Examining the capital ratio and profitability of large European banks.

Abstract

This paper empirically studies the relationship between the independent variable tier 1 ratio and four dependent variables measuring profitability, risk-taking and asset quality. I use a fixed effects regression model correcting for the low and negative interest rates combined with the customer deposit ratio. This paper focusses on large European banks between 2012 and 2017. I conclude that there is no statistical significant relationship between the tier 1 ratio and profitability as measured by return on assets and return on equity. Secondly, this research finds a significant positive relationship between size and the loans to assets ratio. Thirdly, high customer deposit banks have a lower percentage of impaired loans to gross loans. Lastly, no evidence is found that high customer deposit banks are less profitable after 2014 compared to peers.

Key words: Capital ratio, tier 1 ratio, bank profitability, Basel III, customer deposits

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Introduction

Following the global financial crisis of 2007/2008 stricter capital requirements for banks have been introduced by regulators. The Basel Committee on Banking Supervision is a worldwide respected authority on banking regulations. In 1988 they introduced a set of banking requirements and regulations under the name of Basel I. Since then, Basel II and Basel III have been introduced and implemented. Basel II became effective starting 2008, however, after the financial crisis a stricter Basel III was introduced, demanding higher capital ratios from banks. Basel III is phased in over multiple years and will be fully effective 1st of January 2019. Basel III regulation is comprehensive and covers many aspects and ratios of banking. One of the main metrics it covers is the capital ratio. It also includes a leverage ratio requirement and a liquidity requirement (Basel Committee, 2010). One main aspect of the capital ratio is the tier 1 ratio. The minimum tier 1 ratio requirement is 6% in the fully-phased in Basel III version and was 4% under Basel II, a significant increase (Basel Committee, 2017).

Capital ratios in banks have always been much lower in banking than in other types of businesses. Besides, capital ratio in banks have been declining for more than a century (Kaufman, 1992).There is an assumption that a lower capital ratio allows a bank to take on more risk and thereby earn more profit (Short, 1979; Hakenes & Schnabel, 2011). Banks are critical for economies by stimulating growth with capital allocation. Therefore, many governments implement regulations that prevent banks from taking on excessive risk which could endanger the economic prosperity of a country. Following this logic, banks shouldn't be very excited about these regulations as it limits their ability to take risks and thereby generate profit. However, some empirical research shows that higher capital ratios correlate with higher profits (Bourke, 1989; Molyneux & Thornton, 1992; Dietrich & Wanzenreid, 2014). So, should banks be excited about new regulations?

Dietrich & Wanzenreid (2014) noted that the positive relationship they found between the capital ratio and profit is very interesting considering the Basel III regulations. Basel III has been further phased in since then. Building on this research, this paper aims to further examine the relationship

between capital ratio and profit. In this paper the focus is on large European banks during the phase-in period of Basel III: 2012 to 2017. This leads to the main research question:

How do higher capital requirements affect the profitability of large European banks?

Firstly, in the theoretical framework in section 2, previous research is summarized and the hypotheses are established. Secondly, I will discuss the data and the methods used to analyse the data in section 3. The results are discussed in the 4th section followed by the conclusion in section 5. Lastly, the limitations of this paper are discussed in section 6.

Theoretical framework & hypotheses

This section summarizes and discusses the relevant existing literature concerning banking profitability especially regarding capital ratios. Previous studies about the effects of capital ratios on profitability will be highlighted.

A lot has been written about the determinants of bank profitability. There are various ways to measure the profitability of a bank, but as Golin & Delhaise (2001) point out return on assets (referred to as 'ROA' from now on) has become broadly adopted. ROA is useful because it can compare the profitability of banks regardless of their capital structure (i.e. leverage). In contrast, return on equity (referred to as 'ROE' from now on) is influenced by leverage. However, in the existing literature ROE is also a frequently used metric to determine a bank's profitability in addition to ROA.

Capital ratio

The capital ratio is widely regarded as a key determinant of bank profitability. However, the effect of capital ratio on profitability is ambiguous. There are several theories and studies supporting a positive effect of capital ratio on profitability. However, there are also several theories and studies supporting a negative effect of capital ratio on profitability. Firstly, the literature supporting a positive effect will be covered, followed by the literature supporting a negative effect.

Capital ratio negative effect

The first theory supporting a negative relationship follows the ideas of Modern Portfolio Theory and the risk-return spectrum (Markowitz, 1952). A lower capital ratio increases the risk on equity, and this could also increase the return. As there is a higher leverage ratio, more return on equity could be generated (Short, 1979). At the same time a lower capital ratio and thus a higher debt ratio, increases the benefits of the interest tax-shield. Therefore, there should be a negative relationship between capital ratio and profitability.

Secondly, it is assumed in the existing literature that equity is the costliest form of financing for banks (see Hakenes & Schnabel, 2011). Therefore, a higher capital ratio should lower profitability.

Capital ratio positive effect

The first theory supporting a positive relationship between capital ratio and profitability is about funding cost. Various studies mention that a lower capital ratio is associated with higher funding cost and thus lower profitability (Trujillo-Ponce, 2013; Dietrich & Wanzenreid, 2014). A higher capital ratio usually means the probability of financial distress and bankruptcy is lower and therefore financiers demand a lower return. This has a positive effect on profitability.

Secondly, Berger, Herring, & Szegö (1995) say that there is a long-term market capital ratio requirement. This requirement follows by the optimal trade-off between benefits from the tax shield and cost from financial distress. Because interest on debt can be deducted from taxes, it is favourable for a bank to increase debt-financing. However, the possibility alone of being in financial distress causes significant costs. Examples of these costs include bankruptcy, less trust from counterparties and more trouble to attract talented employees. Therefore, there is an optimal capital ratio. Banks that operate below their optimal ratio would be expected to generate less profit than banks operating at their optimal level.

Lastly, Berger (1995) developed a signalling hypothesis. The signalling hypothesis assumes there is asymmetric information. The signalling hypothesis states that a higher capital ratio is a signal by management that private information indicates good prospects for the bank. Then, there could be an

equilibrium where managers of well-performing banks signal this by holding higher capital ratios, if doing so is beneficial and harder to do for less well-performing banks.

Capital ratio previous empirical research

The relationship between capital ratio and profitability is ambiguous. As outlined above, there are arguments for it to go either way. However, most empirical research indicates there is a positive relationship (Bourke, 1989; Molyneux & Thornton, 1992; Goddard, Molyneux, & Wilson, 2004; Trujillo-Ponce, 2013; Dietrich & Wanzenreid, 2014)

Bourke (1989) found that a statistically significant increase of 1% in capital ratio correlated with a 0,1% increase in ROA. He researched banks in Europe, the U.S. and Australia between 1972 and 1981 within the top 500 banks worldwide measured by assets.

Molyneux and Thornton (1992) replicated Bourke's study with European banks between 1986 and 1989 and found very similar results. In their dataset, a 1% increase in capital ratio was associated with a 0,12% increase in ROA.

In 2004 Goddard, Molyneux and Wilson conducted a study into the profitability of European banks in the 1990's. They found a mostly positive relationship.

Trujillo-Ponce (2013) studied the determinants of profitability for Spanish banks between 1999 and 2009. He found that a higher capital ratio has a statistically significant positive effect on ROA but a negative effect on ROE, regardless of size.

Dietrich and Wanzenreid (2014) conducted an extensive study about the determinants of bank profitability across 118 countries with various income levels between 1998 and 2012. First, they find that the determinants of profitability differ significantly between countries with different income levels. However, only for high-income countries they find a statistically significant positive effect of capital ratio on ROA.

Nevertheless, some research indicates there is a negative relationship. This research mostly comes from developing countries. For example, Azam & Siddiqui (2012) find a negative relationship between capital ratio and ROA/ROE in Pakistan between 2004 and 2010 in the private sector.

Given the previous studies into large European banks mostly find capital ratio has a positive effect on ROA/ROE is it assumed this study will also find this.

Hypothesis 1: Tier 1 ratio has a positive effect on ROA and ROE.

Total assets

The main measure for banks' profitability ROA (income/total assets) already accounts for the size of banks. Besides this there is evidence that the cost-curve in banking has a flat U-shape (Athanasoglou, Brissimis, & Delis, 2008). In line with the u-shaped cost curve Barros, Ferreira, & Williams (2007) find that larger banks perform relatively less well. However, in this research all banks are selected to have over 100 billion in assets and it is assumed there is no difference in ROA by size at this size level.

Hypothesis 2: Size has no effect on ROA for banks above 100 billion in assets.

Customer deposits ratio

In the existing literature debt and especially equity are seen as expensive forms of financing compared to customer deposits (Claeys & Vander Vennet, 2008; Hakenes & Schnabel, 2011; Trujillo-Ponce, 2013). A study by Trujillo-Ponce in 2013 finds that for Spanish banks between 1999 and 2009 the customer deposit ratio has a positive effect on both ROA and ROE. Altough that study was in a very specific setting, this study also expects that a higher customer deposit ratio has a positive effect on ROA/ROE.

Hypothesis 3: The customer deposit ratio has a positive effect on ROA and ROE.

Negative interest rates

In 2014 some interest rates became negative, and a lot of other interest rates hit a low. Banks are very hesitant to charge customers negative interest rates on their deposits. This creates a lower bound on the interest they have to pay customers. However, as banking in the Western world is still very competitive, interest-margins have come under pressure (Lopez, Rose, & Spiegel, 2018). These arguments bring us to the hypothesis that the interaction term between 2014 and customer deposits has a negative effect on ROA/ROE.

