The impact of evolving lending channels on the measurement of lending competition

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Abstract

This project aims to model and measure the impact of marketplace lending on lending competition. Current research on the relationship between competition and financial stability show ambiguous conclusions. Further research in this field first requires an accurate measure of competition, including the new and fast-growing concept of marketplace lending. If we are able to select an accurate measure of competition, research is possible on for example the impact of new types start-ups or regulation on competition and financial stability.

Marketplace lending offers lower interest rates to borrowers and higher interest rates to lenders or institutional investors. Lenders have to take into account the credit risk involved with these loan contract. Loan contracts between borrower and lender do not appear on the balance sheet of the marketplace lending company. The marketplace lending companies therefore have a more cost efficient business in terms of regulation, which maintains in the future. Other cost efficiencies are gained by a lack of offices and the use of smart IT-technology. The credibility estimation of a consumer is faster and differs from conventional FICO scores. These online marketplace lending platforms offer risk diversification and securitisation to lenders and fit their risk appetite.

We introduce a variety of competition measures from banking competition literature to apply on the borrowing side of a MPL platform. After the first

introduction, we only select the most-used, most-simple and most-recent measures for analysis; the Panzar & Rosse model, Lerner Index, and Boone indicator. We come up with our self-created framework to analyse these three measures on two types of criteria: conclusive and reflective criteria. These seven criteria have per criterion three predefined answers and possible ratings (negative, neutral, positive). The three conclusive criteria are of utmost importance and entail; theoretical evidence, time dimension, level of measurement and channel differentiation. In the first phase, we check whether the assumptions from theory hold for marketplace lending companies. The second phase defines how the measure should be applied in terms of input and calculations. The third phase evaluates our own criteria framework, resulting in seven ratings per measure. The fourth phase provides improvements to the measure.

The results show that the Boone indicator scores best on our framework, even when considering changing implicit weights of conclusive criteria. We conclude that from a wide variety of competition measures, the Boone indicator is able to model and measure lending competition including marketplace lending. Data comes from annual reports, however might need to be extended with risk and return data to correct for differences between default risk in company portfolio's. This measure has the potential to become an accurate measure with unambiguous conclusions for lending competition including marketplace lending. Applying the Boone indicator can facilitate analysing the impact of marketplace lending on lending competition and clarify the relationship between competition and financial stability.

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I would like to thank Reinoud Joosten for his personal accompaniment, insight and expertise during my thesis project. This project had an open start because of my interest in new trends in the financial sector. Reinoud did support this, by giving me the freedom to create my own project without to much barriers. I did experience our meetings in either Enschede or Tilburg, to be very useful and appreciate his sobering view. Thank you Berend Roorda as second supervisor in this project for you contributions and critical thinking. This project is executed during my internship at the Financial Risk Management department of KPMG. I want to thank my colleagues, who did create a pleasant working environment. Special thanks goes to Galyna Ignatenko who did her frequent supervisory tasks all-ways with great enthusiasm. This subject was of her great interest which resulted in valuable discussions, contributions at utmost important brainstorms. This project also is the finish line of my life as a student. Over the past few years I value my friendships even more than before and aim to maintain these in the short and long future. Last, I want to thank everybody in my environment for being patient-full over the last couple of months.

Setting a goal is not the main thing. It is deciding how you will go about achieving it and staying with that plan.

Tom Laundry

1 Project Description

1.1 Introduction

For decades, processes, products and companies have been getting more digitalised in the financial world. The next phase of digitisation has been initiated by companies using smart technologies to challenge the conventional institutions of the financial world (Arner *et al.*, 2015). New business models place a threat on conventional business models of banks and consist of a customer-centric experience and a low-cost service (McKinsey, 2015).

An impacting and promising stream within this trend is the lending industry. Next to family and friends, banks have been traditionally the most important provider of capital to small businesses and individuals (Ahmed *et al.*, 2016). The number one barrier to grow for Small Medium Enterprises (SMEs) is financing their business plans. Recently, banks have been charging higher interest rates on

debt and have been tightening conditions for SMEs and individuals, due to new regulation such as Basel III and higher operating cost (Nash & Beardsley, 2015). In 2010, the global credit gap for SMEs only, was estimated by the International Finance Corporation (2010) to be $2 trillion. The complexity to estimate an individual his credibility to approve a loan-requests, together with a low scalability, make these types of debt financing unattractive for large banks. Due diligence to extend a business loan of $20,000 costs a bank nearly as much time as to close a $2 million loan[1].

1.2 Trend in Lending

Despite the recent economic crisis, SMEs are the major driver of economic activity in most developing countries and traditional Western world countries (Ventura *et al.*, 2015). Especially start-ups and entrepreneurial companies drive innovation and technological advances, leading to more efficient processes and higher productivity in the long run. Formally registered SMEs account for more than half of the GDP of high-income countries. Lending to SMEs can be a profitable business and currently counts for 20-30% of all credit revenues of banks (Ventura *et al.*, 2015).

That is why new lending industry parties enter the market. Peer-to-peer lending or marketplace lending is the direct loan-making between a credit demanding and supplying party (Aveni *et al.*, 2015). These loans are closed via online marketplaces against low costs. Lenders can be institutions or individuals or a mix of these lenders, whereas typically SMEs and individuals on the borrowing side. The first significant company Funding Circle on marketplace lending, has been financing nothing but SME loans, having a market share of 43 percent at the UK MPL business loans market (HJCO, 2016). The first platform on P2P-consumer loans Zopa, originated in the UK, had a British market share of 56 percent in 2015.

With the use of smart data analysing techniques (for example Machine

[1]Magazine 'The Economist' May 9th 2015.

Learning or Data Mining) to assess credit risk, marketplace lending companies are able to determine credit risk in a fast and accurate way. Banks avoid these small and complex credit requests. In 2014, 12 billion dollars were invested globally in Financial Technology or FinTech, from which 40 percent into new lending companies to fund debt to customers and businesses.[2]

The total value of originated loans via P2P lending platforms has been growing with about 100% every year since 2013 (Aveni *et al.*, 2015). Moldow (2016) calculates that total marketplace lending expands to a $1 trillion industry by 2025. Also conventional banks recognise this new trend. Since the end of 2015, JPMorgan has teamed up with OnDeck to provide loans to small businesses via marketplace lending. Marketplace lending companies can cover their costs with charging just 2.7% more than what is given to investors, banks charge about 7% more from borrowers than given to savers (Aveni *et al.*, 2015).

1.3 Competition and financial stability

One of the conclusions about marketplace lending sounds: "The gulf that long isolated banks from competition is being bridged. Banks still have a future, but they will have to work harder to make it a profitable one."[3] With the emergence of marketplace lending companies, a possible rise in competition might effect financial stability. Although this relationship has been investigated extensively, Beck (2008) states that predictions from empirical studies on the relationship between competition and financial stability are ambiguous.

Allen & Gale (1982) confirm as well that the nature of trade-off between competition and stability is more complicated than was thought. Allen & Gale (2000), Boyd & De Nicolo (2002) and Perotti & Suarez (2002) identify several effects on financial stability, when competition is increasing. Another element in competition has been explored by Keeley (1990). He demonstrated that an increase in competition, is followed by an increase in risk taking. An example is

[2]Magazine 'The Economist' May 9th 2015.
[3]Magazine 'The Economist' May 9th 2015.

described by Allen & Gale (1982): "managers of debt-financed firms have an incentive to take excessive risks, because the debt holders bear the downside risk while the shareholders benefit from the upside potential. This well-known problem of risk shifting is particularly acute in the banking sector where a large proportion of the liabilities are in the form of debt (deposits)." This incentive in risk-shifting problem is worsened through competition Allen & Gale (1982).

This link between competition and financial stability is not directly included in this project. However the previous conclusions on the ambiguity of empirical results and the rise of alternative lending channels compared to conventional banks, demands for a more appropriate measure.

1.4 Peer-to-peer vs. Marketplace lending

Although marketplace lending already exists for 10 years, its nature and spectrum are still developing. The widest definition in financing without a bank is from Aveni *et al.* (2015), who describes 'alternative lending' as:

"Lending that typically targets businesses and borrowers who may be unable or unwilling to receive a loan through conventional channels. Alternative lending often relies on digital data. These loans are often unsecured or use non-traditional collateral to underwrite borrowers."

This alternative lending or shadow banking definition also includes other types of lending like crowdsourcing. Crowdsourcing is the contribution of a small fund (often by individuals), typically in exchange for a certain product or other reward. As we want to exclude these types of funding, we search for a more detailed definitions. Aveni *et al.* (2015) provides a definition for peer-to-peer lending as well: "The loan-making between borrowers and lenders who are directly matched via online marketplaces." This definition gives a better understanding on what peer-to-peer lending is, and how it differs from crowdsourcing-type of funding. A related definition on peer-to-peer lending can be found by Nash & Beardsley (2015): "The practice of lending money to unrelated individuals, or "peers", without going through a traditional financial intermediary." Difficulties come up

with the term 'traditional', because this is a vague and time dependent reference.

From business process perspective the definitions by Aveni *et al.* (2015) and Nash & Beardsley (2015) on peer-to-peer lending both hold, but the actors or so-called peers have changed over time in two ways. The first change is that a peer is not necessarily one lender but can be a pool of lenders. The second change is the involvement of financial institutions like pension funds, in general as the lending actor.

We therefore focus more on the process and not on specific actors. We follow the definition of Aveni *et al.* (2015) and refer to this as Marketplace lending or MPL. This is also in line with the more general definition of the Ventura *et al.* (2015) on MPL: "The practice of lending money to borrowers without going through a traditional financial intermediary such as a bank." We hold the definition of peer-to-peer lending of Aveni *et al.* (2015) as leading in our work, because it covers the essence of the new way of lending better, and refer to this concept as marketplace lending or MPL.

We focus on the process and not on specific actors, therefore we define Marketplace lending (MPL) as:

"The loan-making between borrowers and lenders who are directly matched via online marketplaces."

We show an example of a funding process via MPL in Figure 1.4.1. The process starts when a borrower (can be a individual or SME) applies for a loan at an online MPL platform. When an investor decides to fund this loan, it transfers the funding to the borrower. The borrower than makes monthly payments until the loan matures and all rental payments are completed and the initial amount is returned. In general, the MPL makes revenues by only charging a low commission on contracts.

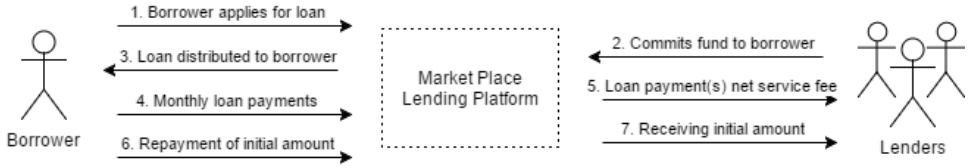

Figure 1.4.1: Process of funding via Marketplace lending.

1.5 Research introduction

With marketplace lending gaining market share in the United States and United Kingdom, more people and companies discover this opportunity to fund against low costs. Therefore, new marketplace lending companies place a threat on banks' market shares and profit in lending. Increasing competition within the lending industry has already started with banks looking for opportunities to create, collaborate or buy marketplace lending platforms.

After the financial crisis in 2008, research has been done on the relationship between competition in banking and financial stability. In Google Scholar, over 55 papers from 2008 are to be found on the exact terms 'competition' and 'financial stability' in the paper's title. Contrastingly, from 2000 to 2008, only 10 papers were published on this subject. Increasing interest is not ony coming from the academic world. The Authority for the Financial Markets (AFM) and De Nederlandsche Bank (DNB) have a common strategic objective concerning financial stability: "Our supervision focuses on the behaviour of market parties that could undermine financial stability and on the transparency of systemic risks." This is given a more practical approach by regulations on supervision of systemic risk at the financial system.

1.6 Research Goal

With the competitive scene including new participants entering the financial market, one does not necessarily need a bank to get finance. However, how does this affect competition and financial stability? From recent research is following

that competition in banking and financial stability are closely (might be inversely) related and that financial stability is having an important function for economy and society.

Financial stability theory consists of applying systemic risk measures to the banking industry. In general, these measures focus on the correlations between assets held on the balance sheets of bank and the interlinkage exposure between financial institutions. Nowadays new lending platforms do not act as a ledger for financial products and therefore, systemic risk measures do not cover the new, to be explored part of the financial market. However, that does not imply that new lending platforms have no impact on financial stability.

So, the closely related areas of financial stability and competition and possible impact of new lending platforms on financial stability, induce a lack of clarity how new lending platforms impact lending in banking. We follow the research methodology of Verschuren *et al.* (2010) to formulate the following research goal:

Develop a model to provide insights how marketplace lending impacts lending.

1.7 Research model

We know our research goal and continue with the next step in the method of Verschuren *et al.* (2010). In the first perspective we review different forms of competition models from literature, used in researching banks or the financial market. Reason in academic literature to build such models, is to research the effect of regulation, mergers or trends on competition in banking. Measures on the output are used as indicators to track these effects.

Marketplace lending is developing quickly in size and nature. However, the majority of research on marketplace lending comes from business literature. We therefore depend on this work and use it as a complement to academic literature.

The knowledge in previous steps generates one or more proposed new model(s) from updating existing model(s). We use criteria derived from literature about marketplace lending, to assess the generated models on the applicability at the new marketplace lending companies in lending landscape.

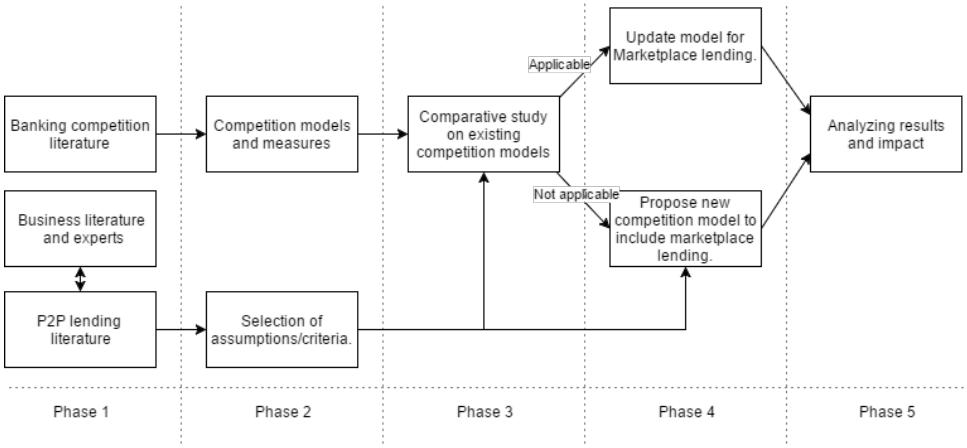

Figure 1.7.1: Research model of this project.

This results in an new theoretical framework giving insights on the impact of marketplace lending on competition and financial stability in banking.

1.8 Research question

The use of academic literature in combination with expertise from companies involved and business literature to describe this new marketplace lending development can best be seen as descriptive research. We aim to build a model which provides understanding of the complexity involving a changing lending landscape and possible impact of this trend in terms of competition and stability. The research model covers the solution path to the defined deliverable in the research goal. Key concepts in this model reflect the research question:

How can we model and measure the impact of marketplace lending on competition in lending?

The research question is answered following the sub-questions:

1. How does marketplace lending compete with conventional lending?

2. Which banking competition models exist in literature?

3. How can we compare competition models and include marketplace lending?

4. How can we model the impact of marketplace lending on banking?

1.9 Structure of thesis

In Chapter 2 we introduce the concept of marketplace lending, how it develops and its consequences in practice. Chapter 3 gives overview on the existing measures of competition in literature. We continue in Chapter 4, where we set up a framework with criteria to analyse competition models and predefined scores. This framework is applied in Chapter 5 on three competition models. We analyse the results and give conclusions in Chapter 6. Chapter 7 finalises this work by discussing the performed and future research.

It is no wonder that bank capital is regulated. When borrowing and lending is profitable, it is tempting for banks to scale up their operations and to borrow and lend too much in relation to their capital, in effect reducing the effectiveness of the potential capital cushion.

Evan Davis

2

Introduction of Marketplace Lending

This chapter treats the new lending channel for individuals and SMEs to fund (often unsecured) debt. We get a better understanding why marketplace lending is so popular over recent years. What is the difference between this new type of lending and conventional lending?

2.1 MPL vs. bank-lending

In this section we treat a general model of MPL to compare the business model to banks conventional model. The differences between both models are introduced and some of them are explained further in this chapter.

Banks take deposits and lend to individuals or businesses themselves, where MPLs only connect borrowers and lenders and therefore take no risk on their balance sheets. Income is not through interest but exists from commission and

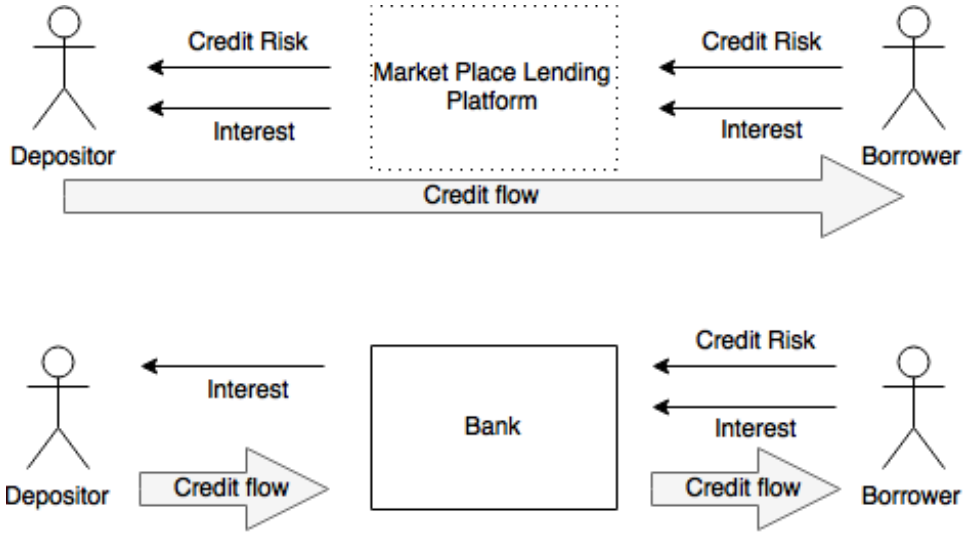

Figure 2.1.1: Credit risk and interest flows for banks and MPL.

fees from borrowers and lenders. Figure 2.1.1 gives an overview of credit, credit risk and interest flows in case of conventional bank lending and MPL. Table 2.1.1 explains the different characteristics for lending at MPL platforms compared to banks.

We have explained the major differences between these two types of lending. The next step is understanding why MPL has gained interest among borrowers and lenders.

2.2 MPL DRIVERS

This section covers the drivers of MPL growth during last years and how the efficiency in MPL is perceived compared to conventional lending. Among other studies in academic and business literature, (Aveni *et al.*, 2015; Deloitte, 2016; KPMG, 2016b; Moldow, 2016; Ventura *et al.*, 2015) analyse the business model and growth of MPL companies over the last years. The results of these analyses are consistent:

Conventional lending at bank	Marketplace lending
Banks pay interest on deposits and issue loans to consumers and businesses. Income is generated by the risk premium for credit risk of a loan. Also, the bank manages the interest rate spread, which is charged on loans or paid on deposits. Potential losses on loans should be covered by capital.	Borrowers and lenders are directly matched via online platforms. MPLs have no interest rate income nor do they have to hold capital to cover potential losses. Income is generated,by fees and commissions from both borrowers and lenders. The estimated credit scoring and other information on applied and issued loans are published to the platform for transparency and control for lenders.
Depositors can only,apply for an offered interest rate and have no influence on how it is invested.	
Banks manage the matching between terms of deposits and loans, for liquidity of deposits and maturity differences.	There is no need to manage terms of deposits and loans, because,borrowers and lenders apply for a term which matches their preference.

Table 2.1.1: Characteristics of bank lending versus Marketplace lending. Source: Deloitte (2016).

1. Obvious arguments for borrowers to look for a loan through MPL is, the available lower interest rates compared to banks;

2. Small loans (typically up to 50,000 euros) are too expensive for banks, because of the expensive application process;

3. MPLs do not have expensive branches to visit as a customer, because they offer a fully digitalised customer experience;

4. These digital services are experienced by clients to be better than services at conventional banks, because process and products are, more transparent, have an up-to-date status, and less time is needed to fulfil the application process;

5. MPLs do not rely on FICO (Fair Isaac Corporation) scores only, and use additional data sets and heuristics to estimate credit risk of borrowers. This way, borrowers with a lack of history to estimate a trustable FICO score

have the possibility to apply for a loan and lenders have better insights to outperform on credit loans;

6. MPLs having innovative credit evaluations, seem to meet high standards. However, prove is needed from a longer record;

7. MPLs have lower costs on operations (besides previous reasons), because of modern IT-systems, smart data analysing tools, a minimum of expensive human interaction, no hold of capital on the balance to cover potential losses, and no credit risk margin;

8. Using pooling techniques, MPLs are able to mitigate and diversify credit risk. These packages of loans (or loan parts) give institutional investors the accessibility to a new asset class to invest in;

9. The interest of MPLs and borrowers are aligned because borrowers are attracted by low interest rates, and MPLs collect more commissions by drawing in more clients;

10. In general, MPLs do not have to be compliant to the same regulatory burden as banks.

We can assign the drivers in this section into one or more of the following types: market-sensitive, leading technology and regulation.

Market-sensitive drivers will change over time because market circumstances have impact on the attractiveness of other financial products, like higher expected return rates on investment funds. The advantage of leading technologies entails, for example, the use of smarter data-analysing tools to assess credit risk, compared to the standards of banks. These technological advantages might disappear in the future, if banks are able to update infrastructure, tools, user-interfaces and digital processes. The regulational advantage for MPLs over banks can stay over time, because MPLs practice a different type of business model compared to banks. As a consequence, requirements from regulation have more impact on the loan costs for banks.

