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**Working Paper**

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IES Working Paper, No. 4/2015

**Provided in Cooperation with:**

Charles University, Institute of Economic Studies (IES)

*Suggested Citation:* Růžičková, Karolína; Teplý, Petr (2015) : Determinants of banking fee income in the EU banking industry: Does market concentration matter?, IES Working Paper, No. 4/2015, Charles University in Prague, Institute of Economic Studies (IES), Prague

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**Bibliographic information:**

Ruzickova K., Teply P. (2015). "Determinants of banking fee income in the EU banking industry - does market concentration matter?" IES Working Paper 3/2015. IES FSV. Charles University.

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# Determinants of Banking Fee Income in the EU Banking Industry - Does Market Concentration Matter?

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January 2015

## **Abstract:**

The wide change of banking models over last few decades has led to an increasing share of fee and commission income of banks. In this paper we deal with determinants of banking fees in the European Union with special emphasis on market concentration based on EU-27 data from 2007 to 2012. For the estimation we use System Generalized Method of Moments, which is appropriate for dynamic panel data, allows for time invariant and lagged dependent variables and is able to deal with endogeneity. We conclude that banks facing higher competition tend to expand more aggressively into non-traditional activities and therefore they report higher fee income shares. Moreover, we found that a higher equity to assets ratio is related with higher shares of fee income since by expanding into non-traditional businesses the bank needs more capital to prevent the potential risks of the new activity. Surprisingly, a high deposits to assets ratio tends to increase the fee income share, which may be possibly attributed to relatively high switching costs and to close relationship between depositor and bank in the EU banking sector. However, macroeconomic conditions do not seem to have a significant impact on the net fee and commission income share.

**Keywords:** bank, fee and commission income, market concentration, GMM system  
**JEL:** C23, G21, L25

## **Acknowledgements:**

This research was supported by the Czech Science Foundation (projects GACR No.14-02108S and GACR No. 15-00036S) and the Grant Agency of the Charles University in Prague (project GAUK No. 105815).

# 1 Introduction

Banking models have widely changed over last few decades. The technological development and digitalization of services has increased the competition among financial institutions which in turn led to decreased cost advantages of banks. As a result, the profitability of traditional activities of banks dropped which consequently led to an expansion of banking activities into non-traditional fee and commission bearing services (Edwards and Mishkin, 1995, Rogers and Sinkey, 1999, Davis and Tuori, 2000).<sup>1</sup> In Europe, non-interest income (NII) has increased from 26% to 41% of total income between 1989 and 1998 (Lepetit et al., 2005). The most pronounced part of NII is net fee and commission income (NFCI) that accounted on average for 58% of all NII between 1993 and 1998 in EU countries. Nevertheless, the composition of NII differs across European countries significantly. Whereas in the United Kingdom NFCI represented more than 70% of NII in 1998, it was only 35% in Portugal and Sweden (ECB, 2000).

The sharp change in banking income composition attracted the interest of academic sphere. The academicians as well as bank managers are mainly concerned by the impact of NII on the risk-return tradeoff, i.e. how does the income diversification affect the magnitude and the volatility of bank earnings. An overall effort to find the optimal banking strategy and to identify the most appropriate level of banking fees can be observed. The literature is mostly unanimous about the relationship between NFCI and banking business model but solving for the optimal fee structure (and therefore optimal business strategy) has not yet been accomplished either on a theoretical level, or in actual practice.

Commercial banks provide the most important financial services such as deposit taking and loan providing (i.e. traditional activities). They make money mainly on charging higher interest on loans than what they are paying on clients' deposits. Investment banking is the part of banking activities that are potentially more risky and generally not as important as activities of commercial banks. This includes services and financial advisory to corporations as well as for example securities issuance (i.e. non-traditional activities). Investment banks make their money mainly

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<sup>1</sup> We refer to traditional activities if we are speaking about activities such as deposit taking and loan providing (in general core businesses of commercial banking). Non-traditional activities are for example retail brokerage, insurance sales, securities issuance (in general core businesses of investment banking).

on trading, fee and commission income (with an approx. >40% NFCI/total income ratio (NFCI/TI)). Universal banks combine commercial and investment banking within one group. The income composition of those banks reflects the combined structure of the business. Investment oriented universal banks have higher NFCI than interest income, commercial banking oriented universal banks have higher interest income than NFCI (Gambacorta and van Rixtel, 2013).

In this paper, a set of European banks' data is used to analyse the links between bank NFCI, business strategies, market and macroeconomic conditions between 2007 and 2012. A special emphasis is set on the link between market concentration and NFCI share. Increasing competition is assumed to be one of the main reasons forcing banks to switch to non-traditional fee bearing activities. Therefore, we hypothesize that higher competition is connected with higher level of fee income in the banking sector.

Still, the relationship between NFCI and Herfindahl index (HI) that is used to measure the market concentration need not to be necessarily the one stated in the hypothesis. The explanation is intuitive. The lack of competition may enable to charge high banking fees. On highly concentrated markets cartels may prohibit the players to reduce their prices; therefore, a possibility to switch to a cheaper provider of banking services remains limited. We also assume that most clients are conservative and not enough flexible to deposit their money or take a loan from abroad because of financial fragmentation in EU markets. Moreover, in case of high concentration the bank will take the advantage of its market power not only by charging higher fees but it will most probably exhibit also higher interest margins. Therefore, the share of fee income does not need to increase. Consequently, we expect to find a negative relation between market concentration and NFCI share.

The rest of the paper is structured as follows. Section 2 provides literature review. In Section 3, we study the determinants of fee income magnitude, especially the impact of market concentration on NFCI. Section 4 summarizes the paper and states final remarks.

## 2 Literature review

As banks have become more involved in non-traditional activities that generate fee and commission income, the number of literature examining the common features of banks expanding into non-traditional areas has grown. While there are more studies trying to document the determinants of NII share at the bank level, the literature studying the relation between market concentration and the magnitude of NFCI is

limited. The first paper examining the correlation between HI and NII was Moshirian et al. (2011). Based on data from 20 developed countries (109 banks), they found that banks facing high concentration have lower levels of non-interest income activity. Moreover, they included a variable measuring the change in market competition which turned out to be significantly negative. This means that even though the concentration is slowly moving variable, also small changes influence the income composition of banks significantly. This indicates that banks in highly competitive markets are more likely to engage in risky behaviour including expansion in non-traditional activities. Similarly as the U.S. studies Moshirian et al. (2011) conclude that large banks with smaller net interest margin (NIM) exhibit higher NII.

The following papers deal with the determinants of NII in general, none of them specialized on the market concentration. Rogers and Sinkey (1999) found that banks with high NII tend to be larger, have smaller NIM, have relatively fewer core deposits and exhibit less risk. Banks with low NIM and few core deposits earn less revenue from traditional activities and must therefore engage in non-interest bearing services in order to remain profitable.

DeYoung and Hunter (2003), DeYoung et al. (2004) and DeYoung and Rice (2004a) also concluded that NII is positively correlated with bank size. They argue that large banks take advantage of economies of scale and operate with very low unit costs. Despite this fact, they tend to earn very low interest margins because of large competitiveness of this market. Thus large banks need to rely heavily on NII in order to be profitable. On the other hand, small banks operating in local markets develop relationships with their customers. Although they have high unit costs, they are able to remain profitable because of high interest margins. NII is less important to those banks. They also found that well managed banks generate less NII, because they do not tend to expand into activities that have poor risk-return tradeoff.<sup>2</sup>

In comparison to Rogers' and Sinkey's study DeYoung and Rice (2004a) included to the model also bank external factors that may influence choice of the proportion of NII. They claim that banks located in states with strong economies and banks with high market power are able to generate more NII. Moreover, they found that banks with more developed payment technologies such as credit cards, debit cards or electronic checks generate increased fee income.

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<sup>2</sup> DeYoung and Rice (2004) found that NII has negative effect on risk-adjusted performance of banks.

Most of the later research is based on the previous ones using data from other countries. Shahida et al. (2006) applied the Rogers' and Sinkey's model on panel of Malaysian Islamic commercial banks. They concluded that banks with higher levels of fee-generating activities tend to have higher assets and core deposits as well as exhibit less risk. Compared to Rogers and Sinkey (1999), they found no significant relationship between fee income and NIM. The fee income and core deposits turned out to be positively correlated. This indicates that Islamic banks with traditional sources of funds are associated with more non-traditional activities as sources of income.