Hypothesis 4:The customer deposit interaction term has a negative effect on ROA and ROE.

Risk-taking

Following the logic of the mean-variance theory (Markowitz, 1952) it is to be expected that banks that are managed in a less risk-averse way have both a lower capital ratio and more risk-bearing assets (Kim & Santomero, 1988). Therefore a negative association between capital ratio and loans to total assets ratio is expected. A lower capital ratio is more risky for banks as the chance of financial distress and bankruptcy increases. Similarly loans are risky assets from a banks perspective. This leads us to test the following:

Hypothesis 5: There is a negative relationship between tier 1 ratio and loans tot total assets ratio.

So, some banks are willing to take more risk and hold a lower capital ratio and more risky loans. Then, these banks are also expected to end up with more impaired loans. Therefore I test the following hypothesis:

Hypothesis 6: There is a negative relationship between tier 1 ratio and impaired loans to gross loans ratio.

Data

This study uses data from the Orbis Bank Focus database. Data is obtained for banks between 2012 and 2017 meeting the following 3 conditions. First, only active banks are considered. Second, only banks with total assets exceeding 100 billion in at least one of the years are considered. Third, only banks from countries that were part of the European union before 1995 are considered.

For the banks included in this paper the following data are gathered from Orbis Bank Focus: Bank name, country, total assets, equity, tier 1 ratio, net income, customer deposit ratio, loans to assets ratio and impaired loans to gross loans ratio.

Data transformations

After collecting the data, the data is inspected and transformed wherever necessary.

Firstly, all banks containing missing values for the tier 1 ratio are dropped (386 out of 1057 observations). Secondly, all banks containing missing values for loans to total assets ratio and impaired loans to gross loans ratio are dropped only in their respective analysis. Thirdly, 2 non-profit banks and 2 banks containing data-errors are dropped from the sample. Then, the ROA in percentages is calculated by diving net income by total assets and multiplying this by 100. Similarly, ROE is calculated. ROA and ROE are turned into percentage variables because of the large difference in scale compared to log of assets which would cause extreme small coefficients in the regression. Furthermore, all the independent variables excluding the 2014 dummy are lagged by 1 year.

Now the distribution of all dependent and independent variables used in the regression is examined and checked for outliers and influence points (Stevens, 1984).

ROA: The graphical analysis of ROA shows that the dependent variable ROA contains outliers and influence points, for example, lower than -1% or greater than 1% (appendix A, figure 1 and 2). But the distribution in the histogram shows a symmetrical distribution, so a log transformation looks inappropriate. Therefore, ROA is Winsorized symmetrically at the 7^{th} and 93^{rd} percentile (appendix A, figure 3 and 4).

ROE: The graphical analysis of ROE shows that the dependent variable ROE contains outliers and influence points. The distribution is skewed to the left, but looks normal otherwise, so a log transformation seems inappropriate (appendix A, figure 5 and 6). Therefore, ROE is Winsorized symmetrically at the 8^{th} and 92^{nd} percentile (appendix A, figure 7 and 8).

Impaired loans to gross loans ratio: The graphical analysis of impaired loans to gross loans shows that the distribution is heavily skewed to the right and has strictly positive values (appendix A, figure 9). To approach a more normal distribution a ln-transformation is performed, the Shapiro-Wilk W test for normality confirms that the distribution of the transformed variable is indeed closer to a normal distribution (appendix A, figure 10 and 11).

Tier 1 ratio lagged: The graphical analysis of the tier 1 ratio doesn't show a clear symmetrical distribution (appendix A, figure 12). However, winsorizing at the 7th and 93rd percentile fixes this as shown by the histogram and the Shapiro-Wilk W test for normality (appendix A, figure 13 and 14).
Total assets lagged: The distribution of total assets is skewed to the right, values are strictly positive and mostly above 100 million (appendix A, figure 15). Therefore, a ln-transformation seems appropriate, as confirmed by the Shapiro-Wilk W test for normality (appendix A, figure 16 and 17).
Loans to total assets ratio and *customer deposit ratio lagged:* Both variables seem normally distributed without outliers or influence points and are not transformed (appendix A, figure 18 and 19).

In addition, 2 other variables are created. A dummy variable for the year 2014 and an interaction term between the dummy and the lagged customer deposit ratio. Since 2014 some interest rates in the European union have been negative. Because banks are disinclined to also lower consumer deposits interest below zero, it is suspected these negative interest rates have a negative effect on banking profitability.

Final sample

The final sample obtained after data transformations is an unbalanced panel data set consisting of 524 observations from 125 banks between 2012 and 2017. All these banks are active, have over 100 billion in assets and are from a European country. The 15 European countries included are those who were member states as of the 1st of January 1995. Those countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom (see appendix B, figure 5 for the distribution of banks over these countries).

Variables

In this section all variables used in the regression will be discussed. Firstly, the four dependent variables are discussed and secondly all five independent variables are discussed.

Dependent variables

ROA: Return on assets. This is net income divided by total assets at year-end in percentages. This ratio measures how much return a bank can generate on its assets. ROA is widely used to compare profitability of banks (Golin, 2001).

ROE: Return on equity. This is net income divided by stockholders' equity at year-end in percentages. This ratio measures how much return a bank can generate on equity. Therefore, ROE is more heavily influenced by the capital structure of a bank. However, the ROE of a bank can be compared to other types of business, contrary to ROA.

Loans to total assets ratio: Loans divided by total assets in percentages. This ratio measures how much of the total assets of a bank are outstanding as loans. This ratio is always between 0% and 100%. Generally, if this ratio is higher it is considered riskier. Because loans are risky assets, however this is a gross generalization as the quality of the loans is critical.

Impaired loans to gross loans ratio: Impaired loans divided by gross loans. Impaired loans are loans which the lender deems very likely not to be repaid fully as agreed upon initially. Gross loans are all loans outstanding. So, this ratio measures how much loans are probable not to be fully repaid as a percentage of total loans. This is a measure of asset quality, which is important to a bank, as mentioned above.

Independent variables:

Tier 1 ratio: Common equity tier 1 (CET1) divided by risk-weighted assets. Common equity tier 1 is a term introduced by the Basel Committee on Banking Supervision. It consists of the core part of equity and consists mostly of the proceeds of equity issues, retained earnings, accumulated other comprehensive income and some convertible bonds and hybrid securities. Risk-weighted assets are the assets of a bank discounted or multiplied with a risk-weighting factor. For example, a loan that is rated to be very secure would be discounted and a loan that is very insecure would be multiplied with a certain factor. Finally, the CET 1 is divided by the assets adjusted to risk. This ratio shows the

percentage of the assets (adjusted for risk) that is covered by the bank's core capital (Basel Committee, 2010).

Total assets: Total assets are the total assets at year-end measured in U.S. dollars.

Customer deposit ratio: Total customer deposits divided by total assets. This ratio shows how much of total assets of a bank is financed by customer deposits (right-side of the balance sheet). This ratio is always between 0% and 100%.

Dummy 2014: Dummy variable that takes on the value 0 in 2012 and 2013 and 1 from 2014 onwards.

Interaction term: This is the interaction term between dummy of 2014 and customer deposit ratio. This will always be 0 before 2014 and equal to the customer deposit ratio from 2014 onwards.

Descriptive statistics

Table 1 shows the descriptive statistics of the data before transformation (see appendix B, table 1 with the descriptive statistics of variables after the transformations). The variables shown are: ROA in percentages, ROE in percentages, loans to total assets ratio in percentages, impaired loans to gross loans ratio in percentages, tier 1 ratio in percentages, total assets in billions of USD and the customer deposit ratio in percentages. For the variables we see the mean, median (p50), 3 different percentiles, standard deviation, minimum value and maximum value.

Table 1: Descriptive statistics of variables before transformations

	ROA	ROE	Loans/Assets	Impaired/Gross	Tier 1 ratio	Total Assets	Cust. dep.
Mean	0.18	3.37	51.04	6.63	15.80	545	36.32
p50	0.25	5.50	54.69	3.63	14.10	282	39.00
p25	0.07	1.66	37.67	2.13	11.90	141	18.00
p75	0.46	8.38	65.90	7.61	17.00	721	52.00
p99	1.24	23.67	94.34	45.18	42.40	2630	84.00
Sd	0.60	15.78	20.76	8.49	6.74	600	22.51
Min	-3.78	-180.30	0.09	0.01	5.50	10.2	0.00
Max	3.97	140.90	97.29	53.29	74.90	3120	100.00

The table above shows that ROA is lower than 1% for most banks. Although not common in other sectors, this is common in the banking business (Trujillo-Ponce, 2013; Dietrich & Wanzenreid, 2014).

ROE is much higher because of the large leverage used by most banks. Tier 1 ratio is well above the 6% fully phased in Basel III requirement for most banks. And the minimum value of 5,5% is equal to the regulatory minimum of 2014, this suggests that all these banks comply with the regulations (Basel Committee, 2017). Total assets are mostly above 100 billion, this is how the sample was selected. In the appendix are more descriptive statistics showing the mean of ROA, ROE and tier 1 ratio over time (appendix B, table 2, 3 and 4). There is also a table showing how the banks are distributed over the 15 European countries (appendix B, table 5).

Methodology

In the following section the methods used to analyse the data are discussed.

