Ringfencing banking activities and competition effects

An assessment of the specialization of banking activities

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Abstract

Since the crisis of 2007/2008 several ringfencing regulations have been implemented to shield the public from exposure due to high risk activities from banks. Among the U.S., U.K. and continental Europe different programs force bank to shield traditional banking activities such as loan- and deposit taking while not allowing banks to benefit from diversification discounts. Besides the result of more resilient banks, the seperation of activities can create a level playing field and increase competition. In this paper the relationship between specialization and the effect on competition is examined by using the Panzar and Rosse (1987) H-statistic as a competition proxy both on bank- and country level. The effects within years and within banks and countries show a negative relation between specialization and competition in the period 2005-2015. Even specialization towards traditional loan based activities is negatively associated with the level of competition among banks. Regulations aimed at enhancing competition competition, should focus on reducing size and increasing cost efficiency and absorbing capacity while allowing for diversification.

Contents

List of Tables

1. Introduction

Since the financial crisis of 2007/2008 several banks has been bailed out by their governments to avoid a greater loss on the financial sector. Public- and governmental funds are used for these bail-outs. The question is why banks are saved and thereby treated differently from other non-financial private companies in case of a bankruptcy.

A key aspect is the central role banks plays in the society. The pivot position in the economy creates a high level of dependency of the public (Stork, 2011). The relatively low amount of financial banking conglomerates could threat the state of the economy as their core business is to manage risks for the society as a whole.

The banks that face these risks are highly interconnected and might have misaligned incentives which lead to the perceptions that banks are too big to fail (Frost et al., 2016). As long as these banks will be bailed out by governments, they enjoy a too-big-to-fail subsidy by which moral hazard is present. The dependency of the public and the too-big-to-fail subsidy indicate the need for the banking sector to be reformed.

The ringfencing programs are a major part of the financial sector reforms and are aimed to shield the assets of depositors from higher risk banking activities within banking conglomerates. By the latter is meant: "Any group of companies under common control whose exclusive or predominant activities consist of providing significant services in at least two different financial sectors, as for example investment banking, securities, and insurance." (G-10, 2001). The rationale is that if high- and low risk activities are separated, the part of the bank that engages in high risk activities can be put to insolvency without losses for depositors and taxpayers. Or stated differently, shielding traditional banking activities, such as loan- and deposit taking, reduces the exposure of the public to the higher risk activities of banks (Stork, 2011).

One characteristic of ringfencing is that it forces banks to narrow down their activities and specialize towards certain activities. As a consequence, these banks can no longer profit from diversification benefits. A surplus in profits from high risk activities is no longer allowed to compensate losses in low risk activities or vice versa. This restriction reduces the comparative advantages that banking conglomerates have over banks that solely engage in loan- and deposit taking activities. The removal of the comparative advantage can ease market entry and increase the level of competition within the banking sector.

The existing literature on the ringfencing programs mainly focusses on it impact on the financial stability

(Acharya et al., 2011), (Cerutti et al., 2010), (Schoenmaker, 2013a). The competition effects however, are often missed. In this research the competition effects are further investigated with the use of the Panzar and Rosse (1977) (P-R) model to indicate the level of competition. The previous literature on banking competition of Bikker et al. (2008) is extended by estimating the competition indicator for the period 2005-2015 on a country basis. In addition to the analysis on country level, the examination of competition effects is conducted on bank level as well. As ringfencing regulations enforce a level of specialization, the following research question is investigated:

What is the effect of the level of specialization of banking activities on the degree of competition for banking conglomerates and European- and North American countries in the period 2005 - 2015?

To find the answer to this question, in chapter 2 the views of existing literature on possible effects of ringfencing and competition effects in the banking sector are shown. Chapter 3 provides insight in the methodology and estimation techniques used to estimate the effect of specialization of banking activities. In Chapter 4 the results are examined. The discussion in chapter 5 explains the limitations of this research and basis for future analysis. The conclusions are provided in chapter 6.

2. Literature

First the different characteristics of ringfencing programs will be addressed. Then the theory on competition is examined in combination with the expected relationship of the main variables.

2.1 Ringfencing

2.1.1 Historical background

After the Great Depression the U.S. Glass – Steagall Act seperated retail- and investment banking for almost 70 years. The Gramm Leach Bliley act of 1999 eased the restrictions and is often indicated as cause of the financial crisis (Financial-Crisis-Inquiry-Commission, 2011). In 2010, ten years and two crises later, the Volcker Rule reinforced a separation of activities as adopted as the Dodd-Frank act was adopted in the U.S. (Dodd-Frank-Act, 2010). Also the UK proposed their revisions to reform the financial sector by the Vickers report (Vickers-committee, 2011). The French-German and Liikanen approach followed suit, though the French and German proposals are ahead of the Liikanen group. The programs are aimed to decrease the dependency of the public on banks, to reduce the too-big-to-fail subsidy. By shielding the activities that are in the interest of the public from the high risk activities, it would be able to let banks fail. This reduces the implicit too-big-to-fail subsidy and its consequence of moral hazard Lehmann (2015). Tough the goals are similar, the characteristics of the ringfencing regulations differ per country. An overview of the key characteristics of the ringfencing programs is given in table 2.1. In the following sections the different versions of ringfencing are discussed.

Table 2.1: Characteristics Ringfencing Programs

Characteristics	Volcker (U.S.)	Vickers (U.K.)	FR-GE	Liikanen (EU)
Holding company with banking and trading activities	No	Yes	Yes	No
Applied to all banks	Yes	Yes	No, only SIFI's	No, only SIFI's
Separated activities	Propriety trading and AIF	deposits	non-deposits	propriety trading and AIF
Non deposit-activities allowed within a bank holding company	No	Yes	Yes	No
Deposit taking entities face exemptions on proprietary trading	Yes	No	No	Yes
Regulatory proposal	2010	2011	2012	2012
Assent of proposal	2011	2013	2013	2014
Start implementation	2011	2015	2015	to be determined
Full implementation	2014	2019	2018/2019	to be determined

In this table the characteristics of the different versions of ringfencing programs for the U.S., the U.K., France, Germany and other European countries are shown based on Dodd-Frank-Act (2010), Vickers-committee (2011) and Liikanen et al. (2012).

2.1.2 United States – Volcker Rule

The Volcker Rule prohibits deposit taking banks to engage in proprietary trading and to acquire or retain interest in investment funds (Financial-Crisis-Inquiry-Commission, 2011). The parts of the wholesale banks that perform these activities will be fully dismantled and a new legally independent entity has to be formed. Only the dismantled, now independent entities are able to engage in proprietary trading and investment funds. The U.S. started the process in 2010 and finished the transition phase in 2014 (Dodd-Frank-Act, 2010). All U.S. banks have to comply with the Volcker Rule. Since the prohibitions apply for the entire banking conglomerate, the U.S. ringfencing method leads to large separations within banks based on their activities. However, deposit taking banks are allowed to proceed in market making activities, underwriting securities and buying and selling securities on behalf of their clients (Lehmann, 2015)

2.1.3 U.K. Vickers report

The U.K. uses a different approach. The final version of the Vickers report states that legal entities can only engage in deposit taking activities if they are sufficiently shielded from other subsidiaries (Vickers-committee, 2011). The report was published in September 2011 by the UK's Independent Commission on Banking, chaired by Sir John Vickers. These entities, called ring fenced bodies, are not shielded from other groups within the same institution as long as they are sufficiently independent. Ring fenced bodies should be immune to shocks of other banking activities and should be solvable on its own (Viñals et al., 2013). Similar to the Volckers rule, the ringfencing regulation in the UK applies to all banks. The U.K. banks can have investment activities and deposit holdings within one banking conglomerate. In 2013 the proposal of the Vickers report received royal assent and the transition process started in October 2015. The implementation will be completed in 2019.

2.1.4 EU Liikanen and FR-GE

Within the EU the proposals of France and Germany differ from and precede the Liikanen proposal. For this reason, here separation is made between the EU-Liikanen and French-German (FR-GE) approach. A committee of the European Commission, chaired by Liikanen, made a ringfencing proposal in 2012 that combines characteristics of the Vickers report and Volcker Rule. In the Liikanen group proposal it is not allowed for institutions that hold deposits to engage in proprietary trading investments in hedge funds and private equity. However, it does allow banks to participate in market making activities. The policy proposal of Liikanen applies to all Systemic Important Financial Institutions (SIFI's) and to all their subsidiaries

(Liikanen et al., 2012). As a consequence, outsourcing the ringfenced activities is not possible. The FR-GE approach deviates from the Liikanen proposal in that it allows a holding company to maintain subsidiaries that engage in both traditional banking activities such as loan issuance and deposit taking, and other banking activities, such as investment and proprietary trading. It states that the non-traditional banking activities should either be stopped or sufficiently shielded from depositary activities. A way to ensure that these activities are sufficiently shielded, is to oblige a subsidiary to comply with the capital requirements on its own (Viñals et al., 2013). In this way the depositors' assets are decoupled while the profits from investment activities can still be conducted (Lehmann, 2015).

2.1.5 To fence ....

There are several arguments in favor of ringfencing, which are often based on macro- financial stability grounds.

The first argument in favor is that ringfencing programs can be used by host countries to protect the domestic banking system against negative effects from subsidiaries of international banking conglomerates according to Schoenmaker (2013a) and Schoenmaker (2013b).The exposures of the host country to the international banking conglomerate are limited by requiring these subsidiaries to be separately capitalized.

Secondly, the argument of separating high- and low risk activities is raised by Stork (2011) Backed by research from Demirgüç-Kunt and Huizinga (2013) and Stiroh (2004), Stork (2011) states that the traditional loan and deposit taking banking activities alone face less risk than combined with higher investment- and private banking activities. In this case, when a bank fails, a government can easily bail out only the low risk, traditional banking activities which are in the public interest. The remaining activities of a bank can be left for insolvency. As no longer the whole bank will be saved in case of a failure, the too-big-to-fail subsidy is reduced.

Finally, a more level playing field can be created as banking conglomerates can no longer use their diversification benefits. Banks that combine different means of financial services can absorb losses in for example traditional banking activities by a surplus from investment activities. De Haas and Van Lelyveld (2010) find that international banks who are able to raise capital and attract liquidity, use this to fund their subsidiaries. This advantage is not present for new entrants who focus on retail deposit and loans as their core business.

2.1.6 ...or to de-fence

There are several arguments against ringfencing as well, which are often based on diversification- and efficiency grounds.

First, high risks can be inherent on traditional banking activities. The question is whether ringfencing is a sufficient solution if traditional banking has risk-taking incentives. Acharya (2011) mentions the endogenous relationship between regulations and the risk seeking behavior. That is, qualifying products such as mortgages and governmental bonds with low risks, actually increases the lending of these products. This in turn increases its risks. If the risks are not well determined and remain apparent in the shielded arm of the bank, ringfencing might be of little use.