Craigwell and Maxwell (2005), Bailey-Tapper (2010) and Kim and Kim (2010) followed the framework from DeYoung and Rice (2004a). Craigwell and Maxwell (2005) investigate the determinants of NII and its impact on financial performance of commercial banks in Barbados between 1985 and 2001. The results show that contrary to other Caribbean countries and developed world, NII in Barbados decreased over the examined period. This was most likely caused by the absence of deregulation and technological change mainly in loan securitization and credit scoring in 1990s. The results support the importance of bank specific and market development factors by determining the NII share, although the found coefficient signs or their significances are not always in line with the findings of DeYoung and Rice (2004a). Contrary to findings in the United States the job growth in the economy has no significant impact on NII. Furthermore, larger banks are associated with lower NII than smaller banks which also deviates from the U.S. empirical results.

Bailey-Tapper (2010) investigates NII based on Jamaican panel data. In contrast with the U.S. evidence, well managed banks in Jamaica tend to generate more NII than other banks. Another result that is in contrast with a priori expectations is that core deposits decrease NII. This suggests that banks do not generate higher fee income in a context where customers' demand is inelastic. This paper also concluded that some macroeconomic conditions, especially exchange rate and interest rate volatility, have significant impact on income diversification of bank.

Kim and Kim (2010) document the long-run trends in the amount and composition of NII at South Korea banks. Most of the coefficients in this study resulted insignificant. Loans to assets ratio as well as core deposits to total assets ratio are negatively correlated with NII share. Besides those two indicators, only technology variables<sup>3</sup> turned out to influence the NII of Korean banks significantly.

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<sup>3</sup> Variables used to proxy development and application of new technologies in the banking sector.



Hahn (2008) based his study on data from 29 OECD countries and he analysed both bank specific as well as macroeconomic factors. He found that large and more profitable banks with relatively low NIM and low loans to assets ratio tend to exhibit higher NII ratio which is consistent with conclusions of Rogers and Sinkey (1999), DeYoung and Hunter (2003) and DeYoung et al. (2004). He also claims that risk-taking banks and less cost efficient banks are diversifying their revenue more aggressively by increasing their NII. Among macroeconomic factors, GDP growth, inflation and market capitalization seem to be important determinants of NII.

We conclude that common factors determining the income diversification can be found but their impact on NII varies across countries. The largest differences can be identified when analysing the developed and developing economies separately. Moreover, there are factors influencing the composition of bank income that need to be studied more deeply.

### 3 Empirical analysis

In this section we examine what determines the magnitude of net fee and commission income of banks. Besides the basic bank interior and exterior factors that are considered to have some impact on the NFCI magnitude, we also include market concentration as a determinant of NFCI.

#### 3.1 Data and methodology

The analysis is based on EU-27 data from 2007 to 2012. The data were taken from Bankscope database, ECB database, Eurostat, The World Bank DataBank and HelgiLibrary database. The final data set is a balanced panel. Our study is based on data from 185 European banks (112 commercial banks, 14 savings banks, 17 cooperative banks, 15 real estate and mortgage banks, 10 investment banks, and 17 bank holdings and holding companies), i.e. on average we have data for almost 7 banks in each country available. The exact number of banks included in the study for each country can be seen in Table 1.<sup>4</sup>

**Table 1: Number of banks included in the study by country**

Austria	:	7	Germany	:	10	Netherlands	:	7
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<sup>4</sup> The inclusion of more banks was not possible due to high number of missing data in the Bankscope database. Strongly unbalanced panel could make the estimation inaccurate. Moreover, we excluded all banks with negative operating income from the final data set, because their NFCI/TI ratio would be misleading.

Belgium	: 3	Greece	: 4	Poland	: 7
Bulgaria	: 5	Hungary	: 3	Portugal	: 7
Cyprus	: 3	Ireland	: 2	Romania	: 2
Czech Republic	: 3	Italy	: 32 <sup>5</sup>	Slovakia	: 3
Denmark	: 9	Latvia	: 1	Slovenia	: 6
Estonia	: 2	Lithuania	: 1	Spain	: 9
Finland	: 3	Luxemburg	: 1	Sweden	: 9
France	: 14	Malta	: 1	United Kingdom	: 31

*Source:* Author's computations

Most of the current authors used FE, RE or pooled OLS estimation method for the analysis of NFCI (NII) magnitude determinants. We claim that those approaches can be outperformed by System Generalized Method of Moments (GMM) which we will apply. This is because we expect persistence in NFCI magnitude and the inclusion of lagged dependent variable leads to inconsistency of the previous methods. System GMM is appropriate for our data set with large number of banks and small number of time periods and is able to correctly deal with explanatory variables that are not strictly exogenous. In the following paragraphs we describe the System GMM theoretically and we justify our choice of the estimation method.

We deal with autoregressive-distributed lag model that uses large set of cross-section data and small number of time periods. The general model of the data-generating process is as follows:

$$y_{i,t} = \alpha y_{i,t-1} + X'_{i,t} \beta + \varepsilon_{i,t} \quad 1$$

$$\varepsilon_{i,t} = \mu_i + v_{i,t}$$

$$E[\mu_i] = E[v_{i,t}] = E[\mu_i v_{i,t}] = 0$$

where  $|\alpha| < 1$ ,  $i = 1, \dots, N$  is the individual's index and  $t = 1, \dots, T$  is a time index. The disturbance term has two orthogonal components: an unobserved individual-specific time-invariant effect, i.e. the fixed effects,  $\mu_i$ , and the idiosyncratic shocks,  $v_{i,t}$ . While the number of individuals (N) is assumed to be large, the number of time

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<sup>5</sup> We had to adjust the number of Italian banks that was considerably higher than in other countries. This was caused mainly by the fact that in Italy, the same banks operating in different regions stand as separate legal entities (i.e. we had in our data for example more than twenty Cassa di Risparmio). Due to the regional separation, the Italian banks resulted to be much smaller than other European banks. In order to have a representative data set, we kept just 32 biggest Italian banks. (We considered also to merge and/or average the data for individual Italian bank types, but since we were not sure about the used accounting standards and consolidation, we decided rather to drop the small banks.)

periods (T) is assumed to be small. The exogeneity assumption required for consistency of pooled OLS estimation model (explanatory variables need to be uncorrelated with the disturbance term) is violated since  $y_{i,t-1}$  and  $\mu_i$  are necessarily correlated. This gives rise to so called dynamic panel bias. It follows that pooled OLS is inappropriate in case of dynamic panel data models (Wooldridge, 2002). Particularly, pooled OLS attributes more predictive power to the lagged dependent variable than it should have (Roodman, 2006).

As shown in Nickell (1981) and Bond (2002) also Least Squares Dummy Variable (LSDV) or Within Groups estimator that can be used to address the fixed effect are not able to eliminate the dynamic panel bias. The latter estimator is constructed as deviations of the original observations from its individual means, which removes the time-invariant individual effects. However, when number of periods is small, the transformed lagged dependent variable ( $y_{i,t-1} - \frac{1}{T-1}(y_{i,1} + \dots + y_{i,T-1})$ ) and the transformed error term ( $v_{i,t} - \frac{1}{T-1}(v_{i,2} + \dots + v_{i,T})$ ) are correlated. This leads to inconsistency of Within Groups estimator that is contrary to pooled OLS biased downwards. This means that the true estimate should lie between the pooled OLS and Within Group estimates. Therefore, we will use these two methods for robustness check as suggested also in Bond (2002).

Kiviet (1995) suggests to use LSDV corrected for the bias. He shows that such procedure yields often more efficient estimates than consistent GMM approach. Anyway, this type of model is appropriate only for balanced panel and is not able to solve the potential endogeneity of other variables (Roodman, 2006).

Two transformations are commonly used for dynamic panel data. The first method is so called Difference GMM. This estimator was originally developed by Holtz-Eakin et al. (1988) and by Arellano and Bond (1991) and it uses the first-difference transformation applied on the original model. This yields the following equation:

$$\Delta y_{i,t} = \alpha_1 \Delta y_{i,t-1} + \Delta X'_{i,t} \beta_1 + \Delta v_{i,t} \quad 2$$

As by Within Group transformation, the fixed effects are no more present, but the new lagged dependent variable ( $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ ) is still endogenous, i.e. correlated with the new error term ( $\Delta v_{i,t} = v_{i,t} - v_{i,t-1}$ ). This can be addressed by assuming that  $v_{i,t}$  are serially uncorrelated. Another drawback of this transformation is that it prolongs gaps in unbalanced panel data. This motivated another transformation called forward orthogonal deviations that subtracts the mean of all available remaining future observations of a variable from the contemporaneous one (Arellano and Bover, 1995). This framework minimizes the data loss.

