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Does the Amount and Time of Recapitalization Affect the Profitability of Commercial Banks?*

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Abstract
In this paper we study the effects of bank recapitalization on profitability during the recent global financial crisis. We used data from 91 systemically important banks in the EU and the US. We found that a higher amount of recapitalization increases a bank's profitability with a lag of one year. Recapitalizations performed in the first two years of the crisis had an immediate negative effect on profitability but it became positive when we tested it at the end of our analysed period, i.e. when most of the banks were out of the crisis. The positive effect on profitability was present only in banks recapitalized in the first two years of the crisis and negative for banks recapitalized later on in the crisis. When we simultaneously tested the effect of time and the amount of recapitalization, we found that in banks recapitalized in the first two years of the crisis, the positive effect on profitability increased with the amount of recapitalization.

1. Introduction

During a crisis, banks usually face heavy losses and new capital is often needed to cover capital shortcomings. One possible way to increase capital is with retained earnings, but the much more difficult question is how to regain profitability quickly and efficiently. One of the main goals of bank management in a time of distress is to achieve safety, stability, and to recover lost confidence. This should result in a quicker, more sufficient and sustainable return to profitability. The relevance of profitability is even more important during a time of crisis and in a low interest rate environment, as is currently the case. Capital is the first line of defence against losses and the inability to build up capital buffers from retained earnings could affect capital adequacy, especially in times of crisis, when raising equity is much harder (Kok et al., 2015).

Several empirical studies (Banerjee et al., 2015; van Ommeren, 2011; Kok et al., 2015; Dietrich and Wanzenried, 2011; Petria et al., 2015) have looked into the effects of different determinants on bank profitability in a time of crisis. It is vital that bank management is familiar with these determinants so that they can adapt their business model. The interesting question, however, is whether there are other important drivers of profitability that were not included in any research so far. Recapitalization could be one of them (Caballero et al., 2008; Philippon and Schnabl, 2013; Li, 2013; Duchin and Sosyura, 2014; Homar, 2014).

Although the above-mentioned researchers mainly investigated the effect of

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recapitalization on lending activity and risk taking, this topic is closely related to profitability. With new capital, banks can wipe-out toxic assets faster and more efficiently, maintain safety, and support new lending as well as other activities. Therefore, if recapitalization is performed in a sufficient amount and promptly, it should affect bank profitability. However, the success rate of recapitalization depends on the capability and the willingness of shareholders to invest new capital. As we have seen in the latest crisis, a significant number of banks had to deal with precisely this problem. In such cases, the government usually stepped in to fill the capital shortfall. Thus, the time and the amount of the recapitalization varies strongly among banks, as does the type of participating investor. Therefore, we can expect that, in addition to the control variables, all of the above-mentioned recapitalization determinants also affect profitability.

This article investigates the following questions regarding the relationship between recapitalization and profitability:

1. Does a higher amount of recapitalization have a positive effect on profitability during a time of crisis (the recapitalization volume channel)?
2. Is there more of a positive effect from the recapitalization amount when it is performed by private investors than there is when performed by the government (the investor channel)?
3. Does recapitalization performed early on in a crisis have a more significant effect on bank performance than recapitalization performed during later stages (the time channel)?

The analysis was performed on a sample of 91 systemically important banks in the EU and the US, covering the period from 2006 to 2015. We found that a higher amount of recapitalization increased bank profitability with a lag of one year. We did not find a significant difference in the effect on profitability when recapitalization was performed by private investors or by the government. The immediate effect of prompt recapitalisation (defined as a capital injection performed in the first two years of the crisis) on profitability was negative, but when testing the effect in the last two years of the analysed period (2014 and 2015), it became positive. However, banks recapitalised later in the crisis experienced a negative effect on profitability even when testing the effect in 2014 and 2015. In prompt recapitalizations, the effect on profitability became more positive when the recapitalization amount was higher. From this we can conclude that the time and the amount of recapitalization do matter.

This paper is structured as follows: Section 2 reviews the previous studies on bank profitability drivers and the effect of recapitalization on bank performance. Section 3 presents stylised facts on bank recapitalization. Section 4 describes the empirical modelling strategy, provides the results of panel regression and an analysis of robustness checks. The article concludes with a discussion of the results.

2. Literature review

To our knowledge, there is currently no research assessing the effect of the amount, type of investor and time of recapitalization, on profitability. However, numerous empirical studies have investigated other determinants of bank performance. Some studies focus on a single country, such as: Switzerland (Dietrich and Wanzenried, 2011), Romania (Roman and Danuletiu, 2013), Spain (Trujillo-

Ponce, 2013), Croatia (Kundid et al., 2011), Slovenia (Banerjee et al., 2015), Greece (Athanasoglou et al., 2008) and Japan (Liu and Wilson, 2010). Others compare groups of countries (van Ommeren, 2011; Roman and Tomuleasa, 2013; Capraru and Ihnatov, 2015; Kok et al., 2015; Athanasoglou et al., 2006; Petria et al., 2015; Staikouras and Wood, 2004; Goddard et al., 2004).

Empirical results compiled from the studies stated above are sensitive to the choice of different time periods and bank samples as well as different approaches to assessing similar risks factors and other variables affecting profitability. The most common measure of bank profitability (Dietrich and Wanzenried, 2011; Athanasoglou et al., 2006; van Ommeren, 2011; Goddard et al., 2004; Banerjee et al., 2015) is return on average assets. Internal factors (bank-specific), such as capitalization, credit risk, operational efficiency, liquidity risk, business models, business growth, funding structure and size are also commonly used. And for external factors (industry-specific and macroeconomic), we see that concentration, regulatory interest rates, real GDP growth, inflation and long-term government bond yields are used. In addition to the above-stated control variables, we used the amount and time recapitalization variables.

From a profitability perspective, recapitalization appears to influence bank lending and risk taking. Li (2013) and Giannetti and Simonov (2013) present evidence that equity injections increase loan supply, although only sufficiently recapitalized banks increase lending to creditworthy borrowers; undercapitalized banks try to regain capital adequacy by deleveraging, consequently reducing lending. Moreover, during a crisis, additional capital can be channelled into lending only once bank capitalisation exceeds a critical threshold (Brei et al., 2013). Similar results were obtained by Homar (2014), who stated that only sufficiently large recapitalizations can increase bank lending, ease access to additional funding and clean up bank balance sheets.

In addition to the expected influence of the amount on profitability, another question occurs. Is there any difference in the effect of recapitalization amount conducted by the government versus private investors? Probably not in the short term, but over time, the effect of ownership can be important due to significant differences, especially in corporate governance. Even though the effect of bank ownership is vague in literature, several authors agree that it matters (Morck et al., 2011; Yeyati et al., 2005; Havrylchyk and Jurzyk, 2011). Especially over longer periods, direct state involvement can have important negative effects on the financial sector and the economy (Mohieldin, 2012). Profitability can be impaired by differences in business activities performed before the crisis, as well as during the crisis and after nationalization took place. From private banks, we can expect higher profitability due to better cost controls and risk management. Banks that needed state aid were probably more distressed and had lower medium-term profitability. They also faced several restrictions in the performance of business activities given by the European Commission.