Next to these qualitative arguments, the study of Autonomous (2016) provides two quantitative arguments or drivers for the growth of MPL. First argument is the gap between savings and borrowing rates is grown from 6 to 10 percent over the last decades, meaning that customers pay relatively more interest on loans over the last few years, see Figure 2.2.1.

The second quantitative argument is based on the spread of interest rates on credit cards and on MPL loans. The spread used for credit cards is with 6 percent tight compared to the spread of about 30 percent in case of MPL loans, as can be seen in Figure 2.2.2. The divergence between high and low quality borrowers seems not well reflected in case of credit cards interest rates. To say this another way, MPLs are better in matching a loan rate to the quality of a borrower's credit risk.

We can conclude from this section that the drivers underlying the MPL growth, are (partly) sensitive to economic circumstances, the ability of banks to improve efficiency, and regulation. Due to future developments, for example, more efficient and IT-driven banks, these advantages of MPLs over banks can fade away. However, drivers like the cost efficiency of MPL platforms because they do not have to be compliant to bank regulation will continue to exist in the future.

Interesting future development of MPLs might follow up on changing economic circumstances, like other investment opportunities being more attractive to current MPL investors. This might lead to a loss of capital supply to MPL platforms and undermine MPL activities. Other risks undermining MPL platforms are more than expected losses or excessive interest charged on loans.

2.3 Efficiency of MPL

We have seen an extensive overview of drivers behind the MPL growth over the last years. Possibly the most important driver is lower costs for consumers and SMEs. In this section we take a closer look on the details of this more cost

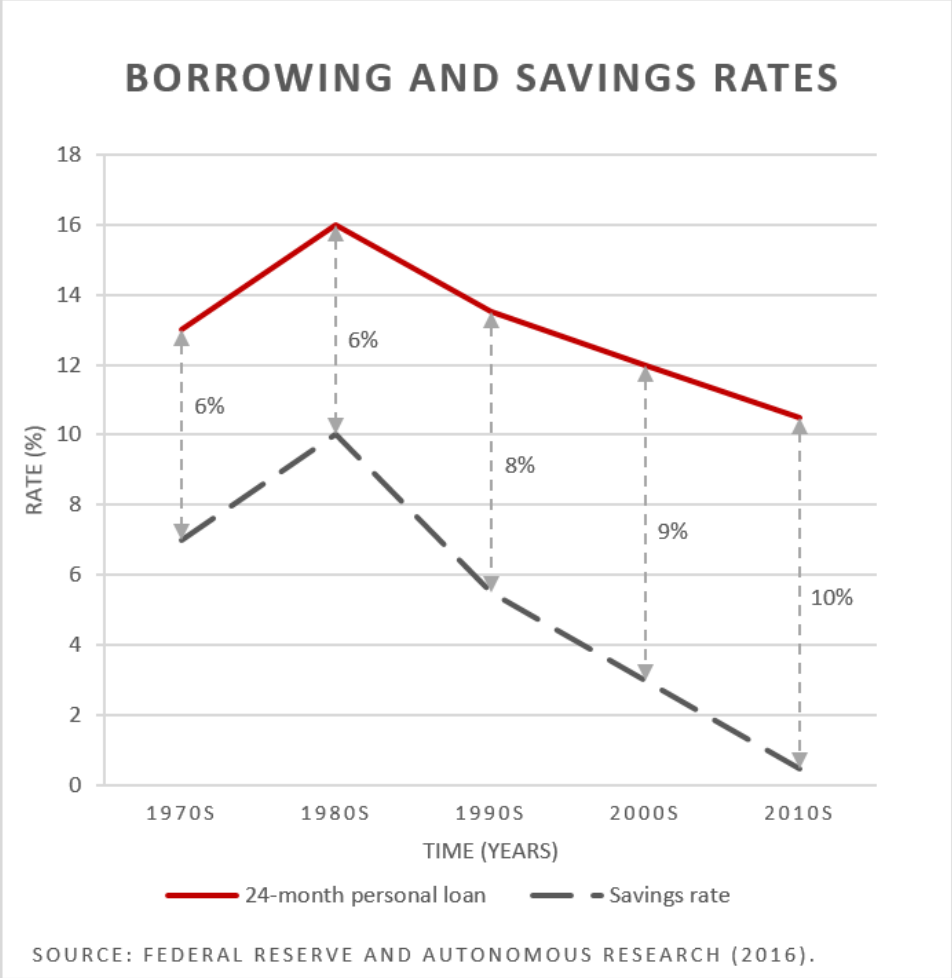

Figure 2.2.1: Gap between borrowing and savings rate has been growing over the last decades.

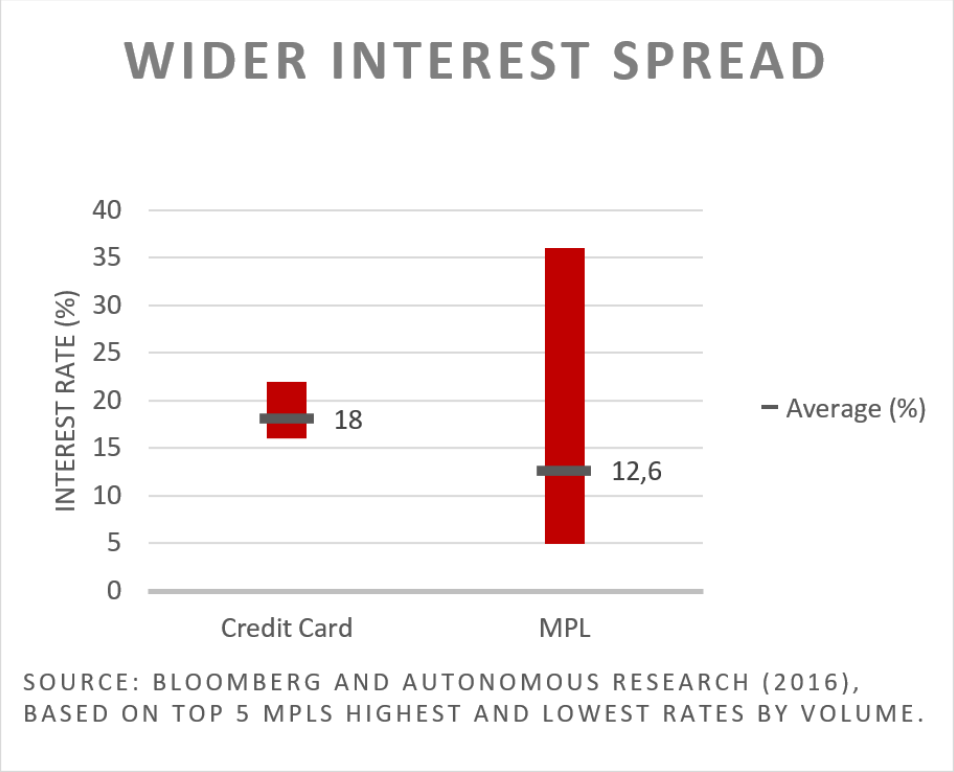

Figure 2.2.2: Interest spread is wider for MPL loans and the average is lower. compared to credit card rates.

efficient way of lending.

A wide variety of studies acknowledge the cost efficiency of MPL, among other Aveni *et al.* (2015); Cognizant (2014); Deloitte (2016); HJCO (2016); KPMG (2016b); Nash & Beardsley (2015); US Treasury (2016); Ventura *et al.* (2015). In general, these studies explain that the interest rate spread is reduced for MPL loans and investments in comparison to banks. For example the study of HJCO (2016) gives figures of borrowers paying 14.8% through Lending Club, instead of 21.64% at traditional banks. Lenders get only 1% at a bank, and perform 8.6% at Lending Club. This results in an interest spread reduction of 14.44%.

Even though these figures speak for themselves, we are curious to have a more detailed explanation how MPLs are able to set these progressive interest rates. We use the study of Moldow (2016) for better understanding how MPLs have over 400 basis points advantage over traditional banks, see Figure 2.3.1. The study takes the operational expenditures of Lending Clubs total balance in 2015 and compares it with a typical bank competitor.

Branch costs appears to consume a third of a banks' total operating expenditures and is the category of costs where MPL win the biggest gain, which of course is possible trough making services accessible via Internet and IT. Second biggest category is on credit supply, collection billing and fraud. The third category is on origination, which happens more efficient at MPL. These three categories dominate the advantage of 425 basis points of Lending Club over typical banking competitors.

MPLs use purpose-built and streamlined IT, to service customers with an appealing interface, fully online application, automated underwriting and simplified customer service and collection processes (Autonomous, 2016). Typical factors in the operating models are; unsecured lending, no funding via regulated depositor money, innovative credit scoring models and a lean operation set-up: no branches, less personnel is combined with a different level of compliance compared to banks (Ventura *et al.*, 2015).

Will banks be able to become more efficient in the future? As the possibilities

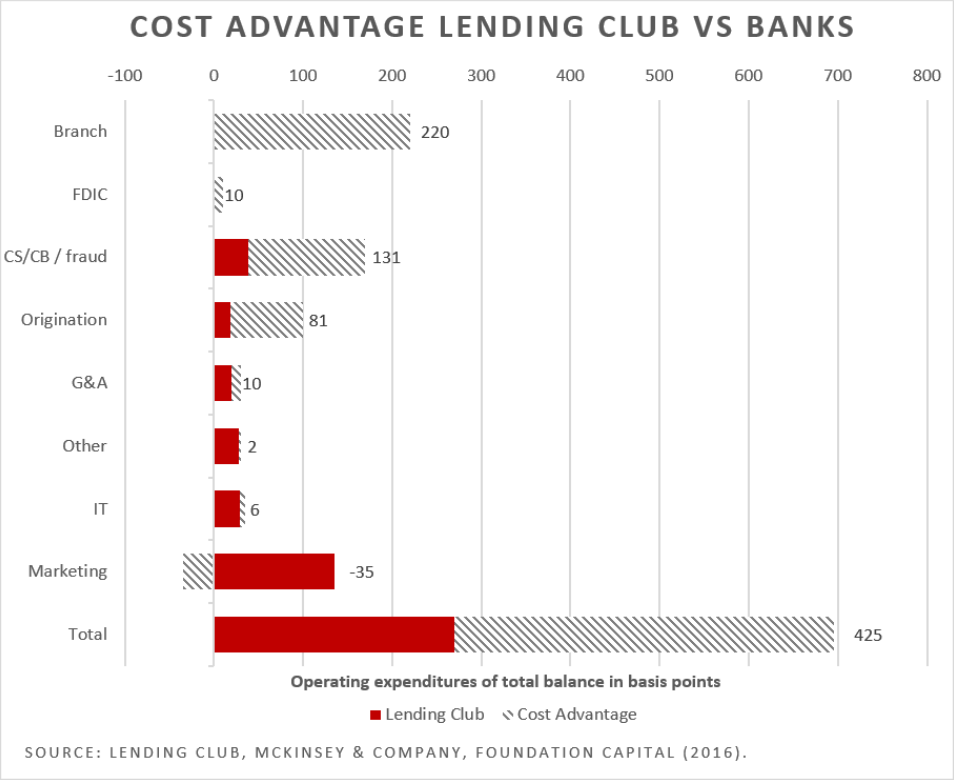

Figure 2.3.1: Case on cost advantages of Lending Club compared to conventional banks.

of IT as an important driver of efficiency, is not restricted to MPLs only. Even if banks might aim for such an efficiency, for example by closing branches and updating IT, it is hard to reach equal basis because of regulation as mentioned in Section 2.2. Moreover, the gap might become wider between MPLs and banks, as 70% of the top 500 global banks stayed the same or less efficient between 2009 and 2012 (Moldow, 2016).

2.4 Preferred choice

Section 2.2 and 2.3 show evidence that less expensive loans through efficiency, form an important driver for borrowers to get a loan via MPL instead of a bank. Especially in case of small loans (up to 50,000 dollars), individuals and SMEs are more successful at MPLs. FICO (2016) shows that less than one percent of the U.S. population is using MPL loans, despite the massive growth in dollar volume over the last years. However, when MPL is getting more mature, also more consumers think of using MPL, with 13% of the consumers in 2015 considering using MPL in the next 12 months. If in the (near) future MPLs becomes more mature, and investors still supply sufficient capital to finance the loans, this will impact the decision of a consumer where to finance debt. Let us assume that the conditions on a loan are equal for banks and MPLs. Now, we present the decision process of the consumer in the decision tree in Figure 2.4.1.

Let us assume that a rational consumer will decide to fund the loan via MPL with lower interest rates, instead of the more expensive loan at a bank, resulting in $p > q$. If an application is declined at an MPL or bank, the consumer can try to apply for the loan via the other distributional channel (bank or MPL respectively), which is reflected by r and s. However, banks have stricter policies to accept loans, due to regulatory compliance and less efficient loans, see Section 2.2 and 2.3. This is supported by the study of Nesta (2016): "33% of borrowers believed they would been unlikely to get funds elsewhere." Therefore, the relative difference r/w is closer to 1 compared to the relative difference s/v. Or:

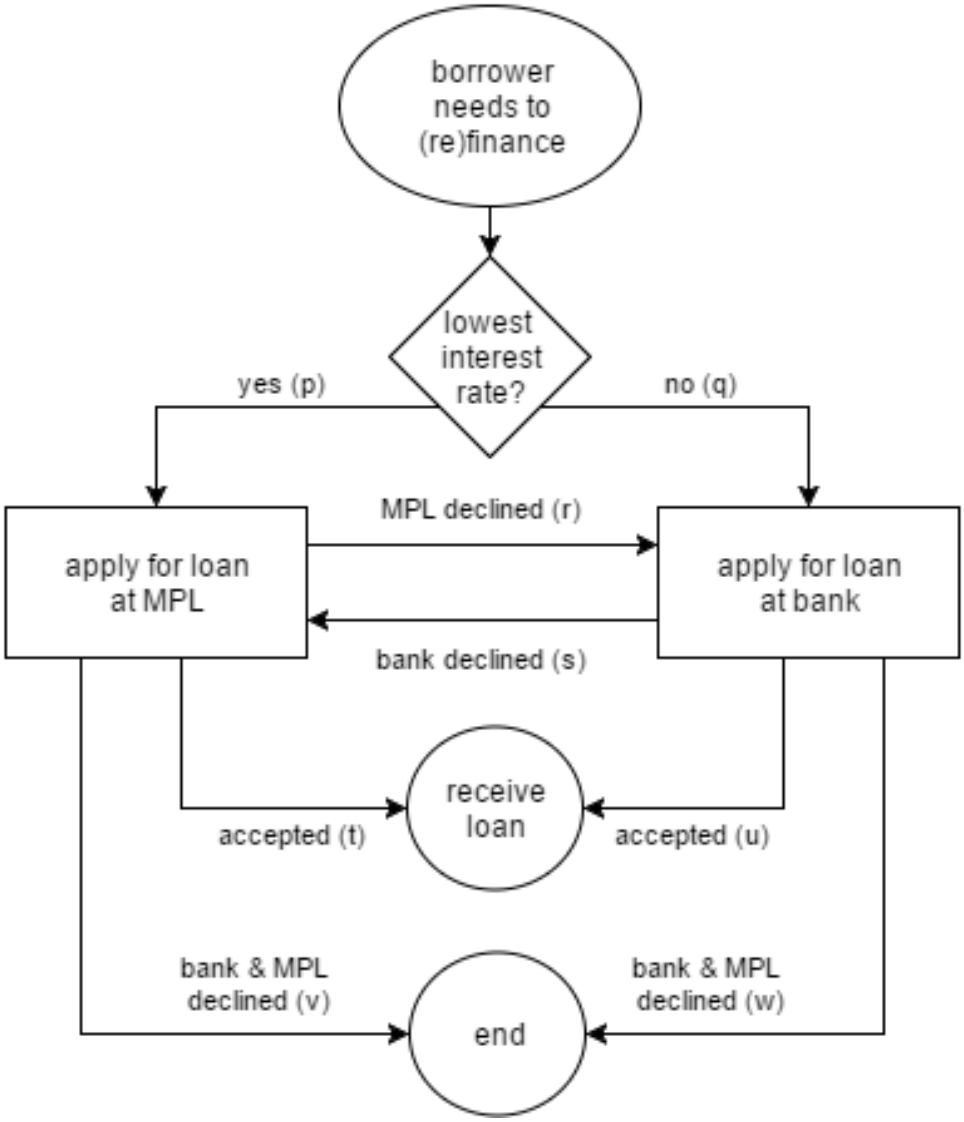

Figure 2.4.1: Rational consumers and strict loan requirements at banks, impact the market equilibrium.

consumers have a higher change to get a loan at MPL when the loan application is declined at the bank, compared to the loan application declined by the MPL and trying to get funding at a bank. This result can be an extra argument for consumers to apply for a loan at MPL in the first place (choosing p over q).

The same kind of decision tree can be made for lenders. However, as investors or lenders have more opportunities to invest in, this tree would be more complex and also depending on the risk appetite of the investor. The current decision tree can also be used to set up a mathematical model with equilibrium of the credit market for consumers and SMEs. However, this will add complexity to the problem and therefore consider this equilibrium outside the scope of this study.

2.5 Business models

In previous sections, we implicitly assumed that all MPLs have the same simple business model, connecting borrowers and lenders to transfer sums of money against interest rates. However, business models differ among platforms; Kabbage is an example of *direct lenders* or *balance sheet lender* (definitions might be inconsistent and therefore we choose to use the definition of US Treasury (2016)). This form of business model lend money from their own capital and therefore have credit risk and look much like the lending activities of a bank. Most of their revenues come from interest income and fees earned on the loans. Other income can come from fees for servicing loans, which are sold to other parties.

Lending Club is an example of *marketplace lenders* or *platform lenders* business model, who facilitate the connection between borrowers and lenders. This way they face no credit risk or have no loans on their balance sheet, and therefore prevent being subject to regulation and examination authority. An example of such a platform can be seen in Figure 2.1.1. *Hybrid business models* of MPLs like OnDeck, combine the two previous approaches of lending into a mixed form. Partly, loans are lend directly to one or more investors, where other loans are funded through the platform. An alternative approach is the loan being split up

into a direct fund part and a marketplace lending part. OnDecks new partner JPMorgan funds loans directly with capital.[1] Marketplace lenders and any hybrid model generate revenues with fees for matching lenders and borrowers and service fees for investors.

MPLs rely on a variety of funding sources, under which institutional investors, for example pension funds or asset managers. Together with hedge funds, they count for about 70% of the investors in MPL Ventura *et al.* (2015). Other parties are individual investors, venture capitalists or depository institutions. It is increasingly common that MPLs separate higher risk loans from lower risk loans to make the higher risk loans available for only institutional investors.

2.6 Origination and Securitisation

We have seen different business models, and want to have a closer look on how funds flow for origination and securitisation, see Figure 2.6.1 for an example. For instance Lending Club is using WebBank as partner to originate loans US Treasury (2016); Ventura *et al.* (2015). WebBank used to be a niche bank and is compliant to bank regulation. Therefore they are allowed to make contractual agreements and receive payments and transact loans.

In case a MPL decides to pool the loans for securitisation, more parties are involved US Treasury (2016). The securitiser pools the loans underlying the CLO (Collateral Loan Obligation) to create notes and certificates with different terms, risk and returns to fit the requirements of (institutional) investors. Therefore, the loans are constructed into different tranches for which holds that the senior notes have the least risk and lowest return. Mezannine notes are riskier compared to the senior notes, as payments are less secure. However, this higher risk is rewarded with higher interest rates. The equity part in the CLO is the tranche with the highest risk and returns.

[1] JP Morgan has launched a new product to serve small business consumers via OnDeck, looking for small loans. https://www.ft.com/content/fd561dca-984e-11e5-9228-87e603d47bdc (January 28th, 2017).

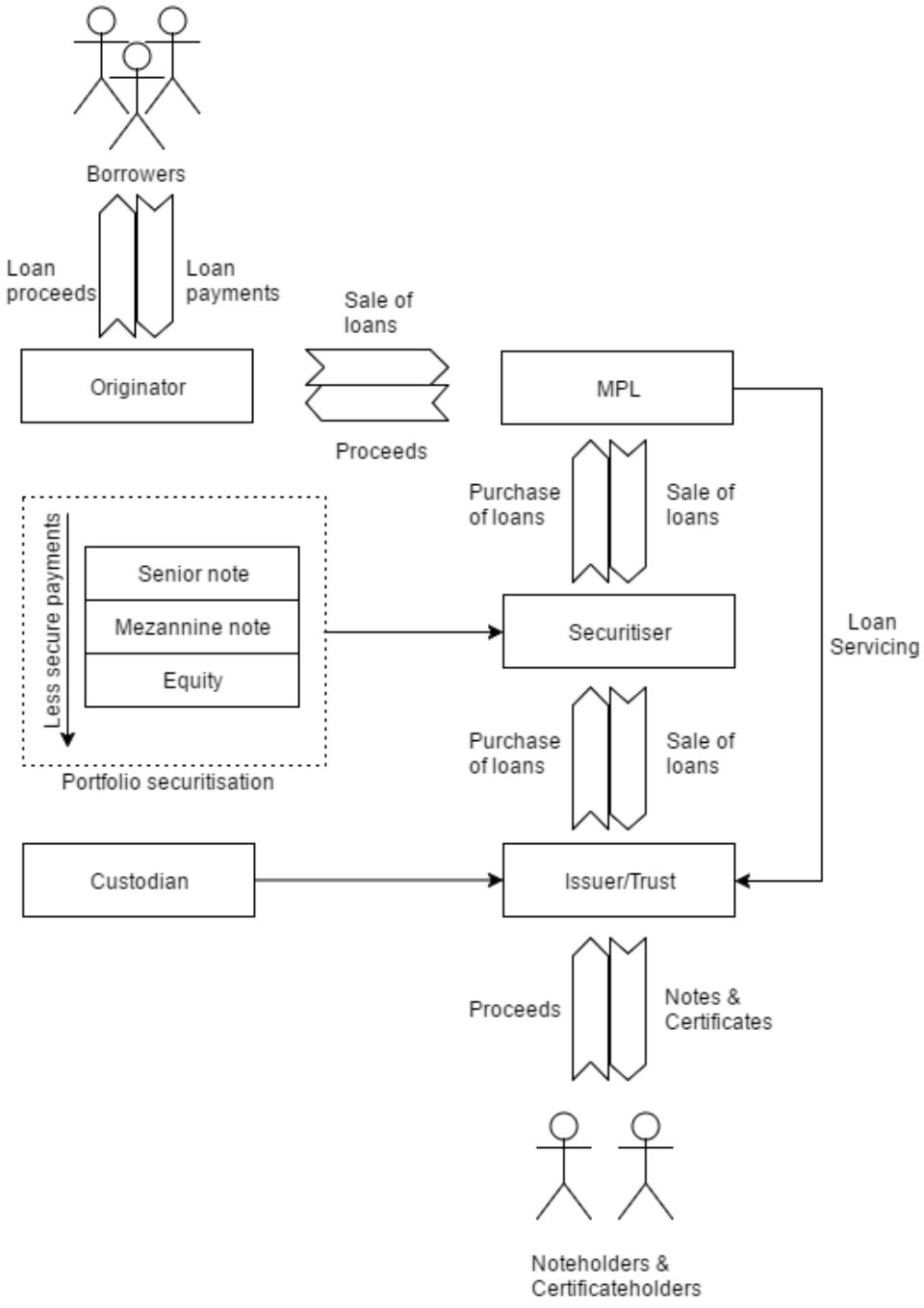

Figure 2.6.1: Example of origination and securitisation process for MPL loans to mitigate risks and returns. Source: US Treasury (2016).

