Potentially contrary to public believes, global debt has grown by 17 % in terms of GDP between 2007 and 2015 (McKinsey Global Institute, 2015). In my opinion, changes in fundamentals like GDP or unemployment need to be set in relation to changes in debt. Imagine, for instance, a decrease in the unemployment rate by 1% while the household debt-to-income ratio increases by 5% and compare this to a stable household debt-to-income ratio. For me, this information drastically changes the interpretation of the fundamental.

In general, it is difficult to disentangle debt from fundamentals. Debt could drive fundamentals directly while fundamentals drive debt via changes in expectations on the future. Furthermore, it is more difficult or even impossible to draw normative statements. Nevertheless,

if one sees the financial system as the main driver, I believe that it changes the perspective on how you look at the economy.

"Convictions are more dangerous enemies of truth than lies." (Nietzsche, 1910, p. 355)

A certain view on the economy is necessary for the construction of a research questions, a data set or a theoretical model. As every view in economics contains by definition value judgments (Issing et al., 2014, pp. 10-12), I am convinced that there is almost no research without underlying convictions in macroeconomics. Researchers might be agnostic in their research question but by incorporating a readymade set of theoretical tools one, at least partially, adopts the values of other researchers. Empirical research mostly follows the mindset of important economic models, which again includes underlying values. I am no different here and my research is influenced by the belief that the financial system and its money and debt creating processes are at the core of economies. This thesis therefore does not coincidentally deal with debt, leverage and money markets.

Chapter outline

It is almost impossible to explain the outcomes of the great financial crisis (GFC) without incorporating debt as a main figure. The key question is therefore rather through which channels is debt affecting the economy. One major channel is based on the aggregate demand-debt deleveraging hypothesis. Chapter 1 tests this channel empirically for Spanish provinces. More precisely, this chapter estimates a proxy for household debt-to-disposable income and asks whether provinces with higher levels predict stronger increases in unemployment in the non-tradable sector. Focusing on changes in unemployment in the non-tradable sector, which is solely driven by local demand vis-à-vis the tradable sector, this chapter shows an important role of this mechanism for the Spanish economy between 2007 and 2010.

Chapter 2 goes beyond the debt-deleveraging channel of households and explores whether there is a stable relationship over the business cycle between newly issued mortgage

debt (the credit impulse for the housing market) and unemployment in the non-tradable sector (driven by local demand). According to the idea of endogenous money, mortgage debt, the major part of money created by banks, could be a direct driver of business cycle fluctuations. Due to relaxations of liquidity and borrowing constraints, mortgage debt is also able to work as an indirect driver. Panel data on Spanish provinces show that a stable relationship between newly issued mortgage debt and changes in unemployment in the non-tradeable sector in the following year holds. Most importantly, results are robust for the upswing of the business cycle. This chapter therefore strengthens the findings that there are stable relationships between debt and aggregate demand, which are not exclusively driven by downturns of the business cycles.

Chapter 3 takes a closer look at the repo market in the US, the most important money market of short-term financing in the world. If one wants to understand the functioning of money and debt in the private sector, it is not sufficient to look solely at debt created within the (regulated) banking sector, as it has happened at early stages of the GFC (see, e.g., Chari, Christiano and Kehoe (2008)). It needs a deeper understanding of the shadow banking system and its relations to the banking sector.

While research about the sharp decline in the repo markets during the GFC has continuously expanded since 2008, knowledge about the structural functioning of the repo market and empirical research why the repo market has not recovered are rare. Based on selected literature, this chapter sets up an organizing framework about the repo market, which connects the hierarchy of money, the occurrence of the segmentation of money markets, the new monetary policy tool (reverse repos) conducted by the FED with primary dealers as the center of the repo market. By exploiting the Primary Dealer Database, regressions show that primary dealers shape the repo market as their matched book is significantly suppressed by balance sheet costs and their open book is suppressed by stress in the financial system. The second part of the chapter focuses on collateral scarcity. By identifying proxies for cyclical

scarcity, this chapter shows that primary dealers move with the market instead of offsetting supply and demand mismatches. If one wants to investigate on structural collateral shortage in the repo market, the allowance to reuse of pledged collateral must be considered. By handpicking data from annual reports for 24 primary dealers between 2003 and 2016, chapter 3 shows that reuse allowance has increased after the GFC while conducted repos have slightly decreased. This break can be explained by either a decrease of collateral within the financial system (structural collateral shortage) or by a contemporaneous increase in the OTC derivate market.

Chapter 1

Household Debt, Deleveraging Needs and Unemployment

Evidence from Spanish Provinces[*] [ϒ]

[*] This chapter is based on joint work with Sebastian Jauch and Sebastian Watzka. A version at an early stage of this chapter is available as CESifo Working Paper No. 3924.

[ϒ] Acknowledgments: We are thankful to the participants of the Annual Meeting of the "Verein für Socialpolitik" in 2016 and the Macroeconomic Research Seminar at University of Munich for useful comments and suggestions.

1.1 Introduction

Spanish unemployment has risen from a low of 7% in 2007 to its height of 26% in 2013. Unemployment rates had been particularly high for young people with every second young Spaniard looking for a job. Given the enormous economic, psychological and social problems that are related with high and long-lasting unemployment, it is of the utmost importance to study the causes of the high increase in Spanish unemployment. We therefore take a close look at one of the possible causes of the increase in Spanish unemployment during the early phases of the recent economic crisis (2007-2010).

By using proxies for household sector debt to disposable income ratios for 50 Spanish provinces together with detailed data on sectoral provincial unemployment data, we document that household debt deleveraging is an important variable in explaining the increase in unemployment between 2007 and 2010.

This chapter contributes to the academic and public debate regarding the relationship between household debt, aggregate demand and its effect on unemployment by studying Spanish provincial household debt and sectoral employment data. More precisely we ask whether the strong buildup in household sector debt prior to the crisis helps in predicting the subsequent increase in unemployment. Following Mian and Sufi (2014), we take advantage of the fact that changes in *non-tradable* employment are driven by *local* demand only which in turn depends largely on changes in local households' financial situations. Spanish households' financial situations have been mainly determined by their deleveraging needs. Thus, by calculating the increased unemployment in the non-tradable sectors of Spanish provinces and regressing those changes on provincial household debt to income levels allows us to empirically test the aggregate demand-debt deleveraging hypothesis for the Spanish case.

The underlying transmission mechanism investigated in this study begins with a deleveraging shock to the balance sheets of individual households. The shock for households is greater if they must direct more effort to restructure their balance sheets. The more debt a household has accumulated relative to its income before the shock occurred, the more deleveraging the household must arrange by increasing savings and reducing spending to restore its balance sheet afterwards. Given the natural dependence of employment to demand in a depressed economy, these deleveraging needs will necessarily increase unemployment. This mechanism is sometimes referred to as aggregate demand-debt deleveraging hypothesis.

The remainder of the chapter is structured as follows. Section 1.2 provides a brief overview of the related literature. Section 1.3 describes the theoretical framework. Section 1.4 presents the empirical evidence for Spanish provinces. Section 1.5 concludes Chapter 1.

1.2 Overview of Related Literature

The effect of household debt on the economy has been repeatedly examined in combination with recessions. Fisher (1933) postulated the debt-deflation theory of great depressions. Mishkin (1978) empirically examined the Great Depression and considered how household balance sheets served as a transmission mechanism for changes in aggregate demand. The American recession of 1973-75 is empirically investigated by Mishkin (1977), who focus on the role of household debt and stock market developments. All these papers find an important negative effect of debt on economic activity. However, whereas Fisher (1933) examines the effect on asset prices, Mishkin (1978) and Mishkin (1977) focus on consumption and aggregate demand. Palley (1994) builds a model of the effects of household debt on aggregate demand based on the different propensities to consume among creditor and debtor households and applies the model to the recession of the early nineties. Palley (1994) concludes

that increases in household debt fuel aggregate demand but that the servicing of this debt subsequently lowers aggregate demand.

The financial crisis and economic downturn of 2007-09 have again drawn attention to the role of household sector debt. Keen (2009) emphasizes the role of debt for aggregate demand. Changes in the volume of debt as a percentage of GDP explain how much of the aggregate demand is debt financed. Keen (2009) validates the link between the household debt and aggregate demand for Australia by showing how both increasing debt and declining unemployment and decreasing debt and rising unemployment move together. The link between housing net worth shocks and employment in the recent recession is shown for the United States in Mian and Sufi (2014) and Dynan (2012). Dynan (2012) uses the Panel Study of Income Dynamics (PSID) to examine the effect of household debt on consumption. She estimates the effect of leverage and that of debt service burdens on the changes in consumption that occurred from 2007 to 2009 and confirms that a significant negative impact exists even after income and wealth effects are controlled for. This approach provides a microfoundation for the deleveraging shock that depresses consumption in addition to wealth and income effects.

Mian, Rao and Sufi (2012) use local retail sales data to show that household debt levels affect consumption. Having illustrated the link between household debt and consumption, Mian, Rao and Sufi (2012) use the elasticity of employment to aggregate demand to measure the transmission of household debt via consumption and aggregate demand on employment and thus, to the severity of the crisis in the United States. The distinction between employment in the tradable and non-tradable sectors is important to the analysis. The demand for tradable goods is determined on a national or international level, which renders the shocks to the household balance sheet in one county unimportant. The demand for non-tradable goods, in contrast, depends only on local consumption. Thus, regional employment in tradable industries

should be independent of local debt levels, whilst employment in non-tradable industries should instead be highly dependent on local debt levels.

The International Monetary Fund (2012) and the McKinsey Global Institute (2010, 2012) reports cover more than one country. The International Monetary Fund (2012) finds that larger increases in household debt lead to more severe recessions and examines country-level case studies in seeking to determine how to address large household debts and house price decreases. The McKinsey Global Institute examines deleveraging across all economic sectors and describes how historic deleveraging processes have taken place (McKinsey Global Institute, 2010) and how the major economies have meanwhile progressed in their deleveraging process (McKinsey Global Institute, 2012). The case studies presented in that report suggest that during an economy-wide deleveraging, a country should begin with deleveraging in the private sector while the public sector compensates for the loss in aggregate demand; then, the latter should begin deleveraging once the nation's economic growth regains its momentum.

1.3 Theoretical Framework

The transmission mechanism of household debt to aggregate demand is as described by Mian and Sufi (2012) or Dynan (2012). In modern consumer theory current household consumption expenditure depends largely on the household's expectation of future income and wealth. If the household's expectations regarding future income are sufficiently high and if the household is not credit-constrained, he or she can rationally take on debt today to smooth consumption. When a negative shock hits the household's financial position or outlook, the household will need to change its consumption behavior accordingly. In particular, for a given shock, households that have increased their debt more than others or that hold higher debt levels must reduce their debt by a larger amount. The household tries to restructure its balance sheet mainly through reductions in consumption spending. Still, it is in principle possible that

aggregate demand is unaffected by this deleveraging process, as households which have acted as lenders in the first place will have the option to consume more when the debt is being repaid. Thus, in aggregate, there might be no effect on aggregate demand if the propensity to consume out of income is the same across households. In practice, however, aggregate demand will most likely be reduced if the propensities to consume differ between debtors and borrowers, if the debt overhang is sufficiently large and if the economy is stuck at the zero lower bound (see, e.g., Eggertsson and Krugman (2012)).

The transmission channel is the necessary restructuring of the household balance sheet. In a boom period, a household takes on debt, anticipating increases in future income and asset prices. The household spends this debt on the purchase of assets, the most important of which is housing, and on consumption expenditure. When the boom period ends, asset prices stagnate or shrink, and future income streams become more uncertain. Households consequently restructure their balance sheets in accordance with their updated expectations. The restructuring of balance sheets comes along with increasing savings and decreasing consumption expenditures. The higher the debt level of the household sector, the larger the amount of debt that the sector must repay and the greater the reduction in consumption and, thus, aggregate demand. The level of debt is a good indicator because there is a natural limit to household debt in terms of debt service. The more debt a household holds, the larger the debt service burden and this burden cannot exceed disposable income if one rules out Ponzi games. If interest rates do not change, an increase in the debt-to-income ratio will alter the debt service burden proportionally. If the aggregated household sector long-term consumption behavior does not change accordingly, a short-term drop in consumption must occur to soften the process of adjustment to the previous debt-to-income ratios. This drop in consumption will dampen aggregate demand and, consequently, will decrease employment.

The model setup is as follows: households spend a fraction α of their income on non-tradable goods NT and the rest of their income $1-\alpha$ on tradable goods T. When households reduce their consumption due to deleveraging needs, demand for both tradable and non-tradable goods is being reduced. Unemployment reacts to this reduction in demand and increases according to the elasticity of unemployment to a reduction in aggregate demand η.

In this model province p is hit by the deleveraging-related demand shock δ_p. However, the total shock to demand in province p, γ_p, consists of a reduction in demand for *non-tradable* goods and a reduction in demand for *tradable* goods from all provinces of the country:

$$\gamma_p = \alpha\delta_p + (1-\alpha)\bar{\delta} \tag{1.1}$$

where $\bar{\delta}$ is the average shock for tradable goods over all provinces:

$$\bar{\delta} = \frac{1}{N}\sum_{p=1}^{N}\delta_p \tag{1.2}$$

The total demand-driven increase in unemployment in province p then depends on the elasticity of unemployment with respect to output reductions η and is given by $\eta\gamma_p$. The increase in *non-tradable* sector unemployment in province p is given by $\eta\alpha\delta_p$ and the increase in *tradable* sector unemployment given by $\eta(1-\alpha)\bar{\delta}$.

It is clear from the above that a province with a large negative demand shock δ_p will experience larger increases in total unemployment than a province hardly hit by a negative demand shock. More importantly, however, this difference in unemployment effects between different provinces due to deleveraging by households will be more pronounced in the non-tradable sector *than* in the tradable sector. In fact, theory predicts that tradable sector unemployment increases should not differ between provinces, as demand for tradable goods is

averaged over all Spanish provinces and the outside world. It is this theoretical implication which we will test empirically in this chapter.

The increase in Spanish unemployment due to the debt-driven demand shock *only* can finally be calculated as follows:

$$\sum_{p=1}^{N} \eta\alpha\delta_p = N\eta\alpha\bar{\delta} \tag{1.3}$$

$$\sum_{p=1}^{N} \eta(1-\alpha)\bar{\delta} = N\eta(1-\alpha)\bar{\delta} \tag{1.4}$$

$$N\eta(1-\alpha)\bar{\delta} + N\eta\alpha\bar{\delta} = N\eta\bar{\delta} \tag{1.5}$$

where (3) is the sum over all Spanish provinces of the increases in unemployment in the non-tradable sector and (4) is the sum of the increases in unemployment in the tradable sector. The last equation (5) then gives the *aggregate* increase in Spanish unemployment due to the debt-driven demand shock *only.*

1.4. Empirical Evidence

Our main object is to identify household balance sheet effects on unemployment. Our identification strategy is hereby based on our theoretical framework as well as on the theoretical framework provided by Mian and Sufi (2014).

1.4.1 Description of the data

Our explanatory variable is provincial household debt to disposable income. Household debt on a provincial basis is not available directly. Mortgage debt contributes by far the most important part of Spanish household debt. According to the survey of household finances (EFF)

in Spain, mortgage debt accounted for 84.2% of total debt in 2008 and for 86.9% in 2011. In addition, this share is almost independent of different income percentiles.[1]

Mortgage data is available from the Spanish Statistical Office (INE) since 1995 and tracks the mortgage debt of dwellings based on its location on a provincial basis. The volume of mortgages at a certain point in time can be approximated by the aggregated volume of newly issued housing mortgages in the five years preceding the crisis, i.e., from January 2003 until December 2007[2]. The average household mortgage debt among all provinces calculated in this indirect way is 85.3% of the total household liabilities in Spain at the end of 2007. This is a very close estimate according to the official number of 84.1% published by the Bank of Spain (2011, p. 111). Our proxy does not add up to 100% because our measure does not include credit card debt or personal loans. Nevertheless, as long as there are no systematic differences in the structure of other liabilities than mortgages across provinces, our approximation is valid. Hence, we are reasonably comfortable that our series capture household debt at a provincial level.

We construct our indicator by dividing our household debt measurement by provincial disposable income, whereby provincial disposable income data is taken from the household income distribution accounts from INE.

[1] The ratio of 2008 mortgage debt to total debt ranges from a maximum of 85.3% for the top income percentile to a minimum of 82.3% for the second highest income percentile. The differences in the income percentiles can be traced to the fact that the highest income percentile uses less than half of its mortgages for main residences, whereas the poorest 40% of households use 87% of their mortgages for main residences (Bank of Spain, 2011, p. 111 Table 6).

[2] Mian and Sufi (2012, pp. 12-13) use the debt-to-income ratio in their analysis but state that using the accumulation of household debt in the five years preceding the crisis as an alternative measure would not change the results of their analysis.

Table 1.1: Identification of tradable and non-tradable economic activities

Category	Economic Activity (CNAE 2009)	Fraction of total unemployment	
		2007	2010
Tradable	A - Agriculture, livestock farming, forestry and fishing	10%	7%
	B - Extracting industries	1%	1%
	C - Manufacturing industries	12%	12%
Non-Tradable	G - Wholesale and retail trade, repair of motor vehicles, motorcycles	11%	12%
	T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	1%	1%
	S - Other community, social and personal services activities	4%	4%
Construction	F - Construction	11%	16%

Note: Goods produced in the subcategories defined as tradable can generally be shipped to other provinces within Spain or even outside Spain. Subcategories defined as non-tradable crucially depend on local consumption. Unemployment rates have more than doubled between 2007 and 2010 so that a constant fraction translates into an increase by more than 100% in absolut numbers.

To determine the explained deleveraging effect, it is necessary to identify the portion of unemployment that results from demand reductions only. To identify this effect, we use unemployment data by economic activity on a provincial level, which can be obtained from the Spanish Ministry of Employment and Social Security (SEPE). More precisely, we use the number of job seekers who are split up into 22 different categories according to the economic activity in which they seek a job. The data is available on a monthly basis from 2006 until 2014. These groups are then clustered into the tradable, the non-tradable and the construction sector (see Table 1.1).

Due to the fact that the demand for tradable economic activities is not bound to the place of production but to the entire economy the tradable sector faces similar shocks across all provinces. The economic activities that we classify as tradable are the extracting industries, the manufacturing industries, agriculture and fishing. All the goods produced in these industries can generally be shipped to other provinces within Spain or even outside Spain. It is obvious, that a less granular distinction would lead to even fewer inaccuracies between these sectors. However, unemployment data for the subgroups 22 groups are only available at the aggregate

national level. Ideally, we would distinguish between manufacturing industries that produce for the entire Spanish market, such as the automobile industry, and manufacturing industries that only produce for local markets. As some of the employment in the manufacturing sector is linked to the local markets, we expect to see a correlation between local spending and manufacturing. An even stricter distinction would eliminate any correlation between manufacturing, i.e., tradable goods, employment effects and household sector debt. Thus, the outcome of this exercise should be seen as rather conservative estimate for the tradable sector. If we could draw a more exact line within the manufacturing sector, the results would be even stronger.

The non-tradable industries produce goods that are linked to local consumption spending, as "Wholesale and retail trade, repair of motor vehicles, motorcycles", "activities of households as employers; undifferentiated goods- and services-producing activities of households for own use" and "other community, social and personal services activities". (Retail) Trade activities like those conducted by grocery stores or clothing and shoe stores crucially depend on local consumption. The same is true of the personnel employed in household services and personal services like hairdressing.

We do not expect a lot of switches of job seekers between subcategories over time due to their specific qualifications. Anyhow, given that this effect would dampen the unemployment effects in subcategories, which are more severely hit by the crisis, our results might be regarded as conservative estimates.

It is not necessarily true that the non-tradable sectors experience higher increases in unemployment than the tradable sectors because the employment elasticities with regards to consumption may be different and consumption on durables may be more affected. However, it is important to note that the non-tradable sector depends on aggregate demand on the provincial level, and the hypothesis to be tested builds on this link. Finalizing the idea, we

expect significant results for the non-tradable sector, while for the tradable sector estimates should have no effect.

The American subprime crisis of 2007 spread to the European and Spanish real economy in 2008. Similar to the US, there was a huge housing bubble in Spain which reached its peak in 2007. Spanish debt issuance peaked in that year and Spanish employment was at its all-time high in 2008. Thus, 2007 serves as a starting point for our analysis of the effects of household debt on aggregate demand and unemployment developments. We argue that debt levels have an effect on consumption and, consequently, on aggregate demand.