Thus, we expect to see a positive effect of higher recapitalizations on profitability. What about the importance of time? As argued by Leaven and Valencia (2008), the speed of bank resolution is of the essence - as soon as the crisis begins, bank losses should be recognized, the scale of the problem should be assessed, and steps should be taken to ensure the financial institution is adequately capitalized. In

the recent financial crisis, banks first tried to raise capital from current shareholders, which was often difficult due to a lack of interest or capital. In the second phase, the government intervened on several occasions, a process that turned out to be very time consuming in many countries.

3. Data and methodology

For the purposes of our study we used annual consolidated balance-sheet data at the individual-bank level from the Bankscope database. Industry-specific and macroeconomic controls were sourced from the ECB, World Bank and Eurostat. Data relating to recapitalization was compiled individually from annual reports and also where relevant, i.e. from European Commission press releases on state aid decisions. The beginning and the end of the financial crisis was dated according to Duprey et al. (2015) and our own estimates (Table 1).

The sample covers systemically important banks identified as critical for the stability of the financial system by either the European Banking Authority (EBA) or the Federal Reserve (Fed). In the European banking union, these banks are placed under the direct supervision of the European Central Bank (ECB) and are included under the Single Supervisory Mechanism (SSM). The balance sheets of the banks are subject to particular regulatory scrutiny: 123 banks participated in an EU-wide stress test (EBA, 2014) and 31 in the USA (Fed, 2015). All banks in the sample are defined as systemically important because of their size, economic importance, or cross-border activities. Even though the focus on systemically important banks ensures international comparability, significant differences remain in terms of the banks' sizes and their business model. Therefore, to increase comparability, all variables were used in relative values.

We used data at the consolidated level and, to avoid double counting, excluded subsidiaries owned by a banking group already represented in the study. Of the 154 systemically important banks, some have to be excluded because of incomplete coverage in the Bankscope database. Also, since our focus lies on commercially-oriented banks, we also had to omit those with a prevailing focus on investment banking activities, as defined in the Bankscope database. However, some banks are registered as bank holdings, or have changed their specialisation during the crisis, so we used the following criteria: We included banks with higher interest income compared to non-interest income during the observation period (2006-2015). Moreover, special-purpose banks such as ''Landesbanken'' and special development banks, usually owned by the government, are also excluded.

For some banks, data on recapitalization derived from annual reports was not available, and had to be dropped. Finally, for a better comparison we excluded banks that were not recapitalized during the crisis and banks in countries that did not experience a financial crisis. The final sample thus comprises 91 banking groups from 18 countries in the EU and the US. The panel is strongly balanced, as all variables for all banks are available for the entire time period.

Measures defined as recapitalization

Capital injections of common equity, preferred stock and conditionally convertible bonds from both private investors and the government are counted as

recapitalization. We also included conversions of subordinated debt and other bank liabilities into equity. However, only Tier 1 qualifying instruments that were exchanged for former claims were used. All other measures not comprising Tier 1 qualifying instruments as well as write-offs and transactions not paid for in exchange by securities or capital were excluded (usually a swap of shares in mergers and acquisitions). Employees' share options were also excluded. Notional recapitalization amounts were used throughout.

Brief review of the selected variables

Dependant variable

Bank profitability is usually proxied by either a return on average assets (ROAA) or a return on average equity (ROAE). In this study, ROAA is used for two reasons. First, ROAA is less volatile then ROAE during a crisis and therefore more appropriate as a measure of profitability. Second, the use of ROAA is motivated by our focus on recapitalization, since new equity increases the amount of capital in a bank (denominator). This can have a significant negative impact on ROAE in the short and medium term. In the long term, more capital can have a positive effect on profitability because it increases stability while also reducing bank risk (Admati and Hellwig, 2013). ROAA is calculated as the net income divided by average assets (average of assets from the beginning and the end of the period) and is thus much less affected by recapitalization. Therefore, it is the preferred choice for our research.

Independent variables

Following the literature, we used three groups of controls: bank-specific, industry-specific, and macroeconomic variables. Bank-specific or internal factors are mainly influenced by banks' management decisions and policy objectives. Bank-specific factors typically include capitalization, credit risk, operational efficiency, liquidity risk, business models, business growth, funding structure, and size. Industry-specific factors were used to control variations across countries; we included concentration and regulatory interest rates. We also added a dummy variable to distinguish different time periods of crisis between countries. The last group of controls are macroeconomic, which are exogenous to bank management decisions. In this group, real GDP growth, the inflation rate and long-term government bond yields were used.

Bank-specific controls

Capitalization (measured in equity to total assets): Most studies identify a positive association between capital and profitability (Dietrich and Wanzenried, 2011; Athanasoglou et al., 2008; Kok et al., 2015; Kundid et al., 2011). However, Rachdi (2013) found a negative effect. On the one hand, positive effects on profitability can be expected in banks with higher capitalization, as they face lower funding costs due to the lower costs of potential bankruptcy and are therefore perceived as more creditworthy. On the other hand, lower capitalization implies higher leverage, generally associated with greater risk taking and higher expected returns (Banerjee et al., 2015).

Credit risk (measured with loan loss provisions to net loans): Poor credit quality has a negative effect on profitability since impairment costs are likely to be

higher for banks with lower quality assets (van Ommeren, 2011; Trujillo-Ponce, 2013). Therefore, we expect a negative impact.

Operational efficiency (measured with the overheads to total assets): Effective cost management leads to lower costs and consequently higher profitability. Therefore, we expect a higher overhead to total assets ratio to be negatively associated with profitability (Roman and Tomuleasa, 2013; Liu and Wilson, 2010).

Liquidity risks (measured as net loans to total assets): The direction of the relationship between liquidity and profitability is uncertain. As argued by Banerjee et al. (2015), if banks do not hold adequate liquid assets to sustain day-to-day operations, they could be faced with higher instability and uncertainty, and therefore with higher potential withdrawals of deposits. However, holding cash and other liquid non-earning assets lowers returns and profitability. Loans to households or corporations are more illiquid assets (Hanson et al., 2015; Farag et al., 2013) as in the case of liquidity issues, banks could not sell them on the market as quickly as bonds or most other types of securities.

Business models (measured as non-interest income to gross revenue): Several studies have found a significant and positive effect for higher non-interest income to gross revenue ratios on profitability (van Ommeren, 2011; Petria et al., 2015; Capraru and Ihnatov, 2015). However, in times of crisis, investment activity is often strongly hit and thus more volatile. Therefore, its impact on profitability during a crisis is uncertain.