The issuer or trustee covers the interests of the note and certificate holders, which includes monitoring payments of the borrowers to the investors, following the contract. The issuer might stay in contact with the MPL to further guarantee a proper execution and administration of the contract. The custodian is saving the securities to minimise fraud, loss and theft.

A more simple technique to lower credit risk is diversification, which divides a sum of money over a large amount of small loan parts. An example of the impact of diversification is given by LendingRobot.[2] This algorithm invests on behalf of the lender and automatically buys small loan parts. The impact is illustrated by a Monte Carlo simulation, which uses up to 250 loans out of all-most 21,000 matured LendingClub loans, see Appendix A.0.1. When starting with a portfolio of only one loan, the total return can be the loss of the complete loan at minimum and the repayment of the total loan at maximum. However, with 250 such loans the band-with of total return is just 2 to 12%, with an average of 8%. Be aware that this tool uses historical data, which gives no guarantees in the future.

2.7 How big is Marketplace lending?

We have seen different business models in Section 2.5, and the drivers behind the MPL growth in Section 2.2. This section gives more information on the actual growth and market size of MPL.

The study of KPMG (2016b) has been investigating the market size of MPL over the last years. Figure 2.7.1 shows the market size of the EU including the UK and the US separately, in newly originated loans via online MPL. Immediately, we see the enormous growth over the years 2013 till 2015 for the EU and the US. The percentage increase is larger for 2014 than 2015, however is still about doubling the market size. The EU MPL market had a value of almost 5.5 billion euros in 2015. The US market is roughly around four times bigger than the EU, about 22 billion dollars large.

[2] https://www.lendingrobot.com/#/resources/charts/.

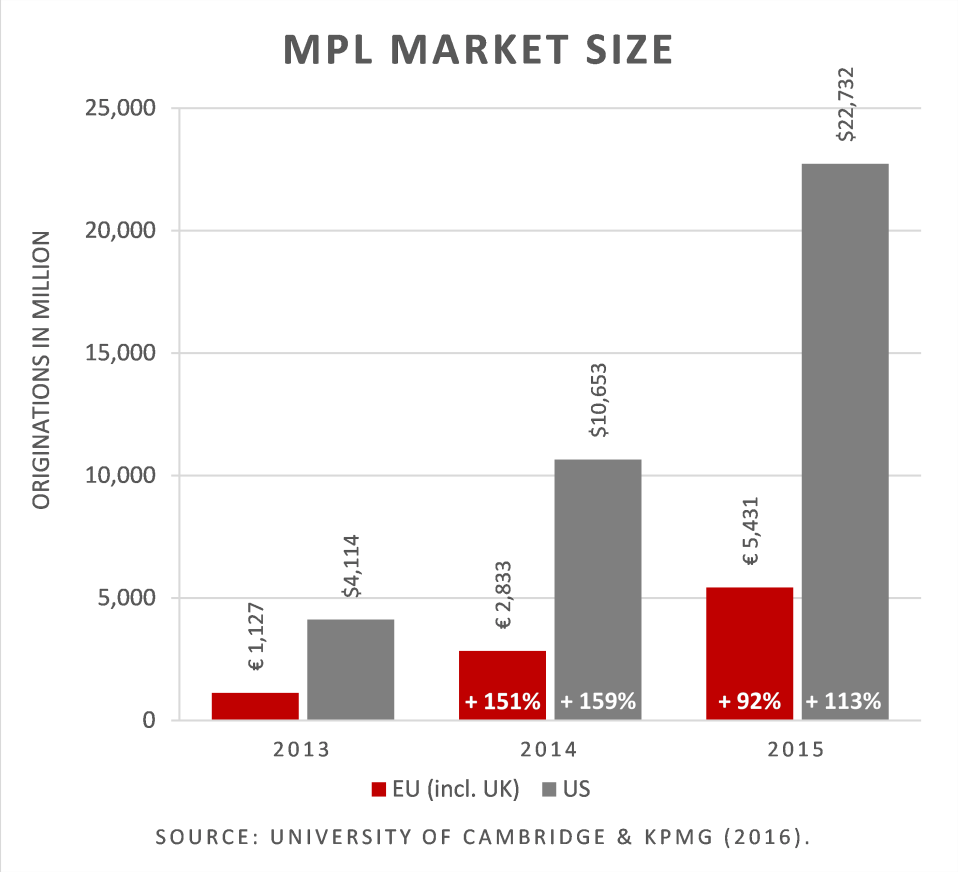

Figure 2.7.1: Market size of MPL in newly originated loans.

From Aveni *et al.* (2015) it follows that MPL grows at high speed but also into different directions, specialising in type of products, consolidation approach or to a specific part of the loan-market. When we combine the studies of KPMG (2016a) and KPMG (2016b), we can divide the market in the UK and EU (resp.), into sub markets having a specific target group or specific loans (see Appendix B.0.1), for example on real estate or pension lending. We observe from Appendix B.0.1 that the UK business lending market (1290 million pound) is bigger than the UK consumer lending market (909 million pound), where the opposite is true for the EU (resp., 212 and 366 million euro).

When we zoom out to a continental scale in Appendix B.0.1 and Appendix B.0.2, we see that the UK is counting for a majority of the market in the EU, as does the US for Americas and China for Pacific-Asia. Differences between Asia and the EU excluding these top countries, are small. However, Asia shows a booming growth, where in 2015 the market is almost four times the market size in 2014, see Appendix B.0.2.

Appendix B.0.3 shows a more detailed overview on MPL loans per EU country. We observe that after the UK, countries like France, Germany and the Netherlands fall behind. However, the potential of MPL in a country like the Netherlands might be promising, as individuals have more than 340 billion euros deposits in 2016.[3] For individuals, MPL can be an attractive alternative to the currently very low savings rates.[4]

MPL loans are typically consisting of short-term credit loans up to 5-years, funding examples are; credit card repayment, debt consolidation and home improvement. However, there exist examples of real estate lending with with long-term horizon. In Europe and the US, the short-term loan market is estimated at a 1 to 4 trillion dollar market by studies of Moldow (2016), US Treasury (2016) and Autonomous (2016), assuming a 2-year average loan duration. Projections predict a 10% MPL market share by 2020, meaning a 100

[3]https://fd.nl/economie-politiek/1186285/nederlandse-banken-5-3-meer-spaargeld-in-2016.

[4]https://www.nd.nl/nieuws/actueel/economie/abn-amro-brengt-spaarrente-verder-omlaag.2453423.lynkx.

billion dollar volume (Autonomous, 2016).

2.8 Credit risk analysis, credit quality and defaults

A less prominent but valid reason for consumers and companies to fund via MPL, is the fast credit application process without time consuming paperwork or consults with a bank salesman, but using smart data analysing tools to determine credit risk quickly. This section takes a closer look on the credit analysis and quality.

Section 2.1 and Section 2.2 already mention that MPL often use a different approach to estimate credit risk, compared to banks. This approach is faster because algorithms can give results on short notice, cheaper because no human interaction is involved, and is experienced more user friendly (Deloitte, 2016). In the Netherlands, banks use public information and history on debts and payment defaults from Bureau Krediet Registratie (BKR). In contrast to institutions in the US, BKR can make lending impossible for individuals. The US most well-known credit rating agency is FICO, which give a score between 300 and 800 points to individuals. FICO uses a model on five different categories, while the exact mathematical model stays private and can change over time.[5] For the general population exist five categories, which are given importance; payment history (35%), amounts owed (30%), length of credit history (15%), new credit (10%) and credit mix (10%). The information is collected from creditors and result in a consumer's risk profile.

Moldow (2016) describes that MPLs have developed their own (additional) data sources and algorithms. The estimation of credit ratings depends on the type of borrower, and use at least public information. For SMEs, additional data from accounting software, credit cards and sales are used. Consumers' financial sources come from bank accounts and credit cards, used to analyse a client's liquidity, behaviour when shopping, controlling expenses, and so on. As an addition, information on behaviour can be taken from online sources, like the

[5] http://www.myfico.com/credit-education/whats-in-your-credit-score/

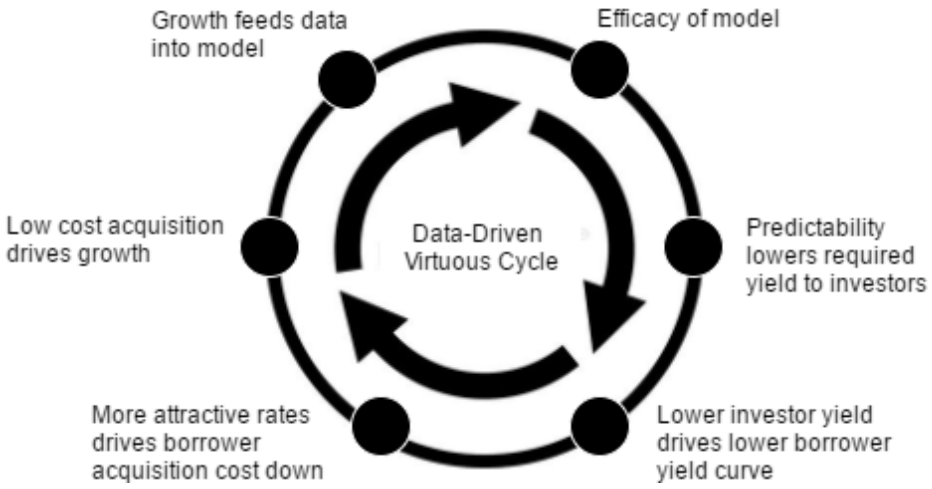

Figure 2.8.1: Improvements on the credit model drives growth. Source: Moldow (2016).

amount of friends on Facebook or how long one is using the same e-mail address. Some MPLs even use heuristics on the amount of time a borrower spends on the platform to decide whether and how much to borrow.

Proper credit risk estimation is an important task for the MPL, because investors or lenders are paid for the risk they've taken on. On the long term, the existence of MPLs depend on whether the actual default rates are equal to the default expectations per category of credit risk. Moldow (2016) explains the impact of credit model improvement on MPL growth, by the data-driven virtuous cycle in Figure 2.8.1.

The study of US Treasury (2016) shows that over 80 percent of the MPL loans issued at Prosper, have FICO scores of 680 or higher, see Appendix C.0.1. Appendix C.0.2 on the Lending Club loans allocates a majority of the loan in one of the three highest grades. This data suggests that the majority of the unsecured consumers are prime borrowers. Prime borrowers are likely to make payments on time and have a strong history of using credit responsibly, therefore they have a below-average credit risk.[6]

[6]http://www.investopedia.com/terms/p/prime-borrower.asp.

Common knowledge in the investors world, is that risk should be payed of with return, which we call risk-premium. Iyer *et al.* (2009) shows that the relationship between a borrowers credit score and the interest rate on funded loans is troubled, because investors need to distinguish between MPL loans in one credit category. The stylised relationship can be found in Appendix C.0.4, which as-well shows the relationship if lenders cannot observe the exact score. Appendix C.0.3 shows the raw relationship of interest and credit score in Prosper loans till 2009. The results argues for transparency for investors on the credit rating, to prevent unnecessary mismatch of risk and return.

The study of Emekter *et al.* (2015) concludes shows conclusive evidence that Lending Club is able to predict default probability successfully, except for one category. Loans with longer maturity and a lower credit grade show higher mortality rates. However, the higher credit risk categories do not payoff significant enough return to justify the default probability.

If failing payments on a loan or defaults occur, who has to go after the borrower to get back as much of the loan and payments as possible? We only show the approach of Prosper to get an idea.[7]

1. The process is triggered by a payment failure. An email is automatically send to the borrower.

2. Two more attempts of a payment are executed, and the borrower is notified if there is a failure.

3. Phone calls to the borrower until they are able to get an answer. Try and workout a payment plan.

4. If after 30 days no payments is made. The collection agency Amsher takes care of the further process.

5. Amsher sends letters and continue to make phone calls and persuade the borrower to pay back the loan.

[7] http://www.lendacademy.com/the-collections-procedure-at-prosper/.

6. If Amsher is not able to solve the issues, the loan is charged off and there are no further expected payments.

7. The loan is handed over to IC system, a collection agency where the try and collect the charged off loan.

MPLs make often difference between a default loan (failed payments) and a charged off loan, for which no further payments are expected. The costs of suing a borrower are often higher than the lost money, and therefore is not common.

2.9 Deposit guarantee & Guarantee fund

For European and US governments it is common to protect deposits of savers for a bank default. However, this is not the case for investors using their former deposits to lend via MPL. Unsecured MPL loans do not give any guarantee for borrowers on a default.

In case the bank of a borrower defaults, the Dutch government guarantees (Deposito Garantieregeling) and pays back a maximum of 100,000 euro per person. The UK government possess the same concept with a ceiling of 75,000 pounds. This gives the average saver guarantee on their deposits and therefore no reason to be scared for a bank default. Now, depositors who switch to lend via MPL, have to be aware that MPLs are not covered by such government guarantees and a well performing investment depends on whether the borrower defaults. Individuals have to make such choices depending on their risk appetite.

A provision or guarantee fund at an MPL is a service to investors for repaying defaulted loans. The name is somewhat misleading, because such a fund is not a right to get repaid. The exception is China, where funds have to guarantee to stay competitive (Aveni *et al.*, 2015). Most platforms with a guarantee fund have been able to pay the all defaulted loans back completely. The guarantee fund therefore grows faster than the expected defaults on loans, and is filled up from loans paying a commission. Returns of loans under such guarantee fund typically have lower interest rate, in return for the guarantee. We do not know whether

guarantee funds are able to payback defaulted loan when a systematic default is triggered, for example by an economic crisis.

2.10 Thoughts on Systemic Risk

We have analysed many aspects of MPL so far. Systemic risk of the banking sector is a major concern of governments and societies. As we have a new type of company in this sector, does MPL contribute to systemic risk of the banking sector?

Systemic risk is an important subject in the Basel-regulatory framework for financial institutions to prevent negative impact on the society. Financial institutions have mutual exposure in the current financial system which makes a default of one institution possibly triggers the default of another institution. This can lead to instability of the whole financial system, which has impact on the economy and society. An example of regulation is a capital cushion to absorb loss giving financial products on a bank's balance.

From Section 2.5, we know that only *balance sheet lenders* have loans on their balance sheet. However, the majority of MPLs are *marketplace lenders*, have no loans on their balance sheet and therefore do not contribute to systemic risk directly. In case a concentration of loan defaults occurs from borrowers, this comes at the expense of the (institutional) lenders. The business of the MPL is not (directly) at risk. On long term, the investors might temporarily avoid investing in MPL loans because of higher default rates than expected.

On the one hand, MPL services diversify funding possibilities which lowers the dependability of consumers and SMEs on banks. The impact of a financial system in distress might therefore be lower. However, a distressed financial economy might result in more defaulting unsecured MPL loans, which might (further) affect institutional investors on their absorbing capital buffers. We conclude that further research is out of the scope of this project, however requires more attention in the future. The main take away is that MPLs have no direct contribution to systemic risk as conventional banks do.

2.11 Money creation

Two theories exist on the creation of money in the economy by banks. We shortly describe both processes in this section. What effect have MPLs on this function or can they create money themselves?

The first theory to create money is fractional reserve banking, as explained by for examle Krugman *et al.* (2007). Basically, when a depositor puts his savings into his bank account, a bank is required to reserve a fraction of the money. The rest of the money can be lend out as loans. When the money is brought into for example a company with employees, these employees might again save their income as deposits. The bank is than required again to reserve the same fraction and is allowed to lend out the other part. The fraction of the money to be reserved is called a reserve ratio. The limit of the money creation process is calculated as the Money Multiplier m, with Reserve Ratio R:

$$m = 1/R \tag{2.1}$$

The minimum reserve ratio is given by central banks and set in the regulatory requirements. From 2012 on, the ECB lowered the minimum Reserve Ratio to 1%[8] in Europe, meaning that the Money Multiplier is 100. On all the euro banks, about 113 billion euro stands as reserve requirements in 2016.

The second approach is explained by McLeay *et al.* (2014) and rejects the first approach of money creation. Money is created by a commercial bank when they issue a loan and create a deposit on a consumers account at the same time. The new deposits are created on a banks liability side of the balance sheet, and the new loan is created on the assets side, see for explanations Appendix D.0.1.

Without discussing the theories further, we can conclude that MPLs are not able to create money in the first place, because they have no loans or deposits on the balance sheet. MPLs do not have direct impact on whether money can be created by other banks as well. However, outflow of deposits (depositor takes out

[8]https://www.ecb.europa.eu/explainers/tellme/html/minimum_reserve_req.en.html.

savings to invest via MPL for higher returns) can lower a banks capital reservation to cover the loans and above all, limits the money creation process. This might force the bank to search for additional and possibly more expensive capital reserves instead of deposits. We wonder how this development has impact on the availability of money in the economy.

2.12 Regulatory requirements

As this report does not aim for a analysis of regulations, we only want to understand how MPLs differ from banks. So far, there is a lot of uncertainty for this young industry on how the products and organisation is seen by financial authorities.

The study of Ventura *et al.* (2015) gives an idea on how the status of regulation was in 2015. Countries like the UK, US and China (having large MPL markets) have a 'dedicated platform status' with a legal status. These platforms need approval by the regulator and have their own regulatory requirements, depending on the precise activities of a MPL. For the US, this means that MPLs are regulated as credit and securities sides. In other European countries than the UK, MPLs are mainly regulated as banks and need a banking license (HJCO, 2016). This banking license gives far more regulatory pressure compared to the dedicated platform status.

As MPL reaches meaningful market size, this attracts new market entrants. Therefore, current MPLs benefit from an approval process by the regulator. A few examples of new companies getting troubles with a naive credit model can quickly cool off the current positive look of investors at MPL. Large UK MPLs have therefore organised their own Peer-to-Peer Finance Organisation (P2PFA) to bundle their interests to the public and government. Transparency can benefit borrowers and investors (US Treasury, 2016), and is a key element in all regulations of MPL. Authorities in Europe started to introduce some vague regulations, but they can serve as guiding principles (Ventura *et al.*, 2015);

1. Managerial standards should be raised.

2. Transparency on all relevant information on nature and risks.

3. Plan on how MPL loans continue if a platform exit the market.

4. Investment caps on the amount invested in one loan and as total portfolio relative to the net worth of an individual.

An exception on the European countries is the Netherlands, they developed some kind of intermediary regulation (HJCO, 2016; KPMG, 2016b). The Netherlands have the largest business MPL in Europe with 74 million euro in 2015, when excluding the UK. At the first of April, the regulatory framework for MPLs is updated in the Netherlands (KPMG, 2016b). MPLs are considered to follow a set of best practises which encourages investors to apply for example diversification. Further requirements exists on areas like; risk, ethics, transparency and operations. It will be of high importance to the authority to measure the effects of the regulations on the growth of the MPL market in the Netherlands.

2.13 Cross-subsidisation at banks

MPLs might pick the cherries from a banks credit lending consumers and businesses. This might not only impact the business of credit lending of a bank but also other businesses within a bank which are cross subsidised by credit loans (Deloitte, 2016). Clients often are involved in a bundle of financial products at a bank, for which the total profit is optimised. This might include under-performing financial products which are cross subsidised with profits from credit lending, because this has been a profitable business. Banks generally are able to earn at least 20% return on equity on personal loan products (Nash & Beardsley, 2015).

2.14 Client Centricity

We have seen an example of how MPL impacts the business of a bank in Section 2.13. This section treats impact on a banks capital buffer which comes from a combination of current advantage from regulations and the impact of MPLs attracting depositor money.

The European Bank Authority (EBA) has written guidelines[9] on how to handle deposits of banks for liquidity ratios in the context of capital requirement regulation. For short-term liquidity, the liquidity coverage ratio (LCR) needs to be a well-reflecting indicator on how deposits behave in stressed market conditions. Therefore, banks need to prove whether deposits behave 'stable' or 'less stable' from historical data. Stable deposits are given more weight in liquidity reasons.

In case customer occasionally invest deposits into MPL loans over time, deposits are less stable for a bank and therefore weighted lower in the LCR. Deposits have an important function for banks as liquidity funds. The attractiveness of investing in MPL loans might impact the LCR of a bank.