1.4.2 Empirical analysis

Figure 1.1: Provincial debt-to-income ratios and unemployment

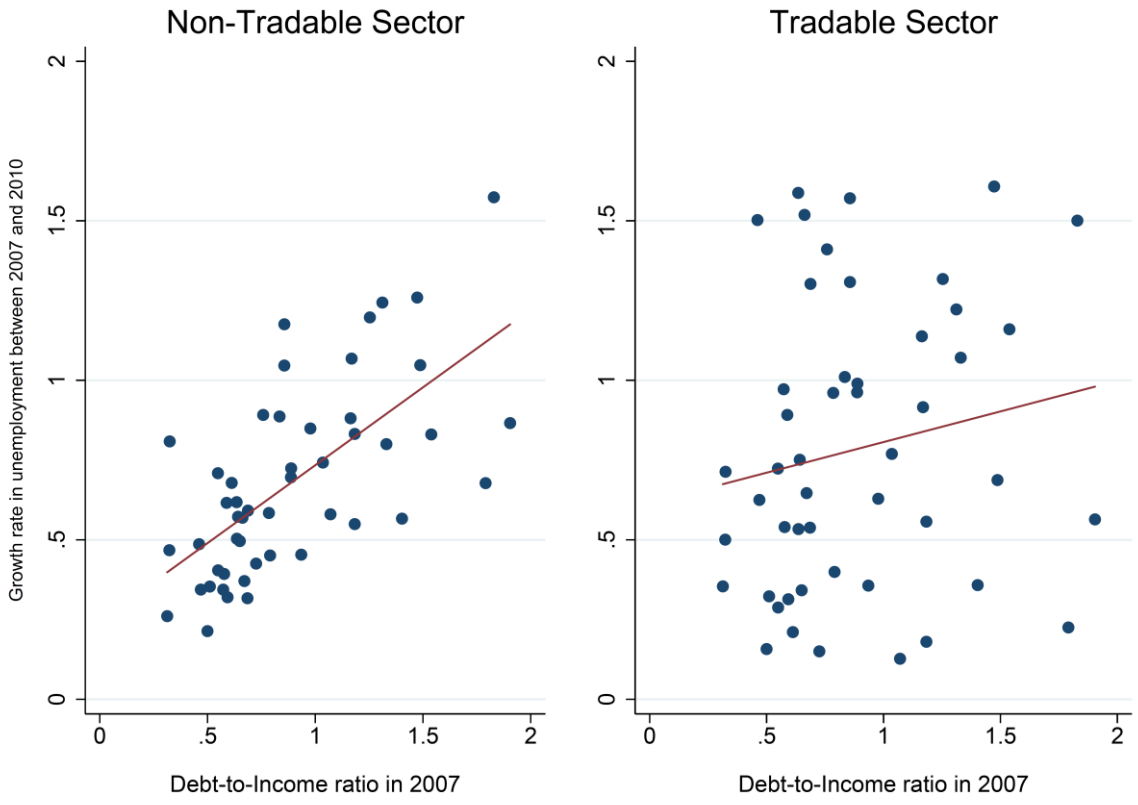


Figure 1.1 shows two scatter plots for the relation between the debt to income ratio in 2007 and the growth rate in unemployment between the fourth quarter of 2007 and the fourth

quarter of 2010. The left scatter plot is constructed with unemployment rates in the non-tradable sector, while the right scatter plot is constructed with unemployment rates in the tradable sector. One can see that the fitted red line is steeper for non-tradable sector than for the tradeable sector, which indicates a stronger relationship between the debt-to-income ratio in 2007 and the growth rates in unemployment in the non-tradable sector. Perfectly in line, the scattering is much higher for the tradable sector than for the non-tradable sector.

We first regress the unemployment growth between the fourth quarter of 2007 and the fourth quarter of 2010 on our measure of household debt to income ratio in 2007 for the 50 Spanish provinces. The provinces Ceuta and Melilla are not considered in our estimation due to explicitly expressed concerns by the Spanish Statistical Office. Nevertheless, they would not change our results.

Table 1.2: The effects of household debt to unemployment growth

	Unemployment growth, 2007 - 2010							
	Total		**Non-Tradable**		**Tradable**		Construction	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Household debt-to-income ratio, 2007	0.47***	0.31*	**0.52*** **	**0.44*** **	**0.27**	**0.02**	0.60***	0.48**
	[0.12]	[0.16]	[0.11]	[0.15]	[0.19]	[0.27]	[0.17]	[0.22]
House price growth, 2003 to 2007		-0,01		-0,01		-0,13		-0,05
		[0.14]		[0.13]		[0.26]		[0.27]
House price, 2007 [in 100.000€]		1.78**		1,11		2,23		2,50
		[0.88]		[0.82]		[1.36]		[1.46]
Emplyoment share of construction sector, 2007		3,07		1,41		5,65		0,78
		[1.88]		[1.90]		[3.47]		[3.48]
N	50	50	50	50	50	50	50	50
R^2	0,29	0,34	0,43	0,45	0,05	0,1	0,18	0,22

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

Table 1.2 shows the regression results for the total, non-tradable, tradable and construction sector respectively. Regression (a) shows our most basic regression. We find that the household debt-to-income ratio is significant for the total, non-tradable and construction

sector but, importantly, not for the tradable sector. The coefficient of 0.52 for the non-tradable sector means that if the debt-to-income ratio was one percentage point higher in 2007, unemployment growth between 2007 and 2010 increased additionally by 0.52 percentage points. Regression (b) adds control variables. House price growth between 2003 and 2007 and house prices in 2007 control for the asset side of the household balance sheet. Whilst results change slightly, the debt to income ratio is still not able to explain unemployment growth in the tradable sector, while the debt to income ratio in the non-tradable sector remains highly significant.

1.4.3 Robustness

Table 1.3: Detailed analysis of non-tradable sector unemployment

	Unemployment growth, 2007 - 2010				
	Non-Tradable Sector				
	(1)	(2)	(3)	(4)	(5)
Household debt-to-income ratio, 2007	0.54*** [0.09]	0.52*** [0.09]	0.97*** [0.16]	0.81*** [0.15]	0.90*** [0.15]
House price growth, 2003 to 2007		-0,06 [0.09]			0,04 [0.10]
House price, 2007 Q4 [in 100.000 €]		0,55 [0.60]			-0,35 [0.51]
Fraction of non-tradable unemployment, 2007					-19.44*** [4.97]
Fraction of construction unemployment			4,43 [3.76]		1,48 [4.27]
Debt-to-Income times Construction Fraction			-20.48*** [5.47]		-7,58 [6.18]
Fraction of tradable unemployment, 2007				4,35 [3.76]	4.75*** [1.54]
Debt-to-Income times Tradable Fraction				-9.01** [4.00]	-5.66*** [2.07]
Spatial Regression	Yes	Yes	Yes	Yes	Yes
N	47	47	47	47	47
R^2	0,56	0,57	0,72	0,65	0,78

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
Regression estimates are adjusted for spatial correlations with correlation between border pairs.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

Table 1.3 takes a closer look at the non-tradable sector. It cannot be ruled out that there are spillovers between neighboring provinces, which would bias our results. Consumers could consume goods and services in a neighboring province and therefore, affecting the unemployment rate in the non-tradable sector in this neighboring province. Regressions are therefore adjusted for spatial correlation with correlation between border pairs. Column 1 and 2 of Table 1.3 therefore repeats the regression of table 1.2 for the non-tradable sector. It indicates that results are not driven by spillovers as we see similar results. Column 3 controls for potential spillover effects from the construction sector. It might be the case that a severe increase in unemployment rates in the construction sector has demand effects and could therefore potentially bias the unemployment growth in the non-tradable sector. We therefore add the fraction of the construction unemployment in 2007 and the interaction term household debt to income ratio times the construction fraction. This brings us in a hypothetical state, where the construction sector does not exist. Interestingly, household debt to income ratios did not only stay highly significant but the coefficient increased from less than 0.6 to 0.97. Column 4 controls in the same manner as in regression 3, but for potential spillover from the tradable sector. Regression 5 adds all controls variables together. Additionally, it adds the level of non-tradable unemployment to adjust for structural differences among provinces. The impact remains economically strong and significant.

Table 1.4: Structural differences in debt levels among provinces

	Unemployment growth, 2007 - 2010							
	Non-Tradable				Tradable			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Household debt-to-GDP ratio, 2007	0.80***	0.81***	0.62**		0,37	0,41	-0,07	
	[0.19]	[0.29]	[0.28]		[0.32]	[0.51]	[0.46]	
Household debt-to-GDP ratio, 2002		**-0,03**		**0,89**		-0,11		-0,24
		[0.56]		[0.58]		[1.06]		[0.85]
House price growth, 2003 to 2007			-0,01	-0,01			-0,15	-0,17
			[0.14]	[0.14]			[0.26]	[0.26]
House price, 2007 Q4			0.00*	0.00**			0.00*	0.00*
			[0.00]	[0.00]			[0.00]	[0.00]
Active person as fraction of total population, 2008 Q1			0,01	0.02***			-0,02	-0.03**
			[0.01]	[0.01]			[0.02]	[0.01]
Emplyoment share of construction sector, 2007			1,93	3.77*			6.22*	6.29*
			[2.10]	[1.95]			[3.57]	[3.18]
N	50	50	50	50	50	50	50	50
R^2	0,38	0,38	0,42	0,35	0,03	0,03	0,11	0,11

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

There is a possibility that our measure of the household debt-to-income ratio captures simply structural differences in debt levels. To disprove this argument, we construct our approximation for household debt for the year 2002. As disposable income is not available for 2002, we use GDP instead. Column 1 of table 1.4 repeats the baseline regressions of table 1.2 with GDP instead of disposable income. Column 2 and 4 of table 1.4 show that the household debt to income ratio in 2002 is not able to explain changes in unemployment in the non-tradable sector between 2007 and 2010. This indicates that structural differences in debt levels between provinces are not able to explain our findings.

As a final step, we try to shed some light on the question whether deleveraging needs are solely demand driven or if a credit crunch forced households to reduce their debt. Mortgage data from the Spanish Statistical Office (INE) provides newly issued mortgages by different entities granting the loan, separating between banks, savings banks and other banks. Savings

banks, known as Cajas in Spain, were most severely hit by the crisis. Out of 45 Cajas in 2007 only 2 survived the aftermaths of the crisis. We therefore construct the average share of mortgages issued by saving banks between 2003 and 2007. Provinces, where Cajas granted loans disproportionally before the crisis, should be more credit constraint afterwards.

Table 1.5: Savings banks and the credit crunch hypothesis

	Unemployment growth, 2007 - 2010			
	Non-Tradable		Tradable	
	(1)	(2)	(1)	(2)
Household debt-to-income ratio, 2007	0.52***	0.47***	0,27	0,06
	[0.09]	[0.11]	[0.17]	[0.25]
Average share of mortgages issued by saving banks, 2003 - 2007	**1.26*** **	**1.21*** **	**1.65***	**1,45**
	[0.39]	[0.45]	[0.88]	[1.01]
House price growth, 2003 - 2007		0,04		-0,07
		[0.13]		[0.26]
House price, 2007 [in 100.000 €]		1.31**		2.48*
		[0.64]		[1.30]
Emplyoment share of construction sector, 2007		0,53		4,57
		[1.34]		[3.09]
N	50	50	50	50
R^2	0,53	0,58	0,11	0,18

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

Table 1.5 shows our results when we add the average share of mortgages issued by Cajas to our baseline regressions. As expected, the average share of mortgages issued by saving banks has a positive and significant effect on unemployment growth in the non-tradable sector. This indicates that the credit crunch did contribute to the unemployment increase in the non-tradable sector. Nevertheless, the household debt to income ratio remains highly significant, confirming the important role of household deleveraging in addition to the credit-crunch hypothesis.

1.5 Conclusion

We investigate in detail the situation of the Spanish provinces regarding their household indebtedness and changes in unemployment. We provide a new measure for provincial household sector debt levels for Spain and find that this variable has a significantly positive effect on changes in the provincial unemployment rates between 2007 and 2010. Due to the distinction between non-tradable and tradable sector unemployment, we are assured to capture demand effects caused by deleveraging needs. Our results are robust for potential spillovers among neighboring provinces and adverse effect from the construction and tradable sector. Finally, this study highlights once more the relevance of household indebtedness for aggregate demand and unemployment.

Chapter 2

Mortgage Debt and Unemployment over the Business Cycle

Evidence from Spanish Provinces[ϕ]

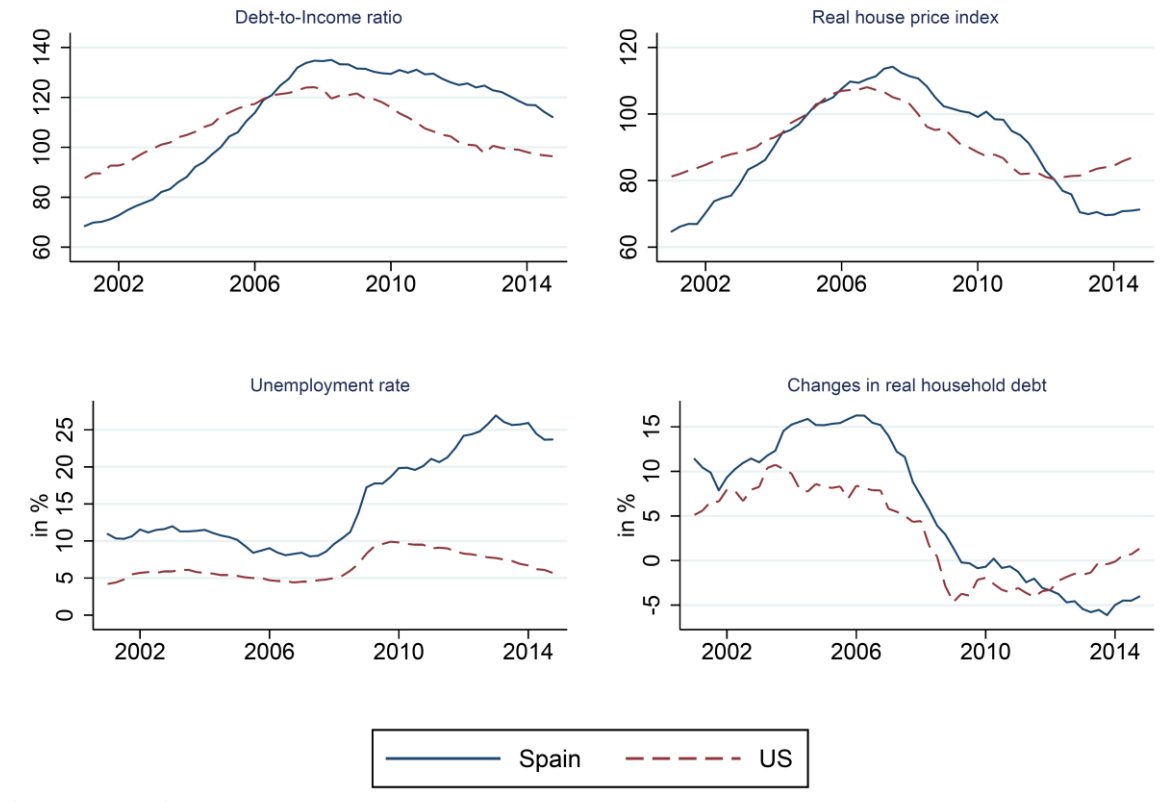
[ϕ] Acknowledgments: I am thankful to the participants of the Macroeconomic Research Seminar at University of Munich for useful comments and suggestions.

2.1 Introduction

This chapter shows that there is a stable relationship between newly issued mortgage debt (the credit impulse for the housing market) and unemployment in the non-tradable sector (a proxy for local demand) for Spain over the business cycle. This study is to my knowledge the first, which is able to test for this relationship on a regional level and gives therefore additional insights into the importance of the debt-driven consumption channel for business cycle dynamics and local demand.

Spain is one of the most interesting countries to analyze as its economy suffered from a similar economic downturn like the US, but duration as well as amplitudes of important macroeconomic variables exceeded the US aggregates by far.

Figure 2.1: The macroeconomic environment in Spain and the US



Sources: FRED, ECB, Eurostat

Figure 2.1 shows that Spain and the US suffered from a similar increase in the unemployment rate between 2006 and 2009 but in contrast to the US, Spain's unemployment rates steadily increased until the beginning of 2014. Debt-to-income, real house prices as well as the real household debt moved together with the unemployment rate. Spain faced the peak of the Spanish housing bubble like the US in 2007 but in contrast to the US, house prices could not stabilize before 2013. This is in line with the change in debt, which has decreased (the second derivative) until the beginning of 2014, while the change in debt had already stabilized around 2010 for the US.

The International Monetary Fund (2012) looks at household debt on a national level for advanced economies and finds that large run-ups in household debt lead to more sever recessions afterwards and a deleveraging in household debt. The McKinsey Global Institute (2015) shows that while households in the United States, the United Kingdom, Spain and Ireland have deleveraged, household debt-to-income ratios in other countries have continued to grow.

Jorda, Schularick and Taylor (2016) argue that it is not total credit which drives recessions and financial crisis, but that it depends on the type of credit which experiences a boom. They show that mortgage credit is a key driver of financial fragility. Total bank lending as a ratio of GDP doubled in the previous 50 years, while real estate lending increased from around 20% up to 70% of GDP and therefore by more than 300 %. For recessions since 1950, Jorda, Schularick and Taylor (2016) show that mortgage credit has significant and economically important effects for the subsequent three to five years, whereas non-mortgage credit appears to be imprecise and weak. Therefore, the authors conclude, that mortgage credit plays a key role in explaining business cycle dynamics.

Mian, Sufi and Verner (2017) investigate on the effects of household debt on GDP, which they call the debt-driven consumption channel. By setting up a vector auto regression

(VAR) for 30 countries, they show that an increase in the household debt to GDP ratio leads to more severe downturns of the business cycle (an increase by 6.2% over the last three years predicts a decrease of 2.1% in GDP over the next three years). Interestingly, they find that the relationship is non-linear, which means that a decline in household debt is not able to predict higher growth rates.

Mian, Rao and Sufi (2012) look on the linkages between debt deleveraging of households and spending cuts in consumption. By using local retail sales data for the US on a county level, they show that household debt levels affect consumption. Mian and Sufi (2014) investigate on the effects of a housing net worth shock on employment for the US and find that the higher the reduction in net wealth of households, the stronger the reduction in employment in the non-tradable sector. Similar results for Spain have been provided in Chapter 1.

Stable linkages between debt and aggregate demand are difficult to test empirically. Country level data analysis lacks the fact that fiscal and monetary policy might be key driver of this channel which is difficult to control for (see, e.g., Mian, Sufi and Verner (2017), Jorda, Schularick and Taylor (2016) and Keen (2009)). As shown in Chapter 1, cross section analyses on a regional level focus on identified shocks, which are amplified by debt-deleveraging driven downturns (see also e.g., Mian, Rao and Sufi (2013) and Mian and Sufi (2014)). This strand is therefore not able to estimate stable relationships over the business cycle.

This chapter moves in between these two strands of identifications and is to my knowledge the first which looks at stable relationships between debt and aggregate demand on a regional level. Being more specific, this chapter looks at how an additional amount of mortgage debt affects unemployment in the non-tradable sector (determined by local demand) on a provincial level for Spain between 2006 and 2014. By controlling for time fixed effects, an increase in newly issued mortgage debt by 1 euro per capita reduces the unemployment rate in the non-tradable sector by 3.6 basis points in the next year. The usage of an instrument and

the addition of unemployment as a lagged dependent variable does not change the results. Furthermore, results are robust if regressions are controlled for house prices and unemployment in the tradable sector. Most importantly, by using an additional data set from 2003 till 2014, I can show that there are no differences between the rise and the downturn of the business cycle as long as time fixed effects are used. This strengthens the findings that there are stable relationships between debt and aggregate demand, which are not exclusively driven by downturns of the business cycles.

2.2 Theoretical Channels

Since the outbreak of the great financial crisis (GFC), the aggregate demand channel has reinvigorated in theoretical and empirical research. Nevertheless, according to Mian, Sufi and Verner (2017), there seems to be a blind spot in explaining the debt-driven consumption channel.

> *"While the existing literature in macro-finance has made important contributions in understanding the "investment" channel for business cycle dynamics […], our results highlight the importance of a debt-driven "consumption" channel for business cycle dynamics. We hope our results will help guide the burgeoning theoretical literature in this area."* (Mian, Sufi and Verner, 2017, pp. 1759-1760)

The baseline idea when it comes to debt is that in a closed frictionless economy without a government debt is always "money we owe to ourselves" (Krugman, 2011). In this simple setting, money and therefore debt should have no macroeconomic implications. This is obviously not true anymore if one relaxes these strict assumptions. According to the International Monetary Fund (2012), inefficiencies and deadweight losses from debt overhang and foreclosures, negative price effects from fire sales and differences between borrowers and lenders lead to negative effects of debt.

Sudden changes in expectations or aggregate demand (demand shocks) are related to debt burdens and therefore amplify downturns of the business cycle. Households with higher debt-to-income levels or with higher decreases in their net wealth need to restructure their balance sheets proportionally by a larger reduction in consumption. Nevertheless, in a standard saver lender economy this is not sufficient to explain an aggregated reduction in consumption as households which have acted as lenders might increase consumption (see, e.g., Eggertsson and Krugman (2012)). An aggregated cut back of consumption is therefore only able to explain economic downturns if the marginal propensity to consume (MPC) is positively correlated with the indebtedness. Mian, Rao and Sufi (2012) provide empirical evidence for the US between 2006 and 2009 and find that the MPC out of housing net wealth is higher for poorer and more levered households.

While it is therefore well understood how downturns are amplified by debt, it is more difficult to explain stable links between the change in household debt and aggregate demand. Based on their empirical results, Mian, Sufi and Verner (2017) conclude that "it is unlikely that increases in household debt are uniquely driven by credit demand or credit supply shocks" (Mian, Sufi and Verner, 2017, p. 1782). Nevertheless, an interaction of both in combination with behavioral biases are able to create feedback loops.[3]

More specific, an increase in house prices, which positively affects the housing net wealth, relaxes the borrowing constraints for households. This allows for second mortgages on the house. Mian and Sufi (2011) find no empirical evidence that second mortgages are used for additional house purchases or pay downs of other forms of debt, which makes it likely that second mortgages are at least partially used for consumption purposes. If these households have

[3] See Mian, Sufi and Verner (2017, pp. 1780-1785) for an extensive discussion on theoretical relationships between household debt and economic growth.

been constrained in their borrowing limits, second mortgages will have direct effects on aggregate demand.

Households could be also liquidity constrained, which means that they might have a high net wealth, but mainly illiquid assets like houses on its asset side. Borrowing against their illiquid assets will therefore have positive effects on consumption. Kaplan, Violante and Weidner (2014) estimate that 20% of households in the US were liquidity constrained ("wealthy hand to mouth households") in 2007, while around 10% of households have been "poor hand to mouth" households.