In this study Stata is used to analyse the data. Because of the panel nature of the data this study analysed the dataset via a fixed effects regression with robust standard errors. The standard equation for a fixed effects regression model is shown below (Stock & Watson, 2015, p. 405).

1) $Y_{it} = \beta_1 * X_{1it} + \ldots + \beta_k X_{k,it} + \alpha_i + u_{it}$

Different entities are specified by i= 1, ..., n. Different periods are specified by t=1, ..., n. Here Y is the dependent variable for entity i in period t. X_1 to X_k are different independent variables. Also, α_i represent the unobserved heterogeneity, and u_{it} is the error term (Stock & Watson, 2015).

In this study 4 dependent variables are used in the regression: ROA, ROE, loans to total assets ratio and impaired loans to gross loans ratio. The 5 independent variables are: Tier 1 ratio, total assets, customer deposit ratio, dummy 2014 and the interaction term. Furthermore, the independent variables are lagged 1 period to test their impact on the dependent variables in the following year. This is also done to prevent the problem of reverse causality that would otherwise arise.

So, this gives equations 2 to 5:

2) $ROA_{it} = \beta_0 + \beta_1 *$ tier 1 ratio $_{it-1} + \beta_2 *$ln(total assets)$_{it-1} + \beta_3 *$customer deposit ratio$_{it-1} + \beta_4 *$dummy $2014_{it} + \beta_5 *$interaction term$_{it-1}$

3) $ROE_{it} = \beta_0 + \beta_1 *$ tier 1 ratio $_{it-1} + \beta_2 *$ln(total assets)$_{it-1} + \beta_3 *$customer deposit ratio$_{it-1} + \beta_4 *$dummy $2014_{it} + \beta_5 *$interaction term$_{it-1}$

4) Loans to total assets ratio$_{it} = \beta_0 + \beta_1 *$ tier 1 ratio $_{it-1} + \beta_2 *$ln(total assets)$_{it-1} + \beta_3 *$customer deposit ratio$_{it-1} + \beta_4 *$dummy $2014_{it} + \beta_5 *$interaction term$_{it-1}$

5) ln (impaired loans to gross loans)$_{it} = \beta_0 + \beta_1 *$ tier 1 ratio $_{it-1} + \beta_2 *$ln(total assets)$_{it-1} + \beta_3 *$customer deposit ratio$_{it-1} + \beta_4 *$dummy $2014_{it} + \beta_5 *$interaction term$_{it-1}$

Regression assumptions

To perform a fixed effects regression, the assumptions of the regression need to hold. Therefore, before estimating the fixed effects regression, a standard OLS regression is performed to determine the multi-collinearity, heteroskedasticity and auto-correlation in the dataset. This is done because Stata doesn't provide test statistics for the multi-collinearity, heteroskedasticity and auto-correlation in a fixed effects regression.

The multi-collinearity is determined by the variation inflation factors (VIF), in the literature there is a convention that the VIF values should be lower than 10, if the VIF values exceed 10 there is a clear

sign of multi-collinearity. If the VIF values exceed 5 but are below 10, then this is a grey area in which it's unclear if there is multi-collinearity but there are signs of possible multi-collinearity (Aylin, 2010). In these models, all VIF values are under 10 and most are under 5, except the interaction term and the customer deposit ratio. This is to be expected since the interaction term is the customer deposit ratio multiplied by the 2014 dummy (this dummy takes on value 1 after 2013). And the high VIF value disappears if either one is left out of the model (Appendix B, table 6 and 7). Therefore, the interaction term is not deleted or modified or deleted but instead untouched and the research is continued regardless of this high VIF value (O'brien, 2007).

Subsequently, the Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity is performed to test for homoscedasticity of the residuals. The Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity shows that there is heteroskedasticity at the 1% confidence level in the models with the ROE, loans to total assets ratio and the loans impaired loans to gross loans ratio. ROA shows significant heteroskedasticity at the 10% confidence level. To keep a consistent methodology over all 4 models the robust standard errors will be used to correct the heteroskedasticity in all 4 models.

This data has a panel nature, which means the data are repeated measurements over time of the same subjects of multiple variables. Therefore, this study uses the Woolridge test for autocorrelation in panel data. The Wooldridge test for autocorrelation shows that there is auto-correlation in all 4 models. This study decided to use a fixed effects model, to correct the standard errors for auto-correlation in all 4 models.

Results

This section will present the results from the fixed effects regression performed as described in the methodology. In addition, the test results to test for multi-collinearity, heteroskedasticity and auto-correlation are presented along with descriptive statistics.

Table 2 below shows the results of the 4 fixed effects regressions that are performed.

Table 2: Fixed effects regression analysis

Variables	ROA	ROE	Loans to assets	Impaired to gross loans
Tier 1 ratio	-0.00429	-0.113	0.139	-0.00622
	(0.00830)	(0.128)	(0.149)	(0.0165)
Total assets	-0.111	-2.419	-5.377***	0.193
	(0.116)	(1.480)	(1.272)	(0.237)
Customer deposit ratio	0.00814	0.103	0.0358	-0.0182**
	(0.00813)	(0.111)	(0.123)	(0.00730)
2014 dummy	0.0685	0.561	-1.423	-0.199
	(0.0652)	(1.000)	(2.143)	(0.125)
Interaction 2014 deposits	0.000930	0.0197	0.0387	-0.00233
	(0.00194)	(0.0277)	(0.0645)	(0.00261)
Year = 2014	-0.0964**	-1.213*	-0.792	0.274***
	(0.0439)	(0.669)	(0.633)	(0.0890)
Year = 2015	-0.0373	-0.353	1.002	0.204***
	(0.0393)	(0.600)	(0.922)	(0.0636)
Year = 2016	-0.0888***	-1.402***	0.0296	0.151***
	(0.0310)	(0.479)	(0.434)	(0.0346)
Year = 2017, omitted	-	-	-	-
Constant	2.145	49.72	153.5***	-1.647
	(2.471)	(31.63)	(24.95)	(4.836)
Observations	524	524	512	465
Number of banks	125	125	121	108
R-squared	0.084	0.078	0.093	0.313
Highest VIF	10.21	10.21	10.20	11.26
Breusch-Pagan/ Cook-Weisberg test, $\chi 2$	2.72*	12.39***	12.98***	51.26***
Breusch-Pagan/ Cook-Weisberg test, df	1	1	1	1
Wooldridge test, F	5.820**	8.791***	12.479***	18.552***

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In the top row are the 4 dependent variables. Each column under each dependent variable represents a different regression. Under the top row are the independent variables and their coefficients, the asterisks indicate the statistical significance as indicated in the notes. Below the independent variables are the observations and the number of banks. The variables 'loans to total assets' and 'impaired loans to gross loans' have additional missing variables. Therefore, these variables have less observations and a fewer number of banks. The R-squared indicates how much of the variation in the dependent variable is explained by the independent variables. The VIF tests for multi-collinearity. The Breusch-Pagan/ Cook-Weisberg test tests for heteroskedasticity. Finally, the Woolridge test tests for auto-correlation.

Tier 1 ratio

Tier 1 ratio has a small negative statistical insignificant effect on both ROA or ROE. Therefore, hypothesis 1 cannot be confirmed. There is no evidence that suggests tier 1 ratio has a positive effect on profitability. Tier 1 ratio has a small positive statistical insignificant effect on loans to total assets ratio. This is not at all in line with hypothesis 5. Hypothesis 5 is not confirmed. Lastly, the coefficient of the tier 1 ratio in the model with the impaired loans to gross loans ratio is also statistically insignificant. So, the small and negative coefficient cannot be meaningfully interpreted. Therefore, hypothesis 6 is not confirmed, no negative relationship between tier 1 ratio and impaired loans to gross loans ratio is found.

Size and profit

There is no statistical significant relationship between a bank's size measured in total assets and its main measure of profitability ROA. This confirms hypothesis 2. However, there is a statistical significant relationship between ln of total assets and the loans to assets ratio at the 1% significance level. The coefficient of -5.377 indicates that an increase of 1 in ln(total assets) decreases the loans to total assets ratio by 5,38%. So a 1% increase in total assets translates into a (ln(101/100)*-5.377=) 0.053 decrease in the loans to total assets ratio.

Customer deposit ratio

The customer deposit ratio has a small positive but statistically insignificant effect on ROA, ROE and the loans to total assets ratio. Therefore, hypothesis 3 is rejected, as there is no evidence at statistically significant levels that there is a positive relationship between the customer deposit ratio and ROE/ROE. Surprisingly, the customer deposit ratio has a statistically significant effect on the impaired loans to gross loans ratio at the 5% confidence level. The coefficient of -0.0182 indicates that a higher customer deposit ratio usually goes together with a lower percentage of impaired loans.

Interaction term

As outlined above, the customer deposit ratio seems to have no effect on ROA and ROE. This is still the case after 2014. The interaction term between 2014 and customer deposits doesn't show any statistical significant relationships. So, over the total period customer deposits are not related to profit, and after 2014 this remains the same and there still isn't any significant relationship. So, hypothesis 4 is rejected as there is no evidence that the interaction term has a negative effect on either ROA or ROE. These results confirm the recent findings of Lopez, Rose and Spiegel (2018). They also find that negative interest rates have had very little effect on bank profitability so far. On top, they find that high-deposit banks don't seem to be affected disproportionally.