2.15 Reaction of banks

We have seen that the MPL market grows fast and might threaten the existing credit loan business for banks.

Banks can react in four different ways to the alternative of bank loans, or in a combination of the options shown:

1. Do nothing, accepting the potential impact;
2. Build a new MPL, owned by the bank but in a separate entity;
3. Partnering up with a MPL to fund all loans in a portfolio which match the risk-appetite of the bank. A cheaper credit risk assessment process can give

[9] https://www.eba.europa.eu/documents/10180/515704/EBAGL201301 (Retail deposits).pdf.

extra advantage for a bank to use MPL;

4. Buying a MPL to expand market share and gain exposure by the banks name.

We consider further discussion of the alternatives out this project's scope.

2.16 Product differentiation or Perfect substitutes

Are unsecured loans at banks and MPLs perfect substitutes or are MPL loans different from bank loans? This section investigates the interchangeability from the perspectives of investor (or depositor) and borrower.

The investor can choose to put his money on a bank account, receiving an interest rate and being protected by the governmental guarantee. The second option entails investing the money via MPL in unsecured loans, which gives a higher return compared to the interest rate on savings but comes with credit risk. Protection against loss giving defaults can be obtained by securitisation or diversification. This also gives an investor the opportunity to find loans matching his risk appetite. We conclude that these two options have very different impacts on the risk and returns of the investor. The choice depends on the risk-appetite of the investor. Therefore, the MPL loans are not a perfect substitute to the investor.

The borrowers as the second key user is looking for an unsecured loan to fund debt. The bank loan and MPL loan have the same characteristics for the borrower and therefore is a perfect substitute for the borrower. However, a rational borrower choose to borrow against the lowest interest rate. Due to regulatory restrictions rand risk-appetite of a bank, a MPL loan can not always be exchanged by the borrower for a bank loan. Whereas in general, a bank loan can always be replaced for a MPL loan. This makes only MPL loans a perfect substitute for bank loans.

I got to spend all of my time every day at work reading and editing papers about cutting-edge technical research and getting paid for it. Then I'd go home at night and turn what I learned into science fiction stories.

Kevin J. Anderson

3

Introduction to competition literature

In recent years competition in banking has attracted much attention of researchers and policy makers (Goddard *et al.*, 2007). The potential high costs for society in case of bank default(s), and the banks' financing function in non-financial business activity put banks into a crucial role resulting in above normal concerns on competition (Leon, 2014). Leon reviews that: "theoretical papers have attempted to explain the ambiguous consequences of competition on access to credit, cost and quality of financial services, innovation, the stability of financial systems, and thus economic development." These important questions can better be addressed with a reliable measure of banking competition.

Different indicators of competition in the banking market do not give unambiguous conclusions (Carbó-Valverde *et al.*, 2009; Liu *et al.*, 2013). Although some researchers might prefer one measure above another, Leon (2014) states that: "there is no consensus regarding the best measure by which to

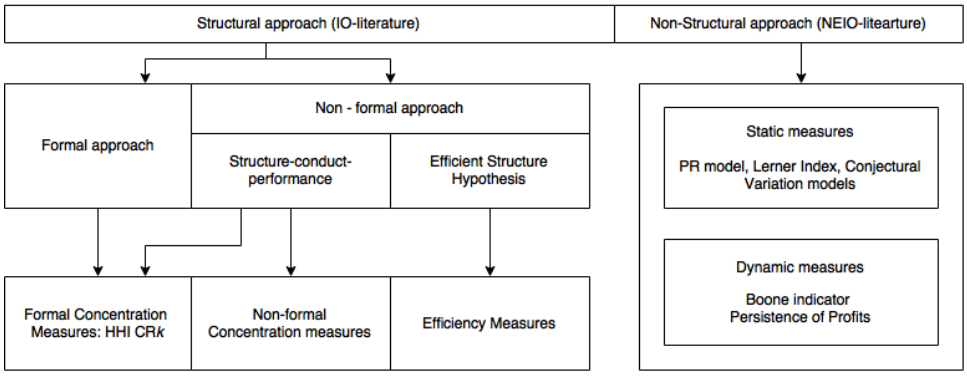

Figure 3.0.1: Overview on the existing research streams.

gauge competition." The choice of competition measure therefore might influence conclusions on the implications of competition. In this chapter, we treat the different research streams in literature regarding competition in banking, following the division in structural, non-structural, formal and non-formally (Bikker & Haaf, 2002). We aim to give a visual overview on existing literature in Figure 3.0.1.

3.1 Early history

Existing research on competition measures in banking is commonly categorised into two major streams (Bikker & Haaf, 2002; Leon, 2014). The first category of research is the structural approach with the Structure-Conduct-Performance (SCP) paradigm as early basis in Industrial Organisation. Structural approaches use concentration ratios to describe market structure and can again be divided in two fields. Any concentration ratio can be used in the field of SCP (non-formal approach) as the market structure measure is chosen at will. On the contrary, two formal derivations (HHI and CR_k) exist based on oligopoly theory in the field of formal approach.

The second research field contains the non-structural approaches, is named the New Empirical Industrial Organisation (NEIO) literature, and developed

after debate on theoretical and empirical deficiencies in structural approaches (Berger *et al.*, 2004; Bikker & Haaf, 2002; Leon, 2014). The non-structural approach ignores the impact of concentration and tests competition and use of market power.

3.1.1 Structure Conduct Performance hypothesis

Within the structural approach we first treat non-formal approaches based on SCP and on the Efficient Structure hypothesis (EH). Mason (1939) inspired Bain (1956) to develop the SCP model, which is an analytical framework offering a causal theoretical explanation for the performance of a firm. The market environment has a direct impact on the market structure, through availability of products and technology. The economic conduct is influenced by the market structure and covers the behaviour of buyers, sellers and firms, which in turn affects the market performance. Market performance can be measured by comparing the results of firms along the industry in efficiency terms.

The first line of criticism is the one-way causality of the SCP model from market structure to market performance, discussed by various authors (Berger *et al.*, 2004; Gilbet, 1984; Reid, 1987; Vesala, 1995). The direction of relationships between the SCP elements is not clear cut (Vesala, 1995). Following Scherer (1980), the integration of feedback effects in the SCP model leads consequently to "everything depends on everything" and therefore provides a weak basis for deriving and testing hypotheses.

In the second line of criticism, Bikker & Haaf (2002) state that most studies using SCP, do not explicitly account for the conduct-element in the framework and therefore focus on the structure-performance relationship. Bikker & Haaf (2002) refer to only one study of Calem & Carlino (1991) which explicitly incorporates bank conduct following the SCP framework. Extensive literature on the relationship between structure and performance is summarised by Bos (2002); Gilbet (1984) and Molyneux *et al.* (1996).

A third line of criticism on the application of SCP is formulated by Goddard

et al. (2007): "empirical models containing a large number of industry- and bank-specific variables often explain little of the variation in performance." Vesala (1995) concludes that studies applying the SCP-hypothesis, do not show reliable validity of the relationship anymore, contrary to the first studies. This conclusion does not hold to the banking industry only, but applies to many industries and on firm level (Fisher & McGowan, 1983).

Theory of contestable markets (Baumol *et al.*, 1982) has a different view on having difficulties for explaining performance with structure and conduct relations. They state that the absence of significant barriers to the market, let potential competition control the behaviour of firms in the industry and might lead to a monopoly environment with "socially optimal outcome." Leon (2014) further adds that: "Other theories show that collusive actions can be sustained even in the presence of many firms."

The SCP uses concentration measures as a proxy for the market structure. As two frequently used, formal concentration measures *HHI* and CR_k are also used in the formal approach, we explain and treat these measures in Section 3.2.

3.1.2 Efficient Structure hypothesis

The second non-formal approach in the structural field is called Efficient Structure hypothesis (ES) and is the alternative to SCP in explaining the relation between structure and performance, developed by Demsetz (1973) and Peltzman (1977). Core of Demsetz work is the endogenous shaping of the market structure by firm performances. The competition is powerful enough if monopoly profits are eliminated which indicates low entry barriers (Vesala, 1995). The Efficient Structure hypothesis entails: "the notion that the structure of the market may reflect differences in efficiency rather than a competitive situation" (Leon, 2014), and is discussed in various studies (Goldberg & Rai, 1996; Smirlock, 1985). When a firm achieves higher production efficiency than its competitors, it might gain market share by reducing prices, which can lead to a more concentrated market (Bikker & Haaf, 2002; Leon, 2014; Molyneux & Forbes, 1995).

Some studies refer to SCP and ES as the collusion and efficiency hypotheses. Bikker & Haaf (2002) points out that SCP investigates: "whether a highly concentrated market causes collusive behaviour among the largest banks resulting in superior market performance." Whereas Bikker & Bos (2004) allocate above average performance of a company under ES as "at most the result of a higher efficiency." Testing the SCP and EH hypotheses gives identification problems as these studies use marketshare as a proxy for both market concentration or efficiency respectively (Bikker & Haaf, 2002).

According to Goddard *et al.* (2007), a considerable body of work does not provide conclusive evidence to solve the 'collusion versus efficiency' debate. In the same line argues Vesala (1995) that this unsolved debate limits specifying which variables are endogenous.

Some studies show the effect of market power and efficiency on profitability by the use of concentration and market share as to be functions of X-efficiency and scale efficiency (Berger, 1995; Frame & Kamerschen, 1997).

3.1.3 Efficiency measures

This section treats the efficiency measures, also treated in the review of Bikker & Bos (2004). Three efficiency measures exist in literature; Scale, Scope and X-efficiency. The latest measure accountable for 20-25% of inefficiencies compared to only about 5% for scale and scope inefficiencies (Berger & Humphrey, 1991). Therefore we choose to only treat the X-efficiency in this project.

Bikker & Bos (2004) use stochastic frontier models for measuring the X-efficiency. This approach allows to test for differences in inefficiencies among banks We assume that $\varepsilon_i = v_i - \mu_i$, where v_i is normally distributed with $v_i\, N(0, \sigma_v^2)$and the inefficiency term μ_i is drawn from a half-normal distribution (non-negative) with $\mu_i\, |N(\mu, \sigma_\mu^2)|$. μ can have negative values for banks performing below the efficient frontier. The profit efficiency is defined by (Bikker

& Bos, 2004) for bank i in Eq. 3.1.

$$PE_i = Eexp(v_i)|\varepsilon_i| \tag{3.1}$$

The result from this equation is a value between 0 and 1, where 1 indicate full efficiency.

3.2 Formal structural approach

The studies of Martin (1993) and Bikker & Haaf (2002) in the field of formal structural approaches (based on IO theory), summarise existing literature on choosing profitability measures, for which mostly the Lerner index is generalised. Cowling & Waterson (1976) presents a formal derivation of the profit maximisation problem for oligopolistic markets and assume:

- Production of a homogeneous product by n unequally sized banks.
- Shape of individual banks' cost function reflects bank size.

This section functions as a bases to treat the two formal measures Herfindahl-Hirschmann Index and k bank Concentration Ratio, based on oligopoly theory. The two indices HHI and CR_k can be used in a structural formal and structural non-formal approach, as the SCP and ES use them as proxy for market concentration to measure competition.
The following derivation is based on the work of Bikker & Haaf (2002). The profit function for an individual bank takes the form:

$$\pi_i = px_i - c(x_i) - F_i \tag{3.2}$$

Where π is profit, x_i is the volume of output of bank i, p is the output price, $c(x_i)$ and F_i are fixed costs of bank i. The inverse of the downward sloping market demand is defined as:

$$p = f(X) = f(x_1 + x_2 + \ldots + x_n) \tag{3.3}$$

To maximise profit of bank i, the first order conditions is:

$$d\pi_i/dx_i = p + f'(X)(dX/dx_i)x_i - c_i' = 0 \tag{3.4}$$

and is rewritten as:

$$p = f'(X)(1 + \lambda_i)x_i - c'(x_i) = 0 \tag{3.5}$$

Then the conjectural variation of bank i to all other banks in the market is:

$$\lambda_i = \frac{d\sum_{j\neq i}^{n} x_j}{dx_i} \tag{3.6}$$

The conjectural variation concept can be used in any static or dynamic equilibrium, if the reaction function of firms is continuous. λ_i depends on the underlying market form and has a range of -1 to $\sum_{j\neq i}^{n} x_j/x_i$. For perfect competition the total market output and price are not affected by an increase of output by one bank, so it should hold that $dX/dx_i = 0 = (1 + \lambda_i)$, so $\lambda_i = -1$.

The Cournot oligopoly expects no reaction of other banks at the market to an increase in a banks own output. Thus an increase of a bank i leads to a total increase of market output by the same amount: $dX/dx_i = 1 = (1 + \lambda_i)$ resulting in $\lambda_i = 0$. In case a bank i increases its output under perfect collusion, banks take revenge with $dX/dx_i = X/x_i = (1 + \lambda_i)$ to protect their market share, meaning that the total market output increases with X_i/x_i units and
$\lambda_i = (X - x_i)/x_i = \sum_{j\neq i}^{n} x_j/x_i$.

3.2.1 Herfindahl-Hirschmann Index

The Herfindahl-Hirschmann Index is the most used concentration measure in literature or even as benchmark when other concentration indices are evaluated (Bikker & Haaf, 2002). This measure takes into account all the banks in the market and use banks market share as its own weight, meaning that greater weights are used for larger banks. The index becomes less sensitive to a change in

the number of firms when the total number of firms in the market becomes large (Davies, 1979).

We use Eq. 3.5 to derive the price cost margin for the performance of the industry (Bikker & Haaf, 2002), by multiplying by x_i and summing over all banks:

$$\sum_{i=1}^{n} px_i + \sum_{n}^{i=1} f'(X)\frac{dX}{dx_i}X^2\frac{x_i^2}{X^2} - \sum_{i=1}^{n} c_i'(x_i)x_i = 0 \tag{3.7}$$

Rearranging terms and multiplying by $1/pX$ gives:

$$\sum_{i=1}^{n} \frac{px_i - c'(x_i)x_i}{pX} = -\sum_{i=1}^{n} \frac{x_i}{X^2}\frac{f'(X)X^2}{pX}\frac{dX}{dx_i}. \tag{3.8}$$

If:

$$\eta_D = \frac{dXp}{dpX} = \frac{p}{f'(X)X} \tag{3.9}$$

than we can rewrite 3.8 to:

$$\sum_{i=1}^{n} \frac{px_i - c'(x_i)x_i}{pX} = -\sum_{i=1}^{n} s_i^2\left(\frac{dx_i}{dx_i} + d\sum_{j\neq i}^{n}\frac{x_j}{dx_i}\right)/\eta_D \tag{3.10}$$

$$\sum_{i=1}^{n} \frac{px_i - c'(x_i)x_i}{pX} = -(1+\gamma)HHI/\eta_D \tag{3.11}$$

where,

$$\gamma = \sum_{i=1}^{n} \lambda_i x_i^2 / \sum_{i=1}^{n} x_i^2. \tag{3.12}$$

The expression in Eq. 3.12 is the average price-cost margin in terms of elasticity η_D Bikker & Haaf (2002). Whereas the *HHI* is the price elasticity of demand and γ captures the conjectural variation.

3.2.2 k-bank Concentration Ratio

Where the *HHI* sums over all banks in the market, the CR_k is summing only on the k largest banks in the market. All k banks are given equal weights and smaller

banks are neglected. The decision on which banks to incorporate in the analysis or the value of k, is arbitrarily chosen. If the market consist of only equally sized banks and k is small compared to the total number of banks, the CR_k will approach zero. From Bikker & Haaf (2002) the derivation follows for the CR_k ratio, where n banks is the total market, k banks are acting as cartel and $n-k$ banks are price takers having equilibrium $p = c_i, \forall i = (k+1), \ldots, n$, for profit maximising purposes.

The supply of these $n-k$ banks is $c_i^{-1}(p)$, and the aggregate value of the competitive fringe is:

$$S_{n-k}(p) = \sum_{i=k+1}^{n} c_i^{-1}(p) \tag{3.13}$$

The industry demand is defined by $D_T(p)$ with $D'_T(p) < 0$. With these conditions the bank cartel, has demand:

$$D_k(p) = D_T(p) - S_{n-k}(p) \text{ where } S'_{n-k}(p) > 0 \text{ and } D'_T(p) < 0. \tag{3.14}$$

Differentiating and dividing by $D_k(p)/p$

$$D'_k(p)p/D_k(p) = D'_T(p)p/D_r(p) - S'_{n-k}(p)p/D_r(p) \tag{3.15}$$

rearranging terms gives

$$\eta_{D_k} = \eta_{D_T} x D_T(p)/D_r(p) - \eta_{S_{n-k}} S_{n-k}(p)/D_r(p) \tag{3.16}$$

where η_{D_k}, η_{D_T} and $\eta_{S_{n-k}}$ are the elasticities of respectively the price of residual demand, industry demand and fringe supply.

For profit maximising reasons, the k bank cartel should set its price-marginal cost margin equal to the reciprocal of the elasticity of its demand curve:

$$\frac{p - c'_j}{p} = \frac{1}{\eta_{D_k}} = \frac{1}{\eta_{D_T}(D_T/D_k) - \eta_{S_{n-k}}(S_{n-k}/D_k} = \frac{C_k}{\eta_{D_T} - \eta_{S_{n-k}}(1 - C_k)} \tag{3.17}$$

The paper of (Berger *et al.*, 2004) acknowledges the common finding in banking literature and Industrial Organisation literature, that the (HHI) and (CR_k) as concentration measures have very weak relationship to measures of profitability when regression includes market share of the firm.

3.3 Other Concentration measures

For the formal approach, only concentration measured derived from theory can be used, meaning the HHI and CR_k. However, the non-formal approach can choose its concentration measure at will. The HHI and CR_k are frequently used in contrast to other concentration ratios, for which Bikker & Haaf (2002) give an extensive overview:

1. Hall-Tideman Index (Hall & Tideman, 1967)
   Based on the HHI, they weigh the market share of the bank by its ranking to include the absolute number of banks into the concentration index.

$$HTI = 1/(2\sum_{i=1}^{n} is_i - 1) \tag{3.18}$$

2. Rosenbluth Index (Rosenbluth, 1955)
   The concentration curve used for the CR_k is used without arbitrary point, and banks are weighted for their ranking. Meaning that all banks are taken into account in this version of the CR_k.

$$RI = 1/(2C) \tag{3.19}$$

   with

$$C = \sum_{i=1}^{n} is_i - 1/2 \tag{3.20}$$

3. Comprehensive Industrial Concentration Index (Horvath, 1970)
   Based on the HHI, a multiplier is used to weight the proportional share of

the leading bank and the sum of the proportional shares of the rest of the industry.

$$CCI = s_i + \sum_{i=2}^{n} s_i^2(1 + (1 - s_i)) \tag{3.21}$$

4. Hannah and Kay Index (Hannah & Kay, 1977)
   The *HKI* include an elastic parameter to proxy for the result of a bank entering or leaving the market or the transfer of sales among banks.

$$HKI = (\sum_{i=1}^{n} s_i^{\alpha})^{1/(1-\alpha)}, \alpha > 0, \alpha \neq 1 \tag{3.22}$$

5. U-Index (Davies, 1979)
   By constructing a simple model to determine the inter-variance of the price cost margins in the industry reflecting in a variable as input for a new index, giving weight to size inequality and the number of banks.

$$U = (\sum_{i=1}^{n} s_i(s_i n^{(\alpha-1)/\alpha}))^{\alpha} \tag{3.23}$$

6. Hause Indices (Hause, 1977)
   To catch the effect of collusion in oligopoly into the concentration measure, Hause proposes two measures with a parameter reflecting the degree of collusion.

$$H_m(\alpha, s_i) = \sum_{i=1}^{n} s_i^{2-(s_i(HHI-s_i^2))^{\alpha}} \tag{3.24}$$

7. Entropy measure (Theil, 1967; White, 1982) The value of the Entropy index falls when the inequality between banks increases. If the market share of a certain bank increases, the weight allocated to the same bank

decreases.

$$E = -\sum_{i=1}^{n} s_i log_2 s_i \tag{3.25}$$

Marfels (1971) and Dickson (1981) classify concentration measures by use of their weighting schemes and structure. Weighting schemes determine how different sizes of banks are taken into account in the concentration measure. Another feature of the concentration measures is their discrete or cumulative structure. The CR_k is an example of a discrete measure, meaning that a certain height at the concentration curve is taken as an arbitrary point which firms are included in the analysis (Bikker & Haaf, 2002). The market share is plotted cumulative on the concentration curve using a descending rank of bank size.

The cumulative or summary measure include all banks with different sizes, meaning that even changes in the market share of small banks have influence. The *HHI* is such a measure and can in favour of discrete measures, identify measured changes to the number of banks included in the analysis.

Bikker & Haaf (2002) conclude: "Various concentration measures may show strongly diverging values for the same market, due to the use of varying weighting schemes, which reflect mainly different assessment regarding the relative impact of larger and smaller banks on competition in a certain market." In our research, we treat only the most used measures *HHI* and CR_k, as they can be applied to both formal and non-formal approaches within the structured approaches.

3.4 Non structural approach

Because of the criticism on the SCP, ES and related concentration measures, new non-structural alternatives to measure competition have been developed. Where the SCP and ES focused on the structure or efficiency aspect to explain a firms profit and performance, the New Empirical Industrial Organisation (NEIO) theory estimates the competitive conduct of firms, which is underestimated by SCP (Leon, 2014).

Two generations of models have been developed sequentially, based on the

view of McNulty (1967), Vickers (1994) and Blaug (2001). The first generation of static measures contain the Lerner Index, Conjectural Variation model and the Panzar-Rosse model and are based on oligopoly theory, and a static model of competition (Leon, 2014). The second generation differs on the state of competition, as the Boone indicator (Boone, 2008) enables to apply dynamic analysis on the market. Meaning that the market is not in a equilibrium but changes over time and places the process of rivalry central to determine competition.