Business growth (measured as the annual growth of loans to customers): Loan growth should lead to higher interest income and consequently to higher profits. However, Foos et al. (2009) argue that gaining market share at lower rates of loan growth can harm profitability. Moreover, if loan growth is generated by easing credit standards, there is a risk of higher loan losses with a negative effect on profitability (Banerjee et al., 2015).

Funding structure (measured as customer deposits to total assets): Prior to the crisis, many banks financed their growth on the wholesale market, which proved to be a very unstable source of funding in a time of crisis. Conversely, customer deposits are considered to be less expensive and a much more stable. Therefore, a higher share of customer deposits in a bank's funding structure likely results in higher profitability (Trujilo-Ponce, 2013).

Size (measured in natural logarithm of total assets): The empirical literature about the impact of bank size on profitability is ambiguous. Larger banks are able to generate higher profits because of the higher number and the larger diversification of transactions, greater marketing power and economies of scale. However, these relationships are likely to break down at a certain threshold, where banks could become too complex to manage because of bureaucratic or other reasons (Athanasoglou et al., 2008). Even though only systemically important banks are included in the sample, the size significantly varies between banks and between countries. Thus, the relationship between size and profitability could go both ways.

Industry-specific and macroeconomic controls

Concentration (measured as the share of total assets of the five largest credit institutions in a given country): According to Kok et al. (2015), banks in highly concentrated markets tend to collude, giving them the opportunity to extract

monopolistic profits. However, a higher bank concentration might also be the result of tougher competition, which would suggest a negative impact on profitability. The overall impact of market concentration on profitability is thus undetermined.

Interest rates (measured as an annual average of the main refinancing operations): During the recent crisis, the main refinancing interest rates changed at a varying pace among countries. As discussed by Trujilo-Ponce (2013), a low interest rate environment, coupled with fierce competition among banks, could hinder banks from establishing appropriate prices for their loans and deposits. Low interest rates may put pressure on operating margins and negatively affect profitability. Therefore, we can expect positive effects on bank performance.

Time of crisis (1 - time of crisis, 0 - otherwise): A dummy variable is used to distinguish between periods of financial crisis. Since the dating of the financial crises differs among countries, we used the definition of Duprey et al. (2015). They define episodes of systemic financial stress as periods in which high financial market stress coincides with a substantial and prolonged decline in economic activity. Our main focus is the banking crisis and we therefore adjusted the beginning and the end of the crisis for some countries, as shown in Table 1.

Table 1 Banking crisis dates

State	Start	End
Austria	2008	2010
Belgium	2008	2013
Cyprus	2009	2014
Denmark	2008	2012
Finland	2008	2011
France	2008	2011
Germany	2008	2010
Greece	2009	2015
Hungary	2009	2013
Ireland	2008	2013
Italy	2008	2014
Latvia	2008	2011
Netherlands	2008	2012
Portugal	2008	2014
Slovenia	2008	2013
Spain	2008	2013
Sweden	2008	2010
United Kingdom	2008	2011
United States	2008	2010

Notes: Our main focus is banking crisis and therefore in some countries we adjust the beginning and the end date of the crisis. Main indicators used in such cases are the share of non-performing loans, credit growth to non-financial sector and profitability.

Source: Own estimates; Duprey et al (2015).

Economic activity (measured in real GDP growth): Real GDP growth is a common measure of the business cycle that proxies the demand for borrowing. In a period of economic growth, we can expect a higher demand for bank intermediation services and therefore a positive effect on profitability. Numerous studies have found a positive and significant impact of GDP growth, although it may vary between crisis and non-crisis periods (Kok et al., 2015; Rachdi, 2013; Roman and Tomuleasa, 2013).

Inflation (measured as the annual average rate of change in HICP): The impact of inflation on profitability depends on the banks' capacity to anticipate

inflation; when inflation is expected, banks adjust both, loan and deposit interest rates, thereby recording a higher increase in income compared to costs, leading to a positive impact on profitability. In cases when inflation is not anticipated properly, the impact can be negative (Roman and Danuletiu, 2013; Athanasoglou et al., 2006).

Long term government bond yields (measured as the annual average long-term interest rate of government bonds with a maturity close to ten years); Due to the nature of balance sheets, banks often have a position in which steeper yield curve is preferred (Dietrich and Wanzenried, 2011; van Ommeren, 2011). However, in a time of crisis, prices of government bonds decreased significantly which affected banks through their exposure to other banks. It also increased their price of borrowing (which usually depends on the government price of borrowing) and therefore we can expect a negative impact on profitability.

Determinants of recapitalization

The amount of recapitalization: From annual reports and where relevant, i.e. from European Commission press releases on state aid, we gathered data about recapitalization amounts for every year when the recapitalization was performed. In order to make a better comparison, the recapitalization amount was defined as the ratio between the recapitalization amount and total assets. We separately gathered data for private investors and the government.

Time of recapitalization: To capture the effects of time, we included dummy variables as presented in Table 2 and in the notes of Tables 4-6. We analysed the effect of recapitalization performed in the first two years of the crisis and banks recapitalized later on in the crisis. We expected a more positive effect on profitability from banks recapitalized promptly compared to banks recapitalized later in the crisis. Moreover, we tested for the effect of banks recapitalized promptly and by a higher amount.

4. Methodology, empirical result and robustness check

We tested our hypotheses within a panel data modelling framework that combines time series and cross section observations. We estimated a dynamic panel data model with the system generalized method of moments estimator (GMM) in order to avoid the problem of correlation between explanatory variables and the error term (endogeneity), which produces biased and inconsistent estimates (Arellano and Bover, 1995). As proposed by Blundell and Bond (1998), we used lagged levels of dependant and endogenous variables as instruments for the first-difference equation, which reduces the potential bias in finite samples and the asymptotic imprecision associated with the difference estimator (Trujillo-Ponce, 2013).

To check for the consistency of the GMM estimator, we tested for the critical assumption of serial correlation, and for over-identifying restrictions. To test for first and second-order serial correlation, we used the Arellano-Bond test for zero autocorrelation in the first-differenced errors. The Sargan test is used for possible over-identifying restrictions (Cameron and Trivedi, 2009). We also used robust standard errors to correct for heteroscedasticity.