Years

In both 2014 and 2016 the year-effect on ROA, ROE and impaired loans ratio is statistically significant. The effect on ROA/ROE is negative, indicating that profitability was lower compared to the dummy base year 2013. The effect on the impaired loans ratio is positive indicating that more loans were declared impaired than in 2013, which makes sense in a less profitable year.

Descriptive statistics

In the first two models there are 524 observations over 125 banks. There are less observations in the last 2 models because some observations for loans to total assets and impaired loans to gross loans are missing. The R-squared value shows how much of the variance in the dependent variable is explained by the independent variables in the model. In these 4 models the independent variables explain the most about loans to total assets, about 9% of variance. VIF values for all models exceed the threshold of 10. However, as indicated before, this is because of the similarities between the customer deposit ratio and the interaction term. Also, if one of these variables is left out of the model the VIF values don't indicate multi-collinearity (Appendix B, table 6 and 7). As can be seen, The Breusch-Pagan/ Cook-Weisberg and Wooldridge test give us significant values for all 4 models. This

suggests that there is both heteroskedasticity and auto-correlation. However, to correct for this the fixed effects model with robust standard errors is used.

Conclusion

In this section the results are interpreted and the main research question is answered using the results.

This paper has estimated the effects of tier 1 ratio, size and customer deposits on profitability, risk-taking and asset quality using a fixed effects regression model. The focus is on large European banks between 2012 to 2017. The main research question is:

How do higher capital requirements affect the profitability of large European banks?

In the dataset this paper analysed, no statistical significant relationship between tier 1 ratio and profitability is found. Therefore, there is no evidence that shows higher capital requirements will lower the profitability of banks. Neither is there evidence that suggests there is a positive relationship between capital requirements and profitability. So, there is no evidence that higher capital requirements affect the profitability of large European banks in any way. These findings disagree with most earlier empirical research (Goddard, Molyneux, & Wilson, 2004; Trujillo-Ponce, 2013; Dietrich & Wanzenreid, 2014). Possibly the different contrary theories (Short, 1979; Berger, 1995) mentioned in the theoretical framework are working in opposite directions creating a non-significant ambigious effect.

Furthermore, no statistically significant relationship is found between either the tier 1 ratio and loans to total assets ratio or the impaired loans to gross loans ratio. Regarding the relationship between size and profit, this research finds no evidence for any relationship between size and profit. However, a negative relationship between size and risk-taking as measured by the loans to total assets ratio is found. This indicates that larger banks loan out a smaller percentage of their total assets.

The data indicates there is no relationship between the customer deposit ratio and profitability. Not over the total period and not after negative interest rates have kicked in in 2014. Furthermore, there

is a negative relationship between customer deposit ratio and the impaired loans to gross loans ratio. This indicates that high customer deposit banks have less impaired loans as a percentage of gross loans. Lastly, 2014 and 2016 have been significantly less profitable with more impaired loans compared to the dummy base year 2013.

Limitations

Finally, the limitations of this research are discussed. There are some limitations to this paper. First, the external validity of this research is limited. This research focused on large European banks in recent years. So, these results can't be applied blindly to for example small banks in China in the coming years. Since the time and location is assumed to play a very big role in the determinants of bank profitability, the external validity is limited. Secondly, the results in this paper are statistical relationships and not definite proof of causal relationships. Thirdly, the sample size of banks is limited and could be expanded with access to a larger dataset.

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Appendices

Appendix A data transformations

Figure 1: Boxplot of ROA.

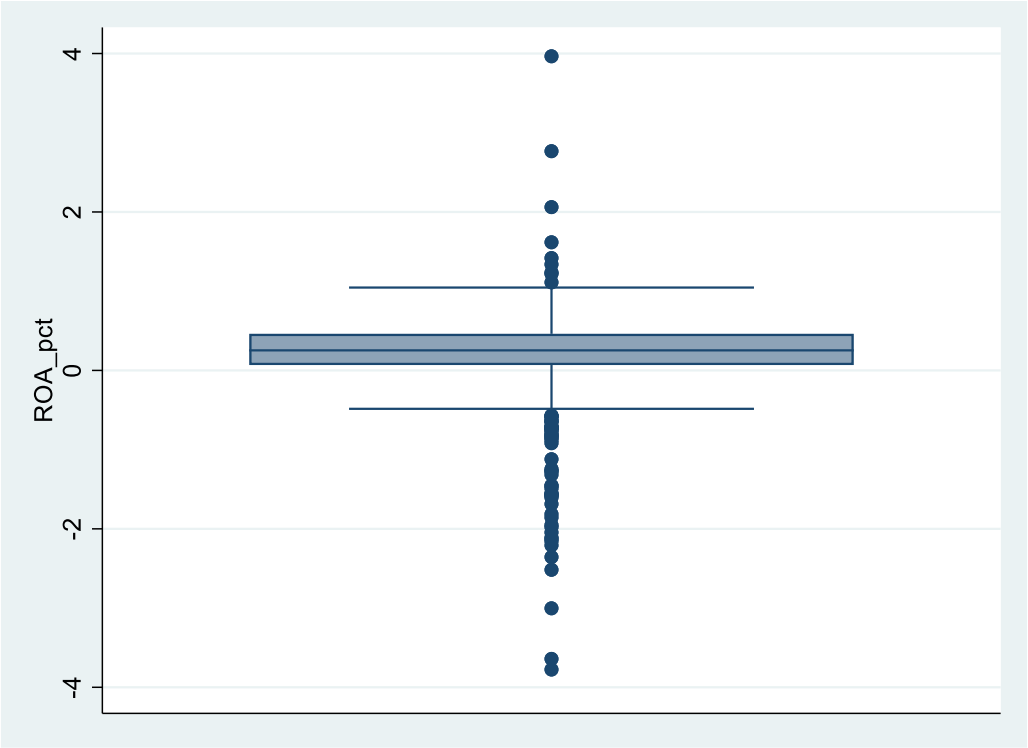


Figure 2: Histogram of ROA

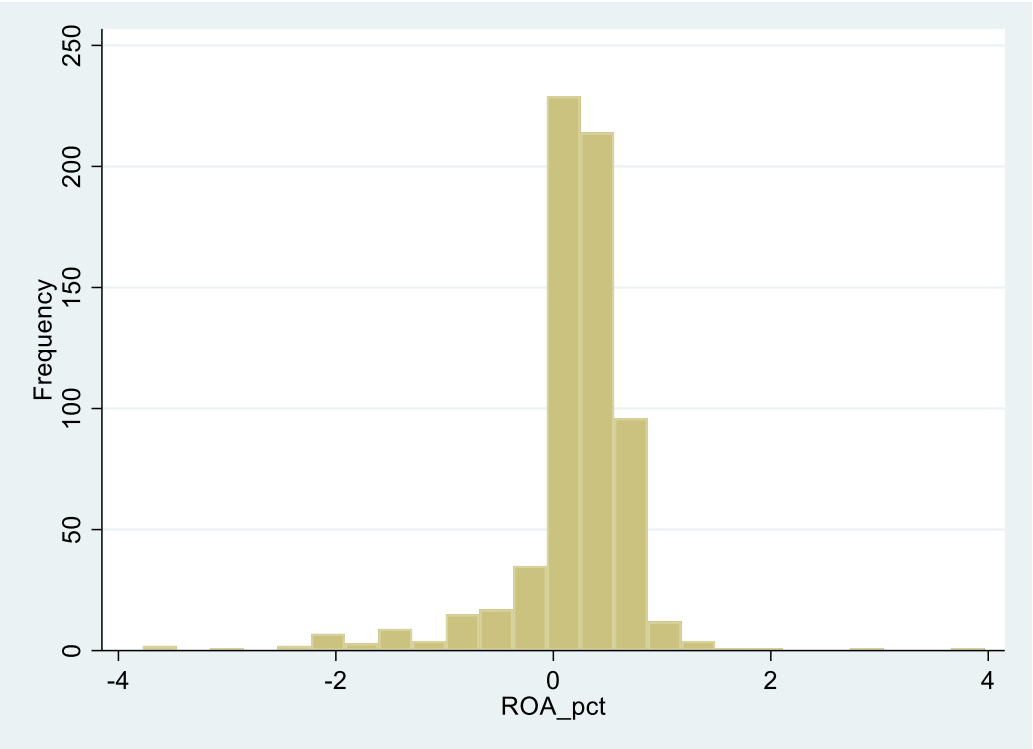


Figure 3: Winsorizing at various percentiles of ROA.