Moreover, Differenced GMM estimator is poorly behaved when the time series are persistent and the number of time series observations is small, because in this case, the lagged levels of the series provide only weak instruments for subsequent first-differences (Blundell and Bond, 1998, Bond et al., 2001). This gives rise to the System GMM developed in Blundell and Bond (1998) that is able to address the persistence of the endogeneity bias. This method combines the differences equation (2) with the level equation (1). As long as  $v_{i,t}$  are serially uncorrelated, we do not need to have strict exogeneity of the explanatory variables. Moreover, in this framework the fixed effects are not removed by the differencing of regressors, System GMM differences the instruments to make them uncorrelated with the fixed effects (Sanya and Wolfe, 2011). This means that the variables in level equation are instrumented with their own differences, which increases the efficiency of the estimation (Gürbüz et al., 2013).

This type of model is the most suitable for our data because past changes in the explanatory variables can better predict the current levels than the current changes (Sanya and Wolfe, 2011). Moreover, when applying the Difference GMM all time-invariant regressors would disappear, which is not the case for System GMM (Roodman, 2006). Finally, it is more robust to missing data, because the lagged observations are used as instruments and not as explicit regressors (Sanya and Wolfe, 2011). Furthermore, we include time dummies in the regressions,<sup>6</sup> because they make the assumption of no correlation between idiosyncratic shocks more likely to hold (Roodman, 2006, Sanya and Wolfe, 2011).

The estimation equation representing our model for each of the net fee and commission magnitude measure is as follows:

$$Y_{i,c,t} = \alpha + \beta Y_{i,c,t-1} + \gamma X_{i,c,t} + \delta Z_{c,t-1} + \epsilon W_{c,t} + \theta D_i + \vartheta T_t + (\mu_i + v_{i,c,t})$$

where:

$Y_{i,c,t}$  ..... net fee and commission income share of bank  $i$  in country  $c$  at time  $t$  (dependent variable), namely NFCI/TI and NFCI/total assets ratio (NFCI/TA),

$Y_{i,c,t-1}$  .. NFCI share of bank  $i$  in country  $c$  at time  $t - 1$ , measured as above,

$X_{i,c,t}$  ..... vector of bank-specific variables for bank  $i$  in country  $c$  at time  $t$ ,

$Z_{c,t-1}$  ... vector of country-specific variables for country  $c$  at time  $t$ ,

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<sup>6</sup> The time dummies are not reported in the tables.

$W_{c,t}$  ..... vector of banking sector-specific variables for country  $c$  at time  $t$ ,  
 $D_i$  ..... bank type dummy,  
 $T_t$  ..... time dummy,  
 $\mu_i$  ..... unobserved bank-specific time-invariant effect,  
 $v_{i,c,t}$  ..... disturbance term which is independent across banks.

## 3.2 Variables

By choosing the proper variables, we follow the papers by DeYoung and Rice (2004a), Shahida et al. (2006), Moshirian et al. (2011) and ECB FSR (2013).

The dependent variable captures the net fee and commission income magnitude that is measured by NFCI/TI ratio ( $nfc\_ti$ ) and NFCI/TA ratio ( $nfc\_ta$ ).

The explanatory (independent) variables are classified as bank-specific, country-specific, and banking sector-specific variables. As already mentioned, besides the variables listed below, we include also lagged dependent variable ( $lag\_DV$ ).

### 1) Bank-specific explanatory variables

The bank-specific variables are mainly supposed to capture the business model of a given bank to which the magnitude of NFCI is clearly linked. We define factors that measure the involvement in traditional retail customer business as well as non-traditional investment banking and asset management activities of a given bank.

*Natural logarithm of total assets* ( $ln\_ass$ ) measures the size of a bank. It is hypothesized that larger banks are on average more involved in non-traditional activities than smaller banks. This is because investment banking requires a certain level of specialization and technology which is present mainly in larger banks.

*Net interest margin* ( $nim$ ) is a ratio of the difference between income from investment of depositors' fund and income attributable to depositors to total assets. It is used to measure the profits of traditional activities. In case the banks with large amounts of non-traditional activities have lower profits from traditional businesses, we would find a negative relation between NFCI and NIM, and vice versa.

*Total customer deposits to asset ratio* ( $depos\_ass$ ) is also used as a proxy for traditional relationship banking. The higher the  $depos\_ass$  the more is the bank using traditional activities and the lower NFCI should be.

*Total equity to total assets ratio (eq\_ass)* is a measure of capital risk (from accounting perspective), the ability of a bank to meet its obligations and absorb potential losses. If we assume that the bank needs capital in order to prevent excessive risk by entering new (non-traditional) activities, we would expect to find a positive relationship between NFCI and *eq\_ass*.

*Common equity Tier 1 capital ratio (tier1)* is a measure of capital risk (from regulatory perspective). We assume that Tier1 is highly correlated to *eq\_ass* and therefore, we would probably need to drop one of them in the final analysis.

*Non-performing loans to gross loans ratio (npl\_loans)* measures the credit risk as well as loan quality. A negative relationship between *npl\_loans* ratio and NFCI would imply that banks involved in non-traditional activities are less risky.

*Loans to assets ratio (loans\_ass)* represents the loan volume and the lending strategy of a given bank. High *loans\_ass* means that the bank is mostly oriented towards core banking businesses and interest income.

*ROAE (roae)* is a proxy for management quality. It captures the bank's profitability.

*Cost to income ratio (cost\_inc)* reflects the efficiency in expenses management.

Bank-type dummy variables: *dcom*: 1 = commercial bank, *dcoop*: 1 = cooperative bank, *dsav*: 1 = savings bank, *dinv*: 1 = investment bank, *dhold*: 1 = bank holdings and holding companies, 0 = real estate and mortgage banks. The time invariance of bank type dummy variables means that they can be tested only in models that do not remove fixed effects, i.e. they will be included in System GMM models, but not in FE models.

## **2) Banking sector-specific explanatory variables**

*Herfindahl index (hi)* approximates the banking sector concentration. It is based on banks' individual total assets market share. The HI's values range between 0–10,000 (0%–100%). Values below 1,000 indicate low concentration, values of 1,000 to 1,800 correspond to moderate concentration, and a HI over 1,800 indicates high concentration (Neven and von Ungern-Sternberg, 1998). The sign of the coefficient is ambiguous, because high competition can be a reason to switch to non-traditional activities, which would lead to increased NFCI share. On the other hand, in highly competitive markets there is a pressure on prices and the fees charged cannot be so high.

*Number of automated teller machines per 100,000 adults (atms), Number of all cards transactions (except e-money function) per capita (cashless)* capture the development and application of new technology in a given banking sector.

### **3) Country-specific explanatory variables<sup>7</sup>**

*Real annual GDP growth rate (gdp)* measures the economic activity in the country.

*Annual inflation rate (inf)* measured as percentage increase in consumer price index.

*Annual unemployment rate (unem)* affects besides other the decisions of customers about their use of certain banking services.

*Long-term annual interest rate (int)* is approximated by ten year government bond yield in the given country.<sup>8</sup>

There is a high probability that some of the chosen explanatory variables will have to be dropped from the final model because of their correlation with other variables.

## **3.3 Descriptive analysis**

In this section, we provide descriptive analysis of variables entering the model. Firstly, we analyse the dependent variables, namely NFCI/TI and NFCI/TA. The scatter plots depicting the relationship between NFCI share and HI can be found in Figure A.1. Figure 1 displays the mean NFCI/TI and NFCI/TA by bank type computed over the period 2007 to 2012. The lowest share of NFCI can be observed in real estate and mortgage banks which have NFCI/TI below 17% and NFCI/TA less than 0.4%. On the other hand, highest share of NFCI was reported in cooperative banks with average NFCI/TI of 30.6% and average NFCI/TA of almost 0.8%.

Interestingly, investment banks do not display an average NFCI/TI ratio around 40% as suggested by Gambacorta and van Rixtel (2013). This is caused mainly by the fact that we have only 10 investment banks in our sample and therefore the special features of each bank affect the overall result heavily. The greatest share of this result can be attributed to 3 Italian banks with average NFCI/TI of less than 10%.

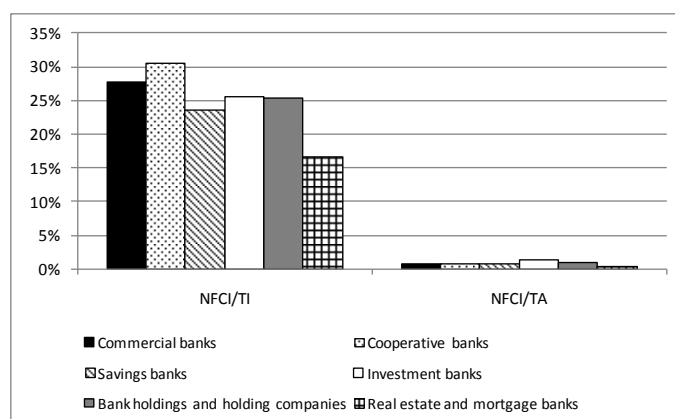
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<sup>7</sup> Country specific variables are included with lagged values and labelled by *lag\_dependent variable*. I.e. in the table with results we include *lag\_GDP* instead of *GDP*.