Second, Cerutti et al. (2010) find a significant need for additional capital buffers when stricter ringfencing regulations are in place. With decreasing interest margins due to low interest rates, revenues and profits decline. Without possibilities to attract capital and liquidity, this may have adverse impacts on the financial stability for the part of the bank for which the regulations are designed.

The last argument against rinfencing is that fragmentation by specialization of banking conglomerates leads to greater dependence on the regulatory environment in which the subsidiary is located. Regional shocks can no longer be absorbed by other parts of the institution. In this case, diversification benefits that have positive impacts on loss absorbing capacity, are not present (Schoenmaker, 2013b). Also, the most efficient allocation of capital can only be achieved if capital can move freely to parts of institutions that are in excess demand. Ringfencing will prevent this from happening (Acharya, 2011).

To summarize, the ringfencing regulations can stimulate the level of competition if international regulation is used to unify policy, risks are not inherent on traditional banking activities and banks are able to fulfill the higher capital needs. In the next section the theory on how competition can be affected will be explained.

2.2 Theory - Competition

In this section the theory of competition policy assessed. The second part describes the competition proxy and method for estimation of the level of competition.

2.2.1 Competition policy

Since both consumers and companies are dependent on the services of banks, there is a strong relationship between the consumer- and companies wealth and the level of competition among banks. That is, banks

in a low competitive environment are likely to exploit the inelastic demand and charge higher prices. The extensive amount of literature on competition effects in the banking sector is proof of its importance but also signals disagreement on desired policy (Bikker et al., 2008); (Cetorelli and Strahan, 2006); (Bikker et al., 2013); (Laeven and Levine, 2007); (Claessens and Laeven, 2004). To understand what the impact is of the level of competitiveness among banks, the focus here will be on the theory of competition policy.

Following the economic theory on competition policy explained by Belleflamme and Peitz (2015), based on the models of Salop and Stiglitz (1977) and Salop (1979), there are two driving effects of competition: the market size effect and the strategic effect.

The market size effect states that competition increases because banks should locate at places where they can supply their product to the demand of most of their potential customers. In this setting, ringfencing programs force banks to focus on core banking activities without the use of spillovers from investment activities. That is, banks are forced to provide a homogeneous product. Without diversification benefits, it can be easier for new market players to enter the market and compete with existing banks on the same product. Ringfencing traditional banking activities is expected to increase the level of competition by creating a level playing field among banks. New market entrants create an increase of supply, which would have a downward effect on price and should eventually increase the consumer wealth. Besides the wealth effect, this should also lower the dependence of the public on banks and increase financial stability (Vickers-committee, 2011). However, in a globalized world where products are easily sold to different consumer segments on-line, it is possible to provide services to potential customers irrespective of the location of the provider and charge different prices for the same product according to their willingness to pay (Belleflamme and Peitz, 2015). Therefore, the market size effect, that states competition will increase, is expected to be small.

The strategic effect states that banks will use differentiated products to relax competition and enjoy market power on the captive market. It leads to maximum differentiation of products. Banks exploit the use of strategically withholding information, creating large opaque institutions with sophisticated, complex diversified products to be sold at higher prices. Bikker et al. (2008) argue that this behavior of banks has led to a significant decrease in competition in the banking sector in 1994-2004. When ringfencing is combined with the strategic effect of maximum differentiation, one can apply the findings of Brämer et al. (2013). In their research they find that market power in an exclusive segment of lending is larger than the level of market power in the full banking sector. Ringfencing will drive banks in an exclusive segment and thus creates an opportunity to exploit the market power within this segment. Shielding activities will in this case have an adverse effect on competition among banks. Ringfencing will then lower the level of competition

and increase the opportunity to raise prices and possibly lead to higher dependency of the public.

According to this theory, increasing national supervision and regulation could either have a negative effect or a positive effect on competition. Before these specialization effects of ringfencing on competition are examined, first a proxy for the level of competition will be determined.

2.2.2 Competition proxies

For the level of competition, different proxies can be used. The most common used proxies in economic research are the Lerner Index, the Hirschman-Herfindahl Index or the Panzar-Ross H-statistic. When the Lerner Index is taken as dependent variable, an upward bias is expected due to the mechanical correlation with the specialization indicator. That is, the larger the number of loans, the larger the revenues generated by these loans. The Lerner Index is directly dependent on the total revenues as these are often taken as proxy for the price component in the index (Berger et al., 2008). Therefore by construction the Lerner index is biased through its correlation with the constructed specialization indicator and will thus not be used. The Hirschman-Herfindahl Index is a competition indicator based on banking concentration. Research of Bikker et al. (2012) shows that any concentration based indicator is an unreliable measure of competitiveness in the banking sector as it can indicate both too high- and too low levels of competition. Therefore, also the Hirschman- Herfindahl Index is not used. Instead the H-statistic from the Panzar-Rosse approach will be taken as a proxy for competition. The approach of Panzar and Rosse (1987) assesses the level of competition based on profit maximizing banks in a long run equilibrium setting. Firms optimally choose prices and quantities in order to reach the long run equilibrium condition. That is, a monopolist will set prices equal to marginal costs whereas in a perfect competition environment marginal costs equal marginal revenues. The approach of Panzar and Rosse (1977, 1982, 1987) indicates to what extent a change in factor input prices for interest-, personnel- and capital expenses will affect the total revenues earned by a specific bank. The attractiveness of the P-R method, is that it is possible to estimate a competition proxy by using regressions with few explanatory variables and it is robust to different geographical extension of the market since it uses bank level data only. In the next chapter the methodology and details of the composition of the competition proxy will be discussed.

2.3 Expected effects

In this section the expected effects of the explanatory and control variables on the level of competition are further discussed. The expected relations are presented in table 2.2.

2.3.1 Explanatory variable

If an increase in specialization of banking activities occurs, banks either increase or decrease their focus on the market. Based on competition theory explained by Belleflamme and Peitz (2015), it is assumed that banks only enter markets where profits can be attained. Previously, the role of the level of specialization is examined by Laeven and Levine (2007) who find a negative relation between the level of diversification and the valuation of firms. They estimate the impact of the level of diversification of banking activities on the valuation of banks. The valuation of firms is done by the use of Tobin's q, which is the ratio of the market value of a bank to its total assets. A ratio larger than one indicates a high valuation and signals a market value that is larger than its book value. That is, the cost to replace a bank is lower than the earning rate of a bank. In this case it is profitable to enter the market. An increase in entrants will increase supply and has a positive effect on the level of competition. A ratio smaller than one shows that the market value is lower than the total assets of the firm. In this case, the high replacement costs make it more attractive to merge banks rather than to increase supply through a new market player. This leads to a decrease in competition due to a decrease in supply. A decrease in diversification levels means a higher level of specialization and is found to have a higher level of competition as a result. This is the rationale for the following hypothesis:

H1: *Banks that have a higher degree of specialization of banking activities face a higher level of competition in their banking sector.*

2.3.2 Controlvariables

There are various factors besides the level of specialization that affect the H-statistic. These factors are controlled for to isolate the effect of specialization. The expected sign of the effect can be found in table 2.2. For each variable the reasoning is provided below. A distinction is made between country- and bank level control variables and variables that control for time related factors.

Table 2.2: Variables: sources and expectations

Variable	Acronym	Source	Expected Sign on H-statistic
Explanatory variable			
Asset based specialization	SPA	Laeven and Levine (2007)	Positive
Control variables - country			
GDP growth	GDPgrowth	Laeven and Levine (2007)	Positive
Inflation	INF	De Haas and Van Lelyveld (2010)	Positive
Current Account balance	CA	Belke and Dreger (2011)	Negative
Log(Loan Loss Reserves)	log(LLR)	Foos et al. (2010)	Negative
Control variables - bank			
Impaired loan ratio	NPL/Equity	Almarzoqi et al. (2015)	Negative
Cost to income ratio	cir	Dietrich and Wanzenried (2011)	Negative
Net interest margin	nim	Dietrich and Wanzenried (2011)	Positive
Total loans	log(loans)	De Haas and Van Lelyveld (2010)	Negative
Control variables - time			
Recession dummy	REC	Bolt et al. (2012)	Negative
Lagged loangrowth	LG(-1)	Foos et al. (2010)	Negative

This table shows the variables used and their expected effect on the competition indicator based on previous literature. The expectations are based on the findings of the authors in their research.

Country

GDPgrowth is included as controlvariable as it reflects the business cycles fluctuations and the H-statistic can be influenced by business cycle fluctuations. Laeven and Levine (2007) find that GDP is positively correlated with the excess value measured by Tobin's Q. This implies in low replacement costs and stimulates market entry, which in turn is expected to positively affect competition.

Inflation is added as control variable as is can affect the level competitiveness within a country. The effect can be two-sided. Inflation can either boost costs such as overhead, plant and equipment and thereby reduces profitability (Demirguc-Kunt et al., 2003). Or inflation increases the interest margins. Also inflation stimulates credit supply if it increases the nominal value of loan portfolios (De Haas and Van Lelyveld, 2010). These effects combined result in a positive effect on bank profits which makes is attractive to enter the market. Therefore the impact of inflation on competition is expected to be positive.

The current account balance reflects a countries' position as a lender in case of a surplus or a borrower in case of a deficit. The main components of the current account entail the import and export trade balances and foreign exchange reserves that reflect a countries' competitiveness towards other countries(Belke and Dreger, 2011). That is, in case of a CA surplus exports are larger than imports, which signals that it is more attractive to provide services rather than to import these. To be able to trade services internationally, the costs of providing these services need to be lower, indicating higher levels of efficiency. This signals a competitive market where it is unlikely to gain large profits and thus it is expected to get little focus of banks that could enter the market. In this case it is not likely to have a further increase in supply. Therefore, a negative relation between the current account balance and the level of competition is expected.

The loan loss reserves are added as control variable to take into account the exposure of banks to credit risk. Foos et al. (2010) find for all banks that the reserves they are obliged to hold for the expected loan losses increase during a crisis increase, which has a negative impact on profitability. Countries with a lot of banks that are highly exposed to credit risk provide a low profit environment in which it is unattractive to operate. The correlation of loan loss reserves with competition is expected to be negative.

Banks

The impaired loan ratio reflects differences of banks in their capability to absorb losses due to non-performing loans. Almarzoqi et al. (2015) points out that low absorbing capacity (reflected by a high value of the ratio) can threat revenues, profits and ultimately the solvency of banks. For that reason, the expected correlation with competition is negative.

The cost-to income ratio is added to control for the different efficiency levels at which banks operate. Following Dietrich and Wanzenried (2011) high values of this ratio indicate low levels of efficiency and profits which lowers the level of competition. A negative correlation between the level of competition and the cost-income-ratio is expected.