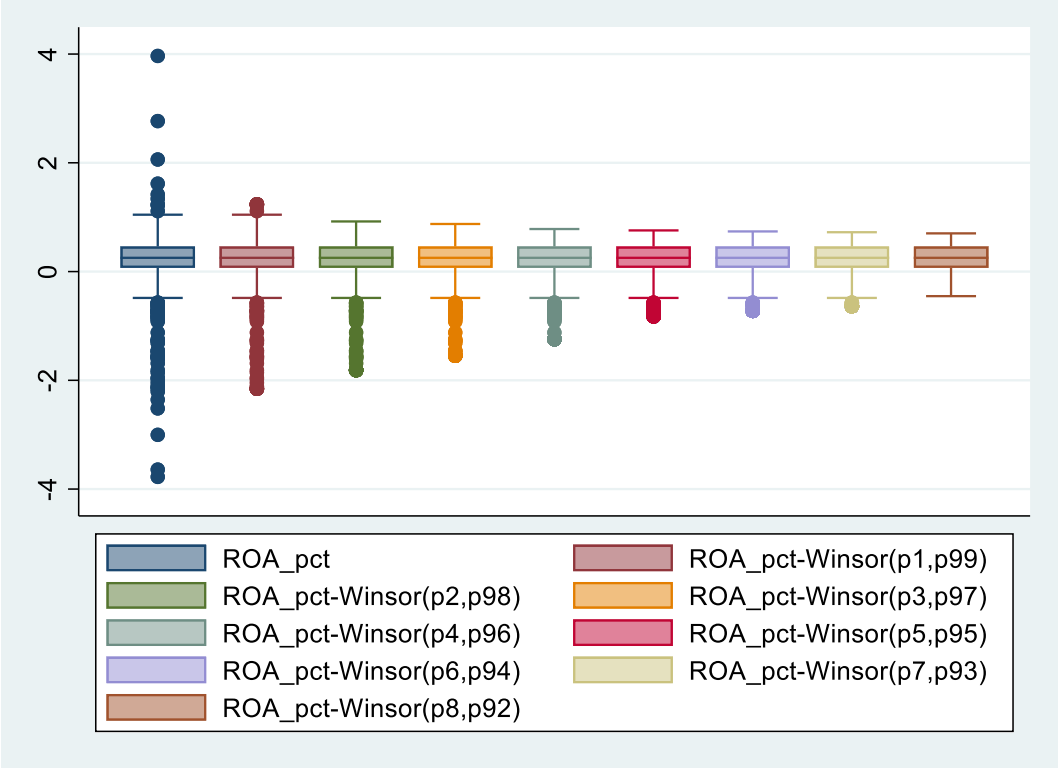


Figure 4: Distribution of ROA after Winsorizing.

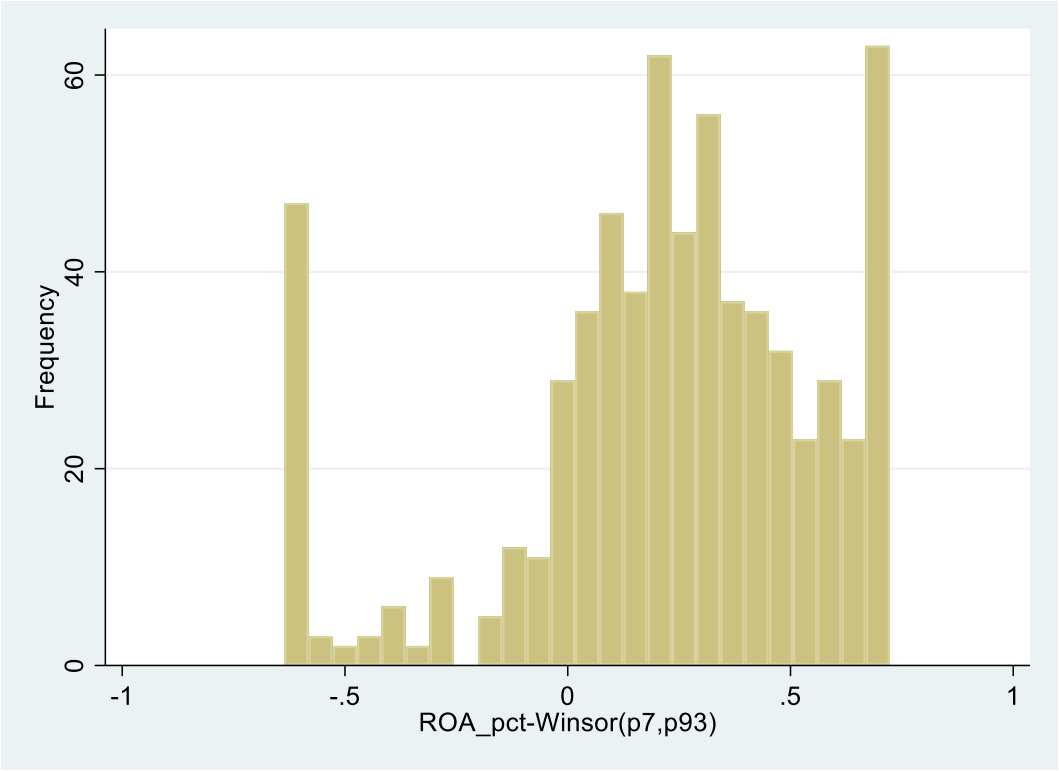


Figure 5: Boxplot of ROE.

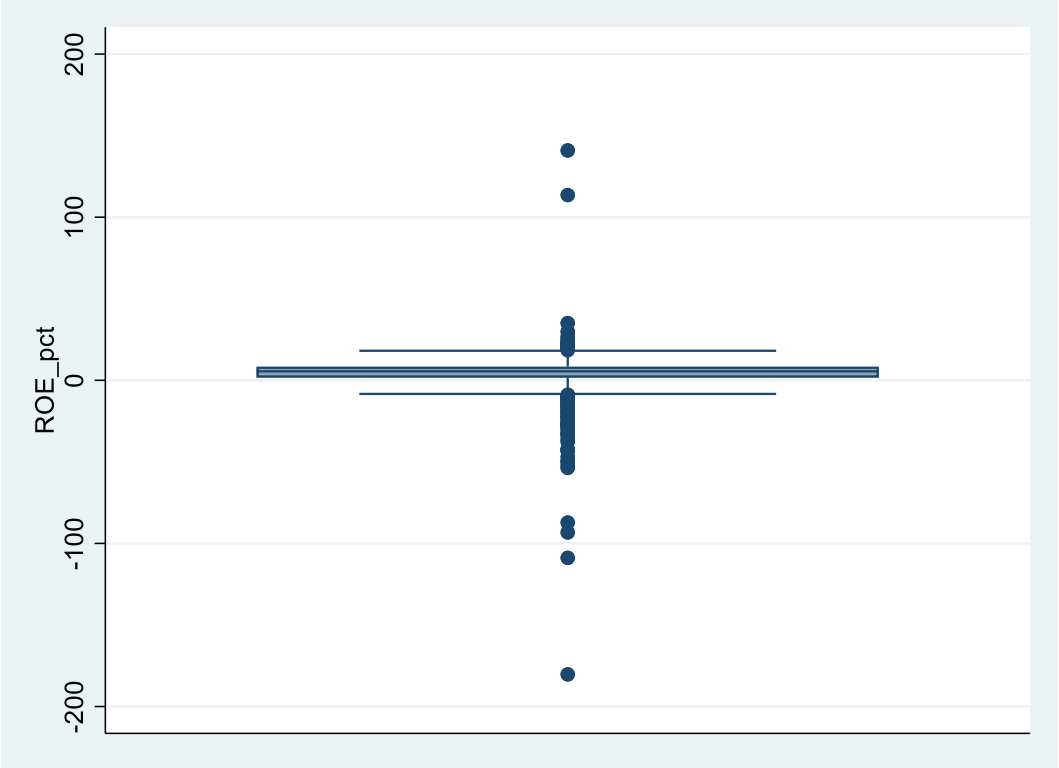


Figure 6: A histogram of ROE.

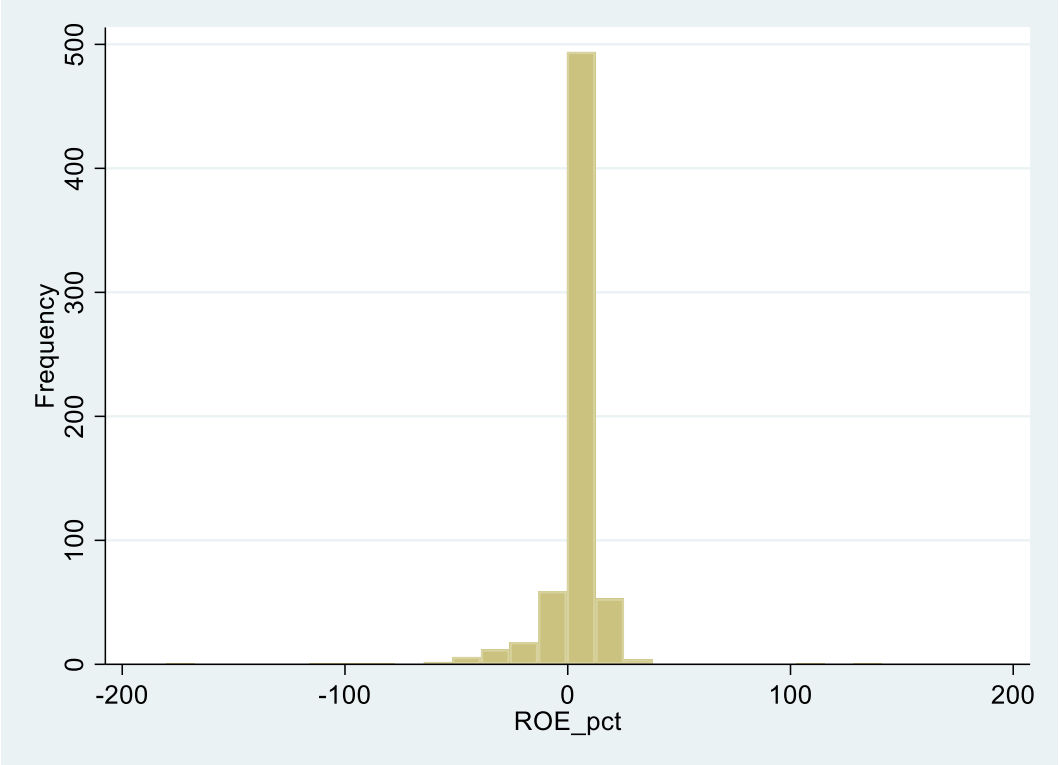


Figure 7: Winsorizing at various percentiles of ROE.