Table 2 Definition of variables

	Variables	Abbreviation	Source	Expected sign
Dependent Variables - Profitability				
	Return on average assets (in %)	roaa	Bankscope	
Explanatory Variables				
Bank-Specific	Equity to total assets (in %)	eqassets	Bankscope	+/-
	Loan loss provisions to net loans (in %)	lossloan	Bankscope	-
	Overheads to total assets (in %)	overta	Bankscope	-
	Net loans to total assets (in %)	loanta	Bankscope	+/-
	Non-interest income to gross revenue (in %)	nintgr	Bankscope	+/-
	Annual growth of loans to customers (in %)	loangr	Bankscope	+
	Customer deposits to total assets (in %)	depta	Bankscope	+
	Logarithm of total assets	size	Bankscope	+/-
Industry-specific and Macroeconomic	Share of total assets of five largest credit institutions (in %)	cr5	ECB	+/-
	Interest rate on the main refinancing operations - annual average (in %)	intmro	Central Banks	+
	Time of crisis dummy (1 – time of crisis, 0 - otherwise)	crisis	Duprey et al. (2015)	
	Real GDP growth (in %)	gdp	World Bank	+
	Annual average rate of change HICP (in %)	inf	World Bank	+/-
	Average long term interest rate (government bonds with maturity close to ten years (in %)	ltint	Eurostat	-
Recapitalization	Amount of recapitalization in total assets (in %)	recapta	AR	+
	Amount of recapitalization in total assets - state investor (in %)	recaptas	AR	+
	Amount of recapitalization in total assets - private investor (in %)	recaptap	AR	+
	DV - Recapitalization performed in the first two years of crisis	ontime	AR	+/-
	DV - Recapitalization performed in the first two years of crisis	ontime2	AR	+
	DV - Recapitalization not performed in the first year of the crisis, but later in the crisis (1 - in year 2014 and 2015, 0 - otherwise)	later2	AR	-
	DV - Recapitalization performed by the government in the first two years of crisis (1 - from the year onwards the recap was made, 0 - otherwise)	ontime_s	AR	+/-
	DV – Recapitalization performed in the first two years of crisis and exceeded 10% of capital (1 - from the year onwards the recap was made, 0 - otherwise)	timebig10	AR	+/-
	DV – Recapitalization performed in the first two years of crisis and exceeded 20% of capital (1 - from the year onwards the recap was made, 0 - otherwise)	timebig20	AR	+/-

	DV – Recapitalization performed in the first two years of crisis and exceeded 10% of capital (1 - in year 2014 and 2015, 0 - otherwise)	timebig10_ly	AR	+
	DV – Recapitalization performed in the first two years of crisis and exceeded 20% of capital (1 - in year 2014 and 2015, 0 - otherwise)	timebig20_ly	AR	+
	DV – Recapitalization performed in the first two years of crisis and exceeded 30% of capital (1 - in year 2014 and 2015, 0 - otherwise)	timebig30_ly	AR	+

Notes: AR stands for Annual Report and DV for dummy variable.

Table 3 Descriptive statistics for the total time period and crisis period

	Total time period					Crisis period				
	Obs.	***Mean***	***St. dev***	***Min***	***Max***	***Obs.***	***Mean***	***St. dev***	***Min***	***Max***
Dependent variable										
roaa	910	0.256	1.366	-13.52	4.429	433	-0.226	1.690	-13.519	4.429
Independent variables										
Bank-specific										
eqassets	910	7.071	3.334	-3.931	19.87	433	6.595	3.208	-3.931	19.70
lossloan	910	1.239	1.855	-1.575	25.43	433	1.902	2.339	0.062	25.43
overta	910	1.842	1.003	0.128	9.356	433	1.752	0.915	0.128	7.823
loanta	910	59.05	15.21	10.33	88.40	433	60.31	14.25	12.23	85.79
nintgr	910	34.58	23.44	-328.3	176.2	433	31.59	27.76	-328.3	172.1
loangr	910	6.198	16.62	-50.82	171.0	433	3.411	17.37	-50.82	168.0
depta	910	63.96	14.90	11.15	98.76	433	63.95	14.72	14.74	98.76
size	910	4.804	1.520	0.143	7.858	433	4.686	1.493	0.330	7.830
Industry-specific and macroeconomic										
cr5	910	49.85	15.61	21.99	95.23	433	51.61	16.54	22.74	95.23
intmro	910	1.574	1.607	0.000	8.813	433	1.426	1.301	0.050	8.396
crisis	910	0.476	0.500	0.000	1.000	433	1.000	0.000	1.000	1.000
gdp	910	0.740	2.773	-14.35	11.90	433	-0.901	2.893	-14.35	6.212
inf	910	1.575	1.485	-9.686	20.13	433	1.190	1.491	-9.686	11.84
ltint	910	3.756	2.256	0.496	22.50	433	4.708	2.650	1.403	22.50
Recapitalization										
recapta	910	0.606	1.492	0.000	20.16	433	0.876	1.914	0.000	20.16
recaptas	910	0.224	1.170	0.000	20.16	433	0.423	1.619	0.000	20.16
recaptap	910	0.383	0.917	0.000	14.43	433	0.453	1.016	0.000	14.43
ontime	910	0.620	0.486	0.000	1.000	433	0.734	0.442	0.000	1.000
ontime2	910	0.163	0.369	0.000	1.000	433	0.048	0.215	0.000	1.000
later2	910	0.026	0.160	0.000	1.000	433	0.014	0.117	0.000	1.000
timebig	910	0.541	0.499	0.000	1.000	433	0.642	0.480	0.000	1.000
timebig_ly	910	0.143	0.350	0.000	1.000	433	0.046	0.210	0.000	1.000

We used a similar specification as Athanasoglou et al. (2006) and van Ommeren (2011), and estimated the following equation:

$$\pi_{i,t} = c + \partial\pi_{i,t-1} + \sum_{b=1}^{B} \beta_b X_{i,t-1}^{b} + \sum_{s=1}^{S} \beta_s X_{i,t}^{s} + \sum_{m=1}^{M} \beta_m X_{i,t}^{m} + \sum_{r=1}^{R} \beta_r X_{i,t-1}^{r} + \textit{time recap dummies} + \mu_i + v_{i,t} \qquad (1)$$

The dependent variable (π_{it}) measures the profitability estimated by ROAA, for bank i at time t. We include the lagged dependent variable ($\pi_{i,t-1}$) and a constant term (c) to account for the persistence of profits. The controls variables fell into either: lagged bank-specific ($X_{i,t-1}^{b}$), industry-specific ($X_{i,t}^{s}$), or macroeconomic ($X_{i,t}^{m}$) groups. We also included lagged recapitalization variables ($X_{i,t-1}^{r}$) to account for the hypothesized effect of the recapitalization amount on profitability. To control for the time effect of recapitalization, we used dummy variables. Finally, the model captures the fixed effects (μ_i) and idiosyncratic term ($v_{i,t}$). Descriptive statistics for the total time period and crisis period are presented in Table 3.

Empirical results

The empirical results are presented in two parts. First, we briefly reviewed the effect of control variables on profitability, both for the total time period and for the crisis period. Further, we tested for the effects of recapitalization on profitability: the effect of the amount in Table 4, the time effect in Table 5 and the combination of time and the amount effect in Table 6. We used the GMM estimator and ROAA as the dependent variable in all regression models. Finally, we performed several robustness checks.