NEIO describes how firms set their prices and quantities in so-called 'behavioural equations'. Although the observations like 'marginal costs equals marginal revenues' are not observed directly, indirect estimates are based on for example the implications of pricing rules (Goddard *et al.*, 2007). Two approaches are common in literature to specify the in- and output (Leon, 2014). The production approach offers financial services like savings or credit by making use of labour and physical capital. Customers can deposit their money at a bank for safety reasons or payment purposes.

The second approach is the intermediation approach, where a bank is in between depositors and borrowers. A bank exploits labour and physical capital in order to attract deposits and fund loans. In this view, deposits are seen as input to provide loans. The total assets or total loans are used as measure for the output. This view is used in many empirical studies and appears to be preferred above the production approach.

3.5 Static measures

Not the process towards an equilibrium but the equilibrium itself as a state, is the definition of competition by Cournot (1838). A few assumptions (common knowledge on market opportunities, free entry and exit) are underlying the thought of a competitive situation, but the assumption on 'number of rivals', plays a central role in the analysis of Cournot (Blaug, 2001; Leon, 2014); the excess on top of the cost price approaches zero when more firms are entering the market. A

monopolist can earn excessive profit, but is limited to demand elasticity.

Bertrand (1883) places the role of quantities in Cournot's oligopoly theory under discussion, and argued that prices are relevant for firms. Following (Leon, 2014): "As a result, the linkages between structure and conduct are less clear than postulates of the Cournot model". Chamberlin (1933) and Robinson (1933) proposed that a mix of perfect competition and reality lead to monopolistic competition. This type of imperfect competition exists because products can be differentiated while not being perfect substitutions. In contrary to conjectural variation, monopolistic competition ignores the effect of choosing its own price and the effect on prices in the market (Leon, 2014).

Leon (2014) states that three types of market structures follow from oligopoly theory; perfect competition, imperfect competition and monopolistic competition. A variety on models try to make conclusions about the conduct of firms, using different methodologies, assumptions and data. The first generation, named static models in NEIO are the Lerner Index, a group of Conjectural Variation models from Iwata (1974), Bresnahan (1982) and Lau (1982). Although based on the same theory, results give conflicting predictions (Carbó-Valverde *et al.*, 2009).

3.5.1 Lerner Index

Originally the Lerner Index comes from oligopoly theory with a quantity setting Cournot model (Leon, 2014; Lerner, 1934). The divergence between the market price and the marginal costs of a firm reflects its market power. Meaning that a bigger discrepancy is associated with more monopoly power.

The market price P of an industry producing one product Q is determined by the quantity q_i performed by firm i. Then the profit maximisation problem of a firm i can be described as in Eq. 3.26.

$$max_{x_i}(P(X)x_i - C(x_i, \omega_l)) \tag{3.26}$$

From 3.26 we can see that the total market quantity of all firms producing X, can

be denoted by $X = \sum_{j=1}^{J} x_j$. Price $P(X)$ is the market price, $C(x_i, \omega_i)$ the total cost of firm i and ω_l the price vector of factors of production.

The marginal cost of firm i can be written as $C'_{x_i}(x_i, \omega_l)$. Using the marginal costs expression, Lerner (1934) introduces the Lerner Index with L_i being the market power of firm i as in Eq. 3.27.

$$L_i = \frac{P(X) - C'_{x_i}(x_i, \omega_l)}{P(X)} \tag{3.27}$$

In case of perfect competition, the Lerner Index is zero, and the other extreme is monopoly power with the Lerner index approaching the inverse elasticity of demand (Leon, 2014). In research on the Lerner Index of banks, assessing marginal costs appears to be a barrier (Leon, 2014). The marginal costs are often extracted from the cost function using total assets as output of the model and as input: labour, deposit and physical capital (Klein, 1971; Monti, 1972; Sealey & Lindley, 1977). Often they use a general form of the Cobb-Douglas production function (named transcendental logarithmic production function or translog function), the marginal cost are obtained by taking the derivative and multiplying by the average costs in Eq. 3.28 (Leon, 2014).

$$C'_{x_i} = \frac{\partial C_i}{\partial x_i} = (\beta_1 + \beta_2 ln(y_i) + \sum_{l=1}^{3} \beta_{2+l}[ln(\omega_{l,i})])\frac{C_i}{x_i} \tag{3.28}$$

Now we can use the Lerner Index measure as a good indicator of market power, which varies over time and is bank specific. In this way, it is possible to compare market power among banks or period. The straightforward application and explanation of the Lerner Index makes this indicator widely used.

3.5.2 Conjectural Variation models

Leon (2014) relates a high Lerner Index or high margins to either inelastic demand of the market or less competition in the market or even collusion. As the Lerner Index does not explain high market pricing power to one of the two

former reasons, Iwata (1974), Bresnahan (1982) and Lau (1982) introduced models to do so. Starting with Eq. 3.26, we apply the first order condition for a firm i which is given by Eq. 3.29 in Leon (2014).

$$p'_X X'_{x_i} x_i + P = C'_{x_i}. \tag{3.29}$$

Conjectural Variation is the expectation of a firm i on how his competitors will react when firm i changes its output or price (Bowley, 1924). The Conjectural Variation is measured by Eq. 3.30.

$$\lambda_i = \frac{\partial \sum_{j \neq i} x_j}{\partial x_j} = X_{x_i} - 1 \tag{3.30}$$

If we substitute the result from 3.30 $\lambda_i = X'_{x_i} - 1$, into Eq. 3.29, the result is Eq. 3.31.

$$P'_X(1 + \lambda_i)x_i + P = C'_{x_i} \tag{3.31}$$

Multiplying with X/P, we can rewrite the Lerner Index to:

$$L_i = \frac{P - C'_{x_i}}{P} = -\frac{(1 + \lambda_i)s_i}{\varepsilon_d} \tag{3.32}$$

In Eq. 3.32, ε_d is the elasticity of demand and $s_i = x_i/X$ the market share of firm i. In a collusive market, if a firm i raise its output one, all N firms raises their output with one as a full exploitation of their market power, this leads to $\lambda_i = N - 1$. Perfect competition implies that $\lambda = -1$ and changes Eq. 3.32 to $P = C'_{x_i}$. This means that the market balances the change in production of firm i, e.g. firm i raises output with one and the total market output decreases with one. The Cournot equilibrium or state where the market does not react on the change of output of firm i, then $\lambda_i = 0$.

To apply this theory in practice, literature exhibits two ways to do so (Leon, 2014). The Iwata (1974) model estimates a conjectural variation value for any individual firm producing a homogeneous product. Both Bresnahan (1982) and

Lau (1982) approach the industry as a whole, with the advantage of using industry level data.

3.5.3 Panzar & Rosse model

?? The model of Rosse & Panzar (1977) and Panzar & Rosse (1982, 1987) is a frequently used approach in banking literature to measure competition and is applied on the newspaper and airline industry as well.

By using reduced-form revenue equations, the PR approach relates gross revenues to input prices and other control variables. The measure of this Panzar & Rosse (PR) approach is called H-statistic, is defined as sum of elasticities of gross revenues relative to unit costs (Bikker *et al.*, 2012; Rosse & Panzar, 1977; Vesala, 1995) and is written in Eq. 3.33 from Leon (2014).

$$H = \sum_{i=1}^{n} \beta_i. \tag{3.33}$$

Rosse & Panzar (1977) show that the outcome of the H-statistic in Eq. 3.33 classifies a company as monopolist or collusive oligopolist in case H is negative. An H-statistic between 0 and 1, corresponds to monopolistic competition and if equal to unity, it indicates competitive price-taking firms in a long-run equilibrium. Literature assumes three different versions of the n-input and single-output production function, the empirical reduced-form equation of the PR model (Bikker *et al.* (2012) provide overview of PR tests and their empirical model choice, Table 1). These versions differentiate on the choice of firm-specific and dependent control variables. In the following commonly used equation, TR is the total revenue, w_i the ith input factor (such as labor, physical capital and financial capital) and CF_j the jth firm-specific control factor. The unscaled revenue equation is defined in Leon (2014) and given in Eq. 3.34.

$$log(TR) = \alpha + \sum_{i=1}^{n} \beta_i log(w_i) + \sum_{j=1}^{J} \gamma_j log(CF_j) + \varepsilon. \tag{3.34}$$

Increasing input prices result in higher marginal costs, reduced equilibrium output and therefore lower total revenues. Because larger firms earn more revenue, which is not related to variations in input prices, many studies include log total assets (TA) as one of the firm-specific control factors. Leon (2014) defines such a scaled revenue function in Eq. 3.35.

$$log(TR) = a + \sum_{i=1}^{n} \beta_i log(w_i) + \sum_{j=1}^{J} \gamma_j log(CF_j) + \delta log(TA) + \varepsilon. \qquad (3.35)$$

Although commonly used, there is no explicit justification or analysis to use log(TA) as a regressor in the equation and is not included in the initial versions of the PR model. Other studies approximate the output price P with TR/TA (price equation), to overcome the problem of measuring firms of different sizes. Leon (2014) gives an example on standardising the measure in Eq. 3.36.

$$log(TR/TA) = a + \sum_{i=1}^{n} \beta_i log(w_i) + \sum_{j=1}^{J} \gamma_j log(CF_j) + \varepsilon. \qquad (3.36)$$

Assuming that market participants behave differently in the same market, they will use different pricing strategies. Vesala (1995) and Gischer & Stiele (2009) argue intuitively, that the use of revenue or price equations gives different estimates of the H-statistic. Goddard & Wilson (2009) go one step further and use simulation to show these differences. Hamza (2011) summarises studies performing the empirical PR tests, which make contradicting conclusion on the same countries within Europe.

For the first time in literature, Bikker *et al.* (2012) provide formal evidence that the price and revenue equations are equal in long-term competitive equilibrium but are different in case of monopoly or oligopoly. Imperfect competition can not be identified via either scaled revenue function or price function, and therefore disqualifies these widely used applications in literature. Following Bikker *et al.* (2012), the solution is the unscaled revenue function which is able to identify

imperfect competition. Complication in using the unscaled revenue function, is the additional requirements on costs, market equilibrium and possibly market demand elasticity for an appropriate H-statistic.

Next to the previous weaknesses, a recent study of Shaffer & Spierdijk (2015) poses even stronger claims on the application of the H-statistic. They show that neither the sign nor the magnitude of the H-statistic can infer the degree of competition. The overall conclusion is that econometrical identification of the H-statistic, would not lead to reliable conclusions about the degree of market power.

3.6 Dynamic measures

Although static models are useful in identifying relationships in market equilibrium, analysis consists only of a snapshot in a dynamic competitive process (Geroski, 1990). The possibility of measuring values not representing the equilibrium values, can not be ruled out (Goddard *et al.*, 2011). The thought of a dynamic competition originates from Schumpeter (1934), he describes the competitive process as firms competing against other firms by creating new innovations or copying innovations from competitors. Although Schumpeter allocated the substantial profit to innovation, the concept of a dynamic competition is used in further research concerning all the aspect of a firms conduct to the market. Cable & Mueller (2008) define both the static and dynamic world, where the dynamic world models the profit of today, dependent on yesterday and converging to the competitive norm, unless any innovation disrupts this converging development.

Dynamic measures do think of competition as a rivalry process between firms, instead of static measures referring to a competition equilibrium in the market (Leon, 2014). The process of firms taking action in order to stay or become more competitive in the market through for example creating new products, innovation, marketing, or takeovers, can not be represented by some static market equilibrium. Through these type of actions, firms gain temporarily

market power and have competitive advantage or even monopoly during a certain time interval. If a firms takes extra risk to gain market power, they might be rewarded through earning monopoly profits. This competition process do not leave space for inefficient firms, which will be removed and might be replaced by other more efficient entrants.

Dynamic measures are the results of recent research on the perspective of seeing competition as process of rivalry. Currently, two developed measures on this perspective are the Persistence of Profits by Mueller (1977, 1986) and the Boone indicator (Boone, 2008).

3.6.1 Persistence of Profits

The Persistence of Profit theory is the work of (Mueller, 1986), leaves the field of static methodologies and comes with two conditions. The first condition is the free entry and exit of new market participants to eliminate abnormal profits of current participants. A free flow of resources across markets, moves to the area with the highest profits and moves until returns are equal over all markets. Although, uncertainties in profits, new innovations, or other disruptions happen over time and ensure that the the industry or companies never obtain the long-run average rate of competitive profit. The second condition therefore, entails that the profit rate of any firm converges towards a competitive value.

If all firms in an industry earn profit rates above the competitive rate, this implies that barriers exist to enter that market. In case of homogeneous profits and perfect competition, companies should charge the same price, meaning that only the efficient firms survive. If some firms in a market with homogeneous products earn abnormal profits, they have some resources available that allows them to make these abnormal profits and other companies have no access to this resource.

Goddard *et al.* (2011) review several studies testing the persistence of profits hypotheses in manufacturing and service sectors but classify the evidence in banking relatively scant. Levonian (1993) finds a lower convergence pace in

banking compared to most manufacturing studies. Abnormal profits seem to be more temporarily, meaning that bank regulation does not completely restrain competition. Roland (1997) and Berger *et al.* (2000) both find differing results for the persistence of profit between above and below average performance in the distribution of banks by performance. Results in the study of Goddard *et al.* (2004) distinguish between the type of banks, where commercial banks have a lower persistence of profits than savings- or cooperative banks. They include bank-specific variables, which are size, diversification, risk and ownership type. Based on recent studies on individual country level (Agostino *et al.*, 2005; Athanasoglou *et al.*, 2008; Bektas, 2007; Knapp *et al.*, 2006), Goddard *et al.* (2011) summarises that persistence of profits is driven by bank-specific, industry variables and macroeconomic conditions. (Athanasoglou *et al.*, 2008; Bektas, 2007)

Goddard *et al.* (2011) defines also a 'less restrictive version' of former theory by describing that convergence towards the long-run average may differ between firms. The alternative hypothesis on this theory is the protection of firms by regulatory requirements or taking preventive actions to discourage new potential entrants, leading to slowly converging long-run average and existing abnormal profits.

Sometimes, authors of former researches use variables or various methodologies to test for relationships or explanatory variables on the persistence of profits and have in common that all research is based on the idea of Mueller (1986). The competitive environment hypothesis of Mueller entails that the profit of all firms in an industry and the industry profit converge to a competitive profit rate $\Pi_{c,t}$, which can change over time due to macro- or micro-economic influences. At every point in time t, Mueller (1986) defines the profit rate of firm i as in Eq. 3.37.

$$\Pi_{i,t} = \Pi_{c,t} + v_{i,t} \tag{3.37}$$

Where $v_{i,t}$ is a random disturbance term. The average return in the economy is

different from the equilibrium value, as this will never be obtained perfectly and therefore we assume a constant fraction of the competitive rate of return:

$$\Pi_{c,t} = \gamma \bar{\Pi}_t, \tag{3.38}$$

meaning that

$$\bar{\Pi}_t = \sum_{i=1}^{n} \Pi_{i,t}/n, 0 < \gamma < 1. \tag{3.39}$$

If Eq. 3.39 holds, than we should also assume that the average deviation of the competitive return is larger when profit rates are temporarily higher than the competitive level:

$$\mu_{i,t} = \frac{v_{i,t}}{\bar{\Pi}_t}, \mu_t = 0, \sigma_{\mu,t} = constant. \tag{3.40}$$

We now substitute Eq. 3.38 and 3.39 into Eq. 3.37 and subtract $\bar{\Pi}_t$ from both sides the equation, we get

$$\frac{\Pi_{i,t} - \bar{\Pi}_t}{\bar{\Pi}_t} = (\gamma - 1) + \mu_{i,t} \tag{3.41}$$

and rearrange to

$$\pi_{i,t} = (\gamma - 1) + \mu_{i,t}, \tag{3.42}$$

where

$$\pi_{i,t} = \frac{\Pi_{i,t} - \bar{\Pi}_t}{\bar{\Pi}_t}. \tag{3.43}$$

We follow Figure 3.6.1 from Mueller (1986) to explain the development of firm *i*'s profit rate Π_t currently above the competitive rate Π_c. In case the hypothesis of converging profit rate in a competitive environment is valid, $\Pi_{i,t}$ should fall to Π_c. The current advantage compared to the competition disappears following a path like A. In case profits are below competitive, profits return to the competitive rate via a path like D.

Paths A and D from Figure 3.6.1, can approximate the following equation to

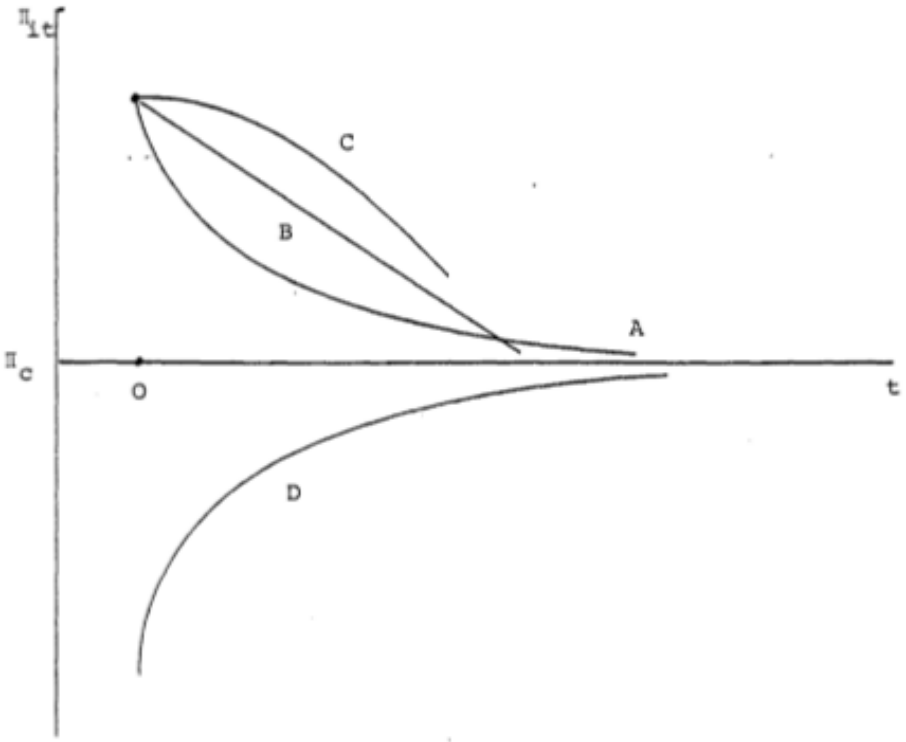

Figure 3.6.1: Possible profit paths in Mueller (1986)

approximate the long-run average Π_c:

$$\pi_{i,t} = a_i + \beta_i / t + \mu_{i,t} \tag{3.44}$$

The β_i measures the speed of convergence to a_i. Above the norm profits should have $\beta > 0$ and firms below the norm $\beta < 0$. The absolute size of β indicates the speed of convergence. Where β should be a large absolute value for all companies, a is expected to be equal for each firm regardless of initial profit.

Mueller (1986) adds an important statement on his first empirical tests on the persistence of one competitive level, because his hypothesis assumes that the competitive level of profit is independent of risk differences.

3.6.2 Boone indicator

The work of Demsetz (1973) in Section 3.1.2 is on efficient market hypothesis; more efficient firms perform better in terms of profit and/or market share, in contrast to less efficient firms. This effect is stronger for heavier forms of competition.

Boone (2008) and Boone *et al.* (2007) focus on the reallocation effect of less to more efficient firms. Which can lead to extreme cases of the least efficient firms leaving the market. Boone (2008) shows that the increase in competition leads to a monotonically increase in reallocation. Competition can be intensified in two different ways (Boone *et al.*, 2007). The first way is a fall in entry barriers cause more firms in the market. The second way is a more aggressive conduct by firms.

The output of firms can decrease through more intense competition, but for less efficient firms this decrease is more then for efficient firms. Therefore, market share and profit of efficient firms grow, at the expense of the market share and profit of less efficient firms. Boone (2008) and Leon (2014) summarise this theorem as the relative profit difference being sensitive to the degree of competition.

The Boone indicator, as many other models, focus on one strong relationship between profit and costs, affected by competition. Boone *et al.* (2007) follow a

simple profitability equation, which can be viewed as a first order Taylor approximation to estimate the intensity of competition:

$$ln(\pi_i) = \alpha + \beta ln(c_i) + \varepsilon_i. \tag{3.45}$$

π_i is the profit and c_i is the measure of costs, and ε equals the entry costs to the market. The Boone indicator β is the profit elasticity, which is the percentage drop in profits of bank i as a result of one percentage increase in the costs of bank i. In theory, this indicator is negative as higher marginal costs are associated with lower profits. This profit elasticity indicator correctly identifies changes in competition. The Boone indicator might be time dependent and therefore can be denoted by β_t.

Other studies choose for different indicators while using Eq. 3.46. Van Leuvensteijn *et al.* (2011) estimate marginal cost c_i directly, where Delis (2012) and Tabak *et al.* (2012) compute marginal cost indirectly. In other studies average costs are used as imperfect proxies (Schaeck & Cihák, 2013). The studies of Van Leuvensteijn *et al.* (2011, 2013) and Tabak *et al.* (2012) choose not to translate the lower costs of efficient firms into higher profits, but use market share as dependent variable, as in Eq. **??**.

$$ln(s_i) = \alpha + \beta' ln(c_i) + \varepsilon_i'. \tag{3.46}$$

The term s_i stands for the market share of bank i. An important advantage of the Boone indicator is the simplicity of the required data, which is equal the data of the Lerner Index, which contains in general balance sheet figures from annual reports.

You don't have to be a genius or a visionary or even a college graduate to be successful. You just need a framework and a dream.