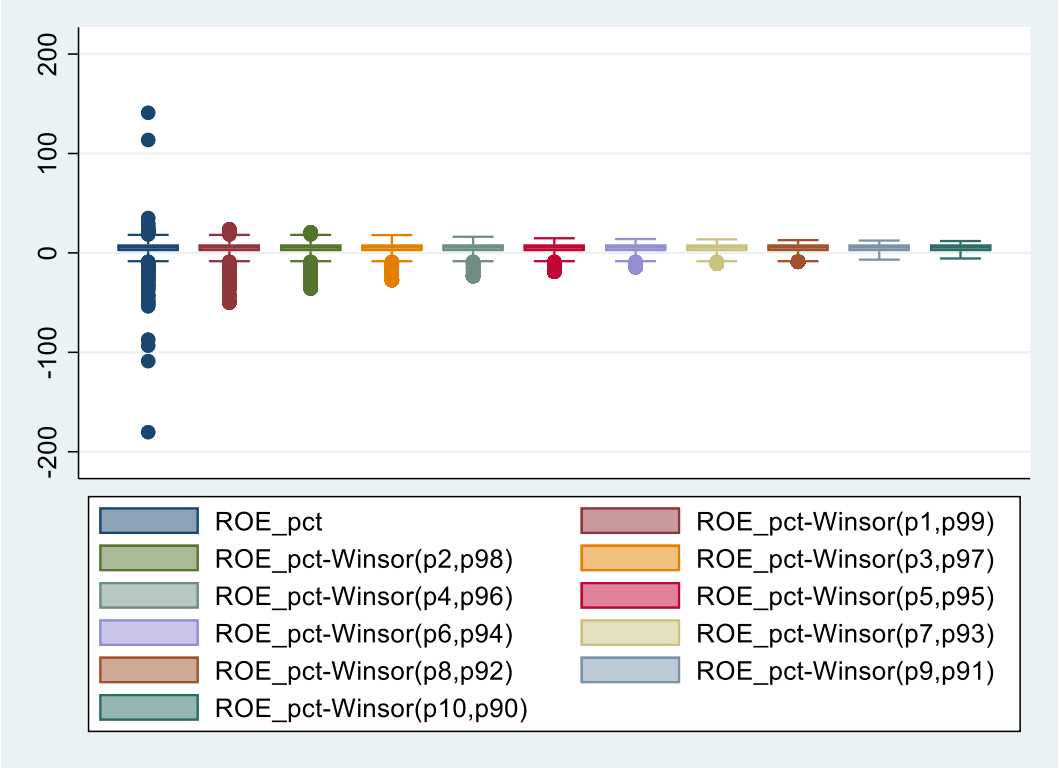


Figure 8: A histogram of ROE after winsorizing at the 8th and 92nd percentile.

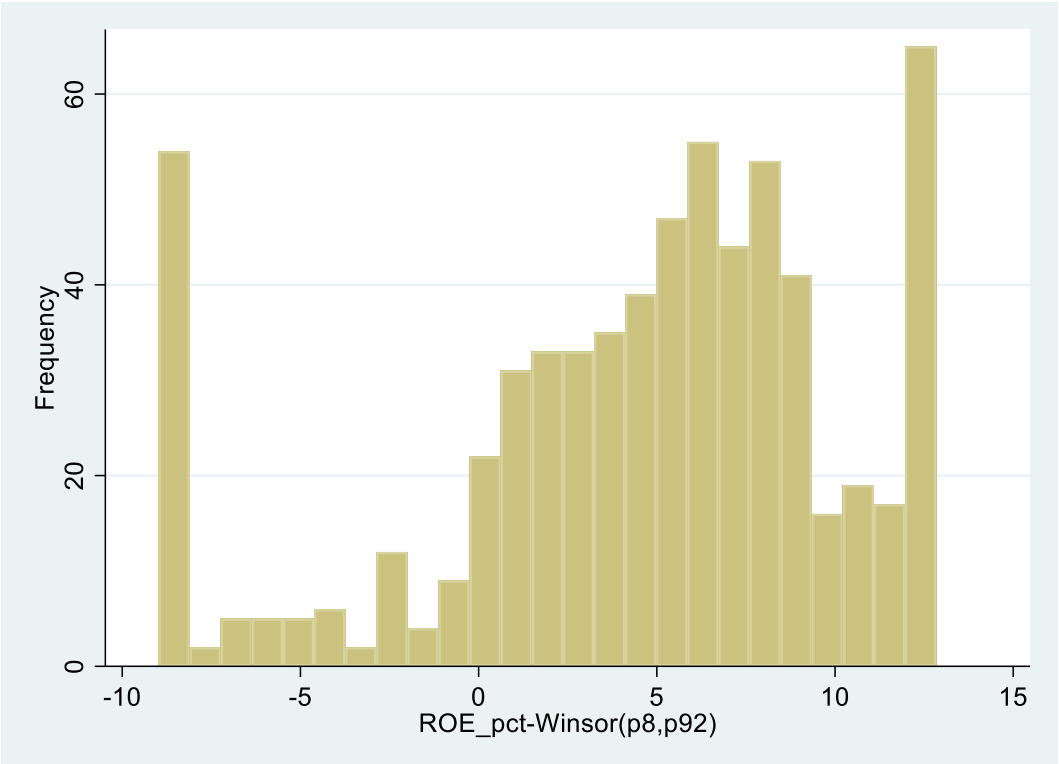


Figure 9: A histogram of impaired to gross loans

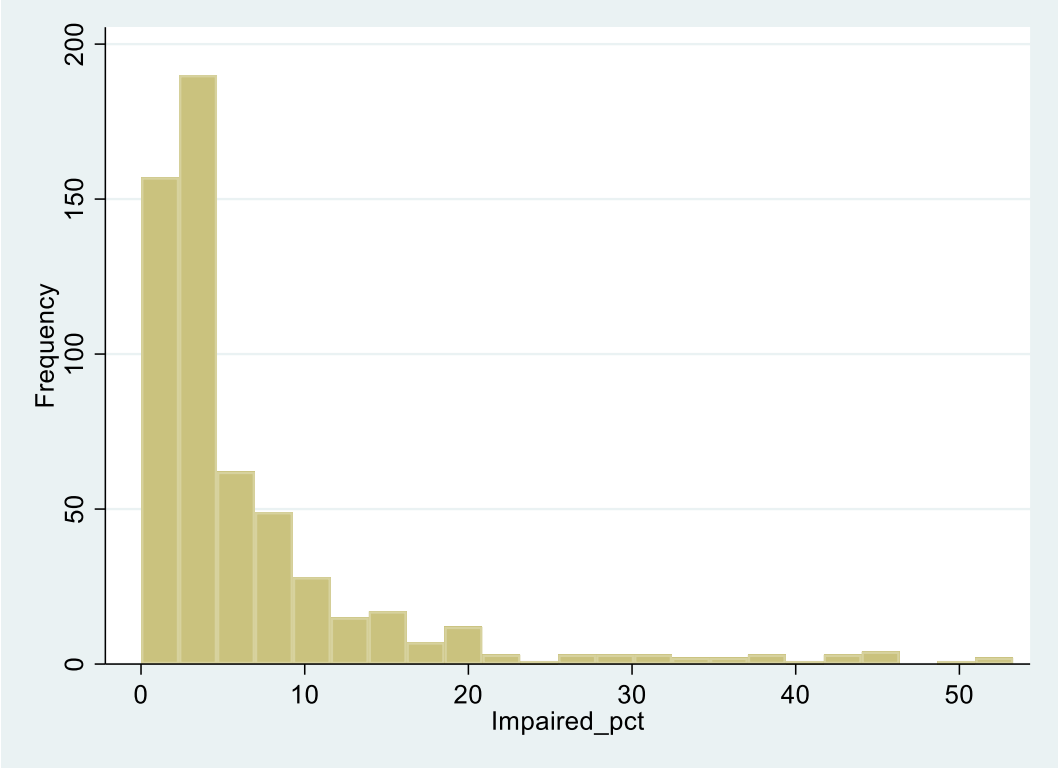


Figure 10: A histogram of impaired to gross loans after the ln-transformation.