<sup>8</sup> According to ECB and Eurostat there are no Estonian sovereign debt securities that comply with the definition of long-term interest rates for convergence purposes. We use data from HelgiLibrary as a proxy for long-term interest rate in Estonia.

Furthermore, Bank of Cyprus Public Company Limited-Bank of Cyprus Group and Bank of Valletta Plc combine investment banking with commercial banking (in Bankscope they are classified as investment banks) and have NFCI/TI around 20%. Banks in PIIGS<sup>9</sup> countries were heavily affected by the crisis. In a Portuguese Banco de Investimento Global SA – BIG we can observe a drop in NFCI/TI from more than 50% in 2008 to less than 9% in 2012. Similarly in Investment Bank of Greece NFCI/TI declined from 81% in 2008 to 38% in 2012. In Spanish Aresbank SA the trend was opposite. In 2008 it had NFCI/TI of 21% while in 2012 it was 53%. All these made the average NFCI/TI ratio in investment banks lower than expected. Still, we believe that in general, higher share of NFCI can be attributed to more non-traditionally oriented banking strategy as reported in many previous researches. Our results reflect rather the special features of most of the included investment banks.

**Figure 1: Average Net fee and commission income/Total income and Net fee and commission income/Total assets by bank type**



Source: Authors based on Bankscope

Figure 2 displays that – on average – there is a moderate market concentration in the European Union (EU-27 HI averages around 1,100). The Czech Republic lies with the HI of 1,030 slightly below the average which means that the Czech banking sector is more competitive than banking sectors of other EU countries, but still it belongs to the group with moderate concentration. PIIGS and CEE<sup>10</sup> report the HI even lower than the Czech Republic. On the other hand, EU-17<sup>11</sup> countries post average HI of nearly 1,200 but they still count to moderate concentration group. The relatively high HI is caused mainly by Finland, Estonia and Netherlands with HIs above 2,000.

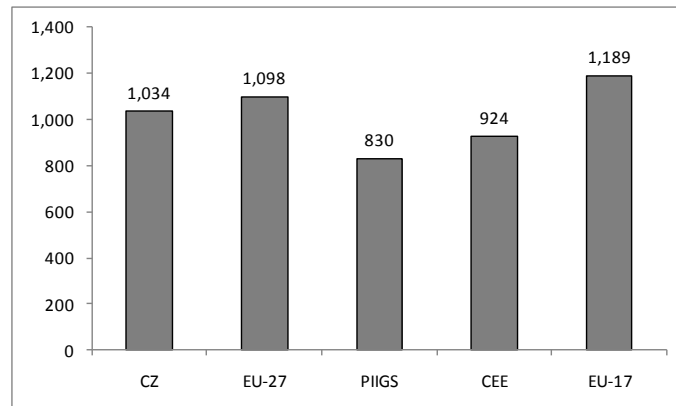
<sup>9</sup> PIIGS refers to Portugal, Ireland, Italy Greece and Spain.

<sup>10</sup> CEE stands for Central and Eastern Europe countries.

<sup>11</sup> EU-17 stands for Eurozone countries.



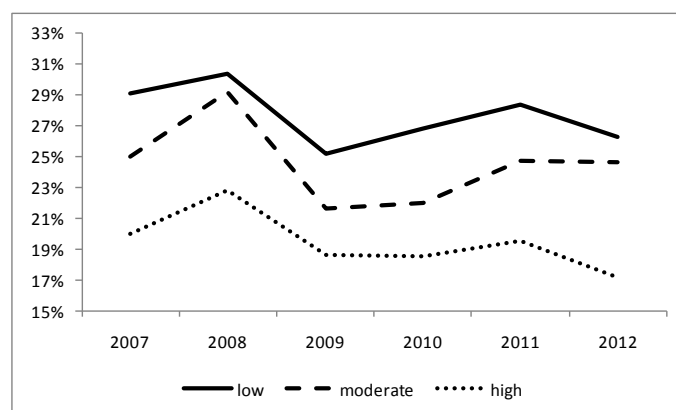
**Figure 2: Average Herfindahl index from 2007 to 2012**



Source: Authors based on ECB

Figure 3 shows the evolution of average NFCI share between 2007 and 2012 by market concentration. The low concentration group includes the banks in countries with levels of assets HI below 1,000. The moderate concentration group includes banks in countries with HI between 1,000 and 1,800. The high concentration group stands for the banks in countries with HI over 1,800. As can be seen, the highest NFCI shares are reported in banks in countries with low concentration over the whole considered period. On the other hand, the lowest shares of fee income display banks that are facing low competition. This figure supports the hypothesis that increased competition forces banks to switch to non-traditional activities that bear high fee income.

**Figure 3: Development of average Net fee and commission income/Total income by market concentration**



Source: Authors based on Bankscope and the ECB

Figure A.2 captures the development and application of new technologies that is measured by ATMs per 100,000 adults and number of cashless transactions per capita. It can be seen that those two measures are not necessarily correlated, in some

countries there might be positive relation but in other there is negative one, therefore no conclusion about the correlation between these two variables can be done.

Figure A.3 and Figure A.4 show country-specific macroeconomic indicators in year 2011.<sup>12</sup> It can be seen that the macroeconomic conditions of PIIGS countries are very poor. This is reflected by the high government bond yields, very low or even negative GDP growth rate and high unemployment rates.

Table A.1 shows summary statistics of used variables reporting the mean, median, standard deviation, minimum, maximum and 1<sup>st</sup> and 3<sup>rd</sup> quartiles of each variable.

### 3.4 Results and findings

Because there is no real theory supporting our assumption about the autoregressive process in NFCI share, we performed the Wooldridge test for autocorrelation in panel data. Table 2 shows the results. The null hypothesis of no first-order autocorrelation was rejected for both dependent variables NFCI/TI and NFCI/TA. Therefore System GMM will be used as the main estimation method. Other methods will be applied only for robustness check because in some cases System GMM may yield unstable results.

**Table 2: Wooldridge test for autocorrelation in panel data – NFCI/TI, NFCI/TA**

	nfc_i_ti	nfc_i_ta
F statistics	2.831	67.424
	(d.f. 1, 184)	(d.f. 1, 184)
p-value	0.0941	0.0000

H0: no first-order autocorrelation, d.f. = degrees of freedom

Source: Authors based on Bankscope

Table 3 shows the model that investigates the determinants of fee income share in European banks. We report the estimation results based on one-step and two-step System GMM, both with clustered standard errors robust to heteroscedasticity and autocorrelation within individuals and with small sample corrections to the covariance matrix. Moreover, in order to prevent the downward bias of standard errors in two-step estimation that may arise when the number of instrument is large (Arellano and Bond, 1991) we apply Windmeijer correction in two-step estimation. After this correction, two-step efficient GMM should be modestly superior to one-

<sup>12</sup> In the model we are using lagged country-specific dependent variables and therefore the last observations entering the model are from year 2011.

step in estimating coefficients with lower bias and standard errors (Windmeijer, 2005).

System GMM yields the best estimation results, because for both dependent variables and with both estimation methods the lagged dependent variable is significant with a 99% confidence level (p-value is below 0.01). Moreover, the null hypothesis of no first-order autocorrelation in residuals is rejected in Arellano-Bond AR (1) for NFCI/TI models. For NFCI/TA, the test does not suggest any first-order autocorrelation, but the p-value reached 0.131 in the two-step model and 0.115 in one-step model, which is very close to the critical value at which the null hypothesis would be rejected. We assume that the test did not performed well in this model, because the previously mentioned Wooldridge test and significant lagged dependent variable both suggest that the NFCI/TA is persistent in time. Arellano-Bond AR (2) with null hypothesis of no second-order autocorrelation is not rejected. These results were expected and are important for the consistency of GMM estimator.

We suppose that some of the explanatory variables such as *nim*, *cost\_inc* or *eq\_ass* are predetermined or endogenous and therefore we instrument them adequately. Hansen test for overidentification with null hypothesis of exogenous instruments was not rejected. The rule of thumb implying that instruments should not exceed the number of groups is not violated. Therefore, our model is unlikely to suffer from overidentification. F-test indicates the joint significance of explanatory variables.

The reported outcome does not include all explanatory variables specified in Section 3.2. In order to obtain valid estimates, we excluded those variables that were insignificant in the initial estimation that included all defined independent variables and significantly correlated with other independent variables.<sup>13</sup> In Table A.4 columns 1–2 and 4–5, regression results with more extended model specification can be found. It can be seen that both models – the full model as well as the restricted one – performed similarly according to the tests. Also the coefficients and their significance did not change dramatically with the restricted specification.<sup>14</sup> Therefore, the results seem to be robust to exclusion of correlated variables.