Mortgage debt and endogenous money creation

> *"Banker's activism affects not just the volume and the distribution of finance but also the cyclical behavior of prices, incomes, and employment."* (Minsky, 2008, p. 252) [4]

Differences in MPCs, borrowing and liquidity constraints are able to explain transmissions between a change in mortgage debt and demand driven variables like consumption or employment. Nevertheless, I like to broaden this discussion by an additional feature which moves besides the heterogeneity of households. The theory of endogenous money creation stands in contrast to the financial intermediation theory (see, e.g., Werner (2014)). The financial intermediation theory assumes banks as intermediaries, where lenders hand over money to borrowers (see, e.g., Eggertsson and Krugman (2012)[5]). The credit creation theory of

[4] The idea of Minsky's banker's activism is not so different from the conclusions drawn by Mian, Sufi and Verner (2017). A credit supply shift, which effects credit demand which again is reinforced by behavioral biases could be interpreted as an explanation of Minsky's financial instability hypothesis (see, e.g., Minsky (1982, pp. 115–127) and Keen (1995, pp. 611–614)) in today's standard terminology.

[5] Eggertsson and Krugman (2012) is a theoretical example for differences between borrowers and lenders. Households can be either patient or impatient, which is expressed in their different time preferences. This naturally makes the patient household a lender who borrows to the impatient household, which leaves both parties better off. When a debt deleveraging shock (a decrease in the debt limit) hits the economy, the impatient household needs to reduce its debt by cutting back consumption. Nevertheless, this shock is still not sufficient in explaining negative impacts on aggregate demand because the lender would simply increase its consumption. It therefore needs a shock that is big enough to move the interest rate into negative territory so that the economy faces a liquidity trap which further affects aggregate demand.

banking argues that it does not need additional savings to create loans, but that debt generates deposits (savings). This argumentation is nowadays backed up by the Bank of England (see McLeay, Radia, and Thomas (2014)) and by the Bundesbank (2017).

It is important to note that banks are exclusively able to create deposits via loans. It is therefore a difference for the economy if corporations or governments borrow money from households or from banks. If corporations issue bonds, deposits simply flow from households to corporations so that the net change in deposits equals zero. If corporations receive a loan from a bank, new deposits are created. According to Jorda, Schularick and Taylor (2016), mortgage debt increased from 20% up to 70% in terms of GDP and, even more importantly, from 30% to 60% in terms of bank's total lending portfolio. This means that more than half of the created deposits by the banking sector are nowadays created via mortgage loans, which makes the mortgage market the key driver of deposit creation.

Figure 2.2: Mortgage loans created via endogenous money creation

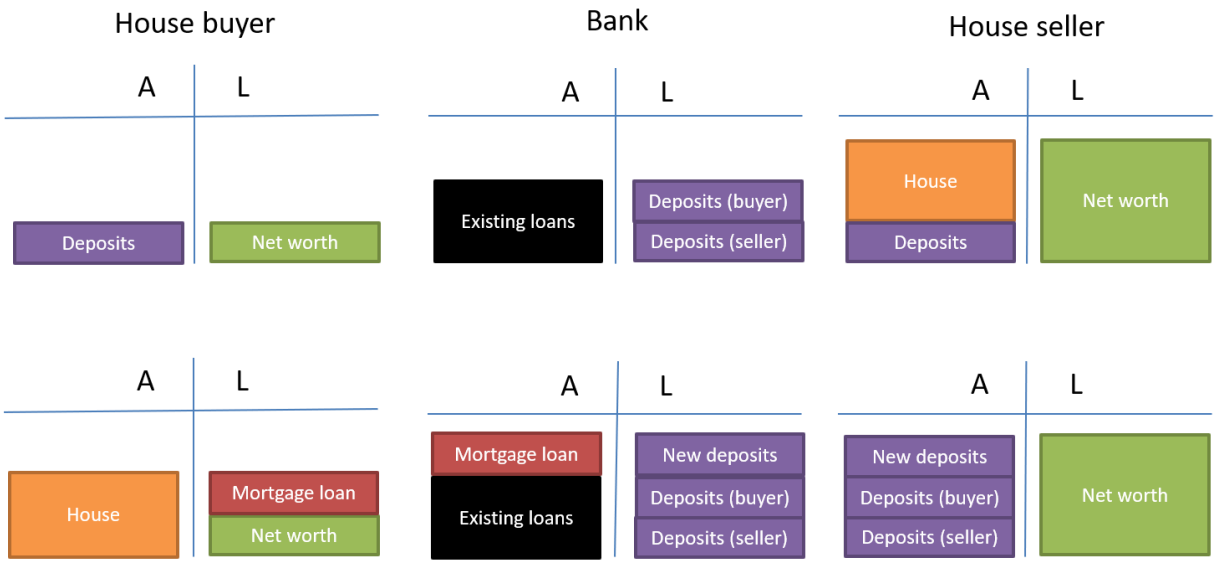


Figure 2.2 shows simplified balance sheets for a house buyer, a bank and a house seller. The house seller owns a house and has deposits on its bank account. As the seller has no mortgage or other loans, his liability side equals its net wealth. The house buyer wants to buy the house from the house seller and therefore uses the savings (deposits) as a down payment to

receive a mortgage loan from the bank. The house seller receives the newly created deposits from the mortgage loan as well as the savings of the house buyer. Net wealth did neither change for the house buyer nor for the house seller, while balance sheet size and leverage of the house buyer has increased.

If the savings of the lender are not absorbed by the borrower, there is a direct and an indirect effect of an additional mortgage loan. A mortgage loan directly increases housing demand. The construction of a new house will lead to spillovers to aggregate demand from the construction sector, while the purchase of an existing house might increase house prices, which relaxes borrowing constraints of other households. Indirectly, the banking sector adds additional savings (additional deposits on the asset side of the house seller) to the economy and therefore additional spending power (liquidity). The house seller faces three options: first, keep the deposits on its bank account, which leads to (precautionary) additional savings. Second, use the additional spending power for consumption purposes, which stimulates demand. Third, purchase new assets, which leads to asset price inflation, which will increase the net wealth of other households.

To make this argument clearer, this scenario can be compared to a simple lender borrower relationship. The direct effect is now unclear. While the borrower is still able to construct or purchase a house, the lender loses investment opportunities like buying a house for him or herself. This again shows the necessity of heterogeneity of households within this framework. Effects on the economy are only possible if there are specific heterogeneities between the borrower and the saver. Additionally, the indirect effect is not existent anymore. As the lender handed over his or her savings to the borrower, he or she does not face additional liquidity. It therefore makes a difference if one argues within a lender borrower framework or within a framework with endogenous money creation.

This argumentation is in line with Keen (2009), who argues that the change in debt as a fraction of GDP explains the credit-driven part of aggregate demand. For Keen (2009), changes in debt are the dominant factor in explaining changes in unemployment. Correlations for Australia provide first evidence for this postulation.

2.3 Empirical Evidence

2.3.1 Description of the data

This chapter intends to test empirically if there is a (stable) effect of mortgage debt on aggregate demand and therefore on (non-tradable) unemployment over the business cycle. The data set is constructed for Spain on a provincial level between 2006 and 2014 on a quarterly basis.

The explanatory variable is newly issued mortgage loans for dwellings. Mortgage data is available from the Spanish Statistical Office (INE) since 1995 on a monthly basis for Spanish provinces. The variable tracks the mortgage debt of dwellings based on its location, which is an important feature for cross-section analyses among Spanish provinces. Mortgage debt is by far the main driver of Spanish household debt. According to the survey of household finances (EFF) in Spain, mortgage debt accounted for 84.2% of total debt in 2008 and for 86.9% in 2011.[6]

It is important to note that I am not measuring mortgage debt but newly issued mortgage credit, which can be seen as the credit impulse of the mortgage market. The "miracle" of creditless recoveries where GDP growth rebounds while credit stocks are still decreasing (see, e.g., Calvo, Izquierdo and Talvi (2006) and Abiad, Dell'Ariccia and Li (2011)), do not appear

[6] As long as there are no systematic differences in the structure of other liabilities (mainly credit card debt or personal loans), this variable might be seen as a proxy for newly issued household debt. Nevertheless, I will not make use of this approximation in this chapter.

as miracles anymore if one compares the correct flows to each other. As GDP growth is the change of a flow, it needs to be compared with the change of the flow of credit which again is the change of the stock of credit and therefore its second derivative ($\Delta D_t - \Delta D_{t-1}$). Biggs, Mayer and Pick (2009) provide empirical evidence for five major banking crises and show that the "miracle" vanishes when one uses the credit impulse instead of the credit change. As the aim of this chapter is to test for stable relationships over the business cycle, where business cycle dynamics should drive unemployment rates, newly issued mortgage debt as credit impulse is the needed variable.

General unemployment effects are insufficient to determine debt effects via the aggregate demand channel. The construction sector is directly affected by the amount of mortgage debt, whereas I am only interested in spillovers from the construction sector. The tradable sector like manufacturing is rather affected by national and global determinants than by local demand. As I want to detect unemployment effects exclusively driven by local demand, unemployment rates for the non-tradable sector are needed.

Table 2.1: Identification of non-tradable economic activities

Category	Economic Activity (CNAE 2009)	Fraction of total unemployment	
		2007	2010
Non-Tradable	G - Wholesale and retail trade, repair of motor vehicles, motorcycles	11%	12%
	T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	1%	1%
	S - Other community, social and personal services activities	4%	4%

Note: Subcategories defined as non-tradable crucially depend on local consumption. Unemployment rates have more than doubled between 2007 and 2010 so that a constant fraction translates into an increase by more than 100% in absolut numbers.

The identification for the non-tradable sector for Spanish provinces is adopted from Chapter 1. Employment data for Spanish provinces is not available on a detailed enough sectorial breakdown. Hence, Chapter 1 has made use of unemployment data by economic activity on a provincial level, which can be obtained from the Spanish Ministry of Employment

and Social Security (SEPE). The number of job seekers is split up into 22 different categories according to the economic activity in which they seek a job. Out of theses 22 subcategories, three subgroups are identified as non-tradable (see Table 2.1).

Figure 2.3: Relations between debt and unemployment for selected provinces

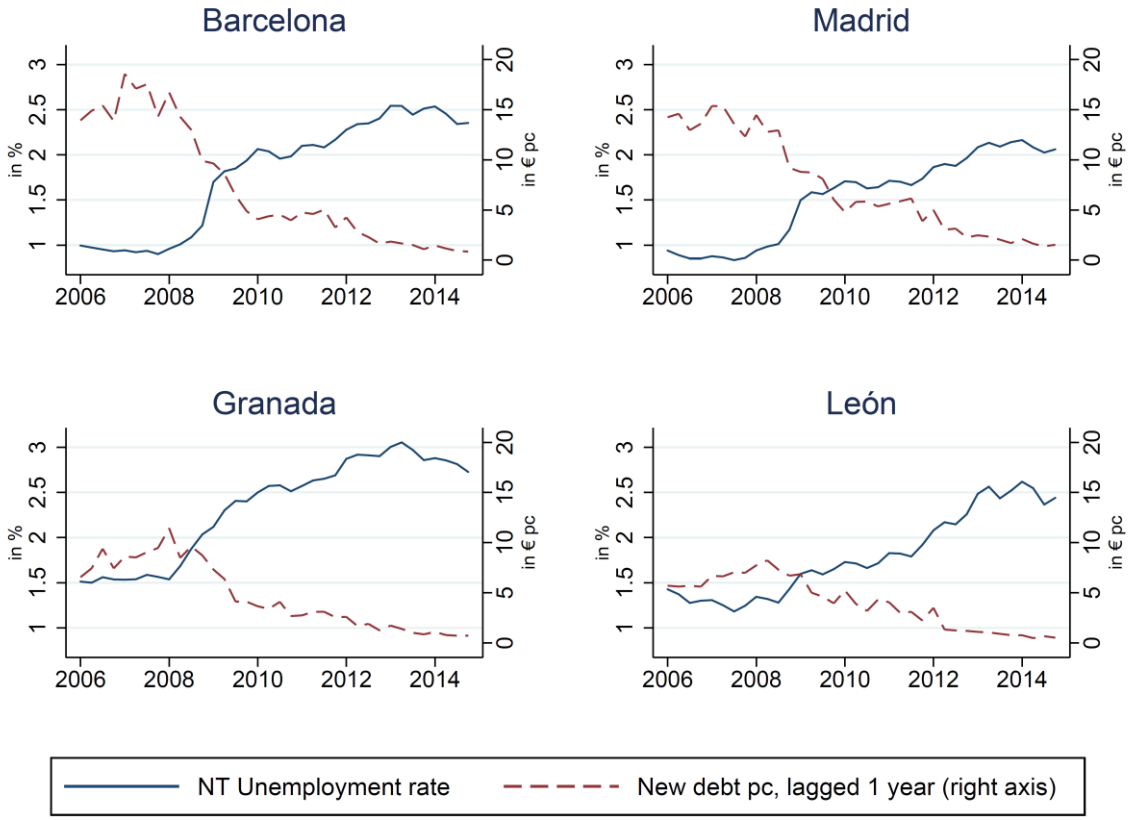


Figure 2.3 gives a first impression of the data set and shows non-tradable unemployment divided by the working age population (left axis) and deflated newly issued mortgage debt per capita (right axis) for selected provinces lagged by four quarters. While the four provinces behave differently in terms of levels, one can see a close negative relationship between the two variables.

2.3.2 Identification

My dataset is a panel dataset for Spain on a provincial level, which leads to my knowledge to an innovative identification approach in this field. There are two main strands of

identification in the literature which focus on the relation between household debt and variables like GDP, consumption and unemployment. The first strand are country level panel data sets (see, e.g., Mian and Sufi (2017) and Jorda, Schularick and Taylor (2016)). This strand gives rather broad answers as it measures main macro variables on a country level. The second strand uses cross section analysis on a regional level (see, e.g., Chapter 1, Mian and Sufi (2013) and Mian Rao and Sufi (2013)). This approach helps to identify the characteristics of a specified shock (identified moment) where the date of appearance of the shock is defined ex post (Nakamura and Steinsson, 2017). Additionally, the within country analysis allows the necessary assumption that the country has been hit by the same shock, but the transmission (debt levels or housing net wealth) effects regions differently.

My analysis stands in between these two strands. In comparison to the first strand, this chapter is to my knowledge the first study which tries to analyze the effects of debt on macro variables in a panel setting on a regional level for a single country. This setting leads to a different identification strategy. Firstly, in comparison to single country analyses, regional data increases the number of data points by a multitude. This allows a singly country panel analysis instead of using a set of countries. One major advantage is that for a regional panel analysis, it is plausible to assume that every region in Spain has been hit by the same external shock, while this is difficult for country analyses. Additionally, I use non-tradable unemployment instead of broad variables like GDP or total unemployment, which helps to focus on the aggregate demand channel. In contrast, the identification of my data set is borrowed from the second strand. Nevertheless, due to its panel structure, interpretation of the outcomes changes. While the second strand identifies a specific shock and is able to measure the effect how this shock translates among regions, my approach turns into the other direction and asks whether there is a stable relationship between debt and unemployment. For the measurement of stable

relationships, a panel data set is needed as this gives the chance to use time fixed effects, which are able to filter out shocks on the national and global level.

The use of my panel data set with time fixed effects allows identifying the unemployment "multiplier" among the cross section but does not give any information on the aggregated general equilibrium effect, which is absorbed by time fixed effects (Nakamura and Steinsson, 2017). The estimated regional "multiplier" gives therefore no direct information on the aggregate multiplier but is able to explain differences between the entities. Nevertheless, if significant, it is an accurate and precise analysis that the estimated multiplier plays a crucial role in economies.

The baseline regression is expressed as follows:

(2.1) $$u_{it}^{NT} = \alpha_i + \gamma_t + \beta D_{it-4} + \varepsilon_{it}$$

u_{it}^{NT} is the number of unemployed persons in the non-tradable sector in province i at quarter t divided by the working population in province i at quarter t. D_{it} is the deflated newly issued mortgage debt in province i at quarter t divided by the population[7] lagged by 4 quarters. α_i and γ_t represent province and quarter fixed effects. Province fixed effects control for province specific differences while time fixed effects capture aggregate shocks and aggregate policy changes. This is especially relevant for changes in fiscal and monetary policy, which might be main drivers of the labor markets during times of crises.

Endogeneity issues

It takes time until a new loan translates into aggregate demand which then affects unemployment. This is the reason why D_{it} is lagged by four quarters. The lag helps to abandon to some extent simultaneous causality as Y_{it} cannot have a direct effect on D_{it} anymore.

[7] I use the total population instead of the working population because the population determines housing demand. Nevertheless, working age population as denominator does not change my results.

Nevertheless, newly issued mortgage debt might be still endogenous. Time depended omitted variables which drive business cycle fluctuations exclusively in province i cannot be ruled out by province and time fixed effects. Think of a company, which moves to province i, builds a factory, employs workers and therefore drives up employment in the non-tradable sector and house mortgages via an increase in aggregate demand.

To deal with these endogeneity issue, I make use of an instrument, which is inspired by the Bartik type instrument literature (see, e.g., Goldsmith-Pinkham, Sorkin and Swift (2018)). While a standard Bartik type instrument uses (industry) shares, I use variations among regions as instrument. This approach therefore rather follows the idea of Blanchard, Adler and Filho (2015) who use this approach for global capital flows and Nakamura and Steinsson (2014) who use regional variations for military spending.

Let Ω be the set of all provinces and Ω_i the set of province i and its neighboring provinces. Hence, the instrument is expressed by

$$B_{it} = \frac{1}{j}\sum_{j\ \varepsilon\ \Omega\setminus\Omega_i} D_{jt} \tag{2.2}$$

The idea is to measure the newly issued debt in province i at time t which is solely induced by national factors but not by provincial specific factors and therefore exogenous to province i. I construct the mean of newly issued debt for every province except province i and provinces which have a border with province i. The reason to leave out border provinces addresses an additional vulnerability. If households live close to a provincial border, they might go to a hairdresser located in the neighboring province, which would distort my results. This concern is addressed by excluding neighboring countries from the instrument.

The first stage regression of the two-stage least squares regression analysis is defined as

$$D_{it} = \alpha_i + \gamma_t + \delta B_{it} + \varepsilon_{it} \tag{2.3}$$

In the first stage, I regress newly issued credit (D_{it}) on the constructed instrument. The error term in this regression captures idiosyncratic factors of province i at time t, which cannot be explained by province and time effects as well as by newly issued debt from other provinces. The error term therefore captures factors, which could drive newly issued credit as well as unemployment in the non-tradable sector, while the predicted value $\widehat{D}_{it}$ should be free of such idiosyncratic factors.

The second stage is defined as

$$u_{it}^{NT} = \alpha_i + \gamma_t + \beta \widehat{D}_{it-4} + \varepsilon_{it} \tag{2.4}$$

By regressing unemployment in the non-tradable sector, which is locally determined, on provincial new loans cleaned by idiosyncratic factors of province i, I heavily reduce endogeneity concerns.

2.3.3 Results

The regressions are estimated on a quarterly basis between 2006 and 2014 for 47 provinces in Spain.[8]

[8] Due to statistical concerns expressed by the statistical office of Spain and misleading interpretations due to high levels of tourism and foreign home owners, the five islands are dropped from the dataset.

Table 2.2: Effects of mortgage debt on non-tradable unemployment

	Unemployment rate in the non-tradable sector						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
New $Debt_{t-4}$ pc	-0.085*** [0.010]	-0.118*** [0.009]	-0.036*** [0.009]		-0.050*** [0.015]	-0.046*** [0.004]	-0.070*** [0.022]
NT $unemployment_{t-1}$				0.648*** [0.105]	0.439*** [0.164]		0.425** [0.177]
N	1.692	1.692	1.692	1.598	1.598	1.692	1.598
R^2	0,259	0,789	0,891			0,825	
IV (2SLS)	No	No	No	No	No	Yes	Yes
Province Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes	Yes	Yes	Yes	Yes
GMM (A-B)	No	No	No	Yes	Yes	No	Yes

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.
The unemloyment rate is expressed in percent. Newly issued mortgage debt is expressed in € per capita. The maximum number of lags used as instruments for the Arellano-Bond estimator is capped at ten. The instrument is used via a two-stage least square (2SLS) regression analysis.

Column 1 to 5 of table 2.2 show the baseline regressions without the instrument. Column 1 is a simple pooled OLS regression. In column 2, province fixed effects are added, which results in a panel fixed effects regression. Column 3 additionally incorporates time fixed effects. Column 2 therefore gives the total effect, while column 3 presents the "stable" effect as time fixed effects lead to an independency of national and global affects. As non-tradable unemployment is expressed in percent, a coefficient of 0.036 means that an increase of 1 euro of newly issued debt for every citizen of province i reduces the unemployment rate in the non-tradable sector by 3.6 basis points. If one looks again at Figure 2.3, D_{it} decreased by 13 euros per citizen for Madrid, which would result in an increase in the unemployment rate by around 50 basis points on a stable basis (coefficient from column 3) and by around 150 basis points in total (coefficient from column 2). As unemployment rates have been fairly low in the non-tradable sector until the crisis (between 1% and 1.5%), an increase by 50 basis points shows, that newly issued mortgage debt is also highly significant in economic terms.

Unemployment can be dynamic which means that u_{it}^{NT} depends on its own lags. Past unemployment has the possibility to affect current unemployment. Structural inefficiencies, hysteresis effects, different types of labor market rigidities and general costs for hiring and firing employees are arguments in favor of dynamic effects. I therefore add lagged unemployment as an additional control variable to the regression in column 4 and 5. This construction leads by design to biased and inconsistent estimators because the lagged dependent variable will be correlated with the error term of the regression. To adjust for this, I use the approach of generalized method of moments (GMM) and take lagged dependent variables as instruments. Being more specific, I use the Arellano-Bond estimators, which is a well-known estimator for employment purposes (see, e.g., Arellano and Bond (1991)). As expected, lagged unemployment is strongly significant (column 4). Adding lagged unemployment and adjusting endogeneity issues with lagged dependent variables as instrument, does not change the results (column 5). Regressions in column 6 and 7 use the two-stage least square regression analysis and therefore incorporate the instrument (see equation 2.2). The reduction in the R^2 from 0.89 (column 3) to 0.83 (column 6) shows that the instrument has successfully filtered out idiosyncratic factors. Nevertheless, newly issued mortgage debt is still highly significant while the coefficient moves within the corridor of the baseline regressions.