The net interest margin is used to proxy for the profitability of banks as it is often the main source of revenues of a bank (Dietrich and Wanzenried, 2011). High interest margins indicate that banks are able to generate large revenues by which profits can be raised. A positive relation between the level of competition and the net interest margin is expected.

The total amount of loans is used to take into account the differences in size between banks. De Haas and Van Lelyveld (2010) find that larger banks are able to expand credit growth faster than their smaller sized peers. As the quantity of loans increases faster for larger banks, these banks will be able to charge lower rates on loans. Banks with a smaller quantity of loans have to charge higher rates to obtain a profit equal to that of the larger banks. Only high risk borrowers will accept these higher rates which leads to different underlying risks for the loanportfolios of banks due to their size. Following this reasoning, the proxy for siz is expected to negatively correlate with the level of competition.

Time

In a recession there are various factors that negatively affect the level of competition. High non-performing loans due to excessive loan growth in pre-recession years, results in large loan losses which are the main driver of profitability of banks (Bolt et al., 2012). Also a drop in share prices reflects a lower valuation of banks which is expected to translate in lower levels of competition.

In retrospect, most crises are preceded by a period of rapid credit growth which causes a negative effect on competition in the long run. This is confirmed by Foos et al. (2010) who find a that loan growth leads banks to an increase in loan loss provisions. Excessive growth in a previous year is expected to signal recession effects in the current year. The recession effects on competition are expected to be negative. For this reason, the first lag of the loan growth is added.

3. Methodology

In his chapter the methodology is explained that is used to estimate the effects of specialization on the level of competition. The first section describes the process of obtaining the proxies for competition and specialization, on both country- and bank level. Examination of the effects on different levels requires two different estimation techniques for the competition proxy. The characteristics and results of these techniques are discussed in more detail. The second section describes the characteristics of the OLS and fixed effects estimation approaches using the proxies for specialization and competition. The fixed effects model is estimated using either variation within individual banks or countries or using variation within time.

3.1 Method

In this section the proxies for competition on country level and bank level are estimated as well as the proxy that indicates the level of specialization of banking activities. These variables will be used as dependent and explanatory variables in the estimation to determine the effect of specialization on the level of competition.

3.1.1 Data

The bank level data is retrieved from Bankscope for the period 2005-2015. Bankscope (Bureau van Dijk) is used because of its accurate data on core factors of annual reports. The data used are of consolidated scope with no further bankspecific selection criteria. A description, definition and source of all variables can be found in table 7.7. The data on the country level variables are retrieved from the Worldbank database for each of the countries in the sample [1].

3.1.2 Competition proxy

The H-statistic as stated in the model of Panzar and Rosse (1977) is used as competition proxy. It is calculated by estimating the reduced-form equation 3.1. This equation relates the inputfactors to the total unscaled revenues. The inputfactors $log(w_1)$,$log(w_2)$ and $log(w_3)$ are proxies for interest costs, personnel

[1] For GDP growth, the Current Account balance and Inflation the following databases are used: http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG; http://data.worldbank.org/indicator/BN.CAB.XOKA.GD.ZS; http://data.worldbank.org/indicator/FP.CPI.TOTL.ZG

costs and costs of physical capital respectively. The definitions and sources of all variables used are described in more detail in table 7.7. The P-R model is estimated with the following control variables captured by the term $CF_{ig,jt}$: log(total assets) and the ratios log(loan-to-asset) and log(equity-to-assets). As these control variables are used in the determination of the H-statistic, these cannot be included as control variables in the estimation of the effect of specialization which is described in section 3.2. The original P-R model requires the coefficients of the inputfactors to be elasticities. The common approach is followed by estimating the reduced form equation in logarithms as the coefficients can then be interpreted as elasticities. For each country the following equation is estimated per year:

$$log(TR_{ig,t}) = \beta_0 + \beta_{1ig,t} log(w_{1gi,t}) + \beta_{2ig,t} log(w_{2ig,t}) + \beta_{3ig,t} log(w_{3ig,t}) + \sum_{j=1}^{3} \gamma_j log(CF_{ig,jt}) + \epsilon_{ig,t} \quad (3.1)$$

$$H_{gt} = \sum_{k=1}^{3} \beta_{kgt} \quad (3.2)$$

where:

$log(TR)_{ig,t}$	= log of the total revenues for bank i in country g at year t
$log(w_1)_{ig,t}$	= log of the ratio interest expenses to total deposits for bank i in country g at year t
$log(w_2)_{ig,t}$	= log of the ratio personnel expenses to total assets for bank i in country g at year t
$log(w_3)_{ig,t}$	= log of the ratio other operating expenses to total assets for bank i in country g at year t
$log(CF)_{ig,jt}$	= log of the controlvariables j for each bank i in country g at year t
$\epsilon_{ig,t}$	= the estimation error term
H_{gt}	= H-statistic for country g at year t
j	= {Total Assets, loan-to assets, equity-to-assets}
i	= {1,2..2965}
t	= {2005, 2006,. . . ,2015}
g	= {1,2,..20}

A high value of the H-statistic indicates a high level of competition. A value of one indicates a long term competitive equilibrium. In a long run competitive equilibrium, the increase in marginal costs due to an increase in inputfactors will lead to an increase in marginal revenues. This results in a H-statistic of value one. A long run competitive equilibrium implies a fully efficient, saturated market without an increase in market

entry as no profits can be obtained. Negative values of the H-statistic indicate a monopoly. Any increase in inputfactors leads to an increase in the marginal costs. By the monopolist's equilibrium condition, any increase of costs increases the price and in turn lowers the monopolist's equilibrium output and revenues. This results in a negative H-statistic. Any value of the H-statistic between zero and one is shown to be an indication of a monopolistic competitive environment where the same condition for profit maximization holds as in the case of perfect competition (Belleflamme and Peitz, 2015).

The starting point of the analysis is on country level as the ringfencing regulations are implemented at a national level. Also, it is common to determine the H-statistic on a country level (Bikker and Haaf, 2002), (Claessens and Laeven, 2004), (Laeven and Levine, 2007). However, the transition from bank level data to country level data has several drawbacks.

The initial dataset contains observations on 3452 banks in twenty countries. Clustering these banks per country reduces the dataset to observations on only twenty countries. In addition, a lot of variation in the specialization variable is lost due to averaging. Moreover, the country level estimation limits the possibility to examine effects of individual banks such as size or the direction of specialization.

To counter these shortcomings, the addition analysis on bank level is performed. It allows a more extensive use of the dataset, without losses of information and extends the analysis to determine the effects of bank related aspects. The H-statistic is determined on country level and on bank level to estimate the effects of specialization on competition on different levels.

Below the process of determining the H-statistic on country level is described first after which the bank level H-statistic is determined.

H-statistic on country level

The country level H-statistic (H_{gt}) is estimated for each country per year using the variation across banks within each country. The sample of banks within each country is used to estimate the unscaled total revenues on the inputfactors as stated in equation 3.1[2]. The number of banks per country must be sufficient to obtain a reliable H_{gt}. The minimum number of banks per country that is requested is twenty, according to Claessens and Laeven (2004). Countries with less than twenty banks are removed from the sample [3]. The remaining sample comprises twenty countries with at least twenty banks for the years 2005-2015. The total number of

[2]The estimation used is a regular OLS with robust standard errors.

[3]Excluded countries are: Albania, Bosnia and Herzegovina, Bulgaria, Belarus, Cyprus, Czech, Estonia, Greece , Croatia, Hungary, Liechtenstein, Lithuania, Latvia, Monaco, Montenegro, Macedonia, Malta, Poland, Romania, Serbia, Slovenia, Slovakia, San Marino and Ukraine

banks in the sample is 3452 with 14964 bank year observations. The derivation of the H-statistic is described in more detail in the appendix for the several countries.

The mean value of H_{gt} over the years 2005-2015 is 0.357 as is reflected in table 3.1.

Negative values of H_{gt} are found for Sweden (-0.047), Luxembourg (-0.075) and Ireland (-0.041). This suggests that the banking sector in Sweden, Luxembourg and Ireland has highly incompetitive characteristics. This is mainly the result of negative values of β_2, personnel expenses. The minimum value of the H_{gt} for all years for all countries is -3.554 and is found for Sweden in 2006.

The highest values of H_{gt} are found for Finland (0.859) and Canada (0.835). This suggests that the banking sector in Finland and Canada has highly competitive characteristics. For Canada this is due to a high relation correlation of β_1, the proxy for interest expenses whereas for Finland also the personnel proxy plays a large role. The maximum value of the H_{gt} of all years for all countries is 2.808 and is found for Finland in 2006.

As the H_{gt} is calculated until 2004 by Bikker et al. (2012), the results of this approach supplement the banking competition literature by providing the H_{gt} for the period 2005 to 2015.

Even though this approach is widely used, it has several drawbacks. First, the dataset is highly incomplete. Each bank has on average only data on 4.3 years from the total of 11 years. Furthermore, the remaining dataset for further estimations is severely reduced as it comprises only twenty countries with

Table 3.1: H_{gt} & $\beta's$ averages per country for the period 2005-2015

Country	H_{gt}	β_1	β_2	β_3
Average	.357	0.218	-0.076	0.151
AUT	.582	0.254	0.164	0.163
BEL	.538	0.447	0.010	0.081
CAN	.835	0.937	-1.541	0.144
CHE	.405	0.347	-0.010	0.068
DEU	.258	0.174	0.025	0.058
DNK	.416	0.105	0.195	0.115
ESP	.227	0.103	-0.140	0.264
FIN	.859	0.389	0.357	0.112
FRA	.164	0.123	-0.078	0.119
GBR	.360	0.129	0.187	0.045
IRL	-.041	0.069	-0.136	0.029
ITA	.191	0.088	0.126	-0.023
LUX	-.075	0.081	-0.310	0.154
NLD	.497	0.279	-0.046	0.265
NOR	.242	0.136	-0.015	0.121
PRT	.504	0.298	0.011	0.195
RUS	.557	0.133	0.301	0.123
SWE	-.047	0.006	-0.920	0.868
TUR	.450	0.116	0.258	0.077
USA	.226	0.152	0.0413	0.033

Source: own calculations

Note: this table displays the average values for the H_{gt} and inputfactors for interest expenses, personnel expenses and physical capital expenses per country over the period 2005-2015.

observations on 11 years. Second, the number of banks per country differ greatly. As a consequence the weight of single observations is more for countries that have only the minimum amount of twenty banks than countries with a larger number of banks. Stated differently, the results are more biased towards individual observations if the number of banks in a country is twenty compared to countries with hundreds of banks in the sample. Third, in estimating the H-statistic on country level, a large amount of bankspecific information is lost. Statements on size or direction of specialization of individual banks can no longer be made. To counter the three issues stated above, the H-statistic is also calculated on bank level per year.