The coefficients of lagged dependent variables are positive (0.44 for NFCI/TI and 0.67 for NFCI/TA) and significant in estimated models implying strong time persistency of NFCI share. Also *eq\_ass* coefficients are positive and significant

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<sup>13</sup> See Table A.2 and Table A.3 for the correlation matrix.

<sup>14</sup> Only *lag\_gdp* was significant in the extended model and turned out to be insignificant after exclusion of correlated variables.

meaning that banks with lower capital risk are better able to expand into non-traditional banking activities and to collect more money on fee income. Contrary to our expectation, we found that *depos\_ass* which is a proxy of traditional banking activities is positively related with NFCI/TI as well as with NFCI/TA. This suggests that the European banks are able to exploit the close relationships with depositors to encourage them to undertake additional fee-based services and/or given the inelastic demand to charge more by selling those services at higher prices.

The coefficients of *dcom* and *dcoop* are significantly positive. This suggests that commercial banks and cooperative banks display on average higher NFCI shares than other bank types. Moreover, *dhold* is positively related with NFCI/TA and *dinv* has significant positive relationship with NFCI/TI in two-step estimation. These findings are in line with Figure 1 and with the expectation that the type of bank and its business strategy are important determinants of fee income share. All other bank-specific variables are insignificant in these models.<sup>15</sup>

As suggested by Figure 3 and the correlation between NFCI/TI, NFCI/TA and *hi*, we have found significantly negative coefficient for *hi*. More precisely, for two-step estimator the coefficient of *hi* in NFCI/TI and NFCI/TA regression was -0.0025 and -0.000041, respectively. Therefore, the more competitive is the market in which the bank operates, the higher the average NFCI share is. From this we can conclude that the competition pushes the banks to offer more non-traditional fee income bearing banking services which are potentially more risky than the traditional ones.

This conclusion may be done since we are using NFCI/TI ratio. NFCI per se includes both, fee income from traditional as well as fee income from non-traditional banking activities and alone cannot be used to measure the extent of non-traditional activities in a given bank. On the other hand, NFCI/TI is commonly used as a proxy for non-traditional banking activities.<sup>16</sup> Other bank sector-specific variables were excluded, because they were insignificant and highly correlated with *hi*.

**Table 3: Relationship between NFCI share and HI – System GMM regression results**

Independent variables	Dependent variable			
	nfc_i_ti		nfc_i_ta	
	two-step	one-step	two-step	one-step

<sup>15</sup> *Tier1* is significant in NFCI/TI models under the extended specification reported in Table A.4. Nevertheless, it was excluded in the restricted specification because of its correlation with *eq\_ass*.

<sup>16</sup> See also Gambacorta and van Rixtel (2013) and DeYoung and Rice (2004b).

lag_DV	0.4385*** (0.1097)	0.4352*** (0.1109)	0.6655*** (0.0235)	0.6657*** (0.0236)
nim	-1.3637 (1.6469)	-1.3603 (2.1642)	0.0074 (0.0175)	0.0110 (0.0188)
eq_ass	0.4006*** (0.1414)	0.3912** (0.1519)	0.0094*** (0.0036)	0.0097*** (0.0035)
npl_loans	-0.1700 (0.1990)	-0.1868 (0.2115)	-0.0024 (0.0020)	-0.0020 (0.0021)
cost_inc	0.0809 (0.1084)	0.0763 (0.1121)	-0.0001 (0.0002)	-0.0001 (0.0002)
depos_ass	9.4005* (4.8345)	8.3168** (4.0162)	0.3025*** (0.1042)	0.2746*** (0.0890)
hi	-0.0025*** (0.0006)	-0.0027*** (0.0007)	-0.0000*** (0.0000)	-0.0001*** (0.0000)
lag_gdp	-0.2604 (0.1913)	-0.3461 (0.2216)	-0.0009 (0.0031)	0.0009 (0.0035)
lag_inf	-0.0547 (0.3032)	-0.0543 (0.4224)	0.0001 (0.0046)	0.0002 (0.0052)
dcom	7.9208*** (3.0088)	8.6518*** (3.1380)	0.1486** (0.0606)	0.1292** (0.0601)
dcoop	9.7720*** (3.0231)	9.8077*** (3.2270)	0.16223** (0.0641)	0.1361** (0.0605)
dsav	3.7773 (3.4364)	4.8735 (3.7366)	0.0927 (0.0705)	0.0585 (0.0703)
dinv	6.2117* (3.5689)	5.7484 (3.6997)	0.0766 (0.0677)	0.0539 (0.0712)
dhold	5.9203 (3.8191)	5.5092 (4.1139)	0.1378** (0.0640)	0.1151* (0.0654)
_cons	3.2414 (-7.6472)	5.5322 (8.2772)	-0.1204 (-0.0878)	-0.0912 (0.0765)
<b>Estimation diagnostics</b>				
Number of observations	925	925	925	925
Number of groups	185	185	185	185
Observations per group	5	5	5	5
Number of instruments	107	107	122	122
F-test	43.94***	50.83***	361.13***	539.75***
Arellano-Bond AR (1)	-1.79*	-1.64*	-1.51	-1.57
Arellano-Bond AR (2)	-1.53	-1.41	0.07	0.07
Hansen test	99.13	99.13	121.44	121.44

Robust standard errors adjusted for 185 clusters in index are in parentheses, \*\*\*/\*\*/\* indicates significance at 1%/5%/10%, p-value of Arellano-Bond AR (1) in *nfc\_i\_ta* models is 0.131 in two-step model and 0.115 in one-step model, time dummies included in the regression are not reported in the table, *\_cons* stands for constant

Source: Authors based on Bankscope, Eurostat, the ECB and the World Bank

Both country-specific variables are insignificant. For *lag\_gdp*, the p-value is close to 0.1 for model with NFCI/TI as dependent variable under one-step as well as two-step estimation. Moreover, in the extended model *lag\_gdp* was significantly negatively related with NFCI/TI. Therefore, despite the insignificance of macroeconomic

indicators displayed in Table 3, we assume that there can exist negative relationship between *lag\_gdp* and NFCI/TI.

### 3.4.1 Robustness tests

We have run many regressions using System GMM with different independent variables and sets of instruments. This is necessary since the optimal set of instruments is difficult to determine and too many instruments may hamper the regression results and Hansen test. The results were stable in terms of coefficients that proved to vary very marginally and the signs remained almost always the same. We never observed one coefficient to be significantly positive under one specification and significantly negative under another. Mostly, only the significances have changed. Some of those regressions results can be found in Table A.4.

Table 4 reports the estimation results of the same model as in Table 3 but using linear regression, fixed effects regression and random effects GLS regression.<sup>17</sup> In all models, we used robust and clustered standard errors. Moreover, we included time dummies, which are not reported in the table.

F-test (Wald  $\chi^2$  in RE regression) is significant for all regressions meaning that explanatory variables are jointly significant. Furthermore, these methods report goodness of fit measure which is not the case for System GMM.  $R^2$  for NFCI/TI model is almost 20% in FE regression and 60% in pooled OLS. For NFCI/TA model  $R^2$  is even higher 85%–89%. Nevertheless, it should be noted that such a good goodness of fit was obtained mainly thanks to inclusion of *lag\_DV*.<sup>18</sup>

**Table 4: Relationship between NFCI share and HI – OLS, FE and RE regression results**

Independent variables	Dependent variable					
	nfc_i_ti			nfc_i_ta		
	OLS	FE	RE	OLS	FE	RE
lag_DV	0.6219*** (0.0866)	0.1254** (0.0631)	0.6219*** (0.0866)	0.6948*** (0.0331)	0.6115*** (0.0535)	0.6812*** (0.0288)

<sup>17</sup> It should be noted that RE became pooled OLS in NFCI/TI model suggesting a high ratio of within to between variation, while in NFCI/TA pooled OLS and RE are significantly different (tested after RE estimation using MLE by Likelihood-ratio test that strictly rejected the hypothesis of no standard deviation of residuals within groups).