The estimation results for the effect of bank-specific, industry-specific, and macroeconomic controls on the return on average assets are summarized in Tables 4-6. All independent variables have the expected sign, both for the total time period and the crisis years, with the exception of overheads to total assets ratio where we find a statistically significant and positive effect. Although the effect of operational efficiency is highly statistically significant and negative without a lag, it becomes positive with a lag. This could be explained with better monitoring and effectiveness due to a larger number of employees or higher salaries, which could increase motivation. It could also be the consequence of better equipment or other costs such as external legal and audit fees which could increase performance and result in higher profitability with a lag.

We found a positive immediate effect of capitalization (equity to total assets) and a negative effect with a lag (lagged value of equity to total assets) for the total time period and during the time of the crisis. This is expected as a higher amount of equity can positively affect profitability because it increases stability and creditworthiness and also enables banks to clean their balance sheets faster and more efficiently. However, with a lag, the effect of capitalization could be negative due to

the high cost of capital (the shareholder's required rate of return). What probably contributed to a different economic effect in comparison with recapitalization is that a large share of new equity was used to cover losses and therefore did not directly affect capital.

Credit risk (lagged value of loan-loss provisions to net loans) is statistically insignificant in most models presented in Table 4. Without a lag the negative effect of credit risk is highly significant since crisis-time impairment costs are relatively high for banks with lower asset quality. In a few models we can see a positive effect (although weak) of loan-loss provisions to net loans on profitability, which could be the result of more clean balance sheets due to the higher loan loss provisions in the previous year. One reason could also be in higher release of impairments as the consequence of improved economic conditions.

The effect of business models (lagged value of non-interest income to gross revenue) proves to have statistically insignificant effect on profitability which could be the consequence of the fragility and volatility of non-interest income during the crisis. Liquidity risk (lagged value of net loans to total assets) has a statistically significant negative effect on profitability. Loans are considered to be less liquid and in the case of liquidity issues and with a deterioration of their quality, banks could not sell them easily on the market. Therefore, a higher amount of loans resulted in a negative effect on profitability.

Business growth (lagged value of annual growth of loans to customers) has a statistically significant positive effect in most models in Table 5 and 6. Banks that expand lending in a time of crisis (also by seizing the opportunity to take over some of the business activities of distressed banks) experience a positive effect on profitability. However, the economic effect is low, which reflects the lack of business activity during an economic downturn.

A higher share of customer deposits (lagged value of customer deposits to total assets) has a weak statistically significant and positive effect on profitability. This could be explained as a consequence of the more stable funding source of customer deposits. However, in most tested models the effect has been statistically insignificant. The size of the bank (lagged value of the logarithm of total assets) has statistically significant and negative effect on profitability with a lag. Larger banks have usually been in higher distress during the recent crisis and therefore the effect of size on profitability was negative. In a non-crisis time the economic effect of size could be different due to benefits of greater market power and economies of scale of large banks.

Concentration (the share of total assets of the five largest credit institutions in a given country) and the interest rate on main refinancing operations have a statistically insignificant effect on profitability in almost all tested models. As expected, real GDP growth rate has a strong and positive effect on profitability; when economic activity is growing, higher demand for bank intermediation is to be expected. The effect of inflation on profitability is statistically insignificant in almost all tested models. Contrary, the effect of borrowing price (long term government bond yields) is highly statistically significant and negative. The combination of significant decrease in prices of government bonds and increase of borrowing costs with debt securities due to a higher required yield resulted negatively on profitability.

Amount of recapitalization

With the first research question, we analysed if the higher amount of recapitalization has a positive effect on profitability during the crisis. To test for the effect of the recapitalization amount on profitability, we estimated the dynamic panel model described in equation (1). In addition, because the newly invested capital is expected to affect bank profitability more strongly with a lag, we used, as a causal variable, lagged values of the recapitalization amount. The control variables remain the same as in equation (1).

First, we tested if the amount of recapitalization affects the profitability without a lag (equity enters equation (1) with contemporaneous values – Model 1, Table 4). In this case, the amount of recapitalization affects profitability in a statistically significant and negative way in both the total time period and for the time of crisis. A negative immediate effect is somehow expected, especially during a time of crisis, where new capital is often used to cover losses made from impairments and provisioning costs. This enables banks to effectively clean their balance sheets and still satisfy capital requirements, but does not positively affect profitability in the current year. Fast and sufficiently large write-offs of toxic assets could be the basis for further business expansion and a positive effect on banks' performance in the future. This is the reason why the specification where capital enters with a lag is more reasonable.

Table 4 GMM estimation results for ROAA; the effect of the amount of recapitalization

Variables	Total time period			Crisis period		
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*
L.roaa	0.508***	0.373**	0.355**	0.253*	0.109	0.178
	(0.144)	(0.170)	(0.162)	(0.133)	(0.150)	(0.180)
L.eqassets	-0.628***	-0.442***	-0.439***	-0.600***	-0.505***	-0.531***
	(0.122)	(0.0975)	(0.0993)	(0.0942)	(0.0911)	(0.101)
L.lossloan	0.191**	-0.0635	-0.0724	0.225*	-0.0721	-0.0481
	(0.0961)	(0.0849)	(0.0971)	(0.119)	(0.163)	(0.172)
L.overta	0.745***	0.557***	0.564***	0.902***	0.848***	0.866***
	(0.231)	(0.194)	(0.196)	(0.173)	(0.185)	(0.187)
L.loanta	-0.0310	-0.0293*	-0.0292*	0.0116	0.00526	0.00877
	(0.0195)	(0.0173)	(0.0174)	(0.0204)	(0.0207)	(0.0209)
L.nintgr	-0.00595	-0.00756	-0.00747	-0.00459*	-0.00363	-0.00394
	(0.00655)	(0.00729)	(0.00733)	(0.00246)	(0.00281)	(0.00285)
L.loangr	0.00435	0.00009	0.00061	0.00749**	0.00265	0.00309
	(0.00361)	(0.00301)	(0.00284)	(0.00336)	(0.00316)	(0.00309)
L.depta	0.0223**	0.0115	0.0105	-0.00389	-0.0193	-0.0175
	(0.0109)	(0.00924)	(0.00944)	(0.0106)	(0.0126)	(0.0119)
L.size	-0.767***	-0.611**	-0.607**	-0.0200	0.182	0.212
	(0.228)	(0.238)	(0.239)	(0.489)	(0.489)	(0.499)
cr5	0.0193	0.00769	0.00866	0.0393**	0.0216	0.0187
	(0.0149)	(0.0229)	(0.0242)	(0.0169)	(0.0150)	(0.0140)
intmro	0.0249	-0.00589	-0.00133	0.191**	0.150	0.122
	(0.0634)	(0.0428)	(0.0434)	(0.0951)	(0.0979)	(0.0938)
gdp	0.0573**	0.102***	0.103***	0.0363*	0.0620***	0.0636***
	(0.0250)	(0.0218)	(0.0214)	(0.0193)	(0.0163)	(0.0170)
inf	0.00730	0.0384	0.0345	0.0317	0.0548*	0.0454
	(0.0365)	(0.0270)	(0.0267)	(0.0427)	(0.0303)	(0.0293)
ltint	-0.230***	-0.131*	-0.135*	-0.305***	-0.225**	-0.215**
	(0.0801)	(0.0688)	(0.0693)	(0.105)	(0.0949)	(0.0920)
recapta	-0.509***			-0.368***		
	(0.0956)			(0.0813)		
L.recapta		0.280***			0.208**	
		(0.0909)			(0.0830)	
L.recaptas			0.276**			0.0883
			(0.134)			(0.0760)
L.recaptap			0.279***			0.363***
			(0.0743)			(0.122)
Constant	7.195***	6.220***	6.207***	0.899	1.355	1.121
	(1.873)	(2.214)	(2.257)	(3.178)	(3.329)	(3.295)
No. observations	819	819	819	433	433	433
No. of banks	91	91	91	91	91	91
AB test AR(1)	(0.0003)	(0.0005)	(0.0003)	(0.0007)	(0.0007)	(0.0010)
AB test AR(2)	(0.8777)	(0.2139)	(0.2046)	(0.2099)	(0.4610)	(0.1325)
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1						