H-statistic on bank level

The bank level H-statistic is determined per bank per year to counter the issues of the country level H-statistic. For all variables in the reduced form equation 3.1, there is only one observation for each bank per year. As opposed to the country level determination of the H-statistic, on bank level there is no longer a sample set of at least twenty observations available that is necessary to provide a reliable H-statistic per bank using an OLS estimation.

The proposed solution is to allow for non-linear functions that estimate the heterogeneous effect on an individual level using a non-parametric model. In order to estimate the heterogeneity on individual bank level without making assumptions on the functional form, the Kernel Regularization Least Squares (KRLS) estimation is used (Ferwerda et al., 2015).

KRLS allows for a non-linear functional form while estimating the correlation of the input factors with the total revenues as is shown in equation 3.3. Similar to the OLS approach, the H-statistic is the sum of the coefficients as is presented in equation 3.4. However, the coefficients are obtained by a different model. This model is based on two key insights (Hainmueller and Hazlett, 2013). The first is the concept of a similarity based view. The second is regularization. In the similarity based concept, information is leveraged on the similarity between different observations rather than a weighted combination as in OLS. It uses the concept that similar observations of explanatory variables are likely to be similar for the dependent variable. It allows complex functions to fit according to the level of similarity of observations.

For each point in time, the reduced form equation 3.3 is per individual bank. This requires a complete dataset. For all variables in equation 3.3 the observations must be available at every point in time, for each bank. This reduces the dataset to 308 banks.

The dependent variable, total revenues, is some non-linear function of the inputfactors and control variables and is estimated according to equation 3.3, where all variables are in logarithms for reasons explained

in section 3.1.2.

$$TR_{it} = c_1 k(w^*_{1it}, w_{1it}) + c_2 k(w^*_{2it}, w_{2it}) + c_3 k(w^*_{3it}, w_{3it}) + \sum_{j=1}^{3} c_j k(CF^*_{jit}, CF_{jit}) + \epsilon_{it} \tag{3.3}$$

where,

TR_{it} = Total Revenues for bank i at year t

c_k = Scaling weight for inputfactor k

w_{1it} = Proxy for interest costs for bank i at year t

w_{2it} = Proxy for personnel costs for bank i at year t

w_{3it} = Proxy for physical costs for bank i at year t

CF_{jit} = control variable j for bank i at year t

j = {log(total assets), log(loan-to-assets), log(equity ratio)}

i = {1,2,..,308}

t = {2005,..,2015}

The similarity concept is reflected by the kernel function $k(w^*, w_k)$. An intuitive interpretation is that it presents the similarity of w^* to w_i (Ferwerda et al., 2015). By using a Gaussian kernel, there is a mapping $\phi(w_k)$ that transforms the variable w_k to a multi-dimensional vector space. The dimension of the mapping is infinite as the Gaussian kernel is used. The best fit will be found as highly complex functions and over-fitting is allowed (Hainmueller and Hazlett, 2013). This leads to the necessity of the second aspect which is the regularization concept.

KRLS uses Tikhonov (1963) regularization. In the fitting process it regulates the level of complexity by penalizing more complex functions. This is done by including a regularization term to the loss function. The loss function indicates how "wrong" the function is at each observation. The regularization term penalizes the degree of complexity in the fitting process. The combination of the similarity concept and regularization creates a trade-off between complexity and a best fit while maintaining estimators with a similar interpretation to an OLS estimator. Ferwerda et al. (2015) and Hainmueller and Hazlett (2013) find that the KRLS can be used as an alternative approach to ordinary regression models. It provides reliable estimators when only a small number of observations is available for the explanatory variables.

The bank level H-statistic that is estimated per year is the sum of the coefficients where the coefficients are the partial derivatives of the non-linear function to each inputfactor as presented in equation 3.4.

$$H_{it} = \frac{\delta k(w^*_{1it}, w_{1it})}{\delta w_{1it}} + \frac{\delta k(w^*_{2it}, w_{2it})}{\delta w_{2it}} + \frac{\delta k(w^*_{3it}, w_{3it})}{\delta w_{3it}} \tag{3.4}$$

The bank level H-statistic, H_{it}, indicates the level of competition for each bank per year. The average H-statistic signals imperfect competition for most banks indicated by a positive H-statistic below 1. A description of the results of the estimations is shown in table 3.2. The average H_{it} has increased compared with H_{gt} and shows a value of 0.528. A value of H_{it} above 1 is shown in approximately 5% of the cases. It suggests that only this small set of banks are in a competitive equilibrium. A negative value of H_{it} is found for less than 10% of the cases, which suggests that a bank operates in a highly incompetitive environment. The main driver of the negative impact of the inputfactors on the total revenues is β_1. While the average effect of all inputfactors on the H-statistic is positive.

The proxy for interest costs, β_1, provides the smallest range and has the lowest averaged value. β_2 Has the highest average value of 0.300 and ranges between -0.541 and 0.976. The largest range is found for β_3, while its average value is 0.211.

Table 3.2: Descriptives on the banklevel H-statistic and coefficients of the inputfactors

variable	mean	sd	min	p25	p50	p75	max	N
H_{it}	0.528	0.349	-0.742	0.367	0.560	0.736	1.788	2965
β_1	0.017	0.096	-0.384	-0.034	0.003	0.056	0.569	2965
β_2	0.300	0.239	-0.541	0.187	0.359	0.450	0.976	2965
β_3	0.211	0.211	-0.940	0.105	0.200	0.318	1.140	2965

This table summarizes the estimation results of bank level estimation of the H-statistic with KRLS for the period 2005-2015.

The bank level estimation approach uses a complete dataset for 308 banks for the period of 11 years with 2965 bank year observations. As opposed to the country level H-statistic, in the bank level estimation process there is no different number of observations among banks which would bias the analysis. Additionally, it provides a more accurate insight in the level of specialization as the extreme values are not removed due to averaging. Also it allows a more extensive analysis by examining the direction of specialization. The

H-statistic H_{it}, calculated by the KRLS method, serves as a proxy for the level of competition for each bank at for a specific year and will be used throughout this paper for all bank level estimations.

Equilibrium test

Panzar and Rosse (1987) base their model on the assumption that markets are in a long run equilibrium. The equilibrium condition is tested in previous research of both Claessens and Laeven (2004) and Bikker and Haaf (2002) by using the return on assets (ROA) as a substitute for the dependent variable. In a long term competitive equilibrium, the ROA should not depend on input factors. Using the ROA as the dependent variable in the reduced form equation would result an H-statistic value of zero. However, more information on the average cost function is needed to confirm a long term competitive equilibrium. Bikker et al. (2012) show that without further information, markets can well be in a long run competitive equilibrium for any value of the H-statistic below 1, even for negative values. The details of the average cost function per individual bank in the sample are not known. The ROA test is not applied as it cannot confirm a monopoly, oligopoly, long- or short run competitive equilibrium without knowledge on the average cost function.

3.1.3 Specialization indicator

A bank level specialization indicator is composed to indicate the level of specialization of the activities that banks engage in. This variable is shown in equation 3.5. This indicator shows to what extend the total assets of a bank consist of loans. It assigns a value near one for high levels of specialization and a value near zero for banks that are more diversified.

$$Specialization(SPa) = \left| \frac{\frac{1}{2} * (TotalAssets) - (Loans)}{\frac{1}{2} * (TotalAssets)} \right| \tag{3.5}$$

A banking conglomerate can choose to diversify its activities or to specialize its activities. For a banking conglomerate that diversifies its activities, loans will make up for example half of the total assets. In this case, the value of the specialization indicator is zero.

A banking conglomerate that specializes its activities, can specialize towards lending activities (loans) or non-lending activities. If a bank specializes towards loans, loans will make up a large part of the total assets. If a bank specializes towards non-lending activities, total assets will consist of loans to a lesser extend. These two extreme cases show that higher levels of specialization result in an indicator value near one.

In addition to the examination of the general effect of specialization, the bank level estimation allows to examine the direction of specialization as well. A dummy variable is created that reflects the scenario in which a bank has a specialization level above the overall mean and it is specialized towards loans. This extends the analysis by examination of the direction of specialization in addition to the effect of a general level of specialization.

The country level estimation of specialization on competition requires the specialization variable to be aggregated. For each country, the average value of specialization of all banks in this country is used. This leads to an increase in the mean from 0.381 to 0.469 as is shown in table 3.3. More important is the reduction in variation in the specialization variable that arises due to averaging the level of specialization per country. The differences in the standard deviation and in the minimum and maximum values show a reduction in variation and thereby a loss of information.

Table 3.3: Descriptives on the specialization indicator

Variable	**Average**	**Stand. Dev.**	**Minimum**	**Maximum**	**p10**	**p90**	**N**
SPA_{gt} (country level)	0.469	0.088	0.253	0.738	0.357	0.591	220
SPA_{it} (bank level)	0.381	0.209	0.001	0.983	0.085	0.662	2965

This table reflects descriptives of the specialization indicator both on country level as on bank level for the period 2005-2015.

In this section the specialization indicator and competition proxies are determined on both a country level and bank level. These variables will be used in as explanatory and depended variables in the estimation approach as will be discussed in the next chapter.

3.2 Estimation approach

This section describes the OLS and fixed effects estimation approaches that are used to examine the effect of specialization on competition. Both individual- and time fixed effects are applied in which the H-statistic is the dependent variable and the specialization indicator the explanatory variable.

3.2.1 OLS

A simple OLS estimation may not suffice to provide reliable results due to possible autocorrelation, heteroscedasticity and unoberserved heterogeneity. These issues are described below.

Autocorrelation

OLS assumes that the error terms over time are not correlated in order to ensure that the test statistics are not invalidated. However, it is realistic to assume that the error terms are correlated when using multiple observations on the same individual over time. The test made by (Wooldridge, 2002)[4] is used to test for the presence of autocorrelation. The results presented in the Appendix 7.2 confirm that autocorrelation is present. The approach of Verbeek (2013) is used by adding the first lag of the dependent variable as explanatory variable in the estimations that use variation over time to counter the presence of autoregressive variables.

Heteroscedasticity

Furthermore, OLS assumes that all variances of the error terms are identical. If heteroscedasticity is present, the estimator will no longer be efficient. Since estimation occurs over a period of 11 years for twenty countries or 308 banks, it is unlikely that for each country or bank the same variances of the error terms are present. The test results in appendix 7.3 confirm the presence of heteroscedastic variances of the error term. The error terms are clustered on the level of the individual to counter this issue. The error terms are clustered on countries- and banks for estimation on country level and bank level respectively. The use of clustered White standard errors counters the invalidation of the test statistics due to unequal variances of the error terms (Verbeek, 2013).