<sup>18</sup> We have run the regression also without *lag\_DV*,  $R^2$  obtained based on pooled OLS dropped in both dependent variables to approximately 25%, while those obtained in FE models were even lower.

nim	-0.5451 (0.3598)	-2.0278 (1.8641)	-0.5451 (0.3598)	0.0204 (0.0149)	0.0080 (0.0155)	0.0186 (0.0145)
eq_ass	0.3165*** (0.0988)	0.2222 (0.2684)	0.3165*** (0.0988)	0.0074** (0.0034)	0.0197*** (0.0060)	0.0089*** (0.0030)
npl_loans	-0.1592 (0.1139)	-0.2044* (0.1227)	-0.1592 (0.1139)	-0.0017 (0.0017)	0.0024 (0.0030)	-0.0012 (0.0018)
cost_inc	0.1452*** (0.0516)	0.1795** (0.0862)	0.1452*** (0.0516)	0.0001 (0.0002)	0.0001 (0.0002)	0.0002 (0.0002)
depos_ass	3.2422 (2.4546)	0.0227 (9.1603)	3.2422 (2.4546)	0.1479*** (0.0507)	0.5163** (0.2182)	0.1710*** (0.0544)
hi	-0.0016** (0.0006)	0.0055 (0.0038)	-0.0016** (0.0006)	-0.0000*** (0.0000)	0.0001** (0.0001)	-0.0001*** (0.0000)
lag_gdp	-0.2627** (0.1271)	0.0800 (0.1544)	-0.2627** (0.1271)	-0.0017 (0.0035)	0.0022 (0.0028)	-0.0013 (0.0032)
lag_inf	0.1939 (0.1689)	-0.0115 (0.2156)	0.1940 (0.1689)	-0.0011 (0.0055)	0.0066 (0.0048)	-0.0004 (0.0050)
dcom	5.4549** (2.2615)		5.4549** (2.2615)	0.1072** (0.0487)		0.1106** (0.0505)
dcoop	6.3215*** (2.3637)		6.3215*** (2.3637)	0.1062** (0.0484)		0.1121** (0.0503)
dsav	3.5120 (2.2870)		3.5120 (2.2870)	0.0590 (0.0527)		0.0571 (0.0557)
dinv	3.6096 (2.9089)		3.6096 (2.9089)	0.0141 (0.0618)		0.0194 (0.0642)
dhold	2.8992 (3.2289)		2.8992 (3.2289)	0.0778 (0.0561)		0.0892 (0.0579)
_cons	-2.5907 (2.3870)	12.4721** (5.8132)	-2.5907 (2.3870)	-0.0495 (0.0453)	-0.2716* (0.1390)	-0.0636 (0.0466)
<b>Estimation diagnostics</b>						
Number of observations	925	925	925	925	925	925
Number of groups		185	185		185	185
Observations per group		5	5		5	5
F-test	100.34***	10.97***		256.64***	89.19***	
Wald chi2			1806.07***			5846.98***
R2	0.5862	0.1924	0.5862	0.8940	0.8471	0.8938

Robust standard errors adjusted for 185 clusters in index are in parentheses, \*\*\*/\*\*/\* indicates significance at 1%/5%/10%, time dummies included in the regression are not reported in the table, *\_cons* stands for constant

*Source:* Authors based on Bankscope, Eurostat, the ECB and the World Bank

System GMM suggests that these methods are biased due to inclusion of lagged dependent variables and because of incorrect treatment of endogenous explanatory variables. But as stated in Bond (2002) and Roodman (2006), pooled OLS and FE can be used for robustness check. In particular, pooled OLS inflates the estimated coefficient for lagged dependent variable by attributing predictive power to it that actually belongs to the bank's fixed effect. The opposite holds true for fixed effect

regression, where the estimated coefficient for *lag\_DV* is biased downwards. The true parameter should therefore lie between these two values (Roodman, 2006), which is satisfied in our models.

The results differ mainly in significance. While *cost\_inc* and *lag\_gdp* were insignificant in System GMM, they turned out to be significant in linear and within regressions of NFCI/TI model. On the other hand, *depos\_ass* came out to be insignificant using the standard methods. The coefficients remained mostly similar as in System GMM. Only *hi* turned out to be positively related with NFCI/TA in fixed effect estimation. This is probably caused by the inconsistency of this model, because there is no other evidence that would suggest that the relationship between NFCI/TA and market concentration should be positive.

Together, the results proved to be robust. We can say that besides the bank interior factors such as bank type, the market conditions seem to play an important role for fee income magnitude determination. In this study, we tested only the impact of market concentration on NFCI share because other sector-specific variables were correlated with *hi* and therefore the estimated coefficient would be not necessarily estimated correctly. Still, we think that technologic development and other exterior factors may be relevant.

### 3.4.2 Summary and comparison of results

In Table 5, we provide the comparison of results found in our study and the current literature. +/- stands for positive/negative coefficient significant at least at 10% level. 0 indicates that the estimated coefficient is insignificant. Unlike in most of the other academic papers, we examined the determinants of NFCI and not NII as a whole. Still, we believe that the results may be compared because as already mentioned NFCI represents the greatest part of NII in most of the banks.

In our analysis most of the coefficients turned out to be insignificant which is not the case in other studies. This could be caused by the inclusion of lagged dependent variable that captures a lot of information and was not present in the previous studies. On the other hand, the signs of all significant coefficients in this study are in line with most of the current literature. Higher equity to assets ratio, i.e. low capital risk, is related with higher shares of fee income. The positive coefficient is also in line with our expectation since we believe that banks expanding into non-traditional businesses need more capital to prevent the potential losses and other risks of the new activity.



**Table 5: Comparison of estimated signs and significance levels for the coefficients on NFCI magnitude**

Authors	Data	Coefficients							
		nim	eq_ass	npl_loans	cost_inc	depos_ass	hi	lag_gdp	lag_inf
Rogers and Sinkey (1999)	U.S. banks, 1989 - 1993	-	+	+		+			
DeYoung and Rice (2004a)	U.S. banks, 1989 - 2001					+			
Craigwell and Maxwell (2005)	Barbadian banks, 1985 - 2001					0			
Ghafari, Sanep (2006)	Malaysian Islamic banks, 1994 - 2004	0	+	-		+			
Hahm (2008)	29 OECD countries' banks, 1992 - 2006	-	+	+	+			-	-
Bailey-Tapper (2010)	Jamaican banks, 1999 - 2010			+		-		0	
Kim and Kim (2010)	South Korean banks, 1999 - 2009					-			
Moshirian, Sahgal and Zhang (2011)	20 developed countries' banks, 1996 - 2010		+					-	0
<b>This study (2015)</b>	<b>EU-27 banks, 2007 - 2012</b>	0	+	0	0	+		-	0

+/- indicates a statistically positive/negative coefficient at the 10% level or better, 0 indicates insignificant coefficients, in case of absence of the variable in the given study the cell is left blank, Hahm (2008) is using lagged independent variables, Rogers and Sinkley (1999) and Bailey-Tapper (2010) are not using *npl\_loans* as a measure of loans quality but use provision for loan losses magnitude

Source: Authors based on individual papers and own results

Deposits to assets ratio influences the NII share positively in U.S. commercial banks as well as in Malaysian Islamic banks. On the contrary, in Jamaican and Korean banking markets the effect seems to be the opposite. This may be caused primarily by different levels of switching costs and dissimilar attitude of the customers. In the U.S. and Malaysian markets, closer relationship between bank and depositor, based on which the banks can charge higher fees on its services than in Jamaica or Korea, probably exists. Our results suggest that EU-27 banking sector resembles the U.S. and Malaysian banking market since the coefficient on *depos\_ass* is significantly positive in our study. We have estimated a negative relationship between Herfindahl index and fee income share. This result supports the findings of Moshirian et al. (2011). Macroeconomic conditions seem to play only limited role in NFCI share

determination. Only Hahm (2008) found that higher lagged GDP growth and inflation are connected with lower NII shares.

Our results are in line with most of the current literature. Nevertheless, there are still many opportunities for further research that should mainly aim to capture the banking market fragmentation better. Highly encouraged is also to increase the dataset mainly talking about prolongation of the time period. This would allow drawing more general results from the model. Last but not least since some variables needed to be excluded due to their correlation with Herfindahl index, other measures capturing the technologic development in a given country that would not be correlated with other regressors should be found and included in the model.

## 4 Conclusion

This paper focused on determinants of banking fee and commission income in the European Union. Since fee income represents the largest part of non-interest income earned by banks, it remains a major challenge for bank management to set and maintain an appropriate fee policy. Nevertheless, solving for the optimal fee structure has not yet been accomplished either on a theoretical level, or in actual practice.

The study was performed on balanced panel data from 185 EU-27 banks spanning the period from 2007 to 2012. Unlike in the existing studies, we have used dynamic panel data and System GMM estimation method. Different bank-specific, banking sector-specific as well as macroeconomic factors were considered. Our results suggest that the magnitude of fee income is highly dependent on the bank business strategy as well as on market conditions. We were primarily concerned about the potential relationship between market concentration and fee income magnitude which in fact turned out to be present. The analysis suggests that banks facing higher competition tend to expand into potentially riskier non-traditional activities more aggressively and therefore they also exhibit higher shares of fee and commission income.