Notes: AB test AR (1) and (2) refer to the Arellano-Bond test, that the average autocorrelation in residuals of order 1 and order 2 is 0. Test variables in the models are defined as follows (the same in both periods): (1) value of the amount of recapitalization in total assets in every year; (2) lagged value of the amount of recapitalization in total assets for every year (3) lagged value of the amount of recapitalization in total assets in every year separately from the government (L.recaptas) and private investors (L.recaptap).

The positive effects of a higher recapitalization amount on profitability with a lag are evident when testing the second and the fifth model (shown in Table 4). This time, we used the lagged value of the recapitalization amount for both the total time period and for the time of the crisis. The effect on profitability was statistically significant and positive. The economic effect is slightly more positive during the total time period (model 2) than for the time of crisis (model 5). In the time of the crisis, a large share of new equity was used to cover losses and maintain or increase capital

adequacy. By contrast, in non-crisis times, new equity is often used for acquisitions and mergers and to increase business activity, which could result in a more positive effect on profitability. For Model 2 (variable L.recapta), we can interpret the results in the following way: if the recapitalization, measured as a share of total assets, increases by one percentage point, the banks' profitability (ROAA) increases by 0.28 percentage point in the subsequent year. This confirms our assumption that the amount of recapitalization positively affects profitability, albeit with a lag.

When testing the effects of the recapitalization amount on profitability performed by private investors and the government, the results show a statistically significant effect only in the total time period. The effect from both types of investors is positive (Model 3, Table 4). As seen in the recent crisis, private investors will not likely invest new capital in distress banks and consequently the government usually steps in and intervenes, which was especially the case with systemically important banks. Although the amount of recapitalization performed by the government was often quite large (usually higher than from private investors), the banks used the bulk of the new capital to cover losses. What is more, banks that received state aid were usually committed to deleveraging and therefore limited in performing business activities, with a negative effect on profitability. Therefore, we would expect more positive effect on profitability from recapitalizations performed by private investors, but this was not the case. We found no difference among the investors when testing the effect on profitability for the total time period. In the time of the crisis, the effect from the government recapitalizations was not statistically significant and therefore we could not compare it with the effect from private investors.

Time of recapitalization

The second research question we investigated was if promptly performed recapitalization had a more positive effect on profitability than recapitalization performed later on in the crisis. We used several dummy variables to test this question. We define "prompt recapitalizations" as recapitalizations that were performed in the first two years of the crisis. For a more suitable assessment, we excluded banks that were not recapitalized during the crisis and banks from countries that did not experience a financial crisis during our observation period. The empirical results and detailed definition of the used dummies in the models are presented in Table 5.

The immediate effect of time on profitability for recapitalizations performed in the first two years of the crisis is statistically significant and negative (Model 1, Table 5). This can be explained by the fact that banks that were recapitalized immediately after the crisis were in bigger distress and much of the capital was used to cover losses and consequently not to support business activities. What if the effect of prompt recapitalization (in the first two year of the crisis) on profitability is evident only after some time, when the majority of banks made it out of the crisis, perhaps at the end of our analysed time period, in the years 2014 and 2015? We added new dummy variables to perform additional tests. We also tested the effect in the years 2014 and 2015 for banks not recapitalized in the first two years of the crisis, but later on in the crisis. The difference between these groups of banks is significant.

Table 5 GMM estimation results for ROAA; the effect of the time of recapitalization

Variables	Total time period			
	Model 1	***Model 2***	***Model 3***	***Model 4***
L.roaa	0.328**	0.399**	0.290*	0.0868
	(0.158)	(0.180)	(0.155)	(0.117)
L.eqassets	-0.312***	-0.350***	-0.306***	-0.329***
	(0.105)	(0.103)	(0.103)	(0.117)
L.lossloan	0.106	0.140	0.0882	-0.000904
	(0.0973)	(0.111)	(0.0941)	(0.0814)
L.overta	0.435**	0.504**	0.429**	0.444***
	(0.199)	(0.217)	(0.192)	(0.167)
L.loanta	-0.0326*	-0.0325*	-0.0353**	-0.0503**
	(0.0167)	(0.0168)	(0.0162)	(0.0241)
L.nintgr	-0.00906	-0.00948	-0.00902	-0.00642
	(0.00882)	(0.00903)	(0.00861)	(0.00852)
L.loangr	0.00681**	0.00692**	0.00698**	0.00622
	(0.00314)	(0.00322)	(0.00307)	(0.00386)
L.depta	0.0127	0.00525	0.0140	0.0219*
	(0.00918)	(0.0106)	(0.00917)	(0.0131)
L.size	-0.522**	-0.576**	-0.490*	-0.201
	(0.248)	(0.254)	(0.251)	(0.243)
cr5	0.0205	0.0168	0.0235	0.0332
	(0.0257)	(0.0247)	(0.0263)	(0.0342)
intmro	0.0221	0.0558	0.0776	-0.0133
	(0.0560)	(0.0553)	(0.0552)	(0.0861)
gdp	0.0716**	0.0667**	0.0789***	0.0818**
	(0.0279)	(0.0284)	(0.0269)	(0.0413)
inf	0.0455	0.0638*	0.0320	0.102
	(0.0307)	(0.0365)	(0.0312)	(0.0742)
ltint	-0.158**	-0.122	-0.180**	-0.273***
	(0.0721)	(0.0792)	(0.0720)	(0.0689)
ontime	-0.271*			
	(0.143)			
ontime2		0.413**		
		(0.198)		
later2			-0.817**	
			(0.332)	
ontime_s				-0.540**
				(0.247)
Constant	4.823*	5.354**	4.456*	3.943
	(2.495)	(2.550)	(2.567)	(2.593)
No. observations	819	819	819	459
No. of banks	91	91	91	51
AB test AR(1)	(0.0008)	(0.0009)	(0.0007)	(0.0011)
AB test AR(2)	(0.9219)	(0.8305)	(0.9110)	(0.6661)
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1				