Unobserved heterogeneity

A third issue with using OLS estimations is possible unobserved heterogeneity. There is unobserved heterogeneity if an unobserved factor, which is correlated with the explanatory variable, also affects the dependent variable, the H-statistic. In case the covariance of the unobserved factors and the explanatory variable is nonzero, the estimates will no longer be unbiased and consistent. Since the unobserved factor is not captured in a variable in the OLS regression, the effect of the unobserved factor is captured by the error term. But because the unobserved factor is also correlated to the explanatory variable, the correlation between the error term and the explanatory variable is not zero. In this case the condition for the OLS to provide a reliable estimate does no longer hold. To solve this issue, the fixed effects estimation approach is used, which is described in the next section.

[4]This test is based on the Durban Watson test and specifically focuses on panel data (Baltagi, 2008)

3.2.2 Fixed effects

The effect of the level of specialization on competition is estimated on country level and on bank level using individual fixed effects and time fixed effects.

The fixed effects estimation approach splits the error term in two components: a constant term [5] and an error term. The constant term captures the unobserved heterogeneity and can be correlated to the explanatory variable [6]. The error term is assumed to be homoscedastic and not correlated with the explanatory variable. For the fixed effects coefficient to be consistent, the explanatory variable must be exogenous. If the error term is normally distributed, then the estimate will also be unbiased. Below the individual and time fixed effect estimations are further described.

Individual fixed effects

The individual fixed effects approach estimates the effect of specialization within an individual over time as reflected in equation 3.6. It uses the time dimension to determine the level of specialization for each country or bank, depending on the level of estimation. The term α_i captures the time invariant constant factors that relate to the specific individual. In addition to the constant time invariant factors, there might be time varying factors that are not captured in α_i but do have an impact on the H-statistic. A major factor that varies across time -whereby its effect is not included in α_i- is the presence of a recession. The recession indicators that are explained in section 2.3, the dummy variable and the lagged variable of loan growth, are included to control for the time varying factors. The following panel model is estimated with individual fixed effects both on country- and on bank level:

$$H_{ig,t} = H(-1)_{ig,t} + \alpha_{ig} + \beta_1 SPa_{ig,t} + \beta_2 LG(-1)_{ig,t} + \beta_3 REC_{gt} + u_{ig,t} \tag{3.6}$$

where:

[5] The general constant term is absorbed by the constant factor α_i and therefore not present in equation 3.6, 3.7 or 3.8

[6] The correlation between the two terms is the basis for the Hausman test which determines whether the random effects method or the fixed effects method should be used. The results in Appendix 7.1 show that the null hypothesis that $Cov(\alpha_i, SPA_{it}) = 0$) is rejected which confirms that the fixed effects method is appropriate.

$H_{ig,t}$ = H-statistic for bank i or country g, depending on the level of estimation, at time t

$H(-1)_{ig,t}$ = First lag of the depended variable

α_{ig} = Individual fixed effects ter

$SPa_{ig,t}$ = Specialization indicator

$LG(-1)$ = Lagged loangrowth

REC = Recession dummy

$u_{ig,t}$ = Error term

Time fixed effects

The time fixed effects approach estimates the effect of specialization within a year over all individuals as reflected in equations 3.7 and 3.8. The time fixed effects approach uses the variation across countries or banks within a given year to determine the level of specialization per year. The term γ_t captures the constant individual-invariant factors that relates to this specific year. Beside the factors captured by γ_t, there are other factors that vary per individual and affect the level of competition. To control for these individual varying factors the control variables that are explained in section 2.3 are added.

The factors that indicate specific individual characteristics are different if the individuals are countries or when the individuals are banks. Different controlvariables are needed to control for country- or bank level estimations. The equation below estimates the country level effect of specialization on competition with time fixed effects:

$$H_{gt} = \gamma_t + \beta_1 SPa_{gt} + \sum_{z=1}^{4} \beta_z Z_{zgt} + u_{gt} \tag{3.7}$$

where:

H_{gt} = H-statistic for country g at time t

γ_t = Time fixed effects term

SPa_{gt} = Specialization indicator for country g at time t

Z_{zgt} = Controlvariables z for country g at year t, z={ GDP growth, inflation, current account, log(LLR)}

u_{gt} = = Error term

To estimate the effect of specialization on competition on bank level the following equation is estimated is with time fixed effects:

$$H_{it} = \gamma_t + \beta_1 SPa_{it} + \sum_{l=1}^{4} \beta_l W_{lit} + u_{it} \tag{3.8}$$

where:

H_{it} = H-statistic for bank i at time t

γ_t = Time fixed effects term

SPa_{it} = Specialization indicator for bank i at time t

W_{lit} = Represents the controlvariables l for bank i at year t, l={Impaired loan ratio, total loans, nim, cir }

u_{it} = Error term

Two important notifications have to be made. First, the controlvariables used in equations 3.1 and 3.3, in determining the H-statistic, differ from the controlvariables in equation 3.8. The results of the estimations would be severely be biased if the same controlvariables were used. But as the most common proxies for size and credit risk are used in determining the H-statistic, alternative proxies are used for the total size, credit risk, efficiency and profitability. Second, the logarithm of the variables loan loss reserves and total loans are used to linearize the trend and to be able to interpret the coefficients of the variables as elasticities.

Model fit

There are two indicators used to indicate which of the two estimation approaches, OLS and fixed effects, provides the best fit. The first is the adjusted R^2 which is a goodness-of-fit measure that indicates what level of the variance in the dependent variable is explained by the variance of the explanatory variable. To ensure efficiency and minimize overfitting, this metric penalizes for additionally added variables. The second indicator for the fit of the model is the Aikaiku Information Criterium (AIC) (Akaike, 1981). The AIC is used to compare models based on their differences with the likelihood function. This metric penalizes for the number of explanatory variables. The preferred model has the least deviation from the likelihood function and thus the lowest AIC value. The fixed effects estimation approach controls for the unobserved heterogeneity and thereby reduces the ommitted variable bias. It is expected to provide a higher R^2 and a lower AIC value.

To summarize, in the first section of this chapter the competition proxies and specialization proxies are determined both on country level and on bank level. The bank level proxies prove to be more solid indicators without loss of information. bank level proxies allow the use of a larger dataset in further estimations, where the H-statistic is the dependent variable and the specialization indicator is the explanatory variable. In the second section is shown that the shortcomings of the OLS estimation approach require the use of the fixed

effects estimation approaches. Both the individual- and time fixed effects estimations are applied at country level and bank level. The results of the estimations are discussed in the next chapter.

4. Results

In this chapter the regression results are presented to answer the question what the impact is of the level of specialization of banking activities on the level of competition in the period 2005 to 2015. First the results of the estimation on country level are discussed. The second section covers the analysis of the results on bank level. In both sections the results of the time- and individual fixed effects estimation approaches are compared with the OLS estimation approach to see the impact of the omitted variable bias.

4.1 Country level estimation

The results in table 4.1 show the results of the estimation of the effect of the level of specialization on the level of competition on country level. The dependent variable is the H-statistic which is obtained by the common approach estimations in the first step as described in section 3.1.1. The results in table 4.1 are discussed below.

4.1.1 Individual fixed effects

For both OLS and fixed effects estimations the specialization indicator (SPa) shows a negative correlation with the H-statistic. The negative sign suggests that across the years in the sample, the level of specialization within a country is negatively correlated with the level of competition. The coefficient is significant at a 10% level in the OLS estimation and at a 1% level in the country fixed effects estimation. The estimated coefficient for the variables that control for a recession, the recession indicator dummy variable and the lagged loan growth, show a positive sign which is not in line with the expectations stated in chapter two. These values are highly insignificant with p-values near 1 for LG(-1) and near 0.8 for REC as is illustrated in table 4.2.

Furthermore, the adjusted R^2 is low and declines when the fixed effects estimation is used. Also the AIC for OLS and fixed effect approaches is similar. This suggests that the fixed effects estimation approach does not improve the model. Combined, these factors indicate low explanatory power of the individual fixed effects model and are reasons to question the results. Further analysis of the effect of specialization on competition is required. Therefore, the effect of specialization within years is estimated using time fixed effects of which the outcomes are discussed below.

Table 4.1: Regression results of country level estimations

	(1)	(2)	(3)	(4)
	H_{gt}	H_{gt}	H_{gt}	H_{gt}
SPa	-0.700*	-0.721***	-0.488	-0.791**
	(0.054)	(0.002)	(0.205)	(0.038)
$H(-1)_{gt}$	0.244***	0.240**		
	(0.009)	(0.018)		
LG(-1)	0.0000694	0.0000246		
	(0.974)	(0.987)		
REC	0.0101	0.0152		
	(0.831)	(0.746)		
GDP growth			-0.0269*	-0.0356
			(0.059)	(0.146)
Inflation			0.0131	0.0159
			(0.167)	(0.146)
Current account			-0.00928*	-0.00999
			(0.098)	(0.170)
Log(LLR)			-0.0680*	-0.0996***
			(0.056)	(0.009)
Constant	0.626***	0.637***	1.515**	2.084***
	(0.003)	(0.000)	(0.011)	(0.001)
Observations	200	200	220	220
Adjusted R^2	0.119	0.089	0.131	0.175
AIC	180.493	178.662	320.404	299.082
Time FE	No	No	No	Yes
Individual FE	No	Yes	No	No

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns [1] and [2] reflect the results of the analysis within countries over time. Column [1] shows the OLS results. Column [2] shows the result of the country fixed effect estimations. Columns [3] and [4] reflect the results of the analysis within years across countries. Column [3] shows the OLS results. Column [4] shows the results of time fixed effects.

Table 4.2: Variables: sources, expectations and actual signs

Variable	Acronym	Source	Expected sign	Actual sign
Explanatory variable				
Asset based specialization	SPa	Laeven and Levine (2007)	Positive	Negative
Control variables - country				
GDP growth	GDP growth	Laeven and Levine (2007)	Positive	Negative
Inflation	INF	De Haas and Van Lelyveld (2010)	Positive	Positive
Current Account balance	CA	Belke and Dreger (2011)	negative	Negative
Log(Loan Loss Reserves)	log(LLR)	Foos et al. (2010)	Negative	Negative
Control variables - bank				
Impaired loan ratio	NPL/Equity	Almarzoqi et al. (2015)	Negative	Negative
Cost/income	cir	Dietrich and Wanzenried (2011)	Negative	Negative
Net interest margin	nim	Dietrich and Wanzenried (2011)	Positive	Positive
Total loans	log(loans)	De Haas and Van Lelyveld (2010)	Negative	Negative
Control variables - time				
Recession dummy	REC	Bolt et al. (2012)	Negative	Negative*
Lagged loangrowth	LG(-1)	Foos et al. (2010)	Negative	Negative*

This table shows the variables used and their expected effect on the competition indicator based on previous literature. The expectations are compared with the actual sign according to the results of tables 4.1 and 4.3.