Michael Dell

4

Comparative Framework

4.1 Comparative framework

We use a framework with criteria in order to structure the analysis of the model and its outcome. This section contains a description per criterion and how the outcome of this criterion is rated, which is always based on a three-points scale; negative, neutral or positive. Our criteria are split up in two categories.

The first category is 'conclusive' criteria or hard constraints; concerning must-have features and need to score either neutral or positive to be assessed as an applicable model to include MPL lending. The second category are 'reflective' criteria or soft constraints, which are both nice-to-have features and practical considerations. There is no need for explicit rating on these criteria to be an applicable model, but might be useful to create an advantage above other equal-scoring models.

Predefined ratings correspond to the outcome of the analysis and can be found in Table 4.1.1 and 4.1.2
We assess the competition models on the following criteria:

1. *Theoretical evidence (Conclusive criteria)*
   Theory on competition models use different assumptions concerning: type and state of competition, behaviour of companies or agents and homogeneity of products. The assumptions applied determine in which context the model is valid and therefore, whether the model is able to include MPL firms.
   Another point of attention is to which research goal the model has been constructed. For example, declaring the type of competition by measuring the concentration of a subset of firms having top 5 highest market share assumes that concentration of firms is an explanatory variable of competition level.

2. *Time dimension (Conclusive criteria)*
   To get insight in how the development of marketplace lending affects competition of the lending market over time, the time dimension should be accounted for in the results. A measure of one point in time can give a feeling on how the situation is at that point in time. However, this is not enough to create insights in the development of competition over time or to measure effects of events on competition. An example can be the rise in issued loans by marketplace lending and its effect on the level of competition.

3. *Industry/individual level (Conclusive criteria)*
   To provide conclusive evidence on the competition of the industry, the measure should be able to assess properly the competition level of an industry and not just the competitiveness of specific firms. Some measures first assess the individual levels of competitiveness and afterwards calculate the industry competition level. However, there are some

complications in calculating an industry average; one needs to weight the individual levels, e.g. by market share of the firms.

4. *Channel differentiation (Conclusive criteria)*
   Marketplace lending companies offer the financial market a new channel to finance debt. Old banks cover credit risk to protect investors or depositors from non paying borrowers, but investors receive higher rates at MPL with which they have to cover credit risk. Another reason for the tighter rate spread at MPL, is lower operational costs to provide a loan compared to banks. The latter is the reason why more financial institutions such as banks, investment companies and other financial institutions, use MPL as a new channel to invest and collect money.

   As the product characteristics of banks and MPL firms differ, we need to distinguish between type of firms within the model. It follows from Section 2.16 that the preferences of borrowers have impact on the choice where they contract their credit loans. Depositors or investors face credit risk in case of placing their money at MPL firms, but this has no impact on the market of consumer or SME credit loans. Banks and MPL firms differ for borrowers in terms of costs; meaning that a choice between firms should be reflected in the model, e.g. marginal costs or the product price of firms.

5. *Regulatory requirements (Reflective criteria)*
   We review the models on whether and how regulatory requirements are taken into account. During recent years, the environment of banks (not MPL firms) is getting more regulated, which might have its consequences on the competitive position of banks, e.g. higher capital costs for holding assets on the balance. MPL firms do not put credit loans on the balance sheet, meaning that they have no obligation to hold capital against unexpected losses and associated costs.

Conclusive criteria	Description of outcome	Rating
Theoretical Evidence	One or more weak assumptions and assumption(s) not applicable to MPL.	Negative
	One or more weak assumptions, although applicable to MPL.	Neutral
	Strong theoretical underpinning and applicable to MPL.	Positive
Time dimension	High barriers to apply model over time.	Negative
	Some small complications to apply model over time.	Neutral
	Model allows to assess competition over time.	Positive
Industry or individual level	No distinction between industry or individual level.	Negative
	Applied on individual level only.	Neutral
	Applied on industry level and possibly on individual level.	Positive
Channel differentiation	No possibility to differentiate between banks and MPL firms.	Negative
	Indirectly differentiation by use of costs or other variables.	Neutral
	Direct choice for borrowers between MPL firms or banks.	Positive

Table 4.1.1: Possible ratings on conclusive criteria.

Reflective criteria	Description of outcome	Rating
Regulatory requirements	No possibilities to include regulatory restrictions.	Negative
	Including regulatory impact via e.g. marginal costs.	Neutral
	Regulatory requirements included in the model, with diversification for banks vs MPL.	Positive
Existing applications and outcome	No practical evidence in literature, limitations to outcome, or unavailable data.	Negative
	Some limitations to the results or other small complications in calculation process.	Neutral
	Practical evidence in literature, data is available and results straightforward to interpret.	Positive
Feasibility of solution	Model with high complexity and time-consuming calculations.	Negative
	Model with high complexity or time-consuming calculations.	Neutral
	Simple calculations and straightforward interpretation of results.	Positive

Table 4.1.2: Defined ratings to reflective criteria

6. *Existing application and outcome (Reflective criteria)*
   Although the theoretical evidence for a model can be strong, practical limitations like the unavailability of appropriate data can classify a model as inapplicable. Another limitation is that application of a model, might give inconclusive results or, that researchers contradict each other by ambiguous conclusions. Therefore, we take into account the work already done in literature and its best practices.

7. *Feasibility of solution (Reflective criteria)*
   We use two criteria on feasibility, the complexity of the proposed model and the time it takes to run the model or do the calculations. The solution of the model can be found by solving the mathematical equations or approach the exact solution by means of simulation. Whether the mathematical equations are solved or simulation is used, is reflected in the quality of the result.

We coin concepts and we use them to analyse and explain nature and society. But we seem to forget, midway, that these concepts are our own constructs and start equating them with reality.

Abdolkarim Soroush

5 Model Analysis

In this chapter, we investigate whether available models from literature can be applied on the development of MPL in the loan market. Chapter 3 represents a variety of models from literature. We explain which models to select for an in-depth analysis. Then, we set up a framework with criteria to assess these models. Finally, we make an assessment per criterion on each model and summarise the outcome on a three-point scale.

5.1 Choice on competition models

We choose three models out of Chapter 3 to finish the analysis within the time horizon of this project.

We have started the introduction to banking competition literature using three main articles in our literature review, see Table 5.1.1. Out of this comprehensive

	Bikker & Haaf (2002)	Bikker & Bos (2004)	Leon (2014)
Iwata	✓	✓	
Bresnahan	✓	✓	
Panzar & Rosse	✓	✓	✓
SCP		✓	✓
Efficiency hypothesis		✓	
X-Efficiency		✓	
Scale & Scope Economies		✓	
CRk measure	✓		✓
HHI	✓		✓
Other Concentration measures	✓		
Lerner Index			✓
Conjectural Variation			✓
Persistence of Profits			✓
Boone Indicator			✓

Table 5.1.1: Overview on models situated in three articles, representing several research streams.

research area, we choose for analysing the Panzar and Rosse approach as this is the latest work in literature on concentration measures. The Lerner Index is a simple and straightforward indicator of competition, successfully applied in different industries and the banking industry. The LI is considered to be a more accurate measure of market power than standard concentration measures. The Boone indicator is a dynamic measure and most recent work in measuring competition. As the results of the Boone indicator are promising, we include this theory in our analyses.

5.2 Analysis of Lerner Index

The relatively simple Lerner Index is used in several industries, including the banking sector. Following from Section 3.5.1, the Lerner Index is a measure of market power and equals the relative divergence between market price and

Assumption	Description	Parameters	MPL
Quantity of firm i	Every firm i serves some part of the loan market.	$q_i > 0$	✓
Demand function firm i	The demand of firm i depends on production of other firms.	$D - q_{j \neq i}$	✓
Simultaneous game	Every firm i choose to produce quantity q_i simultaneously.		✓
Homogeneous product	Product of every firm is perfect substitute for consumers.		✓
Rationality	Firms are rational and act strategically to optimise profit by choosing optimal q.	q^*	✓
Marketprice	Total sum of production q at the market, determine marketprice p^*.	p^*	✓
No entry or exit	There is a fixed number of n firms in the market.	n	✓
Cournot Equilibrium	Nash Equilibrium in which no firm wants to change its strategy unilaterally, given any choosen strategies by other firms.		✓

Table 5.2.1: The Lerner Index assumptions applied to MPL firms.

marginal costs of a firm.

5.2.1 Lerner Index assumptions

The first step is assessing the applicability of the Lerner Index assumptions to MPL firms, to conclude whether and how they differentiate from banks. These assumptions come from Cournot theory and are described in Table 5.2.1. As all assumptions can be applied to MPL firms in the credit loan market, it follows that MPL firms are a special form of banks and can be treated equally like a bank in the Lerner Index. The section ends with proposing some improvements to the Lerner Index.

5.2.2 Application of Lerner Index

The next step is how the Lerner Index measures the gap between price and marginal costs at MPL firms. The Lerner Index focuses only on the credit demand market and not the credit supply market. This could have been a challenge, because the deposit market is hard to assess with the Lerner Index, as Vives (2008) reviews that the Lerner Index has difficulties with capturing

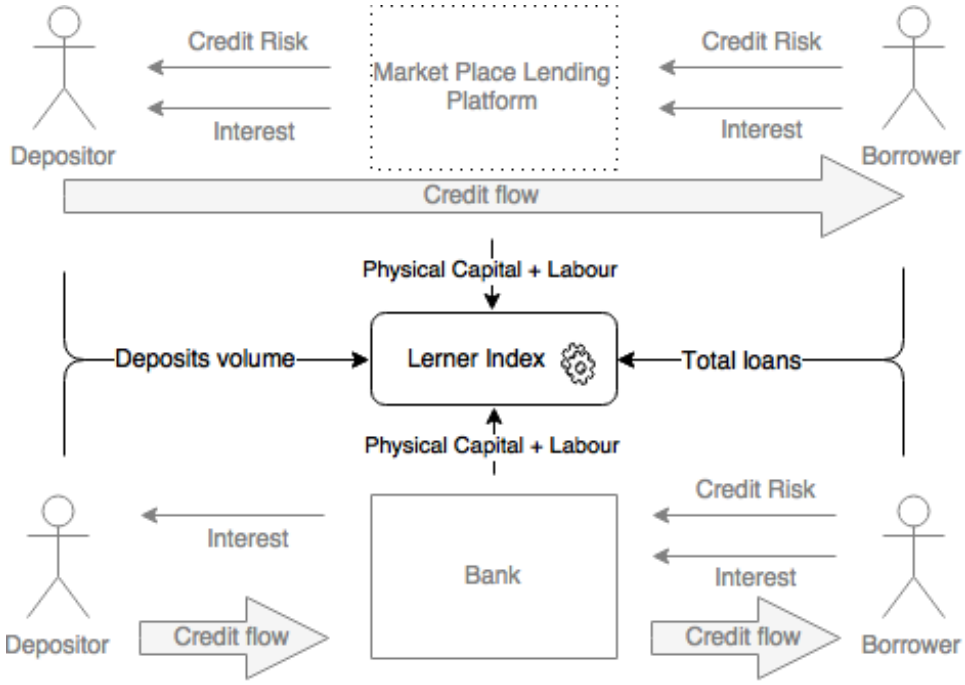

Figure 5.2.1: Application of Lerner Index.

product differentiation. In contrast to banks, credit risk from credit loans at MPL firms are mitigated to the depositor. The characteristic credit risk allows for product differentiation within the deposit market, see Figures 2.1.1 and 5.2.1. Banks offer protection against credit risk of credit loans and the depositor is secured by the government's Deposit Guarantee (2.9), where MPL firms do not offer (this level) of credit risk protection.

The competition in the market for credit loans is measured in output of loans and the input of three cost variables; labour costs, deposits and physical capital. Physical capital contains costs of assets, like IT infrastructure or the office building. Both banks and MPL firms have labour costs, although the magnitude can differ heavily between large conventional banks and small efficient MPL firms. One of the reasons is the totally automated credit application process at MPL firms, described in Section 2.3.

Both market players, banks and MPL firms, need depositors to issue new

loans. Deposits at the asset balance of the bank, give the possibility to create money as described in Section 2.11. The term investors fits better the role of depositors in the MPL situation, because they face credit risk and receive higher returns compared to deposits at banks to at least compensate the credit risk. For further elaboration on this topic, see Section 2.16.

Physical capital contains all the goods enabling the processes within the bank or MPL, like computers. Typically, the IT-costs are higher for banks, having older and more complex IT systems, facilitating a more complex product variety which has to be compliant to extensive regulation. We conclude that the three inputs, labour, deposits and physical capital are all applicable to MPL firms as well, meaning that it is valid to use these factors for input of the MPL cost function.

The cost function should be able to process input and a measure for the output. From Section 3.4 it follows that the intermediary approach has a cost function with three inputs: labour, deposits, and physical capital. Total assets or total loans is the measure of output in this approach. Leon (2014) takes the derivative of the translog function and multiplies with the average cost $\frac{\partial C_i}{q_i}$ resulting in marginal costs C'_{q_i}:

$$C'_{q_i} = \frac{\partial C_i}{\partial q_i} = \left(\beta_1 + \beta_2 ln(y_i) + \sum_{l=1}^{3} \beta_{2+l} [ln(\omega_{l,i})] \right) \frac{C_i}{q_i} \tag{5.1}$$

Where C_i represents the total costs of firm i, q represents the total assets or output, ω_l is the price of input l and model coefficients β. The price of output P is calculated as the average loan. Figure 5.2.1 gives a schematic overview of the situation how data flows from bank and MPL firm to calculate the Lerner Index.

5.2.3 Lerner Index evaluation

We have assessed the assumption of Cournot theory underlying the Lerner Index. This section evaluates how the Lerner Index scores on the criteria we have set up in Section 4.1. The ratings on all criteria are given in Table 5.2.2.

From Table 5.2.1 it follows that all assumptions are applicable to MPL firms.

Criteria	Rating
Theoretical evidence	Neutral
Time dimension	Positive
Industry or firm level	Neutral
Channel differentiation	Neutral
Regulatory requirements	Neutral
Existing application and outcome	Negative
Feasibility of solution	Positive

Table 5.2.2: Results from evaluating the Lerner Index on the criteria framework.

However, the increase in number of MPL firms make the assumption of fixed number of firms weak. Another weak assumption is perfectly substitutable credit loans for consumers, as reasoned in Chapter 2. From the work of Leon (2014) it appears that the Lerner Index can better be thought of as a pricing power index, which is not equal to competition power. Related to this subject of criticism is the work of Stiglitz (1989), Bulow & Klemperer (2002) and Amir (2003), who provide theoretical scenarios in which the margin between price and marginal costs increase and a competition increase at the same time. The Austrian School draws a different conclusion, because intenser competition is an incentive to innovate and reach advantage above rivals. If so, a bank is able to extract margins from customers even when competition is increasing. The prices for supply and demand credits are not adjusted for risk, which might give a distorted image of gap between marginal costs and loan price. We conclude out of two weak assumptions, criticism on the interpretability of the Lerner Index and a lack of risk adjusted prices Leon (2014) (solution is presented in section 5.2.4), that the Lerner Index corresponds to the Neutral-rating in Table 4.1.1 on theoretical evidence.

The time dimension is not an embedded feature of the model. We can overcome this problem by calculating the Lerner Index at different points in time, because data are time dependent. If data are gathered from annual reports to

determine the marginal costs, then a time interval of one year seems to be reasonable. As the model in this way allows for assessing competition over time, the Lerner Index scores positive on this criterion.

The Lerner Index is applied on individual level and can be calculated for industry level, which means a positive rating. To calculate the competitive power on industry level, one needs to assume how the individual competitive power weighs at industry level, e.g. by market share. The papers of Fernández de Guevara *et al.* (2005), Fernández de Guevara & Maudos (2007) and Weill (2013) construct the industry level Lerner Index as such a weighted average of all individual firm levels. From Eq. 3.27 and the paper of Leon (2014) it follows that the industry level Lerner Index is:

$$L_j = \sum_{i \in j} \varphi_{i,j} L_{i,j} \tag{5.2}$$

with all firms i in market j. Market shares are taken as weights $\varphi_{i,j}$, where an unweighted Lerner Index means $\varphi_i = 1/N$, with N firms in market j. Recent work from Boone (2008) and Boone *et al.* (2013) show that if individual Lerner indices decrease with competition: "the average degree of market power may increase, decrease or remain stable", due to efficiency differences between firms. The operating costs and efficiency varies between banks and between different geographical locations, so depends on the economic environment (Chaffai *et al.*, 2001).

The indirect differentiation of MPL firms on marginal costs and loan price results in a neutral rating. This gives consumers of credit loans the choice between conventional banks and MPL firms.

We continue with the reflective criteria (predefined answers in Table 4.1.2) and observe that regulatory requirements are not taken directly into account in the Lerner Index. However, regulatory requirements can result in higher marginal cost, (e.g. holding expensive capital at balance) and therefore differentiates between banks and MPL firms. We therefore evaluate the regulatory requirements on a neutral rating.

Although the Lerner Index is well-used in existing literature, sometimes the application and outcome face difficulties because banks have a wide portfolio of financial products. To subtract the marginal costs and revenues of only credit loans from annual reports is seen as complicated. After data gathering and calculating the Lerner Index with use of the cost function, the results are easy to interpret. We conclude on this criterion that it might be complicated how to derive information on marginal costs and product price which are related to only credit loans at the balance of a bank. This might impact the straightforward conclusion and interpretability of the results and therefore this criterion is rated as negative.

The feasibility of the solution is nothing to worry about as the calculations are simple and fast. Mathematically seen, the Lerner Index is easy to apply and does not need extensive modelling skills, which results in a positive rating on this criterion.

5.2.4 Improvements to Lerner Index

The current development in credit loan competition suggests that price is an important component for individuals and companies. Therefore, one can think that the price setting Bertrand competition better represents the credit loan competition. Vives (1985) states that a Bertrand competition is more efficient than Cournot competition. In case of constant marginal cost and a homogeneous product, the Bertrand outcome is setting the market price at marginal costs. This does not fit the view of the Lerner Index, where the gap between MC en P is a measure of market power. At the same time, Cournot competition appears to be a better approximation of "real" competition.

If loan prices are not adjusted for a risk premium, the Lerner Index can overestimate the market power of firms spending more credit to loans with higher credit risk (Oliver *et al.*, 2006). The argument of over- or underestimating market power, holds also for MPL firms. Typically MPL firms focus on a specific part of the credit loan market, which might not be equal (in terms of average risk

premium) to the credit loan portfolio of a bank. Furthermore, difficulties exist for the average product price and marginal costs of banks which can be a mix of more than the homogeneous credit loans investigated in the model.

A different stream of literature (Lintner, 1965; Sharpe, 1963) about investment decisions, deals with the relationship of risk and return by introducing an efficient frontier or capital market line in the Capital Asset Pricing Model (CAPM).

Any manager looking for an investment tries to approach this line, which is an efficient ratio between risk and return. For any investment having risk σ and return $\bar{r}$ including a risk premium, and laying on the CAPM efficient frontier, it holds that the investment pays the market price for a risk premium above the risk free rate. Lintner (1965) states this CAPM model with the formulation in Eq. 5.3.

$$\bar{r} = r_f + \frac{\bar{r}_M - r_f}{\sigma_M}\sigma. \tag{5.3}$$

The expected return $\bar{r}$ depends on the risk-free rate (r_f), a risk component ($\bar{r}_M - r_f$) and its standard deviation (σ). In this model the price of risk equals:

$$\frac{\bar{r}_M - r_f}{\sigma_M}. \tag{5.4}$$

Now we can adjust the price of a credit loan for risk. At the deposit side of the credit loan market, the same adjustment for risk with use of the CAPM can be applied, to obtain the price of risk adjusted deposits and risk adjusted funding costs. If banks are protected by deposit guarantee regulation from the government, depositors only face the risk of a bank default for the amount of deposits exceeding the deposit guarantee limit. The Lerner Index can now measure the gap between price P and the marginal costs MC without the noise of risk, and compare the two differentiated products from conventional banks and MPL firms (Oliver *et al.*, 2006).

Future MPL loans might become more complex with the use of securitisation. MPL firms can pool loans together and buy protection from counter parties against credit risk to offer depositors a more attractive product. These new type

of products can make the competition of credit loans more complex to measure via the Lerner Index, because comparing loan prices and loan costs (input of cost function) is complex.

5.3 Analysis of PR model

The most used approach in banking literature is the model of Panzar & Rosse (1987) as described in Section **??**. We process the same steps as in the previous section on analysing the Lerner Index; check the applicability of model assumptions on the MPL firms, explore how the PR model should be applied on MPL firms, evaluate the framework criteria and present improvements to the PR. We choose to analyse the unscaled version of the PR model with revenue equation in Eq. 3.34, combined with Eq. 3.33.

5.3.1 PR assumptions

The Panzar and Rosse method relies on the comparative static properties of firms' reduced form revenue equations (Vesala, 1995). By evaluating the PR assumptions, we provide insight whether MPL firms can be treated like a special case of a bank. If so, the assumptions do not create a barrier to apply the PR model on MPL firms. The assumptions from PR theory on unscaled revenue equation are described in Table 5.3.1.

In the long run, an equilibrium might exist when MPL firms are mature and fully integrated in the creditloan market. However, the current situation of rising MPL firms can give complication to the assessment of a long run equilibrium. Revenues at MPL firms are not adjusted for a credit risk premium as the credit risk is transferred to the depositor or investor of the contract. If we assume that the revenues of MPL firms are risk adjusted, we underestimate these revenues.

As the technology for creditloans is now developing, there is no basis to assume that the technological infrastructure and systems are equal over time. This might change to a stable situation in a future period, when the technology of

Assumption	Description	MPL
Long run equilibrium	Observations under long run market equilibrium in future empirical research, when MPL firms are mature.	✓
Homogenous cost structure	Cost drivers of products and participants are the same for all firms, despite the difference in the degree of cost.	✓
Stable cost function	All changes in marginal costs are driven by changes in one or more input prices.	✓
Risk adjusted revenues	All revenues are risk adjusted. Although not for MPL firms as they do not earn risk premiums from credit loans.	
Equal production technology	Market participants have accessibility to equal technological infrastructure and systems during the empirical testing period.	✓
Different pricing strategies	All firms choose an individual pricing strategy to optimise profit.	✓

Table 5.3.1: The Panzar & Rosse assumptions applied to MPL firms.