2.3.4 Robustness

I implement three robustness tests and take house prices, unemployment in the tradable sector and the afforded equity share for house purchases into account. I do not make use of the instrument for regressions with house prices and equity shares as these two variables are locally determined so that debt should be fully locally determined as well.

Table 2.3: Robustness checks

	Unemployment rate in the non-tradable sector					
	(1)	(2)	(3)	(4)	(5)	(6)
$Debt_{t-4}$		-0.036***	-0.030***	-0.035***		-0.032***
		[0.003]	[0.003]	[0.004]		[0.003]
$House\ prices_{t-4}$	-0.019***	-0,001				
	[0.005]	[0.005]				
$Trade\ Unemployment_{t-4}$			0.131***	0.129***		
			[0.018]	[0.018]		
$Equity\ Share_{t-4}$					1.006***	0.591***
					[0.345]	[0.131]
Observations	1.692	1.692	1.504	1.504	1.692	1.692
R^2	0,811	0,826	0,822	0,822	0,884	0,892
IV (2SLS)	No	No	No	Yes	No	No
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.
The unemloyment rate is expressed in percent. Newly issued mortgage debt is expressed in € per capita. House prices are expressed in 10,000 €. The equity share is expressed in percent. The instrument is used via a two-stage least square (2SLS) regression analysis.

It might be argued that it is not debt, which drives aggregate demand but rather the asset side of household balance sheets, which mainly consists out of houses. Economic models with housing in the utility function are not able to give a clear answer on how house price changes affect aggregate demand and therefore consumption and unemployment:

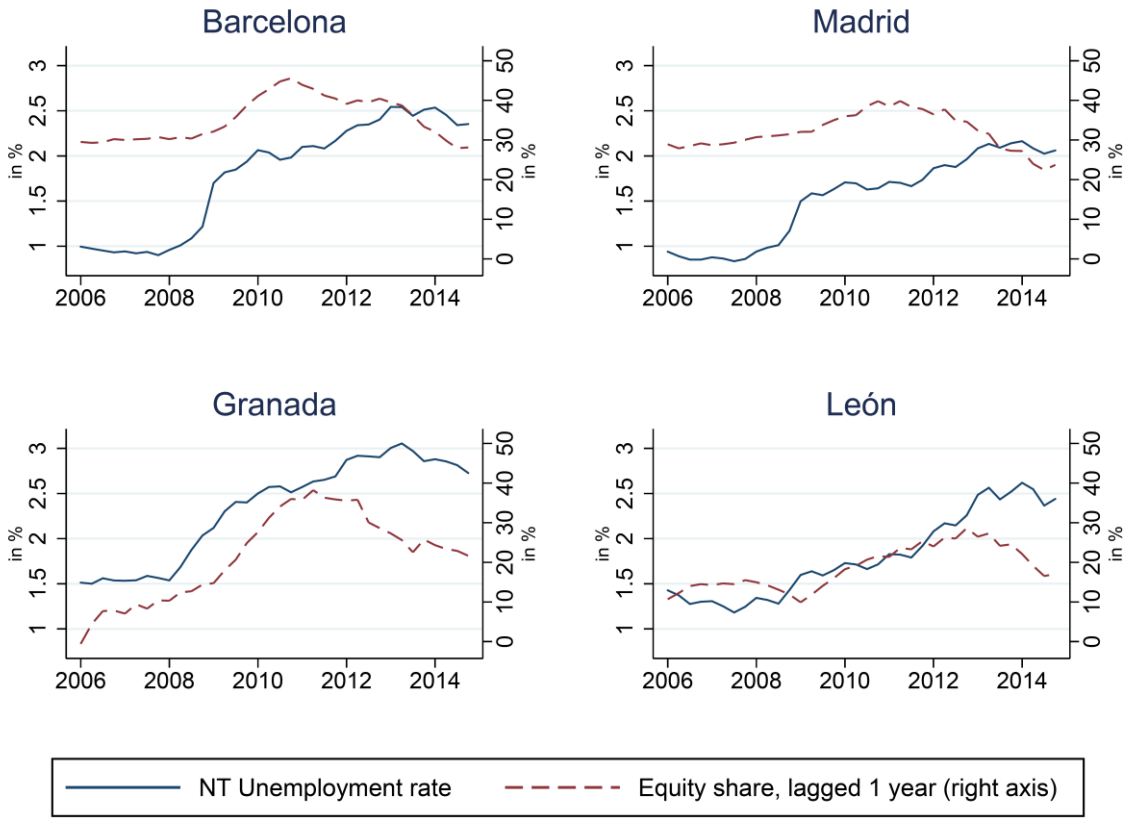
> *"[O]ne can derive an aggregate consumption function where consumption is expressed as a function of income and wealth, and where the marginal propensity to consume out of housing wealth is positive or negative depending on the underlying characteristics of the economy."* (Iacoviello, 2011, p. 9)

In a frictionless model, where households simply keep their house, there should be no effect on consumption. A shift in tastes, where household aim to live in bigger houses might have negative effects on consumption spending, while in a model with borrowing constraints, increases in house prices might increase consumption (Iacoviello, 2011).

Column 1 of Table 2.3 shows that house prices have a significant effect on unemployment. Nevertheless, when debt is added to the regression (column 2), house prices turn insignificant, while debt is still highly significant. If the relaxations of the borrowing constraint are the only factor which explains the significance of house prices, it is plausible that house prices turn insignificant as the debt variable incorporates these additional mortgages.

Column 3 and 4 of Table 2.3 add the tradable unemployment rate as control variable. According to Chapter 1, sectors identified as tradable are “agriculture, livestock farming, forestry and fishing”, “extracting industries” and “manufacturing industries”. The tradable sector should mainly depend on national and global demand. A shock to global demand directly affects a company selling products worldwide, which is located in province i. If the company lays off workers, local demand and therefore unemployment rates in the non-tradable sector are affected via spillovers. Controlling for changes in the tradable sector should therefore capture these effects. As it takes time until these spillovers are resulting in job reduction in the non-tradable sector, tradable unemployment is like debt lagged by four quarters. As expected, one can see a positive significant correlation. Nevertheless, debt is still highly statistically and economically significant. This holds for the baseline regression (column 3) and for the two stage least square regression with instrument (column 4).

Figure 2.4: Equity shares for selected provinces



The mortgage statistic does not only provide the amount of newly issued mortgage debt but also the number of mortgages. This allows to construct the average mortgage. The house price statistic does not provide the total average house prices, but only the average price of sold houses within a quarter. House prices are provided by the Spanish Ministry of Public Works and Transport. By subtracting the average mortgage from the house price and dividing it by the house price gives therefore the equity share of newly bought houses. Figure 2.4 presents the down payments in terms of the house price (equity share) and the non-tradable unemployment rate for selected provinces. One can see that equity shares highly differ among provinces. While the equity share is rather stable in Barcelona, one can see an increase from around zero to more than 30% for Granada.

It could be argued that it is not debt which drives the local economy, but a change of the afforded down payments (equity share). Column 5 of Table 2.3 shows that the equity share is

positive and significant. An increase in the equity share by 1% increases the unemployment rate in the non-tradable sector by around 1 basis point. Column 6 of Table 2.3 shows that debt is still highly significant although I control for the equity share.

Since the GFC, there is an ongoing debate about macroprudential tools to sustain financial stability. The equity share (loan-to-value ratio) is one possible tool within this discussion. Although the equity share is market determined and not exogenously set by policy makers in my data set, results provide first evidence that the equity share could not only serve as a macroprudential tool to sustain financial stability, but also to reduce household debt driven business cycle volatility.

So far, the covered time range has been from 2006 until 2014. One could therefore argue that the regressions mainly cover the downturns of the business cycle and therefore the effects of foreclosures, fire sales, debt overhangs and deleveraging. To expand the time range from 2003 till 2014 instead of 2006 till 2014, I use employment figures of the service sector. Unfortunately, the service sector covers to some extent tradable jobs. Nevertheless, as the other three employment groups are manufacturing, construction and agriculture, I feel safe to cover most of the non-tradable sector. Note that this variable is now employment and not unemployment anymore so that the sign of the coefficient should be positive as an increase in debt should increase employment rates.

Table 2.4: Stable effects over the business cycle

	Employment rate in the service sector					
	(1)	(2)	(3)	(4)	(5)	(6)
$Debt_{t-4}$	0.168***	0.167***	0.117***	0.126***	0.187***	0.190***
	[0.021]	[0.021]	[0.036]	[0.039]	[0.029]	[0.030]
$Interaction_{t-4}$		0.215***		-0,085		-0,024
		[0.036]		[0.062]		[0.053]
N	2.256	2.256	2.256	2.256	2.256	2.256
R^2	0,764	0,78	0,869	0,869	0,477	0,48
IV (2SLS)	No	No	No	No	Yes	Yes
Province Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	No	No	Yes	Yes	Yes	Yes

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.
The employment rate in the service sector is expressed in percent. Newly issued mortgage debt is expressed in € per capita. The instrument is used via a two-stage least square (2SLS) regression analysis.

To test for stable effect over the business cycles, I construct a dummy, which is 1 from the third quarter in 2007 onwards and 0 otherwise. The dummy is interacted with debt. As the variables are lagged by four quarters, first downturns in the labor market are expected in the third quarter of 2008. Regressions of column 1 and 2 of Table 2.4 test for stable effects without time fixed effects. As expected, the interaction term is positive significant. This means that during the downturn, employment effects have been stronger by 0.215 in comparison to the upwind. Nevertheless, newly issued mortgage debt still appears to be highly significant (column 2). As explained, identification without time fixed effects covers the total effect, but not the stable effects. Regression in columns 3 to 6 add time fixed effects. It shows that the interaction term is not significant anymore, which means that differences are already covered by time fixed effects. These results are strongly in favor of my argument that there are indeed stable effects of debt on aggregate demand, which are not just downside driven.

2.4 Conclusion

It has been shown that there is a stable relationship between newly issued mortgage debt (the credit impulse for the mortgage market) and unemployment in the non-tradable sector (unemployment driven by local demand). By controlling for time fixed effects, an increase in newly issued mortgage debt by 1 euro per capita reduces the unemployment rate in the non-tradable sector by 3.6 basis points in the next year. Given the high volatility of newly issued mortgage debt per capita, the effect is economically significant.

The usage of an instrument which reduces idiosyncratic noise and dynamic panel analysis with unemployment as a lagged dependent variable do not change the results. Furthermore, results are robust for controlling for house prices (the asset side of households) and lagged unemployment in the tradable sector. Most importantly, by using an additional data set from 2003 until 2014, I can show that there are no differences between the rise and the downturn of the business cycle as long as time fixed effects are used. This strengthens my findings that there are stable relationships between debt and aggregate demand, which are not exclusively driven by downturns of the business cycles.

Although the equity share is rather market determined and not exogenously set by policy makers in my data set, results provide first evidence that the equity share could serve as a macroprudential tool to dampen household debt driven business cycle volatility. The current discussions about macroprudential tools argues that macroprudential tools could be used for financial stability purposes, while monetary policy focuses on price stability. This could release central banks from leaning against the wind. If mortgage debt is a stable driver of local demand and business cycle volatility, this clear separation is not possible anymore. Macroprudential tools like the afforded equity share for mortgages will directly affect the economy besides financial sustainability and therefore effect price stability as well. Elaborating this idea further, macroprudential tools might be an effective stabilization tool on a regional level and, for the

euro area on a country level to overcome differences in the business cycle among regions or countries which share common monetary policy.

Chapter 3

Repo Markets, Monetary Policy and Collateral Shortage

Evidence from Primary Dealers[ξ]

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3.1 Introduction

> *"Perhaps no other market is so critical to the functioning of the financial system, and yet so poorly understood."* (Singh, 2017, p. 5)

Repo volumes have been halved from its peak level of $ 10 trillion during the GFC. While research about the drop in 2008 has expanded during the previous years, not much insight has been gained why repos have not recovered during the last decade. As the repo market represents the largest source of short-term funding, a solid functioning of the repo market is essential for the financial system.

A repo is a sale and repurchase agreement. The seller of the security receives funding from the buyer of the securities and guarantees to buy back the security (collateral) at the end of the repo. If the seller is not able to rebuy its collateral, the counterpart gains the right to sell the collateral. For the duration of the repo, the buyer of the security is therefore the legal owner of the collateral, while the seller is still the economic owner, which means that the seller is still affected by price changes of the security. Terminology depends on the point of view. The seller conducts a repo (RP), while the buyer conducts a reverse repo (RRP).

As most repos are ongoing, the collateral of a repo transaction is based on a mark to market evaluation. This mark to market mechanism ensures that the value of the collateral does not change in terms of the borrowed cash. If the price of the collateral increases (decreases), the buyer (seller) of the security receives a margin call and hands over additional collateral. In addition, a haircut covers potential losses during the day. This haircut mainly depends on the quality and the volatility of the collateral and the creditworthiness of the borrower. High haircuts and price decreases therefore reduce liquidity while low haircuts and price increases increase liquidity for the borrower. These procyclical features in the repo market have been for instance shown by Adrian and Shin (2010, 2012) and Geanakoplos (2009).

Unsurprisingly, most research has focused on collateral defaults and the breakdown during the GFC. Empirical upheavals in the repo market have been extensively studied by Adrian and Shin (2009), Gorton (2009), Gorton and Metrick (2012), Krishnamurthy, Nagel and Orlov (2014) and Hördahl and King (2008). Theoretical work can be classified into models covering multiple equilibria of run on repos, e.g., Martin, Skeie and v. Thadden (2014), the buildup of systemic risk in the shadow banking system, e.g., Gennaioli, Shleifer, and Vishny (2013) and informational rational ignorance about the collateral, e.g., Gorton and Ordonez (2014, 2016).

This chapter abstracts from the run on repos and collateral default literature and focuses on the structural mechanisms of the repo market and aims to find answers why the repo market has not recovered after the GFC. Based on important literature in this field (see Mehrling (2012), Pozsar (2014, 2015), Singh (2017) and Gabor and Vestergaard (2016)), I develop a consistent organizational framework for the repo market, which combines the hierarchy of money, money market segmentations, the new monetary policy tool (reverse repos) by the FED with the needs and restrictions of important actors in the financial system.

While there is empirical research about the tri-party repo market, this chapter is to my knowledge the first which looks at the functioning of the broader repo market intermediated by primary dealers (PD), the trading arms of global banks. By making use of the Primary Dealer Statistic, I am to my knowledge the first who can show empirically that PDs shape the repo market. Matched books are suppressed by PDs balance sheet costs and open books are affected by stress in the financial system. As balance sheet costs had risen due to banking regulations after the GFC, this finding can to some extent explain why the repo mark has not recovered. The second part of the chapter looks at effects arising from potential collateral scarcity, which potentially suppresses the repo market. It shows that in times of cyclical collateral scarcity, PDs do not appear as market makers by offsetting supply and demand mismatches but move with

the market. This worsens the cyclical collateral scarcity and therefore effects the repo market negatively. To investigate on structural collateral shortage, I handpick data about reuse allowance of collateral from annual reports of 24 PDs between 2003 and 2016. The constructed data set shows that there is a break between reused collateral and repo volumes after the GFC. This break can be explained by either a decrease of collateral within the financial system (structural collateral shortage) or by a contemporaneous increase in the OTC derivate market.

3.2 Organizing Framework

3.2.1 The hierarchy of money

Every claim that is tradable at par on demand makes a claim a money-like claim in the financial system. These claims are hierarchical and can be expressed in the hierarchy of money. Money or money-like claims within this hierarchy have no or only minimal credit and duration risk and are highly liquid. The safest claims are on top of the hierarchy. They include reserves provided by the central bank and T-bills provided by the government. On the second layer are deposits provided by banks. PDs provide repos on the third layer and finally, money market funds (MMF) provide constant net asset values (CNAV). The unique feature of the highest layer is that central banks and governments do not need money higher up in the hierarchy to settle their money, while all the other layers do. Banks need reserves to settle deposits via the interbank market, dealers need deposits to settle their repos and money market funds need repos to settle their CNAVs. The lower the claim is in the money hierarchy, the more difficult it becomes to climb up in the hierarchy in times of crisis and therefore, the riskier (risky in terms of refinancing and not in terms of a potential default) the money claim is. Nevertheless, if times are tranquil and different money claims are traded at par, one cannot see direct differences among different money claims. The most obvious example on this is that households do not differentiate between cash (central bank money) and deposits (commercial bank money)

because they are traded at par, meaning that for 1 € cash you always receive 1 € deposits. This trade at par does not hold because the two claims are identical but whenever there is unwind in the system, the central bank offsets mismatches between supply and demand. Think of a run on cash where the amount of cash is fixed. Without interventions by the central bank, market mechanism would drive up the price for cash in terms of the price of deposits so that at the end one would for instance only get 50 cents cash for 1 € deposits (Mehrling, 2012; Pozsar, 2014; Gabor and Vestergaard, 2016).

Monetary economists distinguish between money (means of final settlement) and credit (promises to pay money). Assets are money whenever they fulfill three functional perspectives: medium of exchange, unit of account and store of value. Since the evolution of the financial systems over the last 30 years, this differentiation has become more and more complicated. Money sits on the asset side while credit sits on the liability side. This means that for banks, reserves are money and deposits are credit, for dealers, deposits are money and repos are credit, for MMFs, repos are money and CNAVs are credit while CNAVs are money for investors in MMFs.

The interest rate on money claims is mainly driven by the position in the hierarchy, the available volume and the possibility of access for different market participants in the financial system. Although T-bills as well as reserves are part of the first tier in the hierarchy, T-bills are available for every market participant while reserves are only available for banks, which have an account at the central bank. Therefore, interest rates on T-bills are on average below the interest on federal funds. For deposits, the money claim in the second tier, every customer with a bank account has the potential to have access. While deposits are guaranteed by the government until a certain threshold, which makes them similar to T-Bills in terms of safeness, every dollar above this threshold is like an unsecured loan to a bank and comes with high risks. This is where the third tier, repos, comes into play. Without the development of new forms of

money-like claims, big actors in the financial system are only able to hold T-Bills, for which they have to pay a high premium or hold deposits, which is like buying an unsecured short-term bond from a bank (Pozsar, 2014).

3.2.2 The three key players of the repo market

> *"A capitalist economy with sophisticated financial institutions is capable of a number of modes of behaviour and the mode that actually rules at any time depends upon institutional relations, the structure of financial linkages and the history of the economy."* (Minsky, 1982, p. 92)

What makes the repo market special is that every participant in the financial system has the possibility to trade in this market as lender and borrower of liquidity. This feature makes the repo market the meeting point between the rather regulated banking system and the rather unregulated shadow banking system. Participants in the repo market are commercial banks, investment banks, broker-dealer banks, MMFs, pensions funds, private and public wealth funds, governments, central banks, international corporations, hedge funds and government-sponsored enterprises (Pozsar, Adrian, Ashcraft and Boesky, 2012).

According to Pozsar (2014, 2015), two main players started dominating the financial system in the early 2000s: cash pools and levered bond portfolios. Cash pools are mainly governments, central banks, international corporations and reserve and asset managers. There are three main factors which have increased cash pools tremendously: FX reserves started increasing after the Asia crisis in the late 1980s, China entered the world trading system and corporations became net savers in the early 2000s. While these players have different intentions, they share one common feature: They are “cash rich but safety poor” Pozsar (2015), which means that their reason to hold cash has a value in itself, so that their main focus is not to lose money instead of gaining high returns.

In contrast to cash pools a second type of asset managers emerged called the levered bond portfolios by Pozsar (2015). The group contains private and public wealth funds, pension funds, mutual funds and ordinary portfolio managers. The bond portfolios faced huge inflows of money after the dotcom bubble when equity was seen as an unsafe opportunity to invest. Dalio, the founder of Bridgewater associates, argued in 2004 that "through the use of leverage, bonds can be made "competitive" with equities" (Dalio, 2010, p. 3). As managers face downturns in bond yields, the need for leverage has become more and more important to meet the expected returns by the public.

Cash pools face certain problems in the financial system because they have no access to central bank money (reserves). Cash pools afford highly liquid assets because their money needs to be available whenever a crisis hits in. While deposits are too risky and the outstanding volume of T-Bills is not able to capture the needs of cash pools, the structure of a repo fulfills the needed criteria. Cash pools act as cash providers and receive collateral. An overnight repo is highly liquid, safe due to the received collateral and its haircut and pays an interest rate above T-Bills. Levered bond portfolios sit on the other side of the repo. They act as collateral providers and receive cash, which they can use to buy additional bonds. This allows levered bond portfolio leverage and therefore higher returns. Cash pools and levered bond portfolios can therefore not exist without each other (Pozsar, 2015).[9]

3.2.3 Primary dealers

> *"Broker-dealers are perhaps the least well understood when it comes to the question who exactly they lend to."* (Pozsar, 2015, p. 8)

Until the GFC, PDs were mainly seen as intermediaries for passing on monetary policy

[9] The increase in levered bond portfolios obviously increases the demand for bonds. The amount of outstanding bonds and therefore the amount of outstanding debt in the public and private sector might not have been possible to get financed without levered bond portfolios and cash pools. This increase in the demand for bonds might have put pressure on yields. It is therefore worth thinking about these features in the context of secular stagnation.

and as distributers of treasury bonds. This view has changed since three main PDs (Lehman Brothers, Bear Stearns and Merrill Lynch) were not able to operate anymore, which forced the FED to trade with PDs directly via the Primary Dealer Credit Facility (Adrian, Burke and McAndrews 2009). As a result, net positions of primary dealers came into focus (see, e.g., Duffie (2010)).