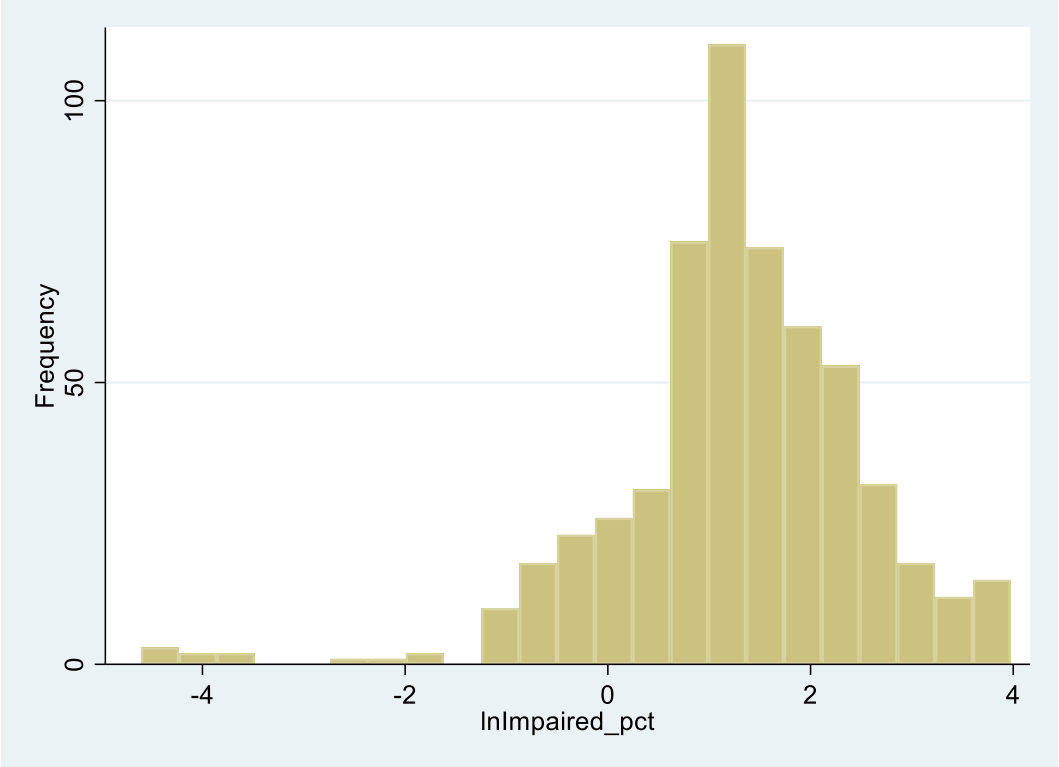


Figure 11: Shapiro-Wilk W test before and after transformation

Shapiro-Wilk W test for normal data

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
impairedlo~t	568	0.64954	132.267	11.809	0.00000
LNimpaired~t	568	0.94025	22.551	7.533	0.00000

Figure 12: Histogram of the lagged tier 1 ratio.

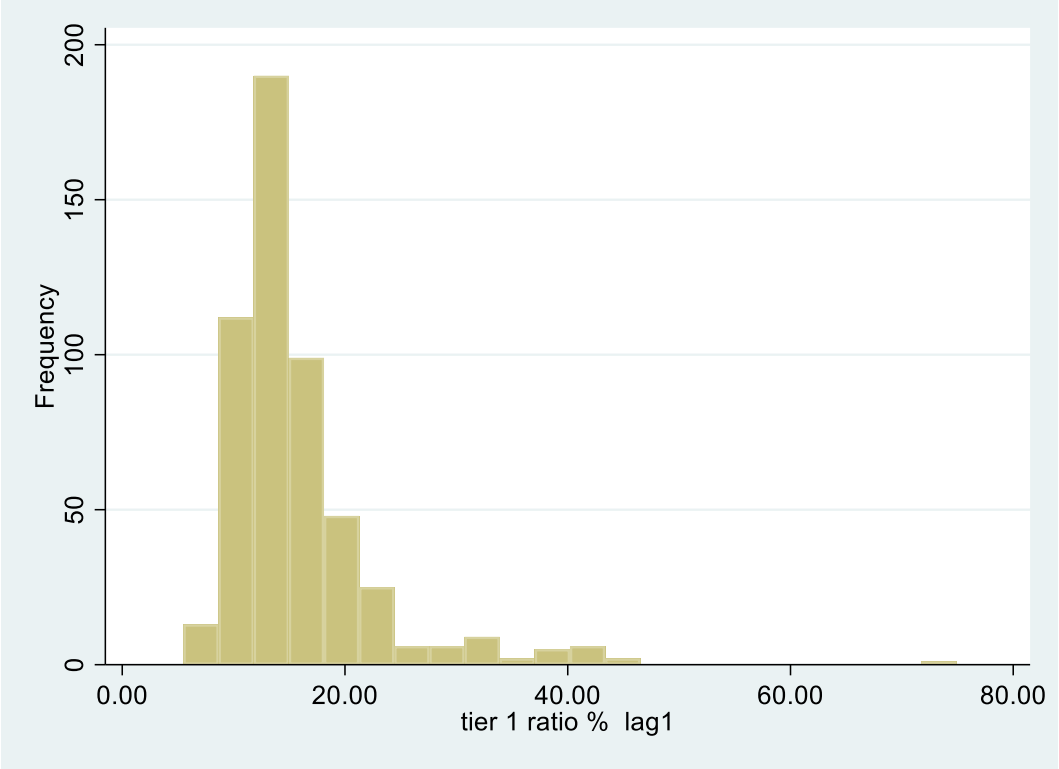


Figure 13: Winsorizing lagged tier 1 ratio at various levels

Figure 14: Shapiro-Wilk W test before and after winsorizing lagged tier 1 ratio

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
Tier1ratio~1	524	0.72504	96.488	11.007	0.00000
Tier1rati~93	524	0.90717	32.576	8.392	0.00000

Figure 15: A histogram of lagged total assets.

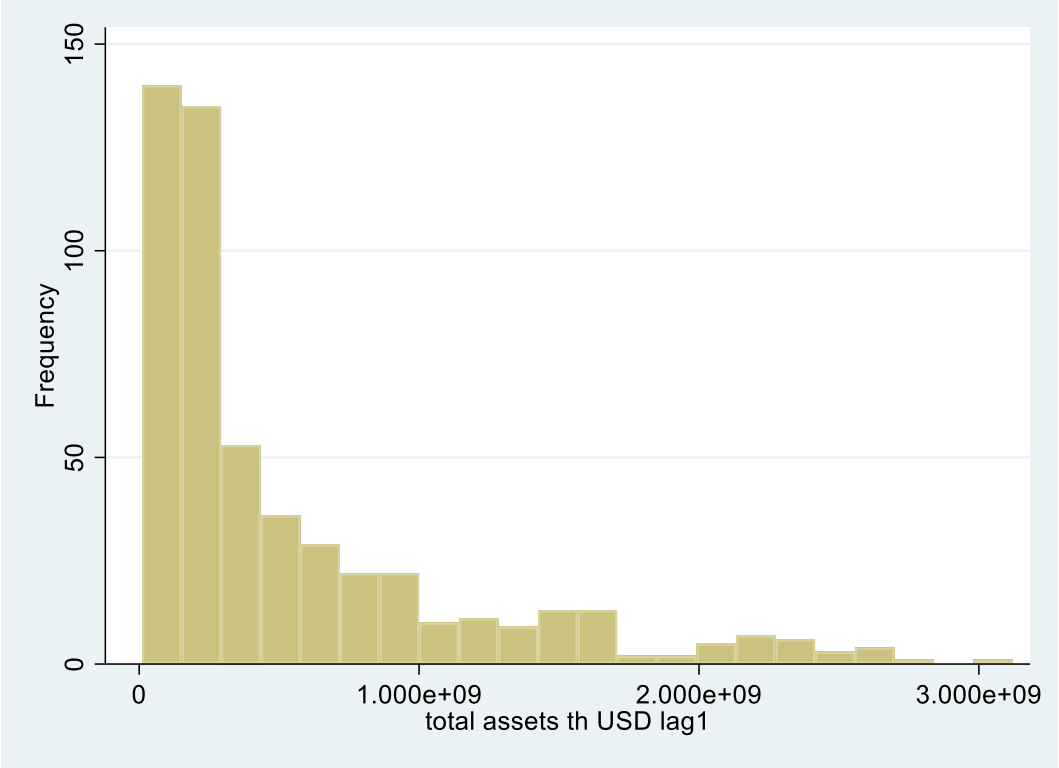


Figure 16: A histogram of lagged total assets after ln-transformation.

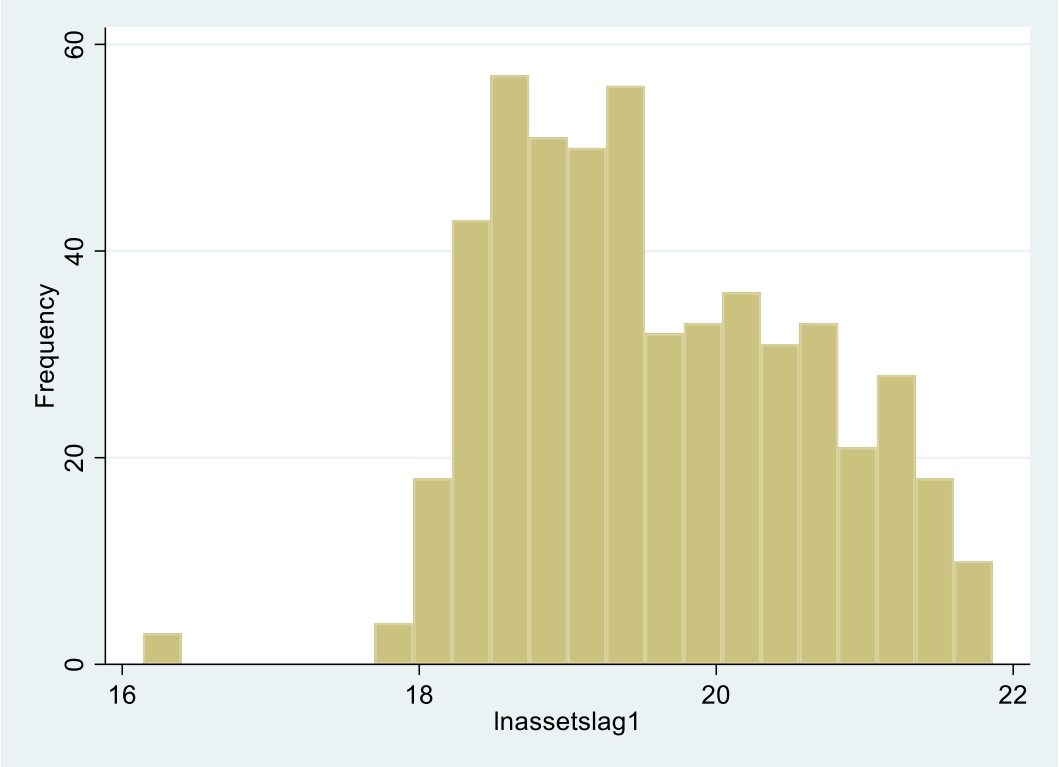


Figure 17: Shapiro-Wilk W test for normality before and after the ln-transformation.