*The sign of the recession indicator differs between the country level estimations (positive) and bank level estimations (negative). Given the highly insignificant results of the country level estimations, the relationship for the bank level results is stated in this table.

4.1.2 Time fixed effects

For the specialization indicator a negative sign appears both using OLS and time fixed effects estimation approaches. The negative sign suggests that across the countries in the sample, the level of specialization within a year is negatively correlated with the level of competition. The coefficient of is significant at a 5% level using time fixed effects. Furthermore, the coefficients of the controlvariables are in line with the expectations except for GDP growth as is reflected in table 4.2. A possible explanation is provided by De Haas and Van Lelyveld (2010) who find a positive impact of GDP growth on credit growth. More specifically, they find that larger banks are able to increase credit growth at a higher pace than their specialized competitors. Its beneficial effect of an increase in profits will be unequally distributed among banks in favor of the larger

banks. However, the analysis on country level does not allow to make any statements on the size of banks. This is one of the reasons to extend the analysis on bank level for which the results are described in the next section. The adjusted R^2 increases when using time fixed effects and is larger compared to the estimations using individual fixed effects. Combined with a decline in AIC, this indicates that the fixed effects approach provides better results than the OLS estimation approach by reducing the omitted variable bias.

Limitations

The results of this analysis are prone to several biases as stated in section 3.1.2, even though these results show a significant and consistent negative relationship between the specialization indicator and country level H-statistic. The first of the biases is that the number of observations on individual countries is limited. The number of observations is only 200 for the individual fixed effects and 220 for the time fixed effects. Furthermore, the country level H-statistic relies on the number of banks in this country. This bias in the determination of the country level H-statistic in the first step, is likely to bias the results of the estimation in the second step as well. In addition, there is a loss of information due to averaging the SPa to obtain a country level specialization indicator. These factors limit the remaining conclusions and interpretation of the results severely.

4.2 Bank level estimation

The results of equations 3.6 and 3.8 are provided in table 4.3 for the bank level analysis of the impact of specialization on competition. The dependent variable is the H-statistic that is obtained by the KRLS estimation approach.

4.2.1 Individual fixed effects

The results of bank level estimations using OLS and individual fixed effects are shown in columns [1] and [2] of table 4.3 and elaborated upon below.

The estimated coefficients for the specialization indicator are negative both for the OLS estimation as for the individual fixed effects estimation approach. The negative sign suggests that across the years in the sample, the level of specialization within a bank is negatively correlated with the level of competition. In the OLS estimation the coefficient is significant at a 10% level. The negative sign of the coefficient of the specialization variable indicates that an increase in specialization of a bank over the years coincides with a

decrease in the level of competition. In addition, the negative sign of the specialization dummy suggests a negative correlation with competition, even for banks that are specialized towards loan based activities.

The signs of the coefficients of the recession indicators, REC and the lagged loan growth, are negative. This suggests that an impact of a recession year negatively relates to the level of competition which is in line with the expectations as stated in table 4.2.

Both the adjusted R^2 as the AIC indicate a higher explanatory power and better fit of the model than previous results of the country level estimations. The R^2 increases and the AIC decreases comparing the individual fixed effects compared to the OLS estimation approach. This indicates that the fixed effect approach provides better approximation than the OLS estimates by reducing the omitted variable bias.

4.2.2 Time fixed effects

The results of bank level estimations using OLS and time fixed effects are shown in columns [3] and [4] of table 4.3 and discussed in more detail below.

Consistent with the previous estimates, the coefficient for the specialization indicator is negative both using OLS and time fixed effects. The negative sign suggests that across the banks in the sample, the level of specialization within a year is negatively correlated with the level of competition. The coefficient of the OLS estimate is consistent on a 10% level. These values suggest that within a year, the level of specialization negatively relates to the level of competition across all banks in the sample. also for specialization towards the loan based activities a negative relation between specialization and competition within years is found, as is reflected by the negative values of the specialization dummy.

The sign of the impaired loan ratio, the cost-income ratio and the net interest margin are in line with the expectations. The proxy to control for the size of banks, log(loans), appears with a negative sign as is shown in table 4.2. This suggest that the size of a bank is negatively correlated with the level of competition. It confirms the findings of De Haas and Van Lelyveld (2010) that large banks enjoy a competitive advantage and thereby support the positive correlation found in the previous section between GDP growth and competition.

The R^2 increases when using the time fixed effects estimation approach and indicates a high level of the fit of the model. Also the AIC decreases, which confirms that the fixed effects approach provides more reliable results by taking into account the omitted variable bias.

The limitations that remain for the bank level estimations are the endogenous choice for banks to specialize and data constraints. These issues will be further discussed in the next chapter.

Table 4.3: Regression results of bank level estimations

	(1)	(2)	(3)	(4)
	H_{it}	H_{it}	H_{it}	H_{it}
SPa_{it}	-0.116*	-0.0601	-0.118*	-0.164
	(0.063)	(0.661)	(0.067)	(0.221)
$H(-1)_{it}$	0.773***	0.424***		
	(0.000)	(0.000)		
REC	-0.0238	-0.00892		
	(0.175)	(0.612)		
LG(-1)	-0.000579	-0.000666		
	(0.336)	(0.276)		
Specialization dummy	-0.0218	-0.00673	-0.0270	-0.0170
	(0.378)	(0.856)	(0.302)	(0.612)
NPL/Equity			-0.000982**	-0.00167***
			(0.010)	(0.000)
log(loans)			-0.0189***	-0.00981
			(0.002)	(0.821)
nim			0.00519	0.0364
			(0.516)	(0.188)
cir			-0.000914	-0.00294***
			(0.142)	(0.002)
Constant	-0.0930***	-0.321***	-0.325**	-0.0203
	(0.000)	(0.000)	(0.014)	(0.975)
Observations	2344	2344	2344	2344
Adjusted R^2	0.642	0.645	0.629	0.698
AIC	1588.636	659.375	1655.398	873.266
Time FE	No	No	No	Yes
Individual FE	No	Yes	No	No

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Columns [1] and [2] reflect the results of the analysis within banks over time. Columns [3] and [4] reflect the results of the analysis within years across banks.

Concluding remarks

The results show that the specialization indicator is negatively correlated with the level of competition. This implies that regulations that should enforce competition, should not be aimed at increasing the level of specialization of banking activities. Regulations that should increase competition need to be aimed at reducing the size, enforce higher absorbing capacity and increase the cost efficiency of banks while allowing for diversification.

The negative relationship between specialization and competition does not support the main hypothesis. Explanations can be found combining the estimation results with the theory and previous literature of chapter two and are summarized below. It might be that no homogeneous product is created despite the enforced degree of specialization. In this situation the strategic effect can dominate. If this effect dominates, maximum differentiation is optimal which does not ease market entry and negatively affects competition (Salop, 1979). Furthermore, if the ringfencing programs lead to specialization of activities, the findings of Cerutti et al. (2010) show a significant increase in capital needs which result in higher cost and put pressure on the profits that make market entry unattractive. Lastly, an explanation for a negative correlation between specialization and competition is provided by findings Brämer et al. (2013). They suggest that a restriction for banks to only engage in activities in an exclusive segment, can create a setting in which a specialized bank is better able to charge differentiated prices and enjoy more market power in a less competitive environment.

5. Discussion

In this section the restrictions, bias and further research will be discussed in more detail. First the bias due to decisions and behavior of banks are elaborated. Second, the limitations due to data constraints are discussed. Finally, a proposal for future research is done that takes into account the solutions for the stated problems.

5.1 Endogeneity

The driving force of the main variable used in this paper, is the decision to specialize or diversify activities.

Diversification discounts or specialization costs due to different levels of specialization, should be attributed to the level of specialization, rather than to decisions regarding banking conglomerates' business models in the first place. The problem is that banks themselves choose to engage in only one activity and thus specialize, or to combine these activities and diversify. The choice for different specialization levels leads to bias the results according to Lamont and Polk (2002) and Villalonga (2004) who find that diversification benefits do exist but the benefits are often overstated due to this bias. Also Laeven and Levine (2007) confirm that controls for these banksspecific traits are necessary to avoid the misleading econometric results. Given the scope of this research, the bankspecific decision to engage in a certain level of specialization is assumed constant and time invariant. In the fixed effects estimators is then controlled for the unobserved heterogeneity term. Another solution can be to use instruments for the specialization indicator. However, since the rationale for firm specific decisions is not known ex ante, it might be hard to find the right instruments.

5.2 Data constraints

In paneldata there are often missing values. Randomly missing, these gaps in the data do not lead to any bias. However, as shown by Verbeek (2013), if the (non) reported data are selected, a bias can occur. Especially when it concerns self-reported data. To take this bias into account, the components of the variables used are the most common reported values such as total assets, interest income and total revenues. Still some countries had to be excluded. An example is Iceland. It has played major role in the crisis of 2008, but due to insufficient data on core components it has not been included.

5.3 Future research

To take into account the possible endogeneity due to the banks' decision regarding the desired level of specialization, future research is necessary. Conditional upon finding a relevant instrument that is sufficiently exogenous, this instrument can be used to internalize the specialization decision in the model. In future research a trade-off should be made regarding on the one hand the number of missing values in the dataset while on the other hand ensuring a representativeness of the dataset. To further analyze the effects of regulations regarding banking activities another distinction can be made. The different levels of risk within the traditional banking category, such as mortgage lending and consumer lending, can be taken into account to examine if risks are inherent on traditional banking activities.

6. Conclusion

The recent ringfencing proposals that are put in place to reform the banking sector, differ per country but do have the same goals. The first goal is to reduce the too-big-to-fail subsidy by separating high- and low risk activities. The second goal of the ringfencing programs is to decrease the dependency of the public on banks. A level playing field and thereby an increase in competition is expected as banks are no longer allowed to enjoy diversification discounts. This forces banks to focus and specialize on a certain type of activities.

Given the heterogeneity in the number of activities across banks and across years, the goal of this paper is to examine the effect of specialization of banking activities on the degree of competition within the banking sector in the period 2005 – 2015.

The model of Panzar and Rosse (1977) is used to determine the unscaled H-statistic as a proxy for the level of competition. An activity based specialization indicator variable is constructed. The H-statistic and specialization indicator are estimated on both country level and bank level.

Individual fixed effects and time fixed effects estimations are separately used to exploit the variation within individuals and the variation within years. The fixed effects results are compared with the OLS results. Also the OLS and the fixed effects estimations are applied at country level and at bank level. The best fit of is obtained by the bank level fixed effects estimations.

The results show a clear negative correlation between the level of specialization and the degree of competition. This negative relationship does not support the main hypothesis that banks face a higher degree of competition in a specialized environment. The negative relation is robust to the different estimation approaches both on country level and on bank level. Moreover, a negative relation is found even when banks are specialized towards loans. This leads to the conclusion that answers the central question:

A higher level of specialization coincides with a lower degree of competition for banking conglomerates in European and North American countries in the period 2005 – 2015.