While the focus on the stability of PDs is important, it overshadows the main function of PDs. Dealers are "the primary source of funding for the entire spectrum of levered investment strategies in the asset management complex" (Pozsar, 2014, pp. 53-54). This means that they stay between the levered bond portfolios and cash pools.[10]

In general, dealers are first and foremost market makers. Market makers are needed in the repo market as cash pools and levered bond portfolios are distributed all over the world. As there is no central counterparty, the dealer arm of global banks occurs as market makers by using its global network.

[10] PDs are mainly global banks like Goldman Sachs, J.P. Morgan Chase, HSBC and Deutsche Bank. If you look at the details, the PD of Deutsche Bank is called Deutsche Bank Securities Inc and not Deutsche Bank AG. The reason for that is Section 23A of the Federal Act, which restricts interactions between securities trading and the depository funding. This simply means that PDs cannot finance securities via their deposits. Interpreting this from a *money view perspective*, Section 23A of the Federal Act strictly separates bank money (deposits) from shadow money (repos). This separation makes PD dealers of the shadow banking system (Gabor and Vestergaard, 2016).

Figure 3.1: A stylized repo market

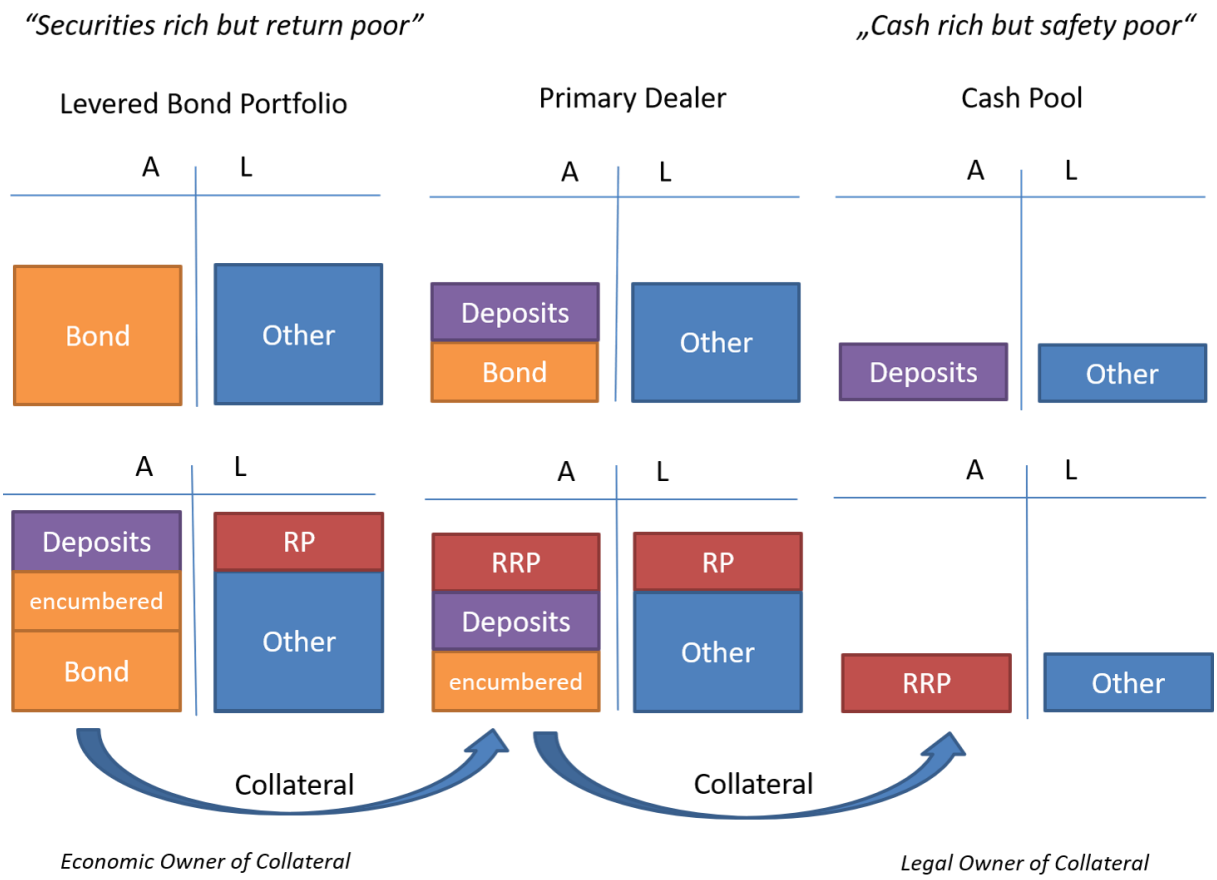


Figure 3.1 summarizes the organizing framework and shows the structural mechanism of the repo market. The levered bond portfolio has bonds on its asset side and needs higher returns to beat its benchmark. The cash pool has deposits on its asset side and craves for more safety. The levered bond portfolio and the cash pool do not know each other, but they both know a PD, an arm of a global bank. The PD has an inventory, which helps to conduct repos in both directions independent of the other side. The PD conducts a repo with a levered bond portfolio so that the repo (RP) sits on the liability side of the levered bond portfolio and the reverse (RRP) sits on the asset side of the PD.[11] The levered bond portfolio hands over collateral and receives deposits in return. The same happens between the PD and the cash pool with the difference that the PD incurs the repo, hands over collateral and receives deposits. In this

[11] A repo and a reverse repo are the same operation but from a different perspective. When a PD does a repo, it hands over collateral and receives liquidity. When a PD does a reverse repo, it hands out liquidity and receives collateral.

scenario, everyone is better off. The levered bond portfolio has deposits, which it uses as leverage to buy additional bonds. It is still the economic owner of the encumbered bond so that it has successfully levered up. The PD has a perfectly matched book, which means that it does not face any additional risks but gains earnings by charging the levered bond portfolio a slightly higher repo rate than it pays to the cash pool. The cash pool has a safe and highly liquid money like claim for which it receives interests above the T-Bill rate.

It is important to recognize that this mechanism needs deposits to settle a repo, but it does not need more deposits when there are more repos. Shadow banking money can operate separately from bank money and a repo is therefore leverage in the financial system without a change in deposits. Gabor and Vestergaard (2016) show this in a more elaborated way.

3.2.4 The segmentation of money markets

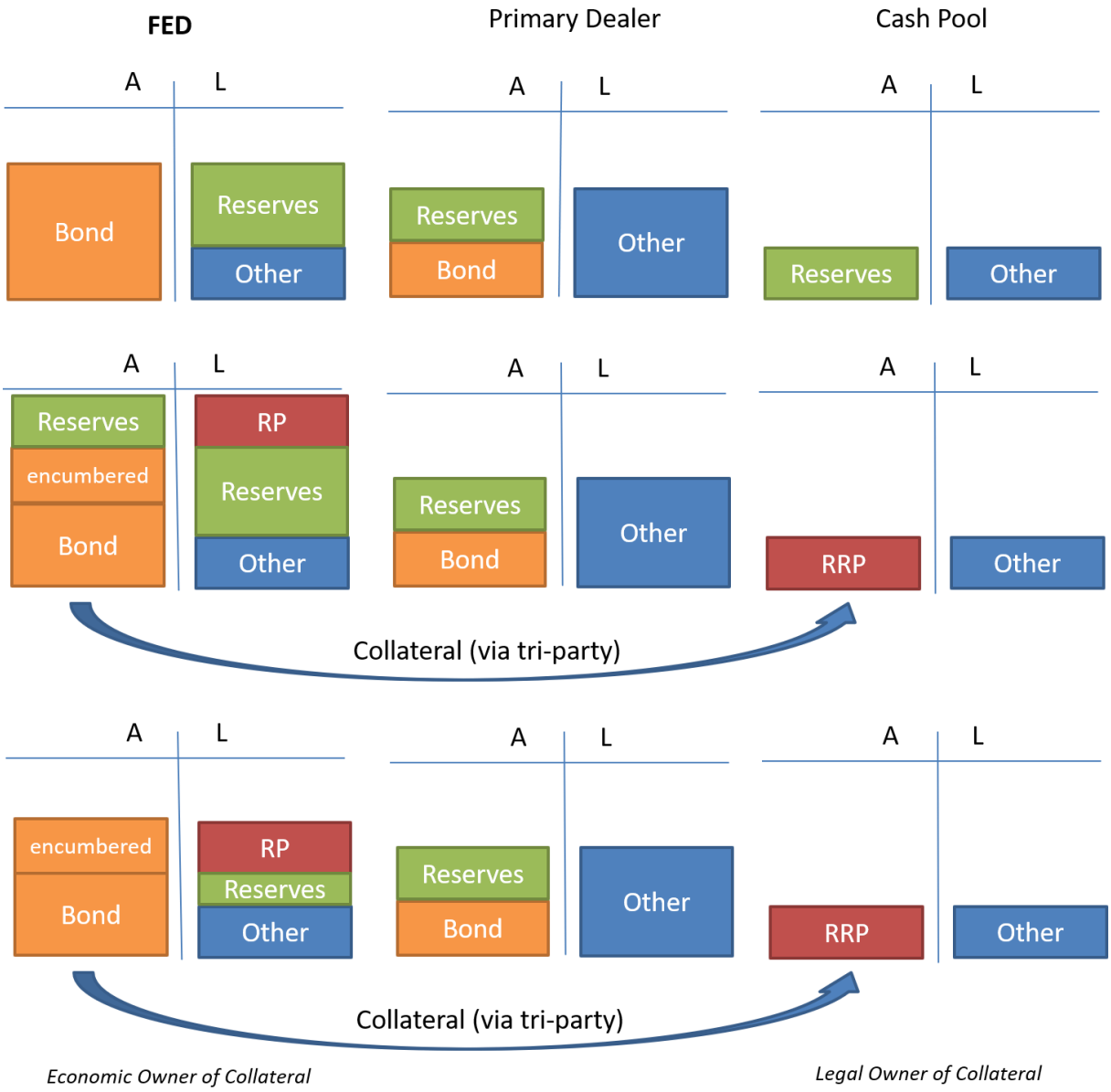
Until the outbreak of the GFC, interest rates among different forms of money-like claims have been traded very close to each other in the money markets. This means that different layers in the hierarchy have been traded at par. This has not just changed during the great turmoil around 2008 but seems to be the new normal in money markets.[12]

The FED is well aware of this segmentation and has introduced a new monetary policy tool. In September 2013, the FED conducted its first overnight reverse repo (ON RRP) at a fixed rate and since September 2014, ON RRPs are an official monetary policy tool of the FED. The FED conducts its ON RRPs with MMFs, government-sponsored enterprises, banks and investment managers. The repo is solely conducted in the tri-party repo market where the underlying collaterals are exclusively treasury bonds. The FED hands out treasury bonds as

[12] This segmentation is for instance one main argument for deviations of the covered interest rate parity (see, e. g., Rime, Schrimpf and Syrstad (2017) and Schlegel and Weiss (2017)).

collateral, receives liquidity and pays the offered repo rate.[13] It therefore behaves like a levered bond portfolio. This new monetary policy tool is only possible due to the asset purchase programs, where now the purchased assets can serve as collateral for ON RRPs.

Figure 3.2: The mechanism of the FED's ON RRPs



It can be seen from Figure 3.2 that the implementation of RRPs has no effect on any balance sheet size. The FED acts as levered bond portfolio but bypasses the PD as the FED

[13] The framing reverse repo is to some extent misleading because it is a reverse repo for the counterparty, while the FED conducts a repo.

trades directly with cash pools via the tri-party repo market. What happens is a simple exchange on the liability side of the FED which reduces reserves in the system and increases the repo volume. By handing out collateral, the FED is able to receive reserves on its asset side, which are directly offset with reserves from the liability side.

The reason for this policy tool is to set an additional floor in the money markets. The interest rate on excess reserves (IOER) should serve as a floor for the effective federal funds rate (EFFR). Whenever the EFFR is below the IOER, banks could borrow at EFFR and lend it to the FED at IOER. This is not what we see in the data, where the EFFR is constantly below the IOER (see, e. g., Bech and Klee (2011)). ON RRPs serve as a floor for the repo rate. As these two interest rates are closely linked to each other, a stabilization of the repo rate should also lead to a stabilization of the EFFR. The combination of the IOER and ON RRPs at a fixed rate, which is set constantly below the IOER, is called the floor-with-subfloor system by Williamson (2016).

When you think in terms of the hierarchy of money, the FED increases money like claims of the third tier (repos) and reduces money like claims from the first tier (reserves). While it has been a standard monetary policy tool to trade actively between the first and the second layer (deposits), ON RRP can be interpreted that the FED has become a dealer of last resort of the shadow banking system.

Figure 3.3: Volumes of the FED's ON RRP facility

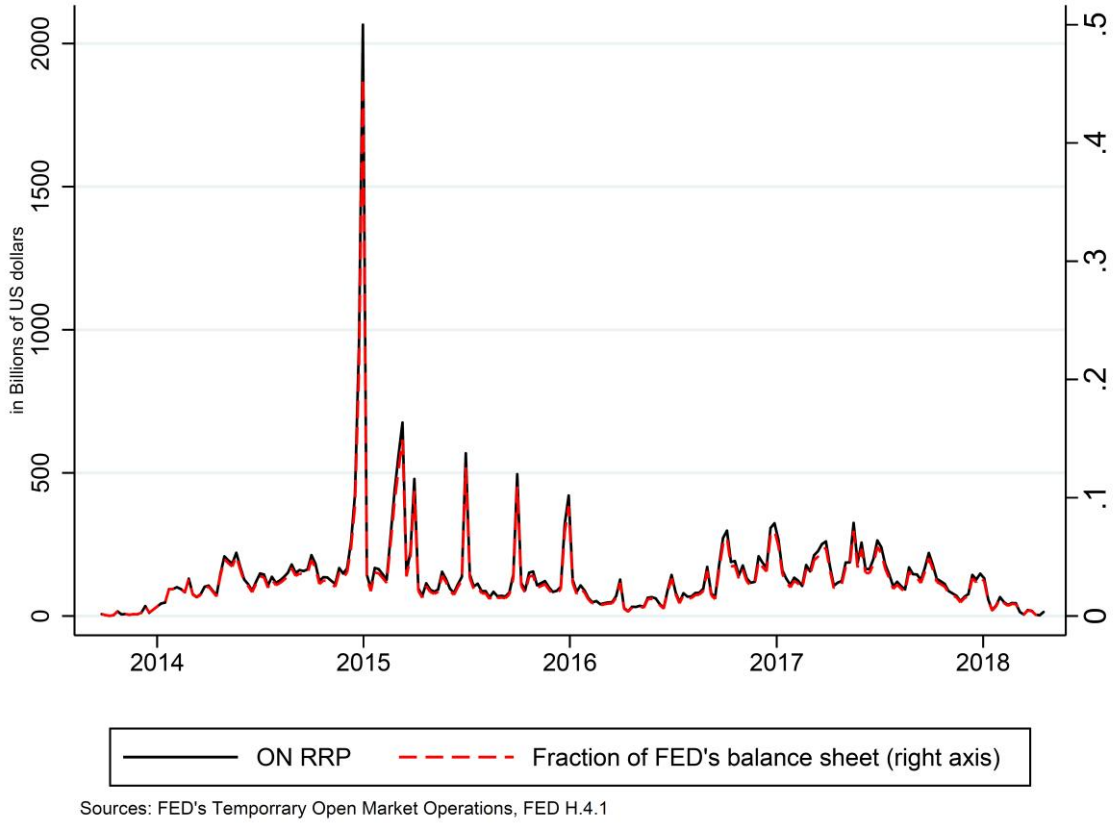
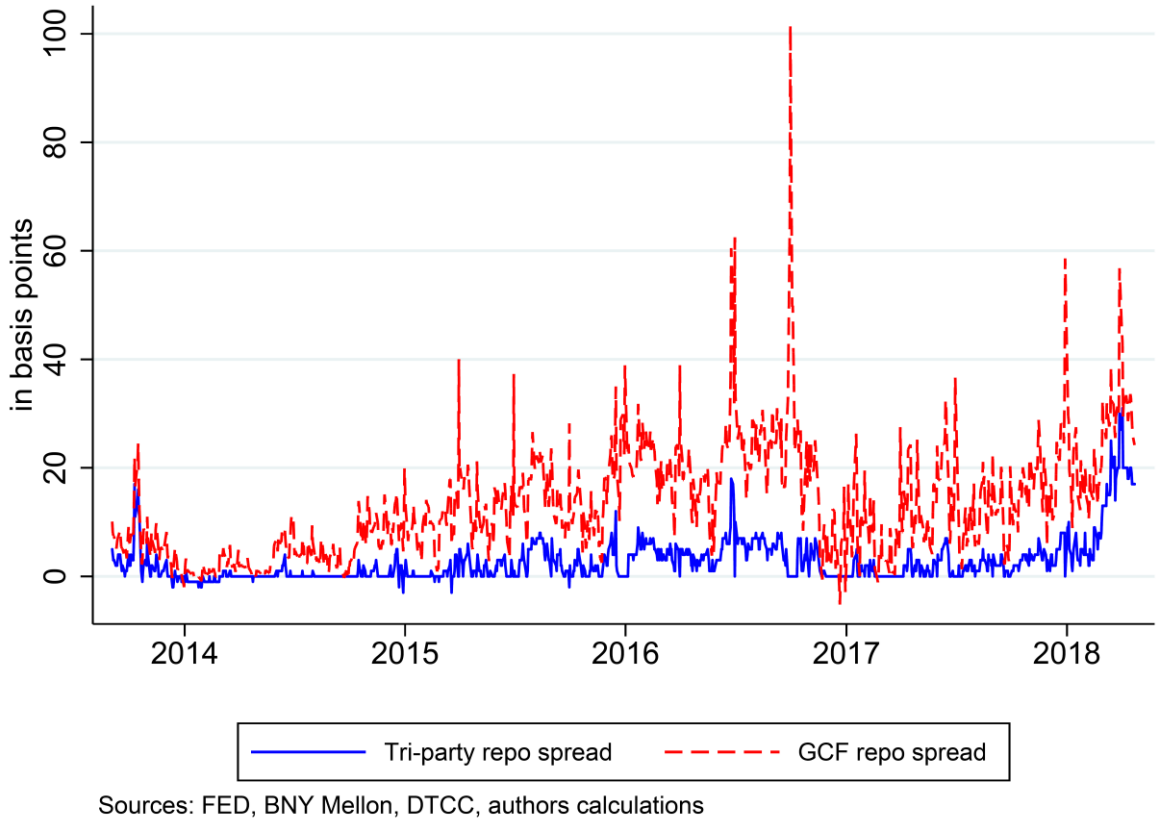


Figure 3.3 shows the volume of ON RRPs. One can see that this new monetary policy tool is not a minor adjustment but moves up to $ 2000 billion with an average amount of around $ 220 billion, which accords for almost 10% of the FED's balance sheet. These sizeable interventions indicate that for the given subfloor set by the FED, there exists a severe supply and demand mismatch, which the FED offsets by ON RRPs.

The structure of a repo depends on the regulatory and institutional framework. In the US, one can differentiate between three main types of repos: bilateral, tri-party and general collateral finance (GCF) repos. A bilateral repo is an arrangement between two counterparties. The terms of a bilateral repo can be freely negotiated among these two parties. Regulations, mainly capital restrictions, depend on the legal entity of the party and not on the repo itself. A tri-party repo includes a third party, which works as a clearing bank. BNY Mellon, the bank which settles the repos on its balance sheet, is responsible for the revaluation of assets, potential

margin calls and the allocation of the collateral. A GCF repo is almost an inter-dealer repo market, where dealer can do repos on a blind basis. In this case only collateral, which serves as collateral on the Fedwire securities service can be permitted (Copeland, Duffie, Martin and McLaughlin, 2012).

Figure 3.4: The repo-subfloor spread



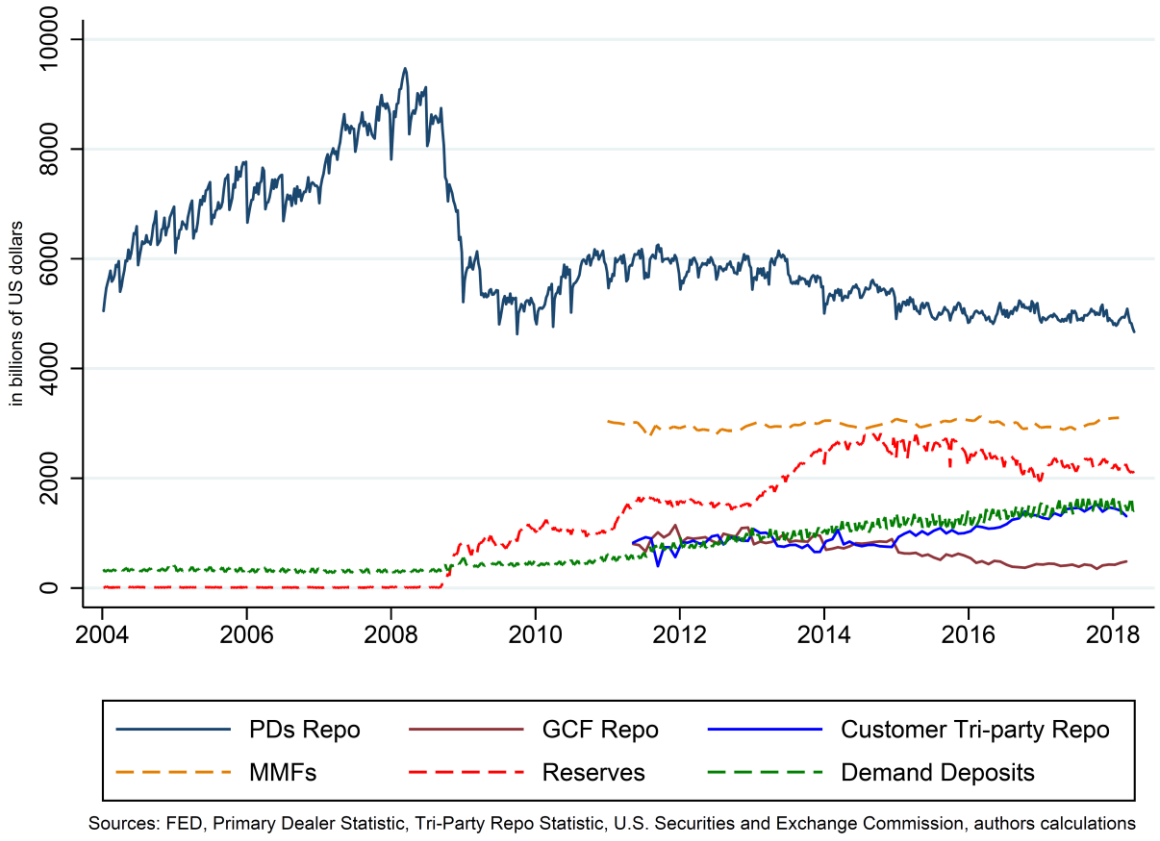
Sources: FED, BNY Mellon, DTCC, authors calculations

Figure 3.4 shows the repo-subfloor spread. Note that both repo rates are the repo rates for treasuries as collateral. The subfloor is the fixed rate set by the FED for ON RRP. The fixed rate has started at 0.01% in 2013 and since the first interest rate raise by the FED it is 25 basis points below the IOER. As the FED is trading in the tri-party repo market, it manipulates the repo rate for treasuries in the tri-party repo market. The blue line presents this nicely. The GCF repo rate moves in general above the customer tri-party repo rate and is more volatile than the tri-party repo rate because the anonymity includes additional counterpart risks.