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
totalasset~1	524	0.75248	86.857	10.754	0.00000
lnassetslag1	524	0.96856	11.032	5.783	0.00000

Figure 18: boxplot of loans to total assets ratio

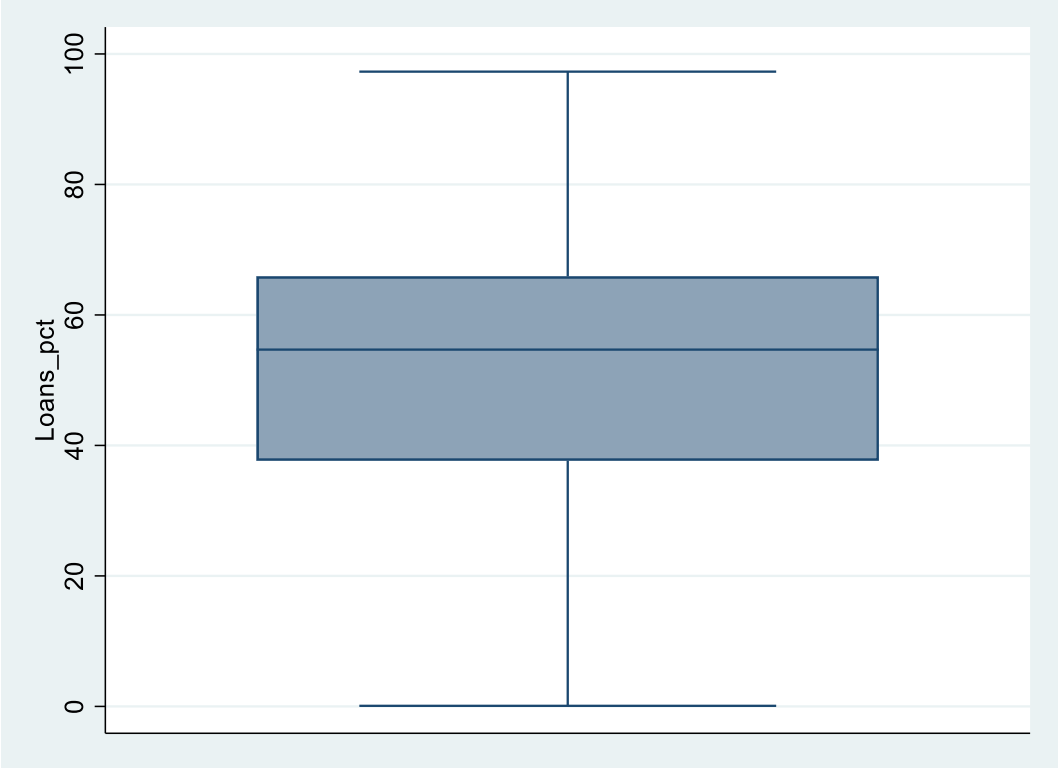
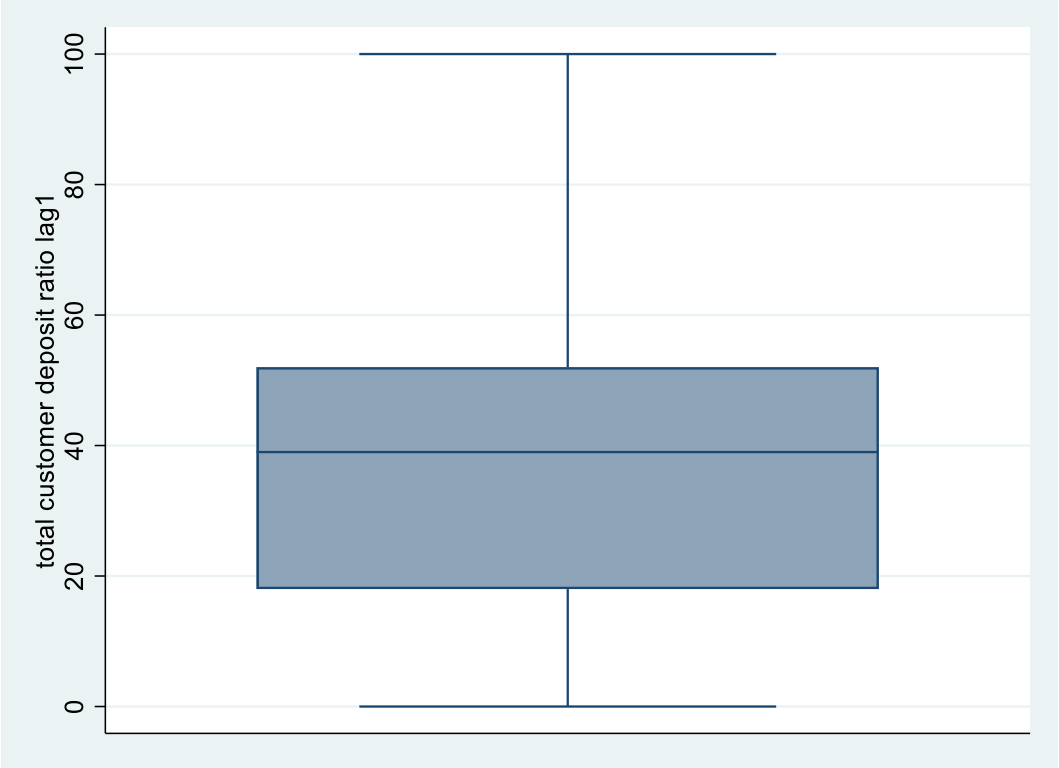


Figure 19: Boxplot of lagged customer deposit ratio



Appendix B Descriptive statistics

Table 1: Descriptive statistics of variables after transformations

	ROA	ROE	Loans/Assets	Impaired/Gross	Tier 1 ratio	Total Assets	Cust. dep.
Mean	0.22	4.48	51.04	1.28	15.14	19.60	36.32
p50	0.25	5.50	54.69	1.29	14.10	19.46	39.00
p25	0.07	1.66	37.67	0.76	11.90	18.77	18.00
p75	0.46	8.38	65.90	2.03	17.00	20.40	52.00
p99	0.72	12.84	94.34	3.81	24.80	21.69	84.00
Sd	0.35	5.91	20.76	1.23	4.17	1.02	22.51
Min	-0.64	-8.98	0.09	-4.61	10.20	16.14	0.00
Max	0.72	12.84	97.29	3.98	24.80	21.86	100.00

Table 2: Return on assets mean from 2012 to 2017

	Year	Mean	Std. Err.
ROA_pct			
	2012	0.01	0.06
	2013	0.13	0.07
	2014	0.16	0.05
	2015	0.23	0.06
	2016	0.20	0.06
	2017	0.35	0.04
N=654			

Table 3: Return on equity mean from 2012 to 2017

	Year	Mean	Std. Err.
ROE_pct			
	2012	0.47	3.36
	2013	1.45	1.29
	2014	3.15	1.07
	2015	5.11	0.74
	2016	3.51	1.08
	2017	6.20	0.61
N=654			

Table 4: Mean of tier 1 ratio from 2012 to 2017

	Year	Mean	Std. Err.
Tier 1 ratio			
	2012	14.77	0.65
	2013	15.70	0.79
	2014	15.11	0.55
	2015	16.29	0.57
	2016	16.91	0.58
	2017	17.91	0.55
N=654			

Table 5: Banks' distribution over European countries

Country	Frequency	Percent
Austria	18	2.75
Belgium	32	4.89
Germany	120	18.35
Denmark	28	4.28
Spain	47	7.19
Finland	8	1.22
France	113	17.28
United Kingdom	123	18.81
Greece	24	3.67
Ireland	11	1.68
Italy	38	5.81
Luxembourg	5	0.76
Netherlands	46	7.03
Portugal	11	1.68
Sweden	30	4.59
Total	654	100

Table 6: VIF values in ROA model with interaction term

Variable	VIF	1/VIF
Tier 1 ratio	1.29	0.77
Total assets	1.09	0.91
Customer deposit ratio	7.32	0.14
Dummy 2014	4.31	0.23
Interaction term	10.21	0.10
Year		
2014	1.64	0.61
2015	1.68	0.60
2016	1.64	0.61
Mean VIF	3.65	

Table 7: VIF values in ROA model without interaction term

Variable	VIF	1/VIF
Tier 1 ratio	1.28	0.78
Total assets	1.09	0.92
Customer deposit ratio	1.16	0.86
Dummy 2014	1.61	0.62
Year		
2014	1.64	0.61
2015	1.68	0.60
2016	1.64	0.61
Mean VIF	1.44	