MPL firms is better integrated in the market.

5.3.2 PR application

The PR model applies on the credit supply market and not on the competition of the deposit market, because the latter is hard to define precisely. The deposit rates are used as input prices in the model, as can be seen in Figure 5.3.1. As explained in Section 5.3.1, the PR model does not differ between different risk premiums within credit loans; all revenues are assumed to be risk adjusted and banks contain comparable portfolios regarding credit risk. The lack of risk-adjusted return on deposits holds for the deposit rates at MPL firms as well. The input prices come from physical capital, financial capital and labour costs combined with firm specific control factors. The aim of the PR model is estimating the β_i elasticities in Eq. 3.34 to calculate the H-statistic as defined in Eq. 3.33.

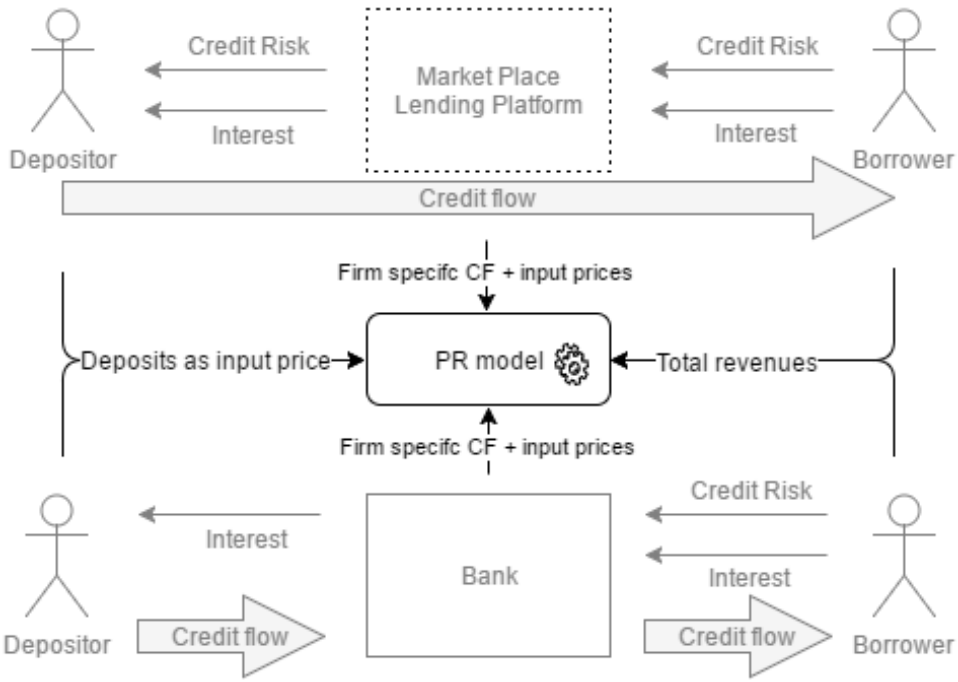

Figure 5.3.1: Application of Panzar & Rosse model.

Criteria	Rating
Theoretical evidence	Negative
Time dimension	Positive
Industry or firm level	Positive
Channel differentiation	Neutral
Regulatory requirements	Neutral
Existing application and outcome	Negative
Feasibility of solution	Neutral

Table 5.3.2: The Panzar & Rosse evaluation results.

5.3.3 PR evaluation

The H-statistic as outcome of the PR model is one number representing the sum of elasticities and can be used as a standard measure with a defined classification for type of competition. However, new theoretical evidence shows that the basis of the PR approach is very weak as different versions of revenue and price equations lead to different conclusions on the same data.

Another limitation to the use of the PR comes from the state of technology, which should be the same overtime, while this is developing and changing in a rapid way, as explained in Chapter 2. A problem to overcome in the PR model is the assumptions of risk adjusted PR revenues, which is not the case and might lead to miscalculating the elasticity outcomes. We therefore conclude that the theoretical evidence scores negative for the PR model, as presented in Table 5.3.2.

The time dimension is a required property of the PR model, as the model uses data over time to calculate the elasticities. This criterion is valued on a positive rating. The same can be concluded for the industry- and individual-level criterion. The model can calculate the individual H-statistic of a market participant and the industry competition classification as a whole.

In section 5.2.3 we have seen that regulatory requirements cause banks to keep more capital at their balances which impacts the marginal costs. The same argument holds for the PR model, as market participants have the ability to change the firm specific cost factors and thereby the marginal costs used for assessing the elasticities.

The most important implication of regulatory requirements with regards to competition, is the higher costs for issuing credit loans. This can be determined for individual parties in the PR model, although regulatory requirements are not taken care for in the PR model. We therefore evaluate this criterion at neutral.

The latest work of Bikker *et al.* (2012) and Shaffer & Spierdijk (2015) is placing a wedge between disqualified studies using price equations or scaled revenue functions. Before these recent studies, the Panzar & Rosse model was the most used approach to assess competition in banking or other industries.

However, the popularity will most probably decline due to these new insights. Therefore we evaluate this criterion as negative.

Feasibility of the solution scores neutral because it is more complex to calculate compared to the Lerner Index and will take more time to do the calculations. The criterion scores neutral on the PR model.

5.4 Analysis of Boone Indicator

Compared to the previous analysis of the Lerner Index and the PR model, the Boone indicator is different because it sees competition as a dynamic process instead of a static state. The Boone indicator is the most recently developed model to indicate the level of competition in an industry.

5.4.1 Boone Indicator assumptions

The Boone indicator is build on the idea that in a more competitive environment, the reallocation effect moves profit and market share from less efficient firms to more efficient firms. Even if the total output declines, less efficient firms are more punished. In Boone (2008) the reallocation effect increases monotonically with increasing competition. Boone (2008) rephrases this to relative profit difference which is sensitive to the degree of competition.

We conclude from Table 5.4.1 that all the assumptions are applicable to MPL firms as well. Meaning that MPL firms are a special form of banks and the Boone indicator can be applied to these firms.

5.4.2 Boone indicator application

Next to the theoretical model in Eq. 3.46, two modifications exist in literature. Delis (2012) and Tabak *et al.* (2012) estimate the marginal costs directly. However, Schaeck & Cihák (2013) use average costs as an imperfect proxy for marginal costs. The second modification is on the reallocation of more efficiency, where researchers (Tabak *et al.*, 2012; Van Leuvensteijn *et al.*, 2013) can choose

Assumption	Description	MPL
Competitive rate	The existence of a competitive rate in the industry.	✓
Distortion rate	Individual profit rate of a company is distorted by a random profit rate.	✓
Average profit rate	Average profit of n companies differs with rate γ from the competitive rate.	✓
Reallocation	Profit and/or marketshare of less efficient firms is reallocated to more efficient firms.	✓
Intensity of competition	Competition becomes more intense when cost of entry drops and new market participants entry the market or firms conduct becomes more aggresive.	✓

Table 5.4.1: Assumptions underlying the Boone indicator.

to make either market share or profit the dependent variable. Because a bank can choose to translate lower costs into higher output or higher profit.

All concentration measures have problems with defining the market, Schiersch & Schmidt-Ehmcke (2010) show that the Boone indicator makes critical assumptions on this area too. A better defined and demarcated market gives more precise results, as other factors or markets have less influence on the outcome of the competition estimate. This rule is common to all non-strucutural measures of competition.

In applying the Boone indicator, we do not need precise information on the volume of deposits or loans. Figure 5.4.1 shows that we need need general information of firms on the profit rates and marginal costs as input for the estimation of the price elasticity β and competitive rate π_i.

5.4.3 Evaluation Boone indicator

We evaluated the Lerner Index and PR-model to the criteria in Table 4.1.1 and Table 4.1.2. We use the same approach to evaluate the Boone indicator. We further explain the evaluation on each criterion. The results can be find in Table

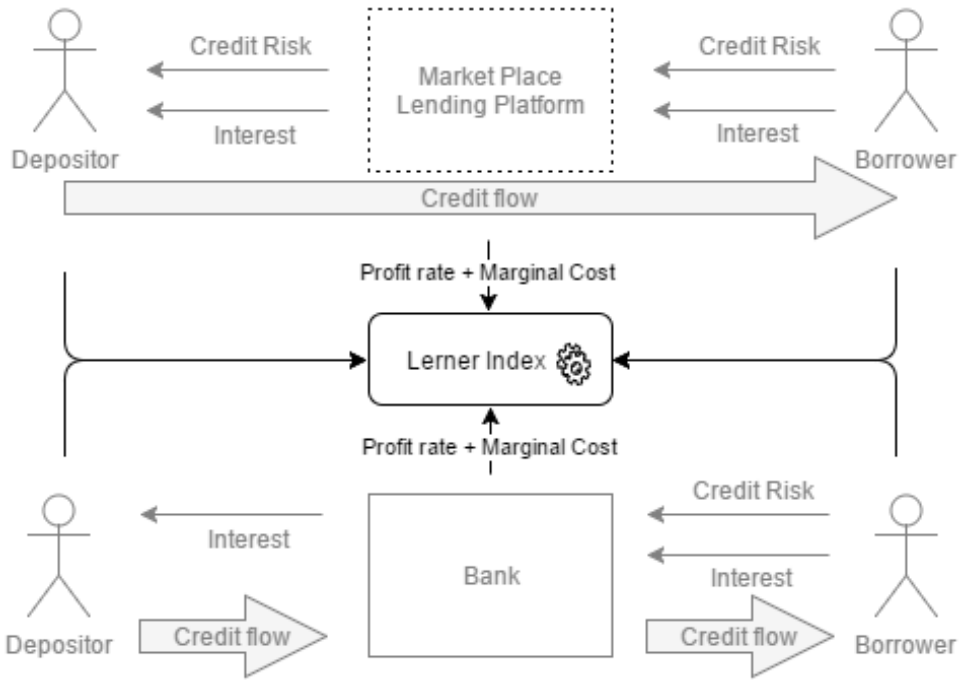

Figure 5.4.1: Application of Boone indicator.

Criteria	Rating
Theoretical evidence	Positive
Time dimension	Positive
Industry or firm level	Positive
Channel differentiation	Neutral
Regulatory requirements	Neutral
Existing application and outcome	Neutral
Feasibility of solution	Neutral

Table 5.4.2: Boone indicator evaluated on framework criteria.

5.4.2.

The Boone indicator or relative profit difference has a robust theoretical foundation as a measure of competition (Boone, 2008). One simple econometric equation with exogenous variables, has its foundations in oligopoly theory. The advantage above other NEIO measures, is that the Boone indicator is continuous and monotonous. In all-most all cases, higher competition leads to a higher Boone indicator, and therefore avoids some drawbacks of other NEIO measures (Leon, 2014). Exceptions are that the approach ignores the possibility of firms to invest profits for innovative purposes to face competition in future, but this effect does not distort the indicator on the long term (Van Leuvensteijn *et al.*, 2013). We therefore evaluate the theoretical evidence of the Boone indicator to be positive.

The time dimension is not a problem for the Boone indicator, because it is a dynamic measure and therefore finds the corresponding price elasticity β over time. This results in a positive rating.

Every firms has its own profit rate and corresponding cost, which allows for calculating the price elasticity β which is the measure of competition. All $\beta's$ together create insights in the competitive state of the industry. Industry and individual competition level can both be calculated in this approach and therefore evaluated positive.

As in all measures, the channel differentiation is a non existing property of the model, but can be differentiated on at the cost part of the model. Lower marginal costs might therefore be a way for MPL firms to differentiate from banks. The Lerner Index, PR-model and the Boone indicator are all evaluated at neutral.

The previous criterion is evaluated neutral because the model has no such explicit property. The implication of regulatory requirements in terms of for example higher capital costs are translated into higher marginal costs in the Boone indicator. But the model does not allow specifically on how regulatory requirements can differ between MPL firms and banks. Therefore, the Boone indicator has neutral evaluation on this criterion.

Boone *et al.* (2007) simulated various cases of competition and found that

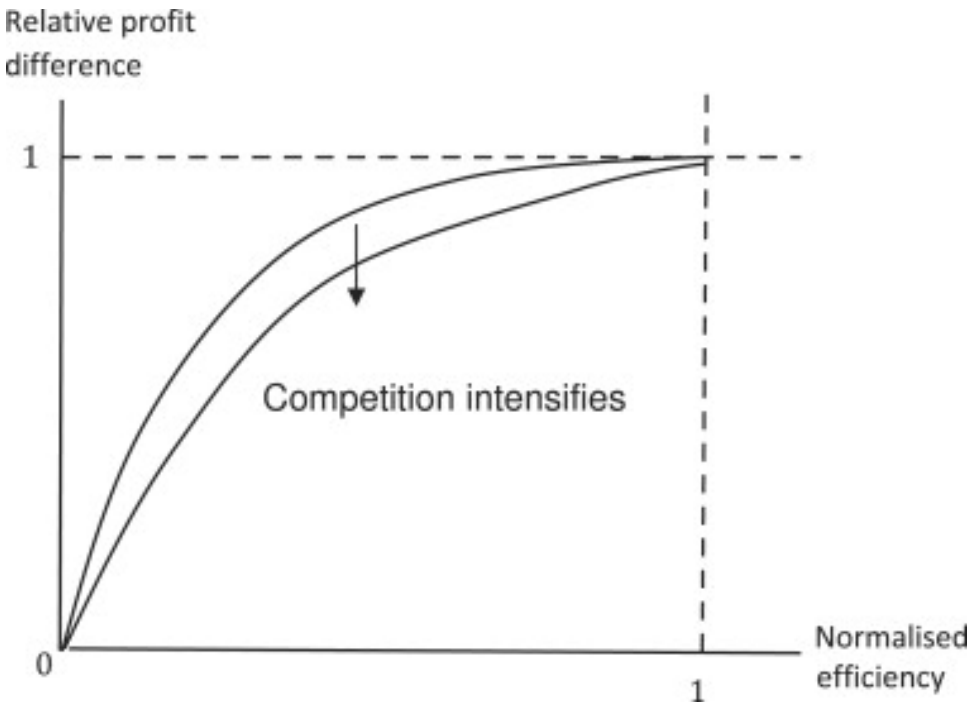

Figure 5.4.2: Plotting relative profit difference against efficiency.

changes in competition are identified correctly. The data requirements for this model are experienced as not challenging. On the same required data set for applying the Lerner Index, we also can estimate the Boone indicator. This data mainly exists from public available reports on quarterly or yearly basis. However data collecting might be more difficult for the specific case of credit loans. We therefore evaluate the criterion as neutral.

The relationship between efficiency and relative profit difference is not necessary to calculate, for getting a competition level indicator (Boone, 2008). In case a researcher wants to normalise companies on efficiency and profit rate, makes the Boone indicator more computationally extensive. An example of the result of plotting companies and its relative profit difference can be found in Figure 5.4.2 from Duygun *et al.* (2013). As the researcher has the choice between level of extensiveness of calculation, we evaluate this criterion neutral.

5.4.4 Boone indicator improvements

The risk adjusted revenues on credit loans stays an important issue in this model as well. We propose to use a different dependent variable instead of profits, which might consist of risk premiums. As Schaeck & Cihák (2013) use the return on assets as a dependent variable, we could use the risk-adjusted return on capital on the portfolio of firm i in Equation 5.5 (Diebold *et al.*, 2010).

$$RAROC_i = \frac{Revenues_i - Costs_i - ExpectedLoss_i}{TotalCapital_i} \tag{5.5}$$

The expected loss of firm i is the average loss expected on it's portfolio of credit loans and is higher for more credit risk on loans. The total capital includes all capital need for a firm to exploit its credit loan activities. For a bank this includes capital buffers for risk management and regulatory requirements of the credit loans, for which MPL firms have no burden to. However, the application of the RAROC as dependent variable puts higher requirements on sample data as there is more specific credit loan information needed, which can be hard to find for a long period in an empirical study.

We have the duty of formulating, of summarising, and of communicating our conclusions, in intelligible form, in recognition of the right of other free minds to utilise them in making their own decisions.

Ronald Fisher

6 Results and Conclusion

We review the results of the criteria assessment in this chapter, resulting in a conclusion.

6.1 Summary of Results

The results of the three models analysed in Chapter 5 on the framework criteria are shown in Table 6.1.1. Only the PR model has a negative rating within conclusive criteria on theoretical evidence as the latest developments in the research of this model show contradictory conclusions on the same data. We show why the PR model is not appropriate to apply for measuring competition in general and credit loan competition with banks and MPL firms more specific. The Boone rating scores positive on three out of four conclusive criteria, compared to one positive rating for the conclusive criteria on the Lerner Index.

	LI - rating	PR - rating	Boone - rating
Conclusive criteria			
Theoretical evidence	Neutral	Negative	Positive
Time dimension	Positive	Positive	Positive
Industry or firm level	Neutral	Positive	Positive
Channel differentiation	Neutral	Neutral	Neutral
Reflective criteria			
Regulatory requirements	Neutral	Neutral	Neutral
Existing application and outcome	Negative	Negative	Neutral
Feasibility of solution	Positive	Neutral	Neutral

Table 6.1.1: Summary of evaluation results.

The most important difference is that the Lerner Index suffers for being a proxy for competition intensity because we calculate the pricing power index. The Boone indicator is a better measure for competition as it is a dynamic measure and can explain changes in competition. This is supported by the paper of Boone *et al.* (2007), claiming that the price elasticity β of the Boone indicator correctly (and therefore better compared to the Lerner Index and PR-model) identifies changes in competition by either an intenser process of rivalry with higher conduct of firms or a drop in entry costs. In Boone (2008) it is stated that data requirements are equal for the Lerner Index as for the Boone indicator. Data on firm level which allows for the Lerner Index to calculate the competition level, are sufficient for the Boone indicator as well. At the three reflective criteria, the Boone indicator scores at least neutral. Where only the Lerner Index scores better on feasibility as it is a simple index to calculate, the Boone indicator is not very difficult when using a first order Taylor approximation.

6.2 Conclusion

We started the project with the question how we can model the impact of marketplace lending on competition in lending. We start with introducing the

concept of MPL lending and investigate what the drivers are behind the fast growth over the recent years. We see that efficiency and regulatory advantages of such MPLs play a major role in offering lower rates to borrowers and higher rates to lenders. Efficiency in estimating credit risk, is also gaining a better customer experience during the credit application process. It seems that a rational borrower prefers the perfect substitute of a MPL loan above a bank loan because of the (currently) lower borrower rates.

Competition literature in banking already provides a wide variety of competition measures over time. We give an overview on these measures, underlying theories and choose the top three best practices of measures for further analysis. We limit our research on the borrowing side of a MPL deal, as the lending side has different characteristics compared to the alternative of deposits.

In the first phase we seek out what assumptions are underlying the theoretical measure and check whether these assumptions still hold for the case of MPL. The second phase explores how the measure should be applied for MPL, meaning how data is performed and processed as input to calculate the value of the measure. These two phases help us to better understand how the measure should be applied to banks and MPLs.

For phase three we have build a comparative framework to qualitatively analyse and assess the competition measures. The comparative framework consist of four conclusive criteria and three reflective criteria. Predefined outcomes with a three-point rating scale (Negative, Neutral and Positive) support the qualitative review of measures. The fourth phase entails improvement to the competition measure to offer a better application to MPL and bank lending.

We conclude on that the Boone indicator has the best outcome on three out of four conclusive criteria and does not score negative on any reflective criteria. It therefore performs better than the Lerner Index or PR approach on the conclusive criteria and more consistent on the three reflective criteria. This project concludes on qualitative evidence that the Boone indicator is the best measure out of the existing competition measures.

The Boone indicator shows empirical consistent evidence and can be applied on MPL firms next to conventional banks. The data is collected from annual or quarterly reports but might need to be extended to correct for differences in risk between firm portfolios. The proposition on such an extended measure has the potential to derive unambiguous conclusions while including the impact of MPL as well. Such an accurate measure is, among others, of great importance to the field of competition and financial stability, to investigate the nature and direction of its relationship in first instance. If this relationship is established, decisions on competition can be related to the impact on financial stability and the other way around.

Because I spent many years during my previous life as an academic researching game theory, some commentators rushed to presume that as Greece's new finance minister, I was busily devising bluffs, stratagems and outside options, struggling to improve upon a weak hand. Nothing could be further from the truth.

Yanis Varoufakis

7 Discussion & Further Research

This chapter contains a discussion on the conclusion and recommendation for further research.

7.1 Discussion

The assumption of MPL loans as perfect substitutes for bank loans, is an important element in applying measures to one market of MPLs and banks. However, we have our strong concerns that bank loans are perfect substitutes for MPL loans as well. However, both type of loans are assumed to be perfect substitutes in this research to be applicable for the theoretical models. It is hard to analyse the impact on theoretical models if only MPL loans are perfect substitutes.

Not all competition measures from literature are analysed in this projects

framework. This might result in overlooking a potential competition measure to apply in the case of MPL and bank loans. We therefore can only conclude on the measures we have analysed with the presumption that current best practises of literature on competition measurement in banking is an appropriate pre-selection.

Criteria within the category of conclusive criteria and within the category reflective criteria from the comparative framework have implicitly given equal weights. Is this impacting the result of the evaluating the competition measures? It does not have impact because there is no configuration of criteria weights, which makes the outcome of either the LI-rating or PR-rating better than the Boone-rating.

At last, the feasibility of a proper data set from MPLs and banks including risk premiums on credit loans is highly uncertain. There is no trigger to these parties to invest in expensive and sensitive storage of data. The current used assumption in banking competition literature, that all banks have on average the same risk premium for their complete portfolio of unsecured loans, is no longer tenable and need to be overcome. The short history of MPL data might as-well limit a proper application of the Boone indicator and decent outcomes.