3.3 Stylized Facts about the Repo Market

It is difficult to measure the volume of repos accurately. Due to their unregulated structure, there is no standardized reporting for bilateral repos (Baklanova, Caglio, Cipriani and Copeland, 2016). In contrast, data quality for the tri-party repo market has improved since the Tri-Party Repo Infrastructure Task Force has introduced the Tri-Party Repo Statistic in 2011. Unfortunately, tri-party repos are just a fraction of the total repo volume. To overcome this data gap, I make use of the Primary Dealer statistic established by the FED.

Figure 3.5: Repo and other money-like volumes in the US



Sources: FED, Primary Dealer Statistic, Tri-Party Repo Statistic, U.S. Securities and Exchange Commission, authors calculations

Figure 3.5 shows the repos conducted by PDs, which peaked in 2007 at around $ 10 trillion and are now at around $ 5 trillion. One can see that GCFs with around $ 0.5 trillion and customer tri-party repos with around $ 1.5 trillion can in sum not even account for half of the repos conducted by PDs. Although repos by PDs have seen this strong decline, they are still by

far the highest volumes in contrast to reserves, demand deposits and MMFs volumes. Nevertheless, from a hierarchy of money perspective, proportions between different tier have changed strongly.

3.3.1 The primary dealer statistic

The Primary Dealer Statistic reports net positions, transactions and financing of securities of PDs since 1998 on a weekly basis. My focus is on the subcategory *financing*, which is separated in *securities in* (reverse repos and other financing types where securities are borrowed) and *securities out* (repos and other financing types where securities are lent for collaterals).[14] Both groups are again separated by collateral types like treasury bonds and mortgage backed securities (MBS) and by duration of the repo. The database has been extended by asset classes in 2013 and 2015.

The strength of this database is that it contains most parts of tri-party and bilateral repos as PDs mainly borrow cash in the tri-party market and lend it to levered bond portfolios via bilateral repos. There is still the chance to miss bilateral repos but as PDs are the main financiers in the financial system, I feel confident to measure most repos in terms of volumes.

[14] Like repos, securities lending provides collateralized short-term funding. The only differences between repos and securities lending is the purpose of lending. While a repo is mainly about lending or borrowing cash, securities lending is mostly to cover short positions. Therefore, the type of the security plays a priority role in securities lending transfers, while for repo transaction this is only a subordinate issue (Singh and Pozsar, 2011). Securities lending should be rather seen as a special type of a repo because it only concerns the purpose of the trade. It is easy for a bank to declare a standard repo as securities lending although it is mainly about cash lending. For this reason, the terminology "repo" always includes securities lending in this chapter (Adrian and Flemming, 2005).

Figure 3.6: Repos with treasury bonds as collateral

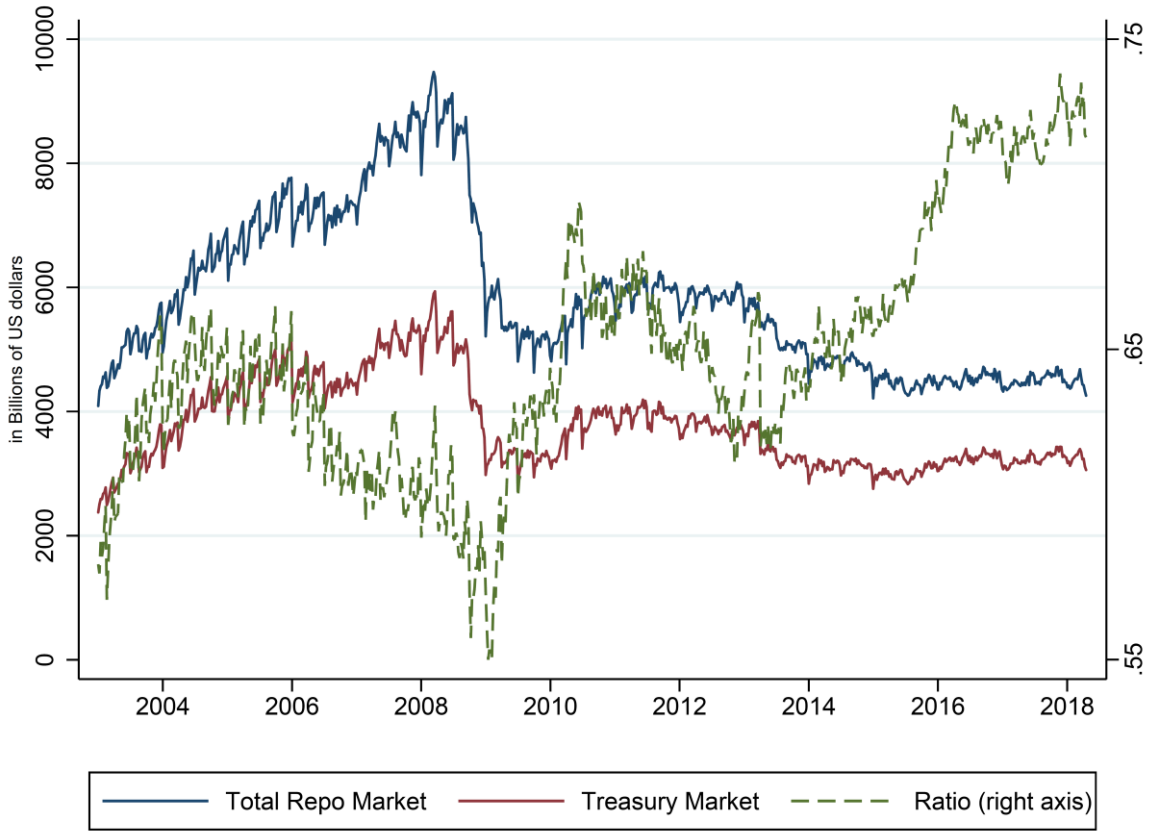


Figure 3.6 shows that repos collateralized by treasury bonds are by far the most important collateral class and peaked in 2008 at around $ 6 trillion. As the overall repo market has declined, the treasury market has declined as well with a currently total financing volume of around $ 3.5 trillion. If one looks at the fraction of the total repo market, treasury bonds as collateral have become more and more important. Since the low point of 55% in 2009, it has increased up to 73%.

3.3.2 Matched and open books

PDs finance in both directions, which means that they do repos and reverse repos. The huge volumes PDs are able to finance is only possible because they mainly finance on a matched book basis, which means that they do a repo and a reverse repo with the same underlying collateral. As long as the haircut covers potential losses, there is almost no risk involved in a

matched book trade, which makes these kinds of trades rather fee-based trades. Nevertheless, given that the repo and the reverse repo sit on the balance sheet of primary dealers, they absorb balance sheet space. Balance sheet space has become costly due to Basel III regulations. Balance sheet costs are mainly driven by the introduction of the leverage ratio, which does not allow for risk-weighting of assets.

An open book position is defined as the unmatched part of PDs and is calculated as securities out minus securities in. A positive open book means that PDs behave like levered bond portfolios (liquidity/leverage takers and collateral givers). Remember that the collateral giver is still the economic owner of the collateral so that the liquidity taker is still facing the risks and potential returns of the collateral. It shows that in the aggregate, PDs have a positive open book. PDs are therefore using leverage to increase returns.

It is important to differentiate open book positions by asset class and the aggregated open book position. If a PD receives equity as collateral from a levered bond portfolio and hands over a treasury bond as collateral to a cash pool, there is credit risk and counterpart risk involved. Unsurprisingly, this risk will be compensated by charging the hedge fund a significant higher repo rate than the PD would have charged for a treasury bond. For a perfectly matched book the underlying collateral needs to be identical.

Figure 3.7: Open book separted by underlying collaterals

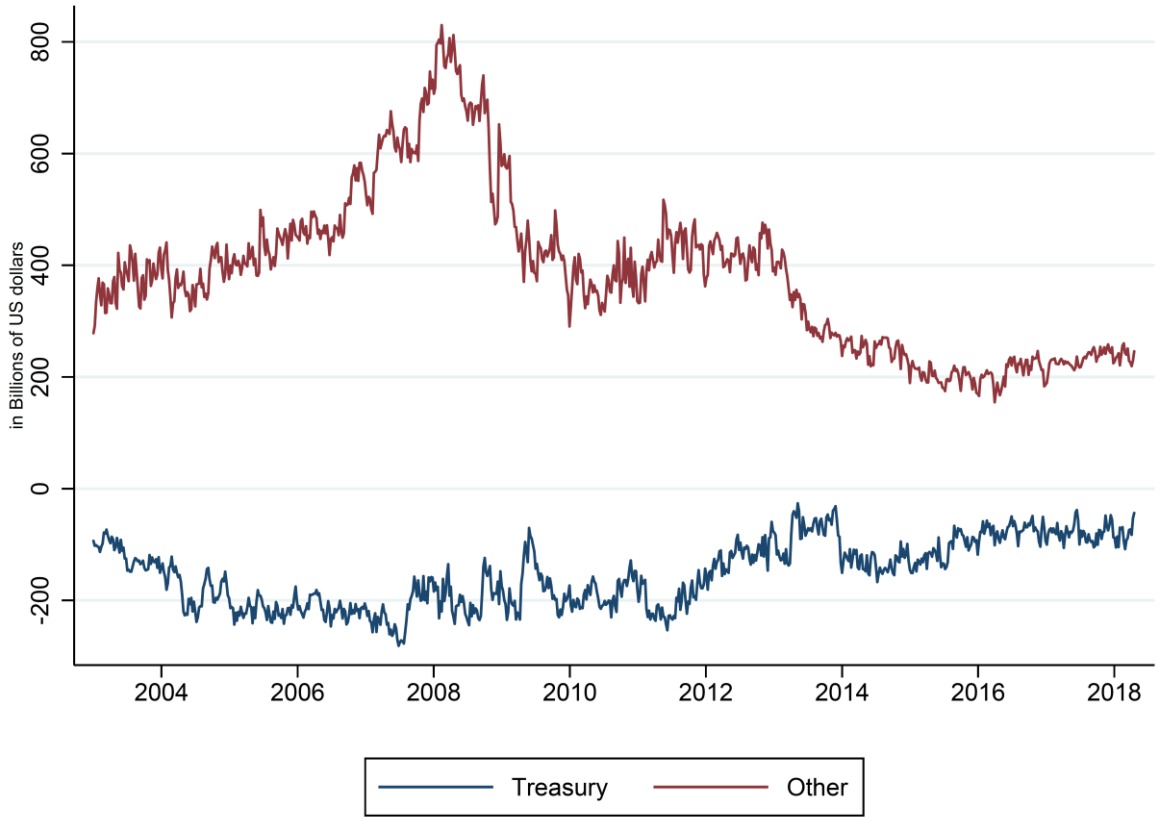


Figure 3.7 shows that open books differ among asset classes. PDs are short on treasuries, the safest asset class, which means that they receive more treasuries as collateral as they hand out. This makes PDs cash pools in the treasury market, while they behave like levered bond portfolios in the other collateral class market.

Figure 3.8: Open book separated by duration of the repo

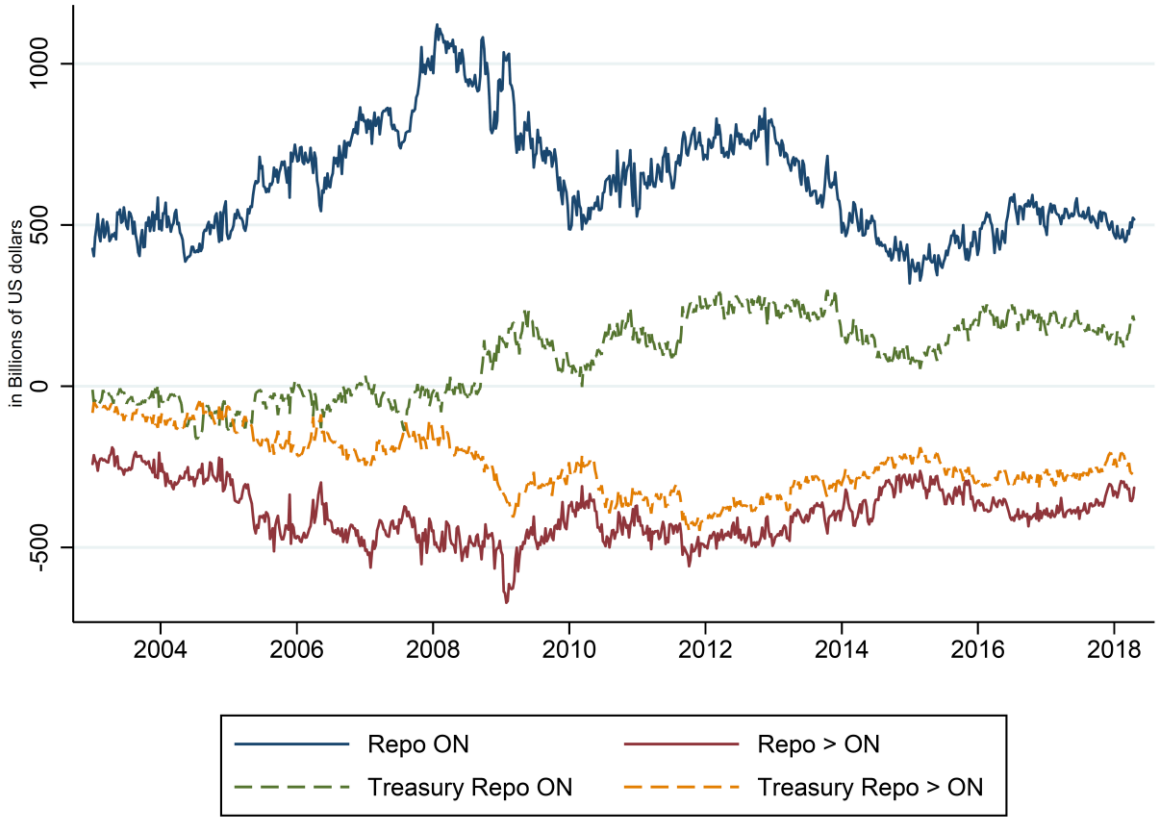


Figure 3.8 focuses on the duration of a repo and differentiate between long-term repos (more than one day) and overnight repos. PDs have a positive open book in repos with a longer duration than one day, while the net financing position of overnight repos is negative. This means that PDs finance themselves mainly overnight, while they hand out long term repos to other investors.

Figure 3.9: Absorbed risks by primary dealers

As PDs are short on treasury bonds and long on riskier collateral, this leads to additional gains because the expected return for treasuries is lower than for riskier collateral. The same appears for the duration mismatch. The repo rate for long-term repos is higher than for overnight repos, which results in additional gains for the PDs.

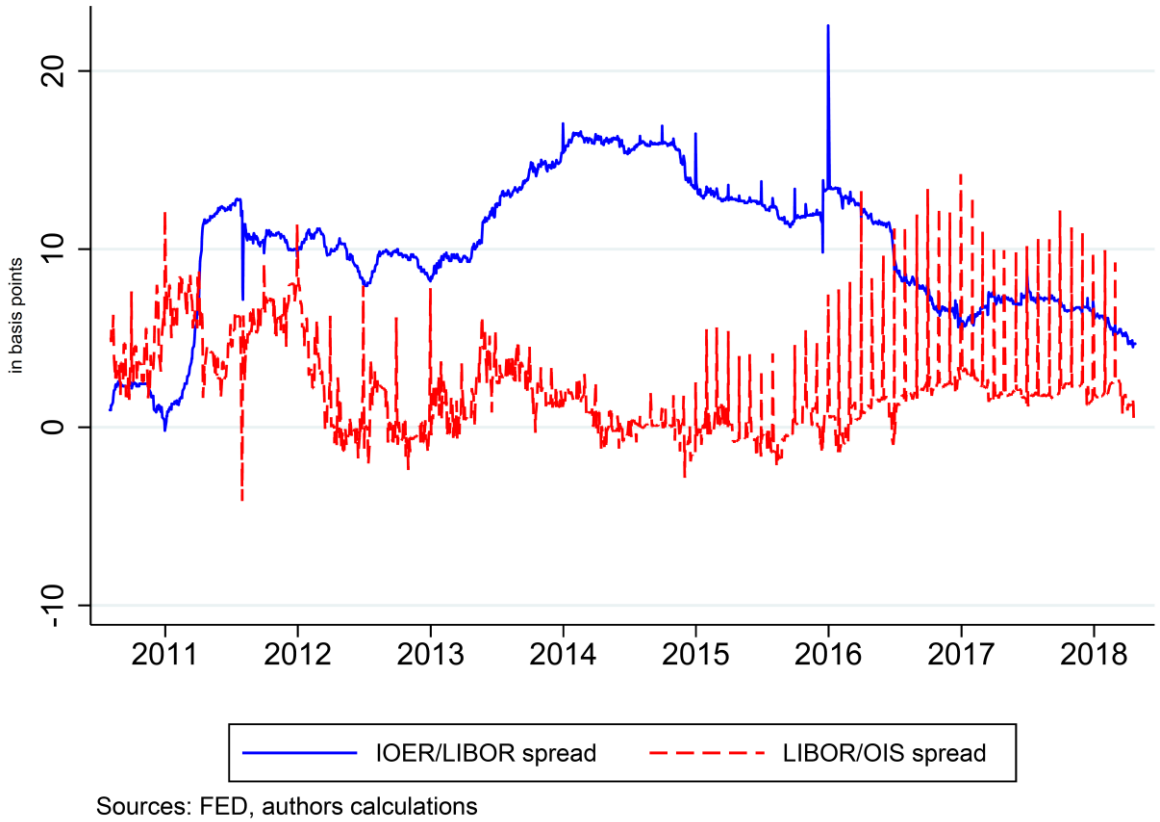
These two features come with risks, which I call collateral risk and the liquidity risk of the repo market. I construct the collateral risk by subtracting the open book of other collateral by the open book of treasuries and the liquidity risk by subtracting the long-term open book by the short-term open book (see Figure 3.9). This shows a highly important feature of PDs, which is to my knowledge not discussed in the literature so far: PDs behave like banks for the shadow banking system, not by handling maturity and risk transformation of loans as commercial banks do but of repos. This behavior of risk taking has steadily decreased since 2008. Collateral risk has decreased from $ 1000 billion to $ 500 billion and liquidity risk has decreased from around

$ 1500 billion to $ 900 billion. During that time, liquidity risk for treasury bonds has increased, which means that PDs have over proportional reduced liquidity risks in repos where treasury bonds have not served as collateral.

3.3.3 Identification

The organizing framework about the repo market showed that PDs should face balance sheet costs whenever they have a matched book while they should face financial risks whenever they have an open book. A book is broadly matched when overall repos equal overall reverse repos and is perfectly matched when repos and reverse repos have the same underlying collateral. Credit risks are therefore only offset when the book is matched by the same collateral. The following regression aims to test for these features within the repo market.

Figure 3.10: Proxies for balance sheet costs and financial stress



Sources: FED, authors calculations

Figure 3.10 presents two key spreads in the money market, the IOER/LIBOR and the LIBOR/OIS spread. The spread between the IOER and the LIBOR rate is an established indicator for balance sheet costs (see, e.g., Tepper and Verdelhan (2017)). The LIBOR rate is the interest rate for an unsecured loan within the financial system. Big banks could borrow money at that rate and lend it to the FED at IOER. As long as the IOER/LIBOR spread is positive, there is a risk free arbitrage opportunity, which should close the window. If this is not happening, banks must face costs to put this trade on their balance sheet. The spread between the LIBOR and the OIS (Overnight index swap) is an indicator for stress in the financial system (counterpart risk). While the LIBOR includes credit risks (interest rate for an unsecured loan), an OIS is seen as credit risk free. As the repo market is mainly an overnight funding market, I calculate both spreads as overnight spreads.

The dataset is constructed from August 2010 until April 2018 on a weekly basis. The reason for the starting point is that I do not want to cover any turmoil of the GFC. The regression type is mainly based on Gorton and Metrick (2012). I take first differences to guarantee stationary processes.

$$\Delta R_t = \beta_0 + \beta_1 \Delta(IOER - LIB)_t + \beta_2 \Delta(LIB - OIS)_t + \beta_3 \Delta X_t + \varepsilon_t$$

The dependent variable (ΔR_t) is the change in repo volumes taken from the Primary Dealer Statistics. The two main variables of interest are the IOER/LIBOR spread, a proxy for balance sheet costs and the LIBOR/OIS spread, a proxy for stress in the financial system.