The findings imply that to enhance the level of competition, regulations should be aimed at reducing the size of banks, increasing the cost efficiency and increasing the loss absorbing capacity of banks while allowing for diversified activities.

Further research is necessary to exclude that high risks are inherent on loan related banking activities. Also to counter possible endogeneity, internalization of the decision of banks to specialize is subjected to future research.

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7. Appendix

7.1 Hausman test

Table 7.1: Hausman test results - bank level

	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B)
	FE	Re	Difference	SE
SPa_{it}	-.165	-.1645477	-.0004523	.0092919
NPL/Equity	-.0006798	-.0006752	-4.61e-06	.0000126
log(loans)	.0166709	.0218994	-.0052285	.009632
nim	.0125262	.0073148	.0052114	.0030293
cir	-.0010353	-.0010541	.0000188	.0000322

b = consistent under Ho and Ha;

B = inconsistent under Ha, efficient under Ho;

Test: Ho: difference in coefficients not systematic

chi2(11) = 12.69

Prob > chi2 = 0.0482

The null hypothesis that the covariance between the unobserved factor α_i and explanatory variable is zero, is rejected. Therefore the fixed effects model is used.

Table 7.2: Hausman test results - country level

	(b) FE	(B) Re	(b-B) Difference	sqrt(diag(V_b-V_B) SE
SPa_{gt}	.9957838	.0130131	.9827708	.4577701
GDPgrowth	-.0158179	-.0209853	.0051673	.0027929
Inflation	.0038275	.0132744	-.0094469	.0103428
CA	.0020809	-.0074417	.0095225	.0103621
lnllr	-.0482798	-.0441274	-.0041523	.0468806

b = consistent under Ho and Ha;

B = inconsistent under Ha, efficient under Ho;

Test: Ho: difference in coefficients not systematic

chi2(11) = 19.51

Prob > chi2 = 0.000

The null hypothesis that the covariance between the unobserved factor α_g and explanatory variable is zero, is rejected. Therefore the fixed effects model is used.

7.1.1 Inclusion time fixed effects

To test if estimating time fixed effects would benefit the analysis, the joint f-test is used to determine if all time dummy variables are jointly zero. The null hypothesis has to be rejected since Prob¿ F=0.0001. Therefore, the also a time fixed effects model is used.

F(9, 288) = 3.82

Prob > F = 0.0001

7.2 Autocorrelation

The Wooldridge test for autocorrelation in panel data is used to test for the presence of autocorrelation both on bank and on countrylevel.

bank level

The Wooldridge-test tests the null hypothesis of no first-order autocorrelation. The Wooldridge test for autocorrelation in panel data (xt-serial tool) is used including the variables $H_{i,t}$, SPa_{it}, NPL/Equity, nim, cost/income, log(loans). The f-test shows a p-value of 0.000. Therefore the null hypothesis is rejected and the presence of autocorrelation is assumed in the bank level estimation.

Countrylevel

The Wooldridge-test tests the null hypothesis of no first-order autocorrelation. The Wooldridge test for autocorrelation in panel data (xt-serial tool) is used including the variables H_{gt}, SPa_{gt} GDPgrowth, INF, CA, lnllr. The f-test shows a p-value of 0.0078. Therefore the null hypothesis is rejected and the presence of autocorrelation is assumed in the countrylevel estimations.

7.3 Heteroscedasticity

bank level

To test for groupwise heteroskedasticity in the fixed effect regression model, the modified wald test is used (xttest3). The null hypothesis that all variances of the error term are identically distributed for all banks is rejected by a zero p-value. That is, the test results are:

$$chi2(11) = 7.1 \tag{7.1}$$

$$Prob > Ch2 = 0.0000 \tag{7.2}$$

Countrylevel

To test for groupwise heteroskedasticity in the fixed effect regression model, the modified wald test is used (xttest3). The null hypothesis that all variances of the error term are identically distributed for all countries is rejected by a zero p-value. That is, the test results are:

$$chi2(20) = 15514.14 \tag{7.3}$$

$$Prob > Ch2 = 0.0000 \tag{7.4}$$

7.4 Tables

Table 7.3: Descriptives of bank level variables for the years 2005-2015

variable	mean	sd	min	max	skewness	kurtosis	p25	p75	N
H_{it}	0.528	0.349	-0.742	1.788	-0.570	4.042	0.367	0.736	2965
$H(-1)_{it}$	0.532	0.347	-0.742	1.788	-0.618	4.131	0.378	0.739	2598
SPa	0.381	0.209	0.001	0.983	0.113	2.290	0.224	0.534	2965
NPL/Equity	24.027	49.301	0.000	979.549	9.016	134.337	3.737	25.902	2965
log(loans)	14.976	2.109	9.458	20.698	0.571	2.657	13.409	16.482	2965
nim	3.114	1.408	0.045	10.032	0.336	3.819	1.995	3.926	2965
cost/income	69.849	25.180	5.381	471.811	5.623	63.433	58.049	75.237	2965
REC	0.238	0.426	0.000	1.000	1.232	2.518	0.000	0.000	2965
LG(-1)	9.163	28.523	-71.030	820.320	14.416	357.852	-0.750	14.550	2598
lner	2.215	0.430	-0.821	4.292	-0.596	6.848	2.020	2.440	2965
lnla	4.029	0.445	-0.198	4.569	-2.596	13.345	3.936	4.292	2965
lnta	15.533	2.151	11.245	21.668	0.687	2.716	13.909	17.003	2965

Table 7.4: Descriptives of countrylevel variables for the years 2005 - 2015

variable	mean	sd	min	max	skewness	kurtosis	p25	p75	N
H_{gt}	0.357	0.505	-3.554	2.809	-2.056	24.594	0.188	0.549	220
$H(-1)_{gt}$	0.356	0.524	-3.554	2.809	-2.014	23.267	0.188	0.549	200
SPa	0.468	0.089	0.219	0.739	0.209	2.794	0.402	0.529	220
GDPgrowth	1.503	2.858	-8.269	9.157	-0.407	4.323	0.310	2.994	220
Inflation	2.567	3.417	-5.205	23.642	2.810	14.362	0.918	2.906	220
Current account	1.983	5.896	-12.194	16.187	0.089	2.591	-2.462	6.060	220
lnllr	13.274	1.231	8.901	15.556	-0.827	3.807	12.452	14.264	220

Table 7.5: Correlation bank level variables

Variable	H_{it}	$H(-1)_{it}$	SPa_{it}	NPL/Equity	log(loans)	nim	cost/income	REC	LG(-1)	lner	lnla	lnta
H_{it} —	1.0000											
$H(-1)_{it}$ —	0.7927	1.0000										
SPa_{it} —	-0.0748	-0.0551	1.0000									
NPL/Equity —	-0.1402	-0.0714	0.0350	1.0000								
log(loans) —	0.1889	0.1508	-0.0477	0.0193	1.0000							
nim —	-0.0269	-0.0290	0.0410	-0.0733	-0.4113	1.0000						
cost/income —	-0.1023	-0.0375	0.0048	0.2345	-0.2495	-0.0810	1.0000					
REC —	-0.0204	0.0008	0.0541	0.0115	0.0643	-0.0739	0.0261	1.0000				
LG(-1) —	-0.0609	-0.0379	0.0490	-0.1244	0.0350	0.0208	-0.0587	0.0599	1.0000			
lner —	0.1080	0.0703	-0.0879	-0.4064	-0.2043	0.2156	-0.0936	-0.0896	0.0289	1.0000		
lnla —	0.0876	0.0823	0.1919	0.1164	-0.0537	0.4352	-0.0734	0.0033	-0.0059	-0.0262	1.0000	
lnta —	0.1691	0.1334	-0.0802	-0.0066	0.9837	-0.4788	-0.2311	0.0622	0.0362	-0.1944	-0.2321	1.0000

In this table the correlation is shown between the regression and controlvariables used in equation **??**. Variables are on bank level. For definition and sources of the variables see table 7.7

Table 7.6: Correlation countrylevel variables

Variable	H_{gt}	$H(-1)_{gt}$	SPa_{gt}	GDP growth	INF	CA	lnllr	LG(-1)	lner	lnla	lnla
H_{gt}	1.0000										
$H(-1)_{gt}$	0.3367	1.0000									
SPa_{gt}	-0.1925	-0.1375	1.0000								
GDPgrowth	-0.0297	-0.1355	0.0388	1.0000							
INF	0.0951	0.0407	-0.1802	0.3569	1.0000						
CA	-0.0387	-0.1006	0.2328	0.0536	0.0326	1.0000					
lnllr	-0.1466	-0.1011	-0.1810	-0.2036	-0.1833	-0.3024	1.0000				
LG(-1)	0.0132	0.1049	0.1623	-0.0902	0.1494	-0.1764	-0.0658	1.0000			
lner	0.2758	0.2653	0.2202	0.0819	0.2773	0.0740	-0.2619	0.1444	1.0000		
lnla	0.0890	0.1048	0.0907	-0.0469	0.1633	-0.2545	-0.0186	0.0951	0.1237	1.0000	
lnta	-0.2372	-0.2133	0.0118	-0.1428	-0.4292	-0.0903	0.6217	-0.1526	-0.3223	-0.1226	1.0000

In this table the correlation is shown between the regression and controlvariables used in the countrylevel estimations. The variables are on countrylevel. For definition and sources of the variables see table 7.7

Table 7.7: Definitions and source of the variables

Name	Description	Source
H-statistic ($H_{gi,t}$)	Proxy for the level of competition. Proxy is estimated for each country g and separately for each bank i for the period 2005-2015	Panzar and Rosse (1987)
Specialization indicator ($SPa_{gi,t}$)	Specialization indicator constructed for each country g and separately for each bank i. It indicates the level of specialization based on assets and is calculated according equation 3.5	Own calculations
Specialization dummy	Dummy variable to indicate if a bank is specialized towards loans. It has value 1 if a bank is specialized above the average level and if the direction of specialization is towards loans.	Bankscope
Control variables		
NBER Recession dummy (REC)	Dummy variable that indicates per year the if the country in which the bank operates is in a recession	NBER
Total loan growth (loangrowth)	Percentage yearly growth in gross loans	Bankscope
Cost income ratio (cir)	Total expenses over the total revenues to indicate the efficiency level	Bankscope
Impaired loan ratio (NPL/Equity)	Impaired loans to total equity indicates the absorbing capacity for NPLs	Bankscope
Net interest margin (nim)		
Total number of loans (log(loans))	logarithm of gross loans, includes Net loans and less: Reserves for Impaired loans/ NPLs	Bankscope
GDP growth (GDPgrowth)	Percentage of annual GDP growth per country	Worldbank
Current account balance (CA)	Annual Current Account balance as percentage of GDP per country	Worldbank