Banks with higher fee income share tend to rely more on equity financing which in turn means that they display lower capital risk. This is possibly related to the fact that banks expanding into non-traditional businesses need more capital to prevent the potential risks of the new activity. Contrary to our expectation we have found that high deposits to assets ratio, a proxy for traditionally oriented banking, tends to be related with higher shares of fee income. This result seems to be largely dependent on the data used since the same relationship was found also in studies from the U.S. but not in studies from Jamaica and South Korea. This may reflect either different levels

of switching costs or more probably different attitudes of clients. Our result suggests a close relationship between bank and depositors which allows the European banks to sell more additional fee-based services and/or given the inelastic demand to sell those services at higher prices. Macroeconomic conditions seem to play only secondary role by fee income determination.

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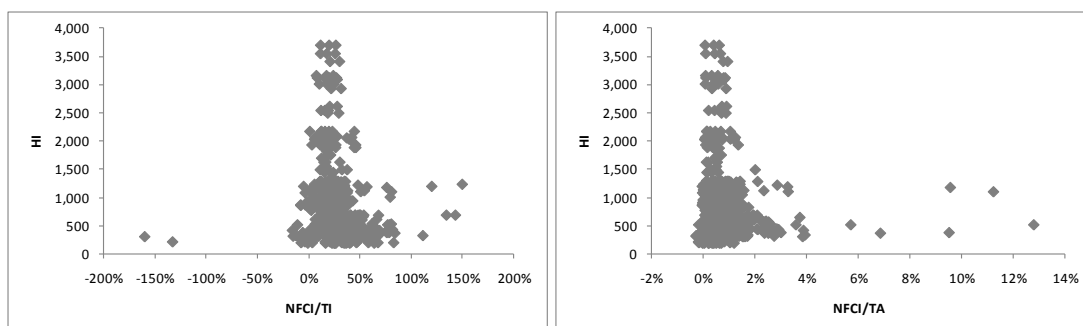
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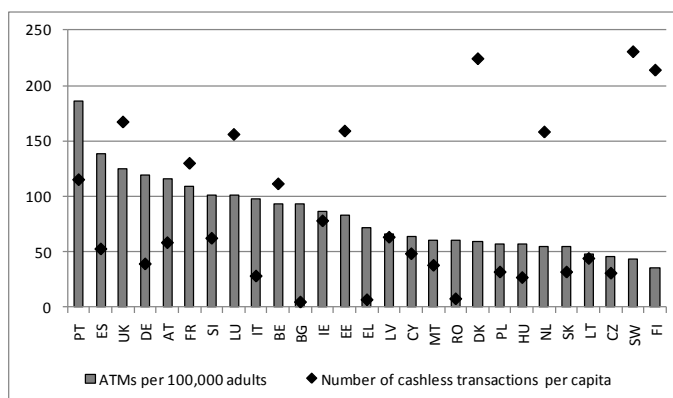
## Appendix

**Figure A.1: Scatter plot NFCI share and Herfindahl index**



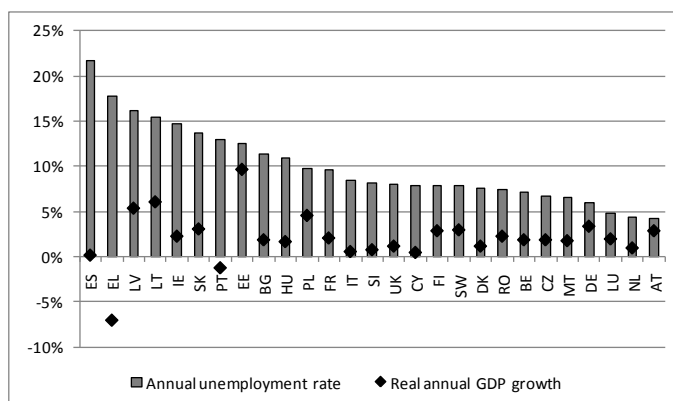
Source: Authors based on Bankscope and the ECB

**Figure A.2: The development of banking sector in 2012 by country<sup>19</sup>**



Source: Authors based on World Bank and the ECB

**Figure A.3: Macroeconomic conditions in 2011 – Annual unemployment rate and real annual GDP growth**

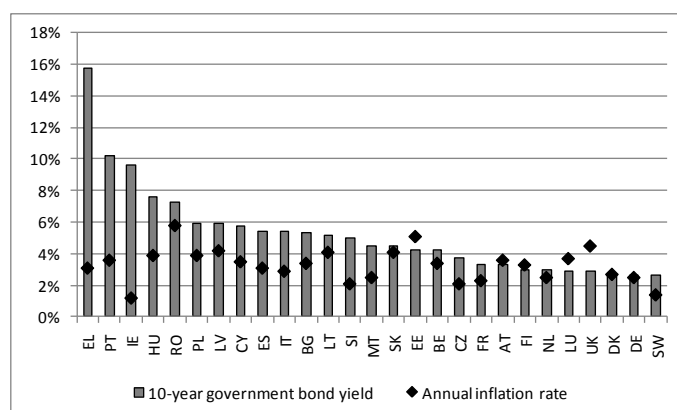


Source: Authors based on Eurostat

<sup>19</sup> For Belgium, Germany and United Kingdom the data of ATMs per 100 000 adults were not available in 2012 and therefore they were approximated by 2011 values.



**Figure A.4: Macroeconomic conditions in 2011 – Long term interest rate and annual inflation rate**



Source: Authors based on Eurostat, the ECB and HelgiLibrary

**Table A.1: Summary statistics of used variables**

Variable	Mean	Std. Dev.	Min	1 <sup>st</sup> quartile	Median	3 <sup>rd</sup> quartile	Max
atms	97	34	35	67	99	122	194
cashless	82	62	1	26	55	130	230
cost_inc	64.4%	31.8%	13.8%	51.7%	60.7%	69.1%	513.1%
depos_ass	0.5%	0.2%	0.0%	0.3%	0.5%	0.6%	0.9%
eq_ass	7.2%	4.9%	-1.8%	4.5%	6.4%	8.6%	55.9%
hi	786	579	183	410	563	1077	3700
lag_gdp	1.1%	3.5%	-17.7%	-0.6%	1.7%	3.3%	11.0%
lag_inf	2.6%	1.6%	-1.7%	1.7%	2.3%	3.3%	15.3%
lag_int	4.4%	1.4%	2.6%	3.7%	4.3%	4.6%	15.8%
lag_unem	7.8%	3.0%	3.1%	6.0%	7.6%	8.4%	21.7%
ln_ass	17.3	2.1	11.6	16.1	17.2	18.8	21.7
loans_ass	58.6%	19.2%	0.5%	47.6%	62.6%	72.6%	99.0%
nfc_i_ta	0.8%	0.9%	-0.3%	0.4%	0.7%	1.0%	12.8%
nfc_i_ti	26.4%	16.3%	-159.5%	19.4%	25.3%	32.1%	149.6%
nim	2.1%	1.3%	-0.4%	1.2%	1.9%	2.7%	12.6%
npl_loans	5.9%	6.5%	0.0%	2.1%	4.3%	7.0%	65.1%
roae	4.1%	21.5%	-239.2%	2.2%	6.5%	12.1%	200.3%
tier1	12.5%	15.9%	-6.7%	8.6%	10.4%	13.0%	376.2%

Source: Authors based on Bankscope, Eurostat, the ECB, HelgiLibrary and the World Bank