Control variables (X_t) are oriented on Gorton and Metrick (2012):

- 10-year treasury rate
- Square of the 10-year treasury rate
- Spread between 10-year corporate bond (BAA rated) and 10-year treasury bond
- Term spread (difference between 10-year and 2-year treasury bond interest rate)

- Total return S&P500 Index
- VIX index of the S&P500
- Effective Federal Funds Rate

The matched book is the outstanding volumes of repos where securities out (repo) equal securities in (reverse repo). The open book is calculated as securities out minus securities in. A decrease in the open book means that PDs receive more collateral than they hand out. They therefore behave like cash pools and reduce leverage.

3.3.4 Results

Table 3.1: Effects on the overall repo volume

	Total repo volumes			
	Matched Book		Open Book	
	(1)	(2)	(3)	(4)
Δ IOER-LIBOR	-13.910**	-12.628**	1,971	1,394
	[6.529]	[5.718]	[2.242]	[2.068]
Δ LIBOR-OIS	-5.247***	-7.276***	-4.616***	-5.464***
	[1.660]	[1.900]	[0.955]	[1.109]
Δ Yield 10Y		377.041**		1,275
		[145.949]		[79.462]
Δ Yield 10Y²		-70.821**		1,823
		[31.607]		[15.389]
Δ Term Spread		-106,482		-16,387
		[73.587]		[40.748]
Δ BAA10Y		9,096		10,306
		[55.215]		[35.939]
Δ S&P 500		-0.226***		-0,031
		[0.073]		[0.042]
Δ VIX		-3.452**		0,134
		[1.535]		[0.843]
Δ EFFR		-162.657**		-90.088*
		[80.629]		[50.423]
N	393	393	393	393
R^2	0,054	0,097	0,067	0,079

The regressions are estimated using ordinary least squares. Variable are expressed in first differences. Heteroskedasticity-robust standard errors are in brackets. ***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

Table 3.1 includes the total repo volumes and therefore tests for the overall matched and open book. It shows that the matched book depends negatively on the proxy for balance sheet costs and financial risk while the open book only depends on financial risks. PDs therefore face balance sheet costs for the matched books and financial risks for their open position. The negative dependency on financial risk for the matched books might be driven by collateral risk (see Figure 3.9). The regression is therefore repeated by using only repos where the underlying collateral is a treasury bond which abandons any kind of collateral risk.

Table 3.2: Effects on the repo volume with treasury bonds as collateral

	Repo volumes with treasury bonds as collateral					
	Matched Book			Open Book		
	(1)	(2)	(3)	(4)	(5)	(6)
Δ IOER-LIBOR	**-10.837****	**-9.391****	**-9.357****	2.004**	1,556	1,568
	[5.168]	[4.483]	[4.496]	[0.932]	[1.052]	[1.077]
Δ LIBOR-OIS	1,45	0,442	0,55	**-2.067*****	**-2.324*****	**-2.101*****
	[1.348]	[1.661]	[1.711]	[0.604]	[0.657]	[0.652]
Δ Matched Book Other			0,025			
			[0.167]			
Δ Open Book Other						0,071
						[0.048]
Δ Yield 10Y		313.497**	311.529**		9,4	9,978
		[144.193]	[145.197]		[41.420]	[41.552]
Δ Yield 10Y²		-47,366	-46,918		2,259	2,29
		[30.670]	[30.900]		[7.645]	[7.654]
Δ Term Spread		-150.320**	-149.833**		-9,197	-8,686
		[62.059]	[61.958]		[24.051]	[23.917]
Δ BAA10Y		31,535	32,391		5,623	5,29
		[46.624]	[46.366]		[19.434]	[19.372]
Δ S&P 500		-0.220***	-0.220***		-0,031	-0,031
		[0.068]	[0.068]		[0.026]	[0.026]
Δ VIX		-3.608**	-3.604**		0,145	0,146
		[1.437]	[1.436]		[0.530]	[0.531]
Δ EFFR		-63,254	-61,332		-30,324	-26,074
		[90.372]	[91.593]		[19.655]	[19.470]
N	393	393	393	393	393	393
R^2	0,023	0,068	0,069	0,043	0,059	0,067

The regressions are estimated using ordinary least squares. Variable are expressed in first differences. Heteroskedasticity-robust standard errors are in brackets. ***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

The results from Table 3.2 strongly confirm the organizing framework. One can see that for the perfectly matched book, financial risks do not play a role anymore, while balance sheet costs still do. The open position highly depends on financial risks and not on balance sheet costs.

The two indicators are economically significant. The spreads are expressed in basis points so that a decrease of one basis point in balance sheet costs, would increase the matched book by more than $ 10 billion, while a decrease of one basis point in financial stress, increases the open book by more than $ 2 billion. Column 3 adds the change in the matched book of other collateral types while column 6 adds the change in the open book of other collateral types. As treasuries are the safest collateral class, changes in the repo treasury market could be driven by reallocations within the repo market. Adding these control variables does not change the results. More surprisingly, they appear insignificant which gives some evidence that repo markets by different collateral classes are not closely linked to each other.

The negative effects of balance sheet costs for the matched book market gives some explanation why the repo market has still not fully recovered. As balance sheet costs are mainly faced by global banks, this gives some evidence that levered bond portfolios and cash pools would conduct more repos but PDs cannot put them on their balance sheet anymore. While these concerns have been already expressed in a more general way by Singh (2017) and Martin (2015), the findings from Table 3.2 can be seen as empirical evidence for that postulation.

The FED's ON RRPs can be interpreted as providing at least partially the balance sheet space, which PDs are currently not able to cover. This is in line with the interpretation of the FED as dealer of last resort for the shadow banking system which has been expressed by Mehrling (2012).

3.4 Collateral Scarcity

Since the GFC, there is a debate whether scarcity of high quality assets (HQA) exists. This debate is mainly driven by four aspects: The GFC and the euro crisis have led to downgradings of treasury bonds and asset backed securities, asset purchase programs by central banks have reduced the available amount of HQA, banking regulation forces banks to hold more HQA for instance driven by the liquidity coverage ratio and finally there might be a general increase in risk aversion which increased the preferences of investors to hold more HQA. The main argument against a scarcity of HQA is that outstanding government debt has increased constantly. Treasury bonds purchased by the FED have been by around $ 2.5 trillion while US government debt has increased by around $ 12 trillion between 2008 and 2017.

While the negative effects of an overall scarcity of HQA are not clear, this debate becomes essential for the repo market. Without the availability of collateral, the functioning of repo markets is disturbed. If cash pools are willing to do repos exclusively with treasury bonds as collateral and treasury bonds of a levered bond portfolio are already encumbered, there will be no repo. A scarcity of HQA in the repo market can therefore lead to severe supply and demand mismatches which could result in funding problems.

The main difference between the overall debate of a scarcity of HQA and collateral scarcity is that one has to differentiate between mobile and immobile HQA. If an investor buys a treasury bond and keeps it on its balance sheet until maturity, this bond has become immobile and is therefore not available for the repo market anymore. According to Fender and Lewrick (2013), there are two types of collateral scarcity. First, there can be a cyclical scarcity of mobile HQA, which means that investors temporarily remove HQA from the repo market. Second, the volume of mobile HQA has changed structurally so that there is a time-independent scarcity.

3.4.1 Cyclical collateral scarcity

I argue that we currently live in a world with cyclical scarcity of HQA in the repo market if one interprets this scarcity as a supply and demand mismatch, where the demand of HQA collateral (cash pools) exceeds the supply (levered bond portfolios). Excess liquidity and collateral shortage in the repo market are always two sides of the same coin. If cash pools are restricted to do repos exclusively with treasuries as collateral, they lose the possibility to reallocate between collateral classes. As already explained, the FED has traded actively in the repo market to absorb excess liquidity in the repo market by handing out treasury bonds as collateral, ergo to overcome collateral shortages.

The reason why cash pools trade with the FED is that the FED can pay a higher repo rate than the market is able to offer. This means that the market does not need the liquidity at the given repo rate. Turning it the other way round, the market is not willing to hand out high quality collateral at the given repo rate. In a world where liquidity is rather a burden than a blessing, we see a temporary reversal in the repo market. For instance, the interest rate for a repo with German Bunds as collateral has gone down to almost -9% at the end of 2016 (International Capital Market Association, 2017). At times of cyclical collateral scarcity the question is no longer “What do you pay me for liquidity?”, but has become “What do you pay me for safe collateral?”.

I want to detect how PDs behave in times of collateral scarcity. Market makers have a strong interest in keeping markets liquid. This gives them the ability to take high volumes on their books in the knowledge to transfer or match this open position later on. Whenever dealers notice that is not the case anymore, they will change prices in favor of the counterpart which should help the market maker to match the book again. Let us say there is a high demand for safe collateral (excess liquidity). A PD receives liquidity from a cash pool but is not able to find a counterpart. The PD will therefore lower the repo rate for the next cash pool and improve

conditions for levered bond portfolios. This price adjustment helps to minimize mismatches. The important point here is that by construction, market makers stabilize mismatches in the first place. They open their book to keep markets liquid whenever this is needed. While the size of their open book depends on capital regulations and their own risk analysis, PDs as market makers should always move against the market in the first place.

I identify three proxies for cyclical collateral scarcity: the repo rate, quarter-end spikes and the volume of ON RRPs conducted by the FED and test how PDs respond to these scenarios.

Repo Rate

The first proxy is the repo rate for treasuries minus the EFFR. Whenever this spread decreases, there is more demand than supply for HQA collateral. This indicator has been mentioned by Fender and Lewrick (2013) as a good indicator of supply and demand imbalances. PDs as market makers should move against the market and increase their supply of collateral to keep markets liquid and to make additional profits.

Table 3.3: The Repo-EFFR spread as a proxy for cyclical collateral scarcity

	Matched Book Treasury				**Open Book Treasury**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ (GCF $Repo_{Treasury}$-EFFR)	-2.176***	-2.329***			0.409***	0.540***		
	[0.264]	[0.295]			[0.123]	[0.132]		
Δ (TriParty $Repo_{Treasury}$-EFFR)			-1.924***	-1.956***			0.841***	1.281***
			[0.648]	[0.738]			[0.311]	[0.321]
Δ IOER-LIBOR		-7.267*		-10.708*		1,064		1,846
		[4.040]		[5.641]		[1.137]		[1.795]
Δ LIBOR-OIS		1,827		-0,292		-2.646***		-2.526***
		[1.393]		[1.668]		[0.637]		[0.675]
Other Control Variables	No	Yes	No	Yes	No	Yes	No	Yes
N	395	393	293	291	395	393	293	291
R^2	0,107	0,178	0,029	0,09	0,024	0,096	0,029	0,095

The regressions are estimated using ordinary least squares. Variables are expressed in first differences. Heteroskedasticity-robust standard errors are in brackets. ***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

Surprisingly, Table 3.3 presents the opposite behavior. PDs lower their open book (receive more collateral than they hand out) whenever the spread is decreasing (column 5-8).

This means that although PDs earn less for a repo, they demand more safe collateral and therefore move with the market. This effect holds for the GCF repo rate (column 5 and 6) and the customer tri-party repo rate (column 7 and 8). The effect of the repo rate on matched repo volumes is not clear. Levered bond portfolios are likely to search for other funding types whenever the repo rate is high, while cash pools should increase demand whenever the repo rate increases. One can see that there is a significant negative correlation which gives some evidence that the repo market is rather supply-side driven.

Results from Table 3.3 additionally strengthen the findings from Table 3.1 by controlling for the repo rate. As the costumer tri-party repo rate has been only available since August 2012, column 3, 4, 7 and 8 additionally serve as a natural robustness check for different time horizons.

Quarter End Spikes

At the end of every quarter most financial actors need to present their quarterly reports, which is a snapshot of their balance sheet on the last day of the quarter. Due to different implementations of Basel III, banks headquartered in the euro area, Japan and Switzerland are allowed to report their leverage ratio as a snapshot at the end of each quarter. This gives an incentive to increase leverage during the quarter and reduce it at the end of the quarter to fulfill leverage requirements. Additionally, every financial actor tries to look as sound as possible for their shareholders and their creditors on reporting days. These two effects reduce the demand for leverage at the end of the quarter, known as quarter end spikes. A reduction in leverage means nothing else than that levered bond portfolios are not being willing to hand over securities to the financial systems anymore which makes these securities immobile for the repo market.

Again, PDs as market makers should step in and act as levered bond portfolios. Leverage ratios for PDs headquartered in the US are not binding at the end of the quarter so that they are

not restricted in their functioning of a market maker. If a trade is profitable enough, even PDs headquartered outside the US could open their books by reducing other activities to bring their balance sheet in line with the afforded capital requirements.

To test for this, I construct three dummies, one week before quarter end, the week after quarter end and two weeks after the quarter end. As the regression uses weekly first differences, the first dummy covers the change in the last week of the quarter, the second dummy the week during quarter end and the third dummy the week after the quarter end.

Table 3.4: Quarter End Dummies as proxies for cyclical scarcity

	Matched Book Treasury		**Open Book Treasury**	
	(1)	(2)	(3)	(4)
Dummy: Last Week of Quarter End	-22.019***	-24.189***	-11.954***	-9.646***
	[7.896]	[8.237]	[3.683]	[3.677]
Dummy:First Week of Quarter End	-56.761***	-51.631***	-3,177	-3,466
	[9.993]	[9.535]	[3.221]	[3.276]
Dummy: Second Week of Quarter End	8,39	9,386	7.295**	8.607**
	[6.897]	[7.782]	[3.385]	[3.618]
Control Variables	No	Yes	No	Yes
N	401	392	401	392
R^2	0,13	0,175	0,049	0,102

The regressions are estimated using ordinary least squares. Variables are expressed in first differences. Heteroskedasticity-robust standard errors are in brackets. ***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

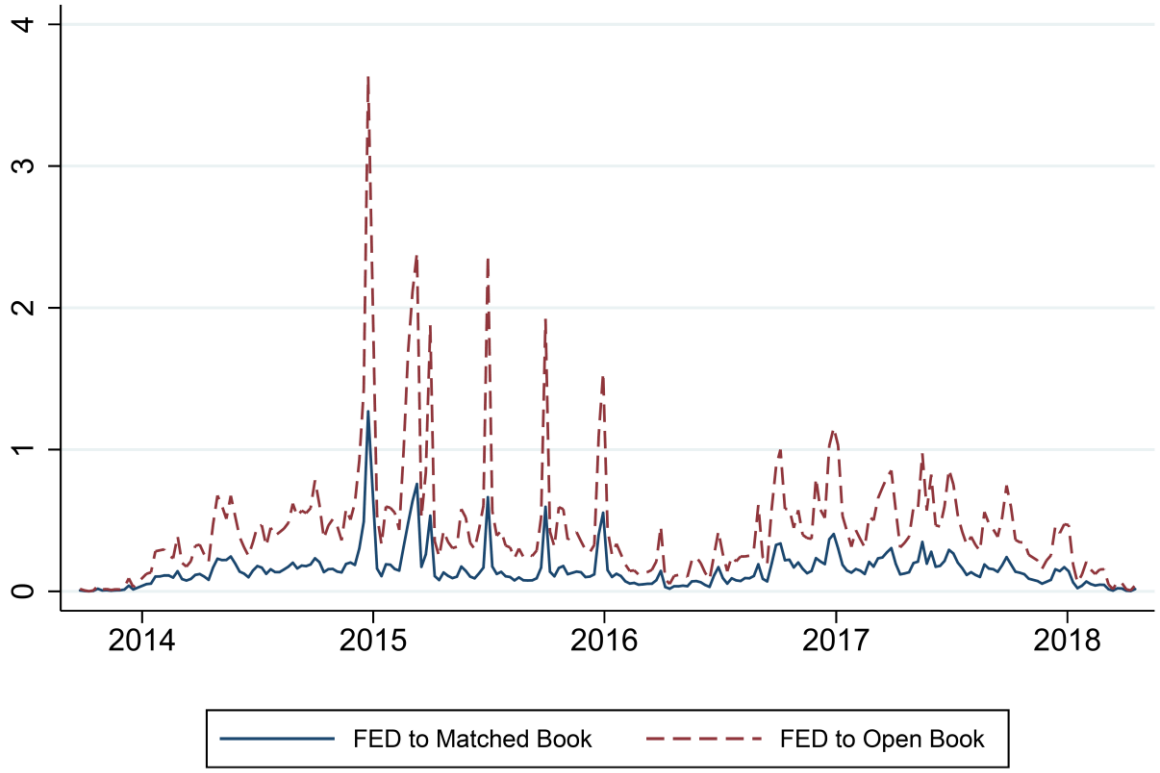
Table 3.4 presents the changes in repo volumes during quarter ends for the matched and the open book of treasury bonds as collateral. As expected, the matched book volumes reduce at the end of the quarter. Additionally, one can see a significant reduction in the week over the quarter end. This does not necessary mean that repos decrease at the beginning of the quarter. This result is probably driven by the reporting date. As data from the Primary Dealer Statistic is reported every Wednesday, and quarter end could be for instance next Tuesday, I expect the severe decrease of repos on Monday. On the next Wednesday, the market has still not recovered so that we see a negative significant effect.

For PDs, we see a similar pattern as one has seen for the repo rate. PDs decrease their open books before the end of the quarter and increase it afterwards (column 3 and 4). This means that the net collateral inflow is increasing so that PDs again behave like cash pools and not like levered bond portfolios.

FED's ON RRP

As a third proxy, I use the volumes of ON RRPs by the FED as a signal of demand and supply mismatches and therefore collateral shortage in the system. Given that the FED operates in the tri-party repo market directly with cash pools, these repos should not appear in the Primary Dealer Statistic.

Figure 3.11: Intensity of ON RRPs in the ON treasury market



Note: ON RRPs have been at $ 2000 bn at the end of 2015. ON RRPs have been capped by $ 1000 bn for presentation purposes.
Sources: FED, Primary Dealer Statistics, authors calculations

Figure 3.11 gives you an impression about the interventions by the FED in terms of the market the FED trades in, the overnight treasury market. The blue line is the volume of ON RRPs as a fraction of overnight securities with treasuries as collateral (potential counterparts of

the FED). The red line is the volume of ON RRPs as a fraction of the open book of PDs in the overnight treasury market. Note that PDs have a positive open book in the overnight treasury market. This means they sit on the same side as the FED so that PDs are on a net basis no counterpart of the FED.

While I have made clear that the FED helps to offset supply-demand mismatches, it is again unknown how PDs behave in this scenario. One would expect that PDs as market makers try to offset these mismatches by handing out collateral at the first place. This drives up their open book positions. Whenever capital regulations and risk adjustments start binding, PDs are not able to offset mismatches anymore and this is when the FED steps in and stabilizes the market.

Table 3.5: ON RRPs as a proxy for cyclical scarcity

	Matched Book Treasury				**Open Book Treasury**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔFED RRP	-0.037***	-0.031**			-0,011	-0.019**		
	[0.014]	[0.016]			[0.008]	[0.009]		
ΔFED RRP (forwarded 1 day)			-0,004	-0,01			-0.027**	-0.033***
			[0.025]	[0.023]			[0.011]	[0.010]
Control Variables	No	Yes	No	Yes	No	Yes	No	Yes
N	232	232	218	218	232	232	218	218
R^2	0,032	0,098	0	0,075	0,015	0,057	0,031	0,077

The regressions are estimated using ordinary least squares. Variables are expressed in first differences. Heteroskedasticity-robust standard errors are in brackets. ***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

To test for this, I add (the change of) the volume of RRPs to my baseline regression and check whether the PDs hand out more collateral. As expected, matched book repos decrease significantly (the coefficient is rather small where a $ 1 change in ON RRPs results in a $ 0.037 change in matched book repos). Whenever the FED increases its ON RRPs facility, PDs behave like cash pools. PDs react counterintuitive and move with the market (column 5 and 6 of Table 3.5). As mentioned, it could be possible that PDs have already increased their open book before the FED's intervention. While my data set is on a weekly basis, ON RRPs by the FED are

available on a daily basis. I use the following day's repo volume by the FED and therefore test how PDs behave the day before the FEDs intervention. It shows that PDs reduce their open book significantly one day before the FED intervenes (column 7 and 8). This indicates that PDs do not only not absorb mismatches but that they could be to some extent the driving force behind the upcoming mismatches.

Table 3.6: Proxies for cyclical scarcity

	Open Book Treasury	
	(1)	(2)
Δ (GCF $Repo_{Treasury}$-EFFR)	0.584***	0.694***
	[0.124]	[0.130]
Last Week of Quarter End Dummy	-12.940***	-12.140***
	[3.874]	[3.937]
First Week of Quarter End Dummy	-3,854	-3,789
	[3.403]	[3.259]
Second Week of Quarter End Dummy	7.990**	9.215***
	[3.340]	[3.435]
ΔFED RRP	-0.012**	-0.012**
	[0.006]	[0.006]
Control Variables	No	Yes
N	394	392
R^2	0,092	0,162

The regressions are estimated using ordinary least squares. Variables are expressed in first differences.. Heteroskedasticity-robust standard errors are in brackets. ***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

The three presented proxies are obviously closely linked to each other. The FED reacts whenever the repo rates falls close to the subfloor and stabilizes the repo rate at the subfloor. At the end of the quarter, we see a sharp decline of the repo rate so that the FED intervenes with high volumes at the end of the quarter. It could therefore be possible that every proxy is driven by the repo rate which again is driven by other factors than supply and demand mismatches. I therefore add the three proxies together (Table 3.6). One can see that every proxy is still significant and moves into the same direction. I therefore feel confident that as a whole, I capture supply and demand mismatches.

In times of cyclical scarcity, PDs move therefore with the market instead of absorbing mismatches. They do not fulfill their role as market makers although these interventions are likely to be profitable. PDs are therefore rather worsening the effects of cyclical scarcity than dampening it. Additionally, these findings can be interpreted as empirical evidence that the FED via ON RRPs is indirectly operating as a dealer of last resort for the repo market and therefore for the shadow banking system.