As this project focus only on lending activities, the requirements on the data is more specific than what research is used to with the whole portfolio of bank activities and aggregated data. However, the Boone indicator does not require much data to do so, and will limit the implications of this more strict requirements.

7.2 Further Research

As an indicator on whether the MPL loan is a perfect substitute for a bank loan and vice verse, research on the selection process of banks and MPLs might give more understanding if borrowers via MPL might (partly) not be able to get funding via a bank. The (hypothetical) case that MPL only serves consumers who cannot get funding at a bank, would have major implications for the

assumptions of a MPL being a special form of a bank.

If we want to research on competition in unsecured lending between banks and lending we need to build a proper data processing approach. This step is of high importance as it might limit further research like experiments. Most probably, the data from MPLs are fairly easy to collect as their IT-systems are straightforward to derive data from. MPLs want to promote their transparency for further establishment in public society. However, a bank's data on credit lending might be more complex to collect, with typically old systems knotted to one another. As these data might be sensitive because of competition, it is highly questionable whether banks want to cooperate. If all data are collected, then the risk premium of all loans have to be based on the returns and risk.

Another important step in the follow up of this project is a quantitative experiment with limited data. We are very curious how the Boone measure will perform, even with a short history of data on MPLs. This further supports the new edge of this research area build on existing banking competition literature, but now including MPL.

Generally, MPLs have no unsecured loans on their balance sheets and therefore do not contribute to systemic risk, as there is no exposure to other banks. However, macro economic effects might impact the default rates on MPL loans on large scale. This might lead to stressed situations at institutional investors with a high exposure in MPL loans, and needs further attention and research from regulators.

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Appendices

A

Diversification in MPL loans

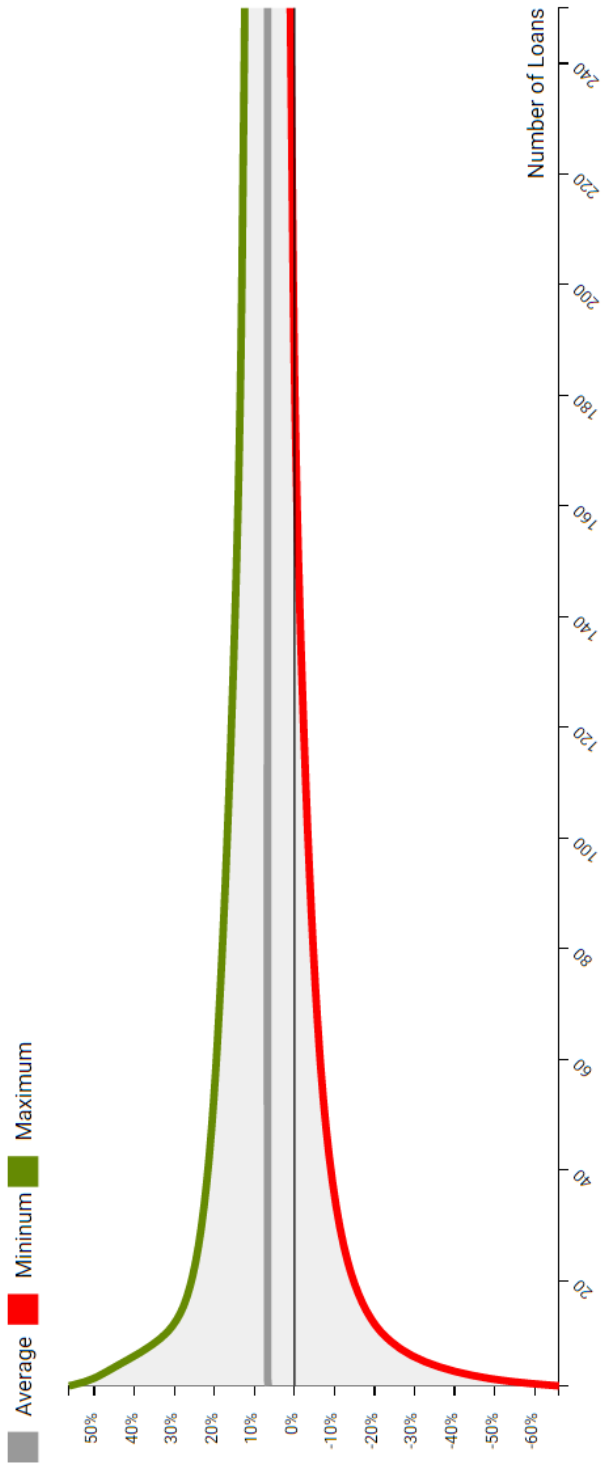


Figure A.0.1: Impact of diversification on MPL loans. Number of loans is offset by total return at minimum, maximum and average. Performed by a Monte Carlo simulation of 21,000 Lending Club loans. Source: https://www.lendingrobot.com/#/resources/charts/.

B

Marketplace lending in numbers

MPL market type	Definition KPMG (2016a,b)	Volume UK (2015)	Volume EU (2015)
Peer-to-Peer Business Lending	"Secured and unsecured debt-based transactions between individuals/institutions and business with trading history; most of which are SMEs."	£1490m	€212m
Peer-to-Peer Consumer Lending	"Debt-based transactions between individuals/institutions to an individual; mostly unsecured personal loans."	£909m	€366m
Invoice Trading	"Businesses sell their invoices or receivables to a pool of primarily high net worth individuals or institutional investors."	£325m	€81m
Equity-based Crowdfunding	"Sale of registered securities, by mostly early stage firms, to both retail, sophisticated and institutional investors."	£332m	€159m
Equity-based Crowdfunding in Real Estate	"Direct investments into a property by individuals, usually through the sale of a registered security in a special purpose vehicle (SPV)."	£87m	€27m
Community Shares	Withdrawable share capital which can only be issued by co-operative societies, community benefit societies and community-based charitable organisations."	£61m	-
Reward-based Crowdfunding	"Donors have an expectation that fund recipients will provide a tangible butnon-financial reward or product in exchange for their contributions."	£42m	€139m
Pension-led Funding	"Mainly allows SME owners/directors to use their accumulated pension funds in order to re-invest in their own businesses. Intellectual properties are often used as collateral."	£23m	-
Donation-based Crowdfunding	"Non-investments model in which no legally binding financial obligation is incurred by fund recipients to donors; no financial or material returns are expected by the donor."	£12m	€22m
Debt-based securities	"Individuals purchase debt-based securities (typically a bond or debenture) at a fixed interest rate. Lender receive full repayment plus interest paid at full maturity."	£6m	€11m
Balance Sheet Business Lending	"The platform entity provides a loan directly to a business borrower."	-	€2m
Profit Sharing Crowdfunding	"Individuals/Institutions purchase securities from a company, such as shares or bonds and share in the profits or royalties of the business."	-	€1m

Table B.0.1: EU submarkets aim for a specific target group or specific loans.

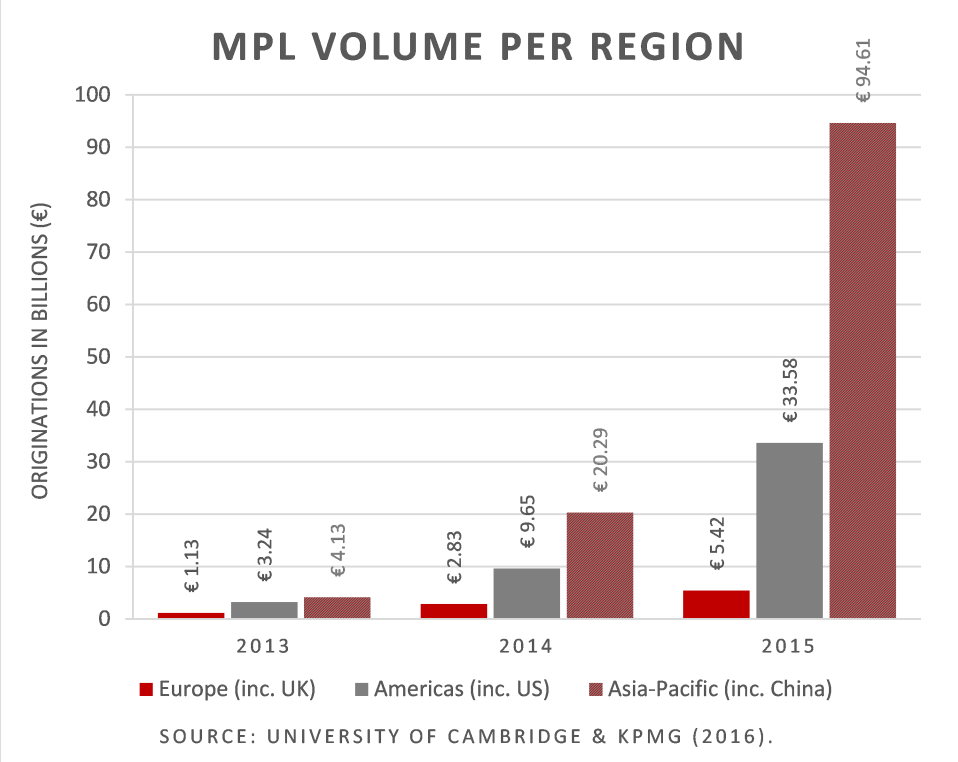


Figure B.0.1: The growth in MPL volume in Asia (especially China) is spectacular.

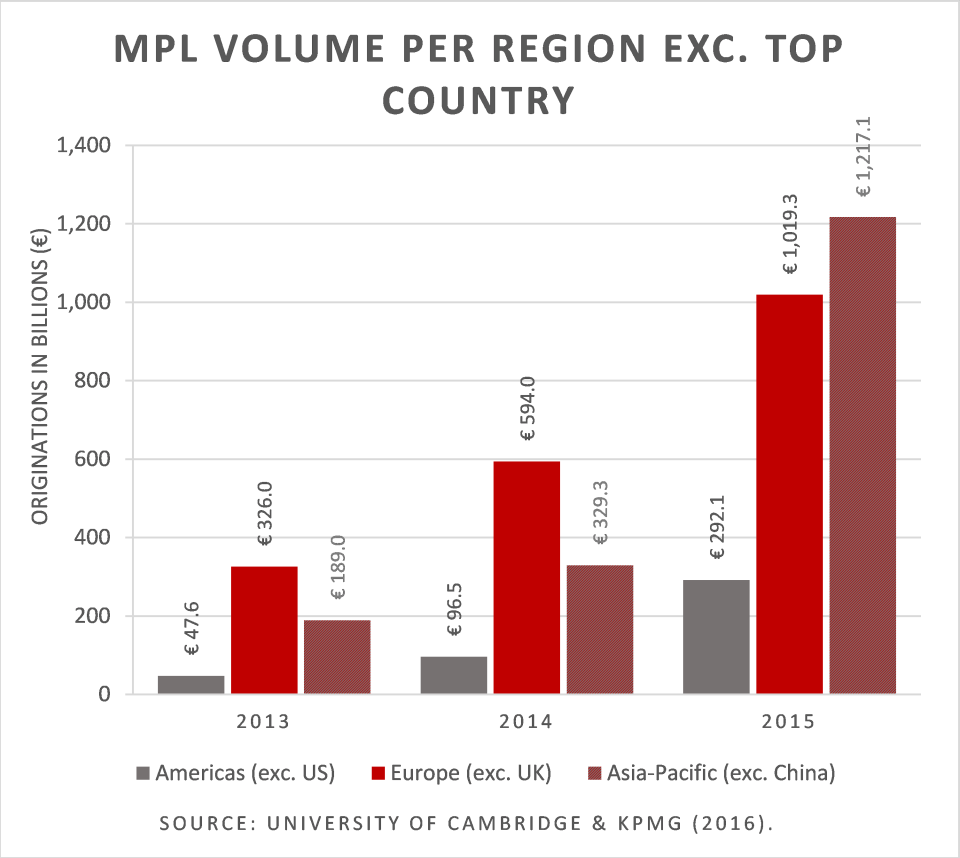


Figure B.0.2: Differences are small between Asia and Europe if we exclude the top country per region.

Figure B.0.3: In this graph on the volumes per EU country, values are plotted on logarithmic scale. One can see that the UK counts for a very large part of the EU MPL volume.

C

Credit loan quality

Loan Grade	Total Issued (#)	Total Issued ($) Billion	Loan Grade ($) as % of All Loans	Average Borrower APR†	Average Experian FICO Score‡
AA	42,695	$0.54	9.25%	8.48%	744
A	97,242	1.33	22.70%	12.89%	711
B	106,880	1.56	26.48%	16.28%	699
C	110,499	1.53	25.95%	20.00%	689
D	57,549	0.65	11.02%	24.95%	677
E	32,585	0.22	3.66%	30.49%	666
HR	13,147	0.06	0.94%	35.10%	658

Note (*): For Prosper Marketplace loans, AA is rated "lower risk"; HR is rated "higher risk".
Note (†): APR for loans originated between July 13, 2009 to June 30, 2015.
Note (‡): FICO for loans originated from September 6, 2013 to June 30, 2015.
Source: Prosper loan origination data as of 4Q 2015 from publically available data aggregated by Nickle Steamroller. Prosper APR and FICO score from Form S-1/A, filed September 21, 2015.

Figure C.0.1: Prosper unsecured consumer credit originations, 3Q 2009 - 4Q 2015. Source: US Treasury (2016)

Loan Grade*	Total Issued (#)	Total Issued ($) Billion	Loan Grade ($) as % of All Loans	36- Month Borrower APR Range†
A	148,203	$2.08	15.89%	5.99% – 10.97%
B	254,535	3.47	26.52%	11.92% – 15.06%
C	245,860	3.55	27.17%	15.59% – 18.99%
D	139,543	2.16	16.48%	19.99% – 23.30%
E	70,705	1.27	9.71%	23.77% – 28.26%
F	23,047	0.44	3.36%	26.99% – 33.99%
G	5,489	0.11	0.86%	31.30% – 35.96%

Note (*): For Lending Club loans, A is rated "lower risk"; G is rated "higher risk".
Note (†): APR as of Q1 2016.
Source: Lending Club loan origination data as of 4Q 2015 from publically available data aggregated by Nickle Steamroller. Lending Club APR range from company website.

Figure C.0.2: Lending Club unsecured consumer credit originations 4Q 2008 - 4Q 2015. Source: US Treasury (2016).

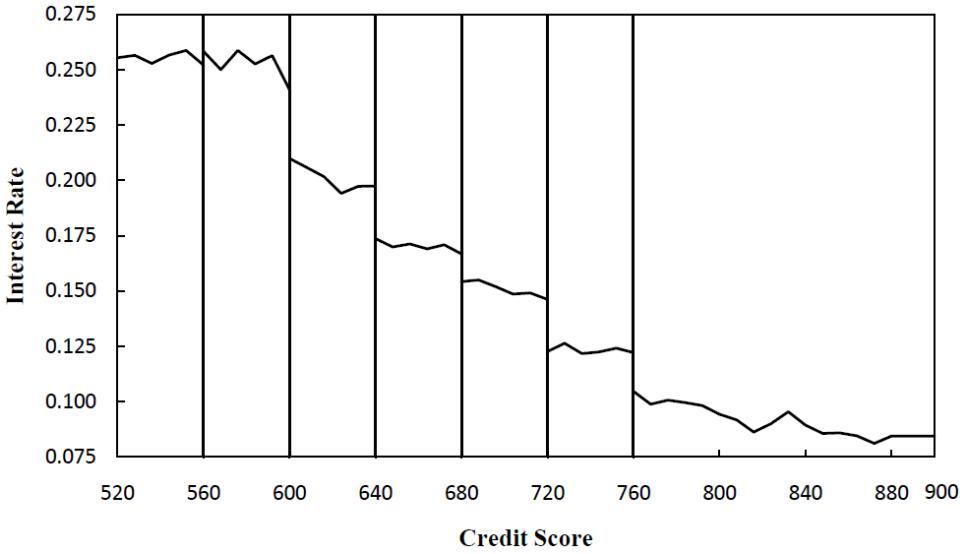


Figure C.0.3: Prosper relationship between interest rate and credit rating on 3-year unsecured loans. Credit categories are seperated by fixed lines. From left to right, the categories are: HR, E, D, C, B, A and AA. Source: Iyer *et al.* (2009).

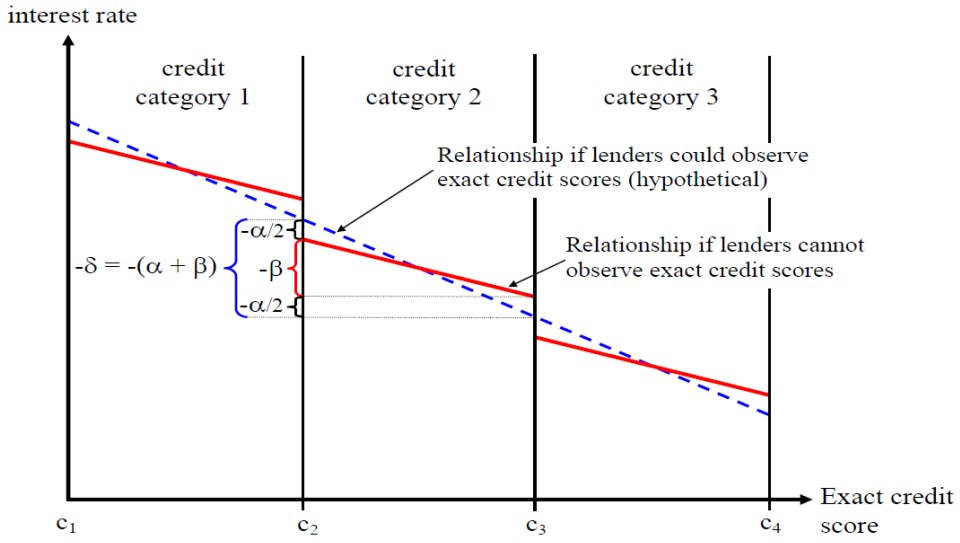
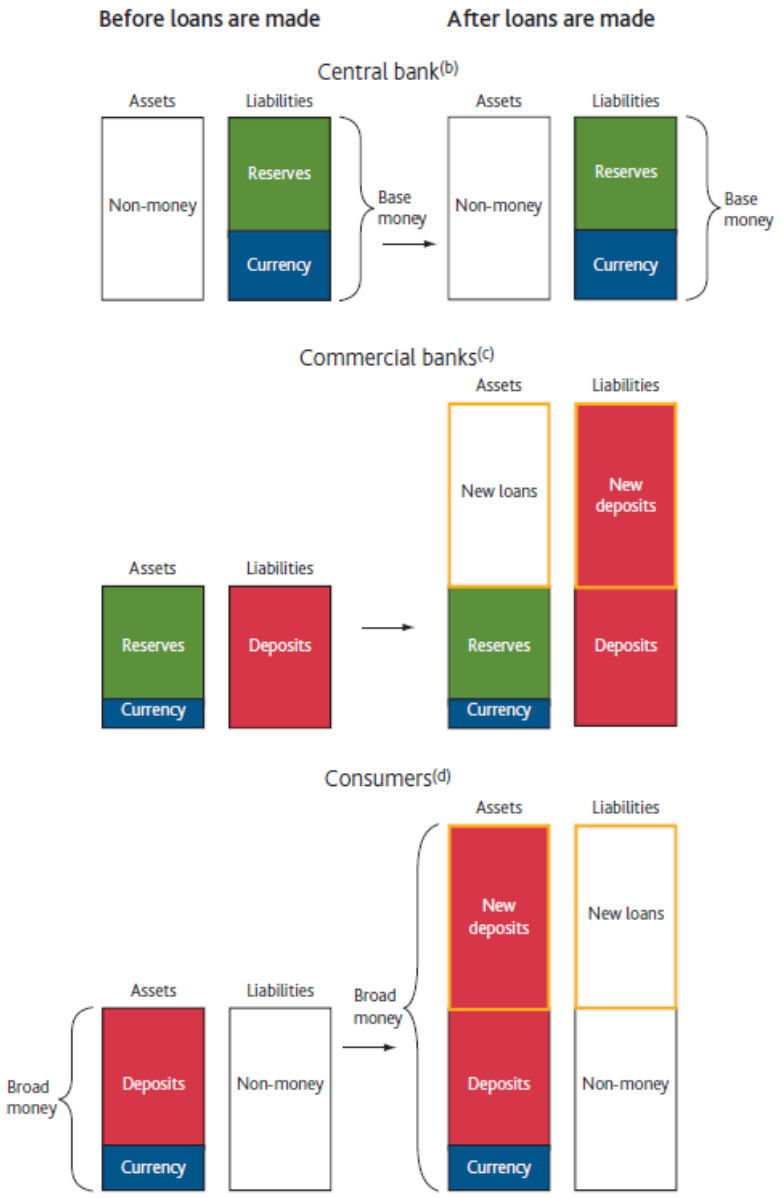


Figure C.0.4: Stylised and actual relationship between credit score and interest rate if lenders cannot observe credit scores. Source: Iyer *et al.* (2009).

D

Money Creation



(a) Balance sheets are highly stylised for ease of exposition: the quantities of each type of money shown do not correspond to the quantities actually held on each sector's balance sheet.
(b) Central bank balance sheet only shows base money liabilities and the corresponding assets. In practice the central bank holds other non-money liabilities. Its non-monetary assets are mostly made up of government debt. Although that government debt is actually held by the Bank of England Asset Purchase Facility, so does not appear directly on the balance sheet.
(c) Commercial banks' balance sheets only show money assets and liabilities before any loans are made.
(d) Consumers represent the private sector of households and companies. Balance sheet only shows broad money assets and corresponding liabilities — real assets such as the house being transacted are not shown. Consumers' non-money liabilities include existing secured and unsecured loans.

Figure D.0.1: Money creation by the banking sector. Source: McLeay *et al.* (2014).