**Table A.2: Correlation matrix – part 1**

	nfc_i_ti	nfc_i_ta	ln_ass	nim	depos_ass	eq_ass	tier1	npl_loans	loans_ass	roae	cost_inc	hi
nfc_i_ti	1											
nfc_i_ta	0.4720*	1										
ln_ass	-0.0317	-0.2789*	1									
nim	-0.0729*	0.3426*	-0.4168*	1								
depos_ass	0.0357	0.2693*	-0.4287*	0.4498*	1							
eq_ass	0.0750*	0.3387*	-0.5435*	0.4373*	0.1626*	1						
tier1	0.0638*	0.0228	-0.1993*	-0.0595*	-0.0321	0.2847*	1					
npl_loans	-0.0441	0.0087	-0.2012*	0.2349*	0.0505	0.2647*	-0.0255	1				
loans_ass	-0.2297*	-0.0097	-0.2140*	0.2868*	0.2792*	0.1206*	-0.1677*	0.1138*	1			
roae	0.0684*	0.1505*	0.0143	0.1503*	0.0787*	0.049	0.0058	-0.367*	-0.0454	1		
cost_inc	0.3375*	-0.0392	0.0192	-0.2177*	-0.053	-0.1342*	-0.0189	0.1128*	-0.1569*	-0.3052*	1	
hi	-0.1508*	-0.0950*	-0.0962*	0.0235	-0.0136	0.0845*	-0.0028	-0.0254	0.1085*	-0.0128	-0.0564	1
atms	0.0674*	-0.0399	0.2039*	-0.2622*	-0.1301*	-0.1129*	0.0479	-0.1122*	-0.1394*	-0.0344	0.0187	-0.3501*
cashless	-0.0474	-0.1730*	0.1115*	-0.3683*	-0.0841*	-0.1621*	0.014	-0.2624*	-0.0899*	-0.0200	0.0677*	0.3037*
lag_gdp	0.0196	0.0579	-0.0511	0.1458*	0.0657*	0.0124	-0.0128	-0.2392*	-0.019	0.1746*	-0.0317	0.0589*
lag_unem	0.0319	0.0165	0.0356	0.0109	0.0022	0.1659*	-0.0063	0.2125*	0.0186	-0.0921*	-0.0088	-0.0299
lag_inf	-0.0876*	0.0607*	-0.2030*	0.3341*	0.1097*	0.1744*	0.018	0.0928*	0.1094*	-0.0133	-0.1263*	0.0503
lag_int	-0.0214	0.1029*	-0.1856*	0.2866*	0.1069*	0.2048*	-0.0376	0.4272*	0.1733*	-0.0983*	-0.0289	0.0474
dcom	0.0954*	-0.0193	0.0443	0.1040*	0.0096	-0.0372	0.0101	0.0651*	-0.1412*	0.0195	0.0120	0.1646*
dcoop	0.0807*	-0.0142	0.1223*	-0.0370	-0.0855*	-0.0247	-0.0586	-0.0062	0.0651*	-0.0079	0.0133	-0.0696*
dsav	-0.0487	-0.0045	-0.1943*	0.1179*	0.2054*	0.1388*	-0.0191	-0.0132	0.1583*	0.0004	-0.0249	0.0017
dinv	-0.0125	0.1486*	-0.1873*	0.0313	-0.1133*	0.2788*	0.1183*	0.0838*	-0.1135*	-0.0116	-0.0879*	-0.0283
dhold	-0.0211	0.0747*	0.2060*	-0.0710*	-0.0888*	-0.1209*	-0.0367	-0.0681*	-0.1124*	-0.0158	0.0298	-0.0993*

\* indicates significance at 5% level

Source: Authors based on Bankscope, Eurostat, the ECB, HelgiLibrary and the World Bank

**Table A.3: Correlation matrix – part 2**

	atms	cashless	lag_gdp	lag_unem	lag_inf	lag_int	dcom	dcoop	dsav	dinv	dhold
atms	1										
cashless	0.0047	1									
lag_gdp	-0.1559*	-0.0798*	1								
lag_unem	0.1871*	-0.1823*	-0.1467*	1							
lag_inf	-0.0898*	-0.1277*	0.2990*	-0.1056*	1						
lag_int	-0.0814*	-0.4124*	-0.1447*	0.3019*	0.2595*	1					
dcom	-0.1519*	-0.0677*	0.0572	0.0185	0.1264*	0.1158*	1				
dcoop	0.0120	-0.1508*	-0.0647*	0.0031	-0.0993*	-0.0325	-0.3940*	1			
dsav	-0.0699*	0.0672*	0.0395	0.1474*	-0.0524	-0.0241	-0.3544*	-0.0910*	1		
dinv	0.0732*	-0.0914*	-0.0382	0.0386	-0.011	0.0641*	-0.2961*	-0.0760*	-0.0684*	1	
dhold	0.1773*	0.0936*	-0.0161	-0.1056*	-0.0408	-0.0765*	-0.3940*	-0.1012*	-0.0910*	-0.0760*	1

\* indicates significance at 5% level

Source: Authors based on Bankscope, Eurostat, the ECB, HelgiLibrary and the World Bank

**Table A.4: Robustness tests – Relationship between NFCI share and HI – System GMM regression results**

Independent variables	Dependent variable					
	nfc_i_ti			nfc_i_ta		
	two-step	one-step	two-step	two-step	one-step	two-step
lag_DV	0.4719*** (0.1215)	0.4686*** (0.1202)	0.4338*** (0.1531)	0.6694*** (0.0261)	0.6678*** (0.0257)	0.6725*** (0.0186)
nim	-0.1628 (0.8064)	-0.1431 (0.8464)	-1.0821** (0.4207)	-0.0000 (0.0181)	0.0021 (0.0173)	0.0176* (0.0105)
eq_ass	0.3891** (0.1594)	0.4178*** (0.1567)	0.3752*** (0.1011)	0.0085* (0.0048)	0.0085* (0.0048)	0.0086*** (0.0031)
npl_loans	0.0058 -0.28	-0.0082 (0.2713)	-0.1648 (0.1087)	-0.0014 (0.0029)	-0.0016 (0.0029)	-0.0035** (0.0016)
cost_inc	0.1081 -0.0823	0.1068 (0.0836)	0.1450** (0.0579)	0.0000 (0.0005)	-0.0000 (0.0004)	0.0001 (0.0001)

depos_ass	9.9781*	10.708	5.3206*	0.2504**	0.2571**	0.1913***
	-5.9346	(6.7512)	(2.8979)	(0.1176)	(0.1149)	(0.0478)
tier1	0.0338***	0.0325***		-0.0003	-0.0003	
	-0.0106	(0.0112)		(0.0002)	(0.0003)	
loans_ass	-0.0559	-0.0594		0.0020*	0.0021**	
	-0.0592	(0.0651)		(0.0010)	(0.0011)	
roae	0.1386	0.1379		0.0013	0.0012	
	-0.1095	(0.1071)		(0.0009)	(0.0008)	
hi	-0.0018*	-0.0017*	-0.0024**	-0.0001***	-0.0001***	-0.0000***
	(0.0010)	(0.0010)	(0.0011)	(0.0000)	(0.0000)	(0.0000)
atms	0.0157	0.0204		0.0000	-0.0000	
	-0.0218	(0.0142)		(0.0003)	(0.0003)	
cashless	0.0083	0.0073		-0.0001	-0.0001	
	-0.0155	(0.0124)		(0.0002)	(0.0002)	
lag_gdp	-0.4237**	-0.4888***	-0.1636*	0.0000	0.0001	-0.0019
	(0.1718)	(0.1838)	(0.0979)	(0.0036)	(0.0037)	(0.0028)
lag_inf	0.0639	0.0005	0.1035	-0.0001	-0.0003	-0.0037
	(0.3030)	(0.3093)	(0.1834)	(0.0052)	(0.0056)	(0.0040)
dcom	5.6329	6.0864*	9.1732***	0.1920***	0.1720**	0.1367***
	(4.5010)	(3.5757)	(3.0624)	(0.0713)	(0.0679)	(0.0435)
dcoop	7.7982*	8.3964**	10.7679***	0.1737**	0.1559**	0.1515***
	(4.0250)	(3.2849)	(3.1155)	(0.0725)	(0.0665)	(0.0441)
dsav	1.8757	2.7344	6.2180**	0.1052	0.0857	0.0933*
	(4.4645)	(3.5802)	(3.1004)	(0.0696)	(0.0703)	(0.0501)
dinv	2.8977	2.8475	8.6049**	0.1225	0.1138	0.1028*
	(5.1984)	(4.3689)	(3.4506)	(0.0833)	(0.0786)	(0.0567)
dhold	3.1515	3.5525	7.5605	0.1835**	0.1656**	0.1398***
	(4.9893)	(4.1767)	(4.7760)	(0.0741)	(0.0707)	(0.0472)
_cons	-0.4841	-0.4387	-2.0010	-0.2291*	-0.2089*	-0.0859**
	(5.9735)	(5.7765)	(2.1311)	(0.1279)	(0.1250)	(0.0413)
<b>Estimation diagnostics</b>						
Number of observations	925	925	925	925	925	925
Number of groups	185	185	185	185	185	185
Observations per group	5	5	5	5	5	5
Number of instruments	156	156	92	156	156	32
F-test	48.67***	53.04***	50.46***	399.04***	483.33***	186.03***
Arellano-Bond AR (1)	-1.95*	-1.7*	-1.61	-1.54	-1.59	-1.51
Arellano-Bond AR (2)	-1.51	-1.4	-1.40	0.08	0.08	0.05
Hansen test	142.5	142.5	76.84	149.76	149.76	13.16

Robust standard errors adjusted for 185 clusters in index are in parentheses, \*\*\*/\*\*/\* indicates significance at 1%/5%/10%, p-value of Arellano-Bond AR (1) in *nfc\_i\_ta* models with all explanatory variables is 0.124 in two-step model and 0.112 in one-step model and 0.13 in the limited two-step model, time dummies included in the regression are not reported in the table, *\_cons* stands for constant  
*Source:* Authors based on Bankscope, Eurostat, the ECB and the World Bank

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