Inflation (INF)	Percentage annual increase in consumer prices per country	Worldbank
Loan-loss-reserves (lnllr)	Natural logarithm of the total loan loss reserves held by banks	Bankscope
Estimation Variables - H-statistic		
Proxy for Total Revenues (TR)	(log of)the sum of Interest (II)- and Non interest income (NII)	own calculations
Proxy for interest expense (log(w1))	log of the ratio Total interest expense (TIE) to total deposits (Dep)	own calculations
Proxy for wage rate (log(w2))	log of ratio of personnel expenses (Pexp) divided to total assets (TA)	own calculations
proxy for price of physical capital (log(w3))	log of ratio of total other operating expense (OOE) to total assets (TA)	own calculations
Total Assets (lnta)	Total assets, or the log of total assets includes: Total earning assets, Cash and due from banks, Foreclosed real estate, Fixed assets, Goodwill, Other intangibles, Current tax assets, deferred tax, Discontinued operations, Other assets	Bankscope
Equity to assets ratio (lner)	Equity ratio defined as gross total equity divided by total assets	Bankscope
Loan to assets ratio (lnla)	Gross loans ratio defined as gross loans divided by total assets	Bankscope
Variables for composition SPA and H-stat		
Gross Interest Income (II)	Includes Interest income on loans, Other interest income, Dividend income	Bankscope
Total Non-Interest Income (NII)	This show the amount of fees, trading and asset sale income to total revenues which also includes net interest income	Bankscope
Total Interest Expense (TIE)	Includes Interest Expense on Customer Deposits, Other Interest Expense, Preferred Dividends Paid Declared	Bankscope
Total Customer Deposits (Dep)	Customer deposits include: Current-, Savings-, and Term deposits	Bankscope
Personnel Expenses (Pexp)	Includes Wages, salaries, social security costs, pension costs and other staff costs, including expensing of staff stock options	Bankscope

Other Operating Expenses (OOE)	Includes Depreciation, amortisation, administrative expenses, occupancy costs, software costs, operating lease rentals, audit and professional fees, and other operating expenses of an administrative nature	Bankscope

7.4.1 Derivation H-statistic

In order to provide insight in how the H-statistic is determined, the step by step process is explained. As an example, the calculations of the U.S. H-statistic per year is used.

US example

First, the reduced costs function 3.1 is estimated for each year per country, in this case the U.S.. The results are shown in table 7.8. The H-statistic for each year is the sum of the coefficients of log(w1), log(w2) and log(w3). The number of observations differ due to the fact that the availability of the data on each variable differs per year throughout the set. For 2005, the H-statistic is $0.2313(= 0.141 + 0.0956 - 0.00521)$, for 2006 the H-statistic is $0.2056(= 0.162 + 0.0801 - 0.0365)$ etc. The average values of the coefficients β_1, β_2 and β_3 over time are 0.152, 0.0413 and 0.033. The average value of the H-statistic, 0.22, is stated in table 3.1 among the averages of all countries. These steps are done for each country to obtain the countrylevel H-statistic. As an illustration, the regression results for the U.K. and France are given in the tables below.

For the bank level H-statistic, estimating the reduced form equation with OLS provides inaccurate estimates due to factors explained in chapter 3. Therefore, the KRLS estimation approach is used to estimate the reduced form equation and provide the coefficients for each of the 308 banks. After this step, once the coefficients are estimated, the H-statistic is derived according to the same process as the country level H-statistic. The sum of the coefficients β_1, β_2 and β_3 is the H-statistic per bank per year. The averages of the H-statistic and coefficients of the 308 banks are stated in table 3.2.

Table 7.8: U.S. Example derivation H-statistic: estimation results of the reduced cost function

	(2005)	(2006)	(2007)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)	(2014)	(2015)
	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)
log(w1)	0.141***	0.162***	0.0468	0.175***	0.166***	0.187***	0.160***	0.205***	0.146***	0.136***	0.142***
	(0.000)	(0.000)	(0.441)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
log(w2)	0.0956	0.0801**	0.0479	0.0855*	0.0676**	0.0552	0.0452	0.0296	-0.00980	0.0211	-0.0629
	(0.188)	(0.036)	(0.313)	(0.064)	(0.047)	(0.164)	(0.456)	(0.674)	(0.877)	(0.716)	(0.295)
log(w3)	-0.00521	-0.0365	0.0292	0.0190	0.0384	0.0137	-0.00324	0.0188	0.0355	0.0888*	0.165**
	(0.946)	(0.613)	(0.587)	(0.634)	(0.220)	(0.688)	(0.933)	(0.761)	(0.533)	(0.084)	(0.012)
lner	-0.0749*	-0.0402	-0.0625	-0.0616	-0.151***	-0.140**	-0.0993*	-0.105	-0.140**	-0.0589	-0.0240
	(0.076)	(0.252)	(0.109)	(0.215)	(0.003)	(0.015)	(0.080)	(0.137)	(0.036)	(0.383)	(0.630)
lnla	0.154***	0.201***	0.246***	0.219***	0.212***	0.256***	0.284***	0.261***	0.285***	0.354***	0.343***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnta	-0.0360***	-0.0274***	-0.0174***	-0.0348***	-0.0301***	-0.0240***	-0.0310***	-0.0337***	-0.0373***	-0.0383***	-0.0437***
	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-2.015***	-2.484***	-2.975***	-2.141***	-2.050***	-2.415***	-2.750***	-2.416***	-2.765***	-2.929***	-2.878***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	327	341	355	364	418	432	452	465	476	479	476
Adjusted R^2	0.390	0.349	0.355	0.550	0.569	0.575	0.581	0.559	0.527	0.594	0.594

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the regression results for the U.S. for the years 2005 (column 1) until 2015 (column 11). It provides the coefficients of the inputfactors log(w1), log(w2) and log(w3). The sum of these coefficients is the H-statistic per year for the U.S.

Table 7.9: France-example derivation H-statistic: estimation results of the reduced cost function

	(2005)	(2006)	(2007)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)	(2014)	(2015)
	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)
log(w1)	0.155***	0.133***	0.122***	0.124***	0.126***	0.137***	0.131***	0.138***	0.0845	0.130***	0.0747**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.103)	(0.000)	(0.029)
log(w2)	0.0405	-0.0144	0.0190	0.0553	0.0378	-0.0462	-0.0471	0.00893	-0.233	-0.194	-0.487***
	(0.728)	(0.850)	(0.773)	(0.553)	(0.603)	(0.331)	(0.428)	(0.923)	(0.258)	(0.176)	(0.002)
log(w3)	0.0909	0.0355	0.0833	0.115	0.111	0.208***	0.204**	0.0545	0.104	0.117	0.188
	(0.148)	(0.620)	(0.278)	(0.126)	(0.161)	(0.007)	(0.038)	(0.504)	(0.425)	(0.398)	(0.197)
lner	-0.0467	-0.199*	-0.264**	-0.140	-0.151	-0.0357	-0.0550	-0.0525	-0.136	0.0871	0.0702
	(0.648)	(0.052)	(0.027)	(0.297)	(0.147)	(0.631)	(0.504)	(0.565)	(0.249)	(0.530)	(0.560)
lnla	0.156**	0.203***	0.257***	0.257***	0.423***	0.416***	0.436***	0.551***	0.570***	0.610***	0.583***
	(0.041)	(0.002)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnta	0.00250	-0.0535**	-0.0586**	-0.0244	-0.0408	-0.00388	0.0105	0.00871	-0.0257	-0.00208	-0.0188
	(0.921)	(0.030)	(0.048)	(0.409)	(0.133)	(0.869)	(0.697)	(0.694)	(0.443)	(0.944)	(0.568)
Constant	-2.781***	-2.238***	-1.833***	-2.347***	-2.930***	-3.775***	-4.079***	-4.985***	-5.400***	-6.110***	-6.919***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	79	100	108	113	119	134	141	139	143	143	142
Adjusted R^2	0.414	0.436	0.507	0.434	0.610	0.646	0.694	0.684	0.544	0.697	0.619

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the regression results for France. for the years 2005 (column 1) until 2015 (column 11). It provides the coefficients of the inputfactors log(w1), log(w2) and log(w3). The sum of these coefficients is the H-statistic per year for the France.

Table 7.10: U.K.-example derivation H-statistic: estimation results of the reduced cost function

	(2005)	(2006)	(2007)	(2008)	(2009)	(2010)	(2011)	(2012)	(2013)	(2014)	(2015)
	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)	log(TR)
log(w1)	0.0571	0.0602	0.0442	0.0900***	0.167***	0.165***	0.166***	0.178***	0.199***	0.155***	0.139***
	(0.575)	(0.477)	(0.410)	(0.008)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
log(w2)	0.00445	-0.110*	0.0155	0.232**	0.311**	0.212**	0.293***	0.167**	0.408***	0.263***	0.255***
	(0.972)	(0.083)	(0.846)	(0.022)	(0.010)	(0.027)	(0.001)	(0.016)	(0.002)	(0.005)	(0.008)
log(w3)	0.173*	0.170***	0.0160	0.00110	-0.0448	0.175*	-0.0218	0.0573	-0.202	0.0844	0.0849
	(0.094)	(0.004)	(0.868)	(0.992)	(0.706)	(0.052)	(0.802)	(0.272)	(0.513)	(0.419)	(0.346)
lner	-0.00334	0.215*	0.0583	-0.187**	-0.168	-0.258***	-0.161*	-0.141	-0.129	-0.344**	-0.392**
	(0.983)	(0.079)	(0.562)	(0.049)	(0.127)	(0.004)	(0.085)	(0.212)	(0.595)	(0.050)	(0.030)
lnla	0.223**	0.487***	0.340***	0.387***	0.490***	0.627***	0.618***	0.556***	0.621***	0.642***	0.683***
	(0.014)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
lnta	-0.0709***	-0.0386	-0.0617***	-0.0960***	-0.0758***	-0.0625***	-0.0497***	-0.0672***	-0.0720***	-0.0453***	-0.0548***
	(0.001)	(0.114)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.790*	-4.301***	-3.142***	-1.240*	-1.921**	-1.953***	-2.899***	-2.605***	-2.839*	-2.387***	-2.427***
	(0.088)	(0.000)	(0.000)	(0.098)	(0.022)	(0.002)	(0.000)	(0.001)	(0.072)	(0.007)	(0.006)
Observations	75	79	80	84	88	89	101	103	111	114	116
Adjusted R^2	0.457	0.619	0.552	0.711	0.666	0.808	0.742	0.666	0.551	0.744	0.644

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This table shows the regression results for the U.K. for the years 2005 (column 1) until 2015 (column 11). It provides the coefficients of the inputfactors log(w1), log(w2) and log(w3). The sum of these coefficients is the H-statistic per year for the U.K.