Notes: AB test AR (1) and (2) refer to the Arellano-Bond test, that the average autocorrelation in residuals of order 1 and order 2 is 0. Test variables in the models are defined as follows; (1) dummy variable (ontime) with a value 1 from the year onwards when recapitalization was performed in the first two years of the crisis and 0 otherwise; (2) dummy variable (ontime2) with a value of 1 in the year 2014 and 2015 if recapitalization was performed in the first two years of the crisis and 0 otherwise; (3) dummy variable (later2) with a value 1 in the year 2014 and 2015 if recapitalization was not performed in the first two years of the crisis but later in the crisis and 0 otherwise; (4) dummy variable (ontime_s) with a value 1 from the year onwards when recapitalization was performed by the government in the first two years of the crisis and 0 otherwise.

For banks recapitalized in the first two years of the crisis, the effect on profitability in years 2014 and 2015 is statistically significant and positive (Model 2, Table 5). This is expected as after several years in the crisis, most banks clean their balance sheets and in improved economic conditions increase their business activities and consequently profitability. Prompt recapitalization was an important factor,

because it enabled banks to effectively achieve profitability due to increased stability (higher amount of capital) and ability to increase lending and other activities.

The effect of time is especially evident when comparing the effect on profitability with banks recapitalized later in the crisis (Model 3, Table 5). In this case the effect in the years 2014 and 2015 is highly statistically significant and negative. This confirms the argument by Leaven and Valencia (2008) that the speed of the bank's rescue is of the essence and confirms what we saw in many banks during the recent crisis: banks that were not recapitalized at the beginning of the crisis were usually rehabilitated later, with a negative effect on profitability. And as can be seen, even if an individual bank was not in distress at the beginning of the crisis, it is highly likely that it was after a few years of crisis due to the very high level of interconnectedness among financial institutions in the developed world.

Additionally, we tested the effect on profitability during the years after recapitalization was performed by the government. The results can be seen in Model 4, Table 5. The government usually recapitalized more troubled banks because of the unwillingness of private investors and the need for maintaining financial stability, especially in systemically important institutions. Consequently, the negative effect on profitability was much higher when recapitalization was performed by the government in comparison with the whole sample (Model 1, Table 5).

When we added a time dummy variable for every observation year in order to better control for the non-observable effect on profitability in a specific year, the effect was very similar for recapitalizations performed in the first two years of the crisis (ontime2 variable) and later on in the crisis (later2 variable). However, when testing the effect from the years after recapitalization was performed (ontime variable), the estimation becomes statistically insignificant.

The amount and time of recapitalization

What if we combine time and the amount of recapitalization? Could we expect a more positive effect in promptly recapitalized banks with a higher amount? We added a dummy variable with a value of 1 for banks recapitalized in the first two years of the crisis and when the value of recapitalization exceeded a certain amount of capital; otherwise it was 0. First, we tested the effect from the years following recapitalization, i.e. during the first two years of the crisis. In both cases, when recapitalization exceeded 10% of capital (timebig10) and 20% of capital (timebig20), the effect was negative. Once again, the explanation of the estimation could be that the banks that received a larger amount of equity injections in the beginning of the crisis were probably more distressed, as capital is usually a scarce thing in a crisis and therefore not usually invested unless necessary.

To test the effect in the years 2014 and 2015 we used several dummy variables for recapitalizations performed in the first two years of the crisis and when recapitalization exceeded 10% of capital (timebig10_ly), 20% of capital (timebig20_ly) and 30% of capital (timebig30_ly). The positive effect on profitability in the years 2014 and 2015 increases with the amount of recapitalization. This is expected as prompt and larger recapitalizations enable banks to cover losses quickly and effectively, while at the same time achieve capital requirements and increase business activities.

Table 6 GMM estimation results for ROAA; the effect of time and the amount of recapitalization

Variables	Total time period				
	Model 1	***Model 2***	***Model 3***	***Model 4***	***Model 5***
L.roaa	0.329**	0.327**	0.379**	0.370**	0.369**
	(0.159)	(0.161)	(0.175)	(0.165)	(0.162)
L.eqassets	-0.313***	-0.313***	-0.344***	-0.337***	-0.343***
	(0.105)	(0.104)	(0.102)	(0.103)	(0.101)
L.lossloan	0.107	0.104	0.125	0.123	0.124
	(0.0973)	(0.0977)	(0.107)	(0.105)	(0.105)
L.overta	0.454**	0.459**	0.493**	0.499**	0.530***
	(0.199)	(0.199)	(0.211)	(0.205)	(0.205)
L.loanta	-0.0335**	-0.0333**	-0.0325*	-0.0331*	-0.0338**
	(0.0169)	(0.0166)	(0.0168)	(0.0171)	(0.0171)
L.nintgr	-0.00906	-0.00913	-0.00938	-0.00963	-0.00980
	(0.00882)	(0.00885)	(0.00902)	(0.00891)	(0.00879)
L.loangr	0.00705**	0.00729**	0.00689**	0.00676**	0.00676**
	(0.00314)	(0.00317)	(0.00320)	(0.00319)	(0.00321)
L.depta	0.0135	0.0137	0.00672	0.00673	0.00480
	(0.00910)	(0.00910)	(0.0104)	(0.0105)	(0.0110)
L.size	-0.529**	-0.530**	-0.558**	-0.543**	-0.515**
	(0.246)	(0.254)	(0.255)	(0.250)	(0.258)
cr5	0.0208	0.0197	0.0171	0.0204	0.0225
	(0.0257)	(0.0257)	(0.0246)	(0.0258)	(0.0256)
intmro	0.0145	0.0291	0.0570	0.0630	0.0671
	(0.0620)	(0.0623)	(0.0550)	(0.0554)	(0.0558)
gdp	0.0707***	0.0722***	0.0693**	0.0694**	0.0675**
	(0.0272)	(0.0275)	(0.0281)	(0.0285)	(0.0285)
inf	0.0456	0.0463	0.0598*	0.0586*	0.0600*
	(0.0305)	(0.0305)	(0.0350)	(0.0350)	(0.0355)
ltint	-0.155**	-0.158**	-0.131*	-0.137*	-0.139**
	(0.0731)	(0.0736)	(0.0774)	(0.0719)	(0.0703)
timebig10	-0.354*				
	(0.183)				
timebig20		-0.385*			
		(0.214)			
timebig10_ly			0.383**		
			(0.195)		
timebig20_ly				0.533**	
				(0.261)	
timebig30_ly					0.953**
					(0.465)
Constant	4.839*	4.799*	5.216**	4.993*	4.897*
	(2.488)	(2.565)	(2.545)	(2.559)	(2.588)
No. observations	819	819	819	819	819
No. of banks	91	91	91	91	91
AB test AR(1)	(0.0009)	(0.0009)	(0.0008)	(0.0008)	(0.0008)
AB test AR(2)	(0.9803)	(0.9180)	(0.8623)	(0.8427)	(0.8065)
Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1					