3.4.2 Structural collateral scarcity

The only way to gain full ownership of the collateral in a standard repo is a default of the owner of the collateral. This is not true for collateral which allows for reuse (rehypoceation).[15] Reusability plays a crucial role in repo markets. Every repo is backed by collateral. Whenever this collateral is reused, another repo can be conducted with the same collateral. This leads to collateral chains and can be interpreted as collateral velocity. If you look at Figure 3.2 again, you see that the bond of the PD is encumbered, because the PDs need its own inventory to conduct a repo with the cash pool. This is not the case if the levered bond portfolio gives an allowance to reuse of its collateral. High collateral velocity can increase the (matched) repo volume whenever the inventory of PDs is binding. Collateral shortage is therefore not just driven by the pure amount of mobile collateral, but also by the allowance to reuse the collateral. The question of a structural collateral shortage can therefore not be answered without taking the collateral velocity into account.

The reason why primary sources of collateral allow for reuse agreements is that the counterpart slightly reduces the repo rate. While in normal times this is an easy way to earn additional profits, it comes with a risk in times of financial fragility. Reusability does not

[15] There is a slight difference between rehypoceation and reuse. Rehypoceation allows the legal owner to use the collateral for another repo, while reuse gives the legal owner more rights like selling or lending the collateral to a third party (Singh, 2017). Rehypoceation can therefore be seen as a subcategory of reuse so that in this chapter, I will only use the word reuse.

increase the risk of losing the collateral, but it might take time until the primary source receives its collateral back. This has happened at a large scale in 2008 due to the default of Lehman Brothers.

Singh (2017), Singh and Pozsar (2011), Singh and Aitken (2010) and Singh and Stella (2012) estimate collateral provided by primary sources (hedge funds, insurance companies, pension funds, commercial banks and official sector accounts). By dividing this amount by the total amount of repos, they receive a reuse rate. They show that this reuse rate has reduced from 3.0 in 2007 to 1.8 in 2015. Recent estimates indicate that there has been a first rebound up to 2.0 in 2017 (Singh and Alam, 2018).

While this reduction might worry policy makers, the estimations of 1.8 is still a high number, meaning that on average every collateral is almost pledged twice. In contrast, Fuhrer, Guggenheim and Schumacher (2016) show that the reuse rate of collateral in the Swiss Franc repo market is just about 10% of the outstanding collateral. Fuhrer et al. (2016) track the International Securities Identification Number (ISIN) of the underlying collateral, which makes this analysis more robust. They find that variations in reuse rate can be explained by shortages of collateral. If there is not enough collateral available in the repo market, market participants use collateral from long-term repos for short term financing. As the Swiss Franc repo market is rather small and depends mainly on Swiss bonds, it is difficult to apply these results to the US market.

Singh (2017) and Singh and Stella (2012) are to my knowledge the only researchers who focuses on reusable collateral within the PD system and discuss data collected from balance sheets of PDs. I follow their idea and handpick data on collateral with the allowance to reuse from annual reports between 2003 and 2016. Although wording and ordering differs among years and PDs, I find data for 24 PDs so that there are only two missing current PDs (Daiwa and Royal Bank of Scotland). I leave out TD Securities because it has been a PD just

since 2014. As Lehman Brother declared insolvency in 2008, the reuse of pledge collateral is set to zero afterwards. Bear Stearns was taken over by J. P. Morgan Chase in 2007 and Merrill Lynch was taken over by the Bank of America in 2008. I treat these two mergers as one bank from 2003 onwards to ensure comparison over time. These adjustments reduce my total observations from 24 to 21 PDs.

Figure 3.12: Collateral with reuse allowance of selected PDs

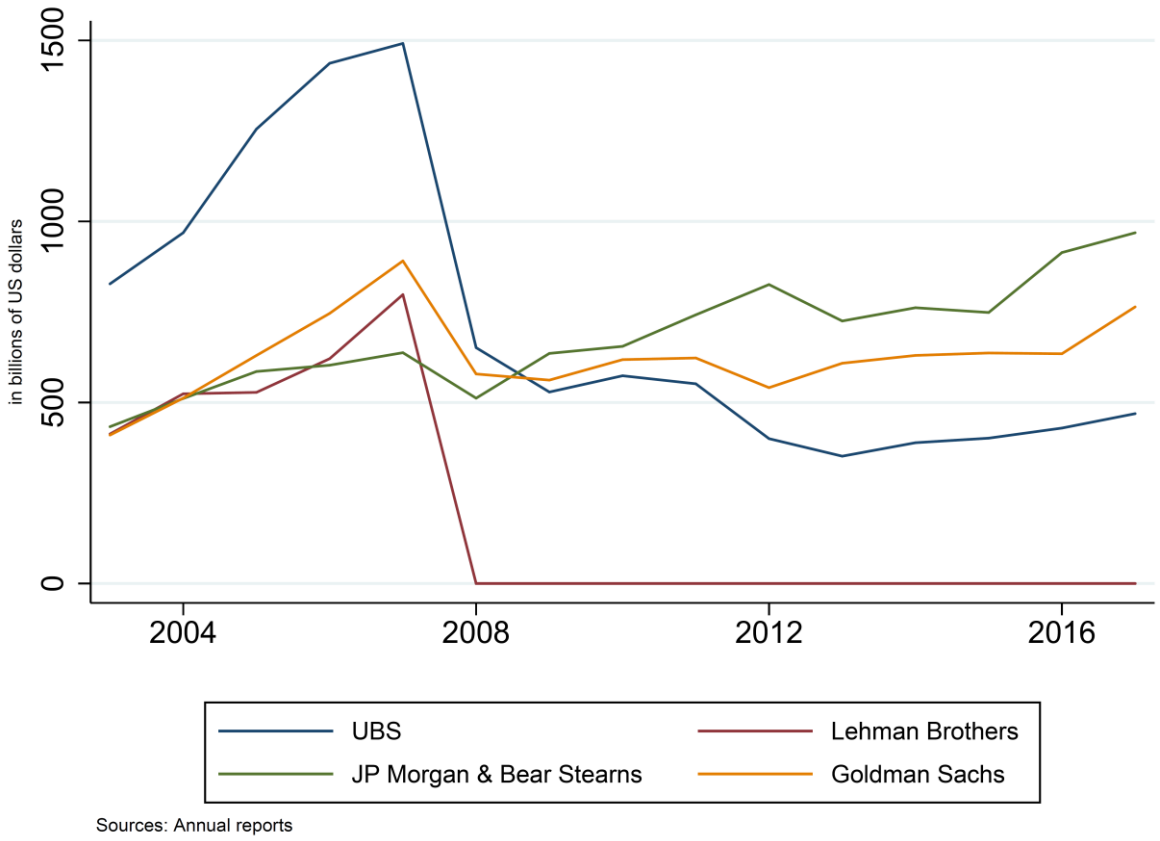
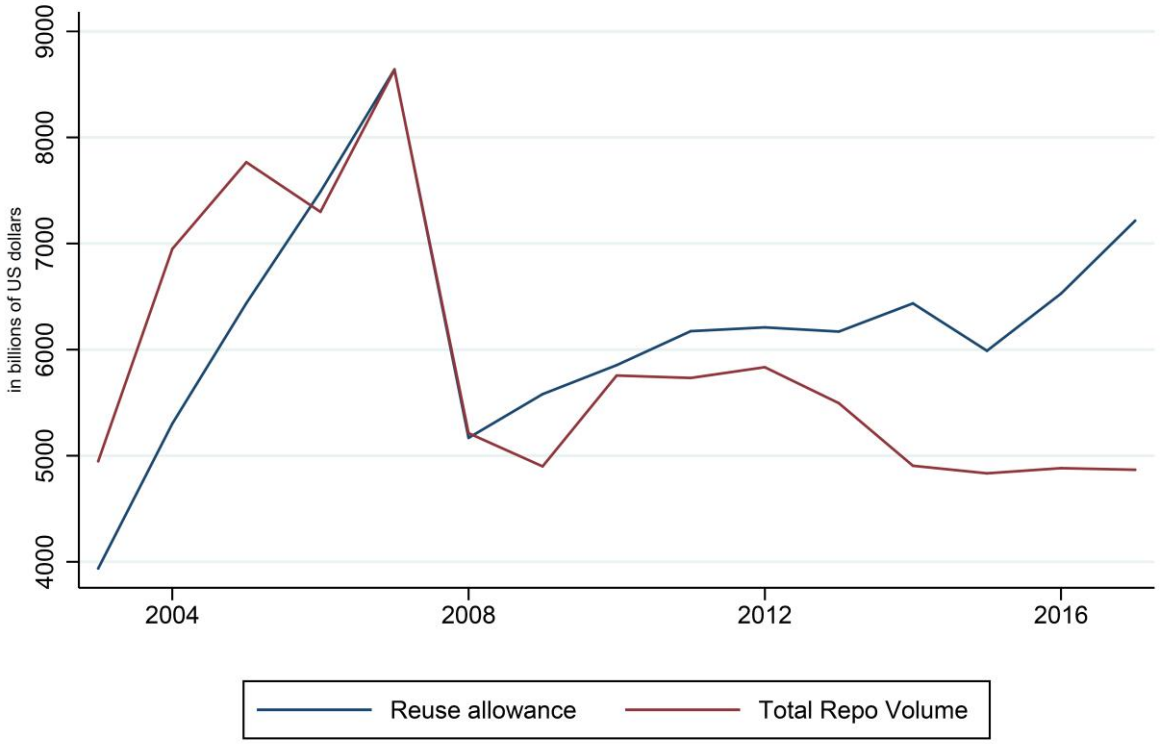


Figure 3.12 shows the amount of collateral with reuse allowance for selected PDs. It can be seen that the volumes behave very differently over time. While UBS currently holds only about one-third of its peak level in 2007, J. P. Morgan & Bear Stearns increased their volumes constantly.

Figure 3.13: Aggregated collateral with reuse allowance



Sources: Primary Dealer Statistic, annual reports of Bank of America, Bank of Nova Scotia, Barclays, Bear Stearns, Bank of Montreal, BNP Paribas, Canadian Imperial Bank of Commerce, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, J.P. Morgan, Jefferies, Lehman Brothers, Merrill Lynch, Mizuoh, Morgan Stanley, Nomura, Royal Bank of Canada, Société Générale, UBS and Wells Fargo.

Figure 3.13 sums the collateral with the allowance to reuse over all PDs and compares this to the overall repo conducted by PDs. It shows that the allowance for reuse more than doubled until the financial crisis and decreased dramatically afterwards. Since 2010, one can see a steady increase from around $ 5 trillion to $ 7 trillion. There seems to be a break between collateral with the allowance to reuse and the total volume of repos conducted by PDs around 2010. Whenever PDs ask for reuse allowance, they should use this allowance to conduct another repo. As every allowance is costly for PDs, one would ceteris paribus expect a one to one relationship. This is what we see between 2003 and 2009. Unexpectedly, this pattern breaks around 2009 and turns in the other direction. While repos slightly decrease, we see a steady increase in the allowance for reuse.

Figure 3.14: Hypothetical change of collateral volumes since 2003

Note: This figure assumes a one to one relationship between repos conducted by PDs and the volume of collateral with reuse allowance of PDs since 2003. This is not necessarily true in practice.

Figure 3.14 shows this hypothetical reduction of collateral in the repo market by simply subtracting the volume of collateral with allowance to reuse from the repo volume under the assumption of a one to one relationship between a repo and the allowance to reuse.

During the last 14 years, some dealers have been removed while others have been added to the list of PDs. This might lead to misleading interpretations of Figure 3.13. The purpose of the first regression is therefore to check whether this break is stable over PDs at that time and not just over the sum. Additionally, I control for bank specific characteristics as it is assumed that changes of the banks size and soundness of the bank will have effects on needed collateral with reuses allowance. The regression is set up as

$$Repo_{it} = \beta_0 + \beta_1 Reuse_{it} + \beta_2 Reuse_{it} * D_t + \beta_3 X_{it} + \varepsilon_{it}$$

The repo volume ($Repo_{it}$) is taken from the Primary Dealer Statistic and is therefore not dealer-dependent. Data has shown that PDs report their annual reports not necessarily at the end of December. End of the reporting period varies between October and March among PDs. Differences in the reporting date leads to differences in the repo volume and adds additional variation to the regression. $Reuse_{it}$is the volume of collateral with reuse allowance taken from annual reports. D is a dummy, which is 1 for the years 2009 until 2016. β_2 of the interaction term therefore shows the effect of the difference of reuse after the break in terms of reuse before the break.

Bank specific control variables (X_{it}):

- Balance sheet size
- Market capitalization
- Return on Equity (ROE)
- Capital adequacy ratio (CAR), which is equity divided by risk-weighted assets

Table 3.7: Correlations between repo volumes and collateral with reuse allowance

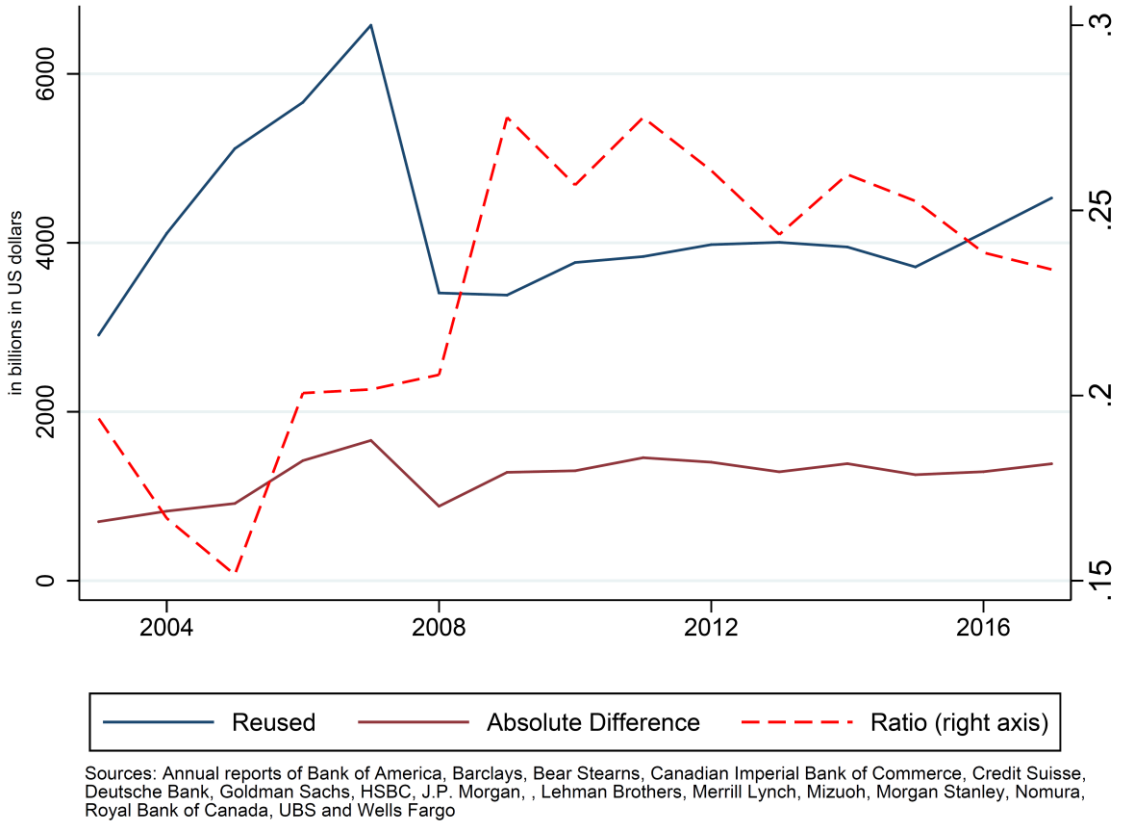
	Full sample		**Balanced sample**	
	(1)	(2)	(3)	(4)
Reuse Volume	2.89***	2.15**	2.87***	2.14**
	[0.62]	[0.83]	[0.66]	[0.91]
Reuse Volume*$D_{2009-2016}$	-3.12***	-2.26***	-3.15***	-2.50***
	[0.37]	[0.57]	[0.43]	[0.64]
Balance Sheet size		-0,1		-0,03
		[0.22]		[0.23]
Market Cap		-0,65		-1,18
		[2.45]		[2.54]
CAR		-126.56*		-111,09
		[66.48]		[73.23]
ROE		30.50***		29.35***
		[8.16]		[8.50]
Bank fixed effects	Yes	Yes	Yes	Yes
N	256	234	192	178
# of banks	21	21	13	13
R^2	0,43	0,48	0,44	0,49

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

The regressions presented in table 3.7 show that the break after the GFC is existent over PDs for the full sample, but also for the balanced sample where only PDs appear where I have data from 2004 until 2016. Reuse volume is positive significant, while the interaction term is negative significant. This means that for the years after 2008, the correlation between the reuse volume and repo volume has significantly changed in the opposite direction. Sample splits, not presented in this chapter, confirm these findings.

Based on experiences during the GFC, it could be reasonable that PDs have started keeping additional collateral with reuse allowance on their balance sheet as a buffer instead of conducting additional repos. Fortunately, 16 out of 21 PDs do not just report collateral with the allowance to reuse but do also report their collateral which they have actual reused.

Figure 3.15: Aggregated reused collateral



Sources: Annual reports of Bank of America, Barclays, Bear Stearns, Canadian Imperial Bank of Commerce, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, J.P. Morgan, , Lehman Brothers, Merrill Lynch, Mizuoh, Morgan Stanley, Nomura, Royal Bank of Canada, UBS and Wells Fargo

Figure 3.15 shows the sum of reused collateral (blue line). The brown line represents the absolute difference between the allowance for reuse and actual reused collateral, while the red dashed line (right axis) is the difference as a fraction of actual reused collateral. It shows that the difference, which can be interpreted as a buffer, seems to be rather stable in absolute terms, so that the buffer fraction moves strongly between 15% in 2005 and 28% around 2010.

Table 3.8: Correlations between repo volumes and reused collateral

	Full sample		**Balanced sample**	
	(1)	(2)	(3)	(4)
Reuse Volume	3.73***	2.34**	3.65***	2.29*
	[0.68]	[1.04]	[0.72]	[1.20]
Reuse Volume*$D_{2009\text{-}2016}$	-3.66***	-2.97***	-3.62***	-3.23***
	[0.51]	[0.65]	[0.60]	[0.69]
Balance Sheet size		-0,15		-0,08
		[0.19]		[0.20]
Market Cap		1,11		0,17
		[4.64]		[5.01]
CAR		-102,21		-84,97
		[69.65]		[71.37]
ROE		29.57**		28.85**
		[11.22]		[12.23]
Bank fixed effects	Yes	Yes	Yes	Yes
N	195	187	167	159
# of banks	16	16	12	12
R^2	0,43	0,48	0,42	0,46

The regressions are estimated using ordinary least squares. Heteroskedasticity-robust standard errors are in brackets.
***, **, * Coefficient statistically different than zero at 1%, 5% and 10% confidence level, respectively.

I repeat the regression with actual reused collateral instead of collateral with the allowance to reuse. Table 3.8 shows that there is still a significant break around 2009 so that a change in the difference between the allowance to reuse and actual reused collateral is not able to explain the divergence between a repo and collateral reusability.

If a change in actual reused collateral cannot explain the break in the pattern between repos and reusable collateral, exclusion process gives some evidence that collateral in the repo market has reduced significantly from 2009 onwards. If this is true, one could interpret this as a good sign because the market is able to increase the reuse of collateral whenever a structural shortage of collateral appears. This effect can therefore dampen the strong linkages between available collateral and conducted repos. This result is also in line with the findings of Fuhrer et al. (2016), who showed that reuse increases in times of collateral shortage.

Nevertheless, there are data limitations which do not allow for definite statements. The Primary Dealer Statistic covers repo and securities lending volumes, while the annual reports of banks cover the total volume of collateral with reuse allowance. It is therefore possible that (parts of) the discrepancy is explainable by an increase in the OTC derivatives market. The value of derivatives is measured on a net basis (the margin), while the value of repos is measured on a gross basis (total transaction volume) in the balance sheet. There are therefore good reasons for global banks to move some parts of their dealer activities to the OTC derivative markets as balance sheet costs have increased. According to Singh (2017), banks do not need to provide the amount of underlying collateral for their OTC derivative transactions. It is therefore not possible to give a final answer if collateral has actually reduced or has moved to the OTC derivatives market.

3.5 Conclusion

According to Singh (2017) and Pozsar (2015), the repo market is still a poorly understood market. I have worked out a framework which combines the hierarchy of money, the segmentations of money markets with the three key players in the repo market: levered bond portfolios, cash pools and PDs. With the help of the Primary Dealer Statistic, it has been shown that PDs shape the repo market which is in line with the presented framework. Balance sheet costs negatively affect the matched book, while financial risks affect the open book of PDs. Balance sheets costs are able to explain a sizable reduction in the repo market. A decrease of balance sheet costs of one basis point would increase the matched book repo market by more than $ 10 billion.

The second part of the chapter investigated on the possibility of collateral shortage as an explanation of a suppressed repo market. With the help of three different proxies, I showed that PDs move with the market and therefore worsening cyclical collateral shortage instead of

opening the book and reduce supply and demand mismatches. By setting up a data set on collateral with the allowance to reuse, I showed that there is a break between the reuse of pledge collateral and the repo volume around 2009. This break can be explained by either a decrease of collateral within the financial system (structural collateral shortage) or by an increase in the OTC derivates market.

These findings underpin the need for a central (clearing) counterparty, which helps excluding PDs from intermediating between levered bond portfolios and cash pools. If cash pools and levered bond portfolios conduct repos bilateral, the current suppressing effect of PDs on the repo market could be bypassed.

In addition, this chapter showed that data limitation in the shadow banking system are still an issue. While there have been a lot of progress on several fronts like tri-party repos, money market funds and hedge funds, data on underlying collateral in the bilateral repo market as well as in the OTC derivates market is still not sufficient.

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