Notes: AB test AR (1) and (2) refer to the Arellano-Bond test, that the average autocorrelation in residuals of order 1 and order 2 is 0. Test variables in the models are defined as follows; (1) and (2) dummy variable with a value of 1 from the year onwards when recapitalization was performed in the first two years of the crisis and exceeded 10% of capital (timebig10) or 20% of capital (timebig20) and 0 otherwise; (3), (4) and (5) dummy variable with a value of 1 in the year 2014 and 2015 if recapitalization was performed in the first two years of the crisis and exceeded 10% of capital (timebig10_ly), 20 % of capital (timebig20_ly) or 30 % of capital (timebig30_ly) and 0 otherwise.

Once again, we added a time dummy variable for every observation year to better control for the non-observable effect on profitability in a specific year. The effect in the years 2014 and 2015 (variables timebig10_ly, timebig20_ly and timebig30_ly) is very similar; there is a statistically significant and positive effect increase with the amount of recapitalization. When testing the effect from the years

following recapitalization (variable timebig10 and timebig20), the estimation becomes statistically insignificant.

Robustness check

We conducted a number of robustness checks to ensure that our main findings do not depend on a specific setting. Firstly, we checked for the influence of possible outliers. We used the Winsor option available in the Stata software programme (Banerjee et al., 2015). Thus, data was winsorised at the 1st and 99th percentile; all the data below the 1st percentile was set to the 1st percentile value and all the data above the 99th percentile was replaced with the 99th percentile value. The results are very similar in signs as in statistical significance, both for controls and recapitalization variables. However, there is one difference worth mentioning; the effect on profitability in 2014 and 2015 of recapitalizations performed in the first two years of the crisis was statistically insignificant (variable ontime2, Model 2, Table 5), although economic significance is positive and the coefficients are very similar to the main findings. We tested for possible autocorrelation in residuals of the order 1 and order 2 with the Arellano Bond test and the results showed that there was no second order autocorrelation in the residuals.

In order to compare the results and further check for robustness, we used the ordinary least squares (OLS) regression with the fixed effects panel estimation method. The OLS panel regression results mostly confirm our main findings. However, there are some differences in statistical significance what is expected due to considerable differences between estimators.

In addition, we tested if the overidentifying restrictions in our model were valid. At first the Sargan test rejected the null hypotheses that overidentifying restrictions are valid. According to Roodman (2009) and Chao et al. (2014) the power of the Sargan test diminishes with an increase of the moment conditions (instruments) and therefore, one should not adhere to the Sargan test too faithfully. This could be the case in our regressions as well, given that we used a large number of control variables in order to single out the effects of recapitalization by other impacts. Nevertheless, we inspected the issue further. First, we checked the validity for every specific variable and we obtained similar result, both for the total time period and during the time of the crisis. The next possibility is that the dependent variable was not sufficiently explained, and thus residues/outliers were present that affected the test. Consequently, we added additional lags for the dependant variable. After that, we could not reject the null hypothesis, indicating that the instruments are valid. We are aware that this regression could be problematic, because it could reduce the power of the Sargan test; however, we still strongly believe that our regression is robust.

Finally, we used return on average equity as a dependant variable. The volatility of this variable is very high and there are some outliers that can significantly affect the results. However, signs of control variables and most importantly, recapitalization variables, are very similar, although coefficients are, as expected, much higher. The main findings are the same using both variables; the amount of recapitalization positively affects profitability with a lag, and time is important, because when recapitalizations are performed promptly, the effect on profitability in 2014 and 2015 becomes positive compared to the negative effect we

see in banks recapitalized later on during the crisis. Also, the effect on profitability of recapitalizations performed in the first two years of the crisis increases with the amount of recapitalization.

5. Conclusion

During the crisis, banks usually face heavy losses and the existing amount of capital is often not sufficiently large enough to fill the capital gap and to achieve the ever-higher capital requirements at the same time. Banks are not able to sufficiently increase capital from retained earnings due to inadequate or negative profitability and therefore, recapitalization is often needed. Among bank recapitalization, characteristics differ significantly and that raises the question if the recapitalization volume, type and time affect profitability in a time of crisis.

Trying to answer this question, we performed econometric tests with a novel data set of 91 systemically important commercial banks in the EU and US for the period from 2006 to 2015. We found that the higher amount of recapitalization positively effects profitability with a lag. This is expected, as it usually takes time for newly invested equity results to have a more positive effect on banks' performance. The higher the amount of recapitalization, the faster and more efficiently banks can wipe out their toxic assets and are able to support the expansion of business activities with a positive effect on growth. Therefore, sufficient recapitalization is suggested; not just for the amount to fill the capital gap and to meet capital adequacy, but for the amount that enables banks to support further activities. We did not find a significant difference when recapitalization was performed by private investors or by the government.

Next, we analysed the time effect of recapitalization on profitability. The immediate effect of promptly recapitalised banks (recapitalised in the first two years of the crisis) was statistically significant and negative. However, the effect on profitability became positive when we tested it for the years 2014 and 2015, when most banks had made it out of the crisis. The effect became positive only for banks recapitalized in the first two years of the crisis and remained negative for banks recapitalized later on during the crisis. Therefore, we can say that the time of the recapitalization is important.

Finally, we simultaneously tested the effect of the time and the amount of recapitalization on profitability. In the years 2014 and 2015, the effect on profitability for banks recapitalized in the first two years of a crisis showed that the positive effect on profitability increases with the amount of recapitalization. Therefore, we can conclude; at the very beginning of the crisis, bank losses should be recognised and adequate recapitalization measures should be taken. Even if the bank is in relatively good condition with regard to the level of its capital, it is highly likely that it will need to strengthen capital because of the high level of interconnectedness among financial institutions. As seen in the crisis, stability and confidence in the financial sector can be very fragile in times of crisis, with significantly negative consequences. Prompt and efficient recapitalization increases the positive effect on profitability, which is in the interest of financial institutions and for the economy as a whole.

Even though our sample included the complete time period of the recent crisis, there are some limitations. A longer time series would include some additional data for banking activities in the years before the crisis, when numerous banks increased capital not to cover their losses and achieve capital adequacy, but to support business activities and perform mergers and acquisitions. Also, some banks are still facing difficulties and therefore, the consequences of recapitalization measures in the time of the crisis are harder to observe. In addition, it could be fruitful to focus on the distress of specific banks instead of the state even though, as could be seen in the recent crisis, the time of distress for an individual financial institution often overlaps with a crisis in the entire national banking system.

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