Banking Supervision and Risk-Adjusted Performance in the Host Country Environment

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Abstract

We study the effect of the banking supervision in institutional settings of foreign-bank dominated financial systems of Central, Eastern and South-Eastern Europe in post-crisis period 2012-2018. For a dataset of 450 banks from 20 economies of the region, we use a mediation-moderation analysis framework to establish a relationship between regulatory scrutiny, supervisory activities and a bank risk-adjusted economic performance. We find that a higher intensity of supervision monitoring activities, especially by the centralized form of supervision, contributes to the decline of the bank's riskiness in case of larger size banks while not affecting their economic performance. The regulatory power and capital regulation stringency indicate a positive effect on the risk-adjusted performance for capital constrained banks, but moderately decrease the economic benefit for larger banks. In light of the ongoing debate on the architecture of supervision in the region, the findings highlight the potential area of attention for regulators and policymakers and thus, contribute to the designing of effective supervision mechanism.

AMS/JEL classification: G20, G21, G28

Keywords: supervision; financial regulation; RAROC; causal mediation analysis; moderation analysis; Central Eastern and South-Eastern Europe

1. Introduction

Our paper investigates the economic impact of banking supervision on the performance and riskiness of financial institutions. Specifically, we focus on the analysis of banking supervision in post-communist countries of Central, Eastern and South-Eastern Europe (CESEE). We refer to these countries as "host countries", since a common feature of these countries' banking system is a significant presence of subsidiaries of large multinational banks, prevalently with parent banks from Western Europe (Claessens and Horen 2014). Most of these subsidiaries are of systemic importance in the host country, but in many cases, these foreign operations are not material for the parent bank and thus for the home

country supervisory authority. This has significant implications for the supervisory monitoring activities due to the information asymmetries, misalignment of incentives and coordination issues between home and host supervision authorities (Beck et al. 2013).

While the academic literature has paid increasing attention to the impacts of financial regulations on the banking sector e.g. Demirgüç-Kunt et al. (2008); Laeven and Levine (2009), few studies are dedicated to the analysis of supervision activities in monitoring and enforcement of established rules, which are often carried out by national regulators or on behalf of the supranational banking authorities in case of cross border banking activities. Supervision is rarely examined separately from regulations for several reasons. In a practical world, it is difficult to explore the regulation and supervision separately due to their overlapping nature, as they can interact in a complex way (Ongena et al. 2013). Partly it is attributable to the relative opacity of supervisory activities that stems from supervisors' reliance on confidential information (Eisenbach et al. 2017). Therefore, relatively little is known about the distinct impact of supervisory' monitoring efforts on the performance of the banks.

In this paper, we build upon recent studies with a focus on a broad concept of supervisory attention without limiting to the specific supervisory program similarly as Eisenbach et al. (2016); Hirtle et al. (2020) and adapt it to the analysis of the banking sector in Central, Eastern and South-Eastern Europe. In the theoretical part (see Appendix A), we present a contract theory-based framework of the regulations and supervision in the financial intermediation industry. This framework allows us to identify the areas for enhanced supervisory attention that we consider as a treatment effect in a core empirical part of this paper. Our main hypothesis is that the supervisory monitoring efforts are associated with lower riskiness of the banking institutions and simultaneously do not impact their performance. For identification, we exploit a cross-country difference in supervisory activities and supervision structure to analyse the potential effect of supervision scrutiny on the risk-adjusted performance of the regional banking sector. Specifically, we attempt to answer the following questions:

(1) How the proposed proxies for a signal to the higher supervisory attention: i) too-big-to-fail (TBTF) status measured as top three highest-ranking banks on the country level, and ii) lowest quartile of solvency ratio on the country level, relate to the risk-adjusted performance of the banking units in CESEE.

(2) How the intensity of supervision impacts the economic performance of the banks in risk-adjusted terms and what contribution to this effect a structure of supervision i.e., decentralized versus centralized or supranational form (Single Supervisory Mechanism (SSM)) has.

These questions are especially relevant for the regulation of the banks in the region of our interest, where the cross-border banking activities are significant and supervisory structure plays a significant role in the financial stability for the national economies and consequently for the European Union (EU). In this study, we are motivated also by the latest European Central Bank (ECB) discussions on the allocation of power and responsibilities for conduct and supervision policies for the economic and financial environment, in the context of integrated supervision and regulations (Ampudia et al. 2019; Carstens 2019; Schoenmaker et al. 2011).

Our main findings indicate that the intensity of supervision activities measured by the number of inspections and audits on country level effectively contributes to the decline of the bank's riskiness, while the economic performance remains unaffected. This effect we observe for the larger and systemically important banks. The regulatory power and stringency by enforcement of the capital requirements indicate a positive effect on the economic performance for capital constrained banks,

but moderately decrease the risk-adjusted performance of larger banks. Additionally, our findings suggest that the supervision structure (i.e. centralized or de-centralized supervision) matters only for the segment of the larger banks (TBTF) in the national economies of the countries of the CESEE region. For the bank units with lower capitalization (measured as the lowest quartile of solvency ratio on a country level), we find no statistical evidence that the supervisory structure contributes to the supervisory efforts ultimately leading to the improving risk-adjusted-performance. The findings of our study provide important implications by identifying areas of attention for the regulators and policymakers and, therefore, contribute to creating an effective supervisory mechanism in the CESEE region.

This paper is structured as follows. Section 2 describes the institutional background and provides a literature review; Section 3 elaborates the empirical strategy and describes the methods. In Section 4 we present the results of the analysis, discussions, and policy implications; Section 5 provides a robustness check in a form of sensitivity analysis and Section 6 presents the concluding remarks.

2. Literature review

The questions related to the effectiveness of banking regulation have always been important for researchers and policymakers, especially after the financial crisis of 2007–2009. In the definition of Ayadi et al. (2016), the banking regulation is a combination of supervisory and restrictive policies aiming both to protect the banking sector from excessive risk-taking and from moral hazard behavior. In the academic literature, the impacts of financial regulations and supervision on the banking sector are studied by many prominent researchers (Barth et al. 2004, 2010, 2013; Demirgüç-Kunt et al. 2008; Laeven and Levine 2009; Melecky and Podpiera 2013). However, few studies are dedicated to the analysis of supervisory efforts in monitoring and enforcement of established rules, primarily due to the scarcity of data on the activities of supervisors and overlapping nature between regulations and supervision. In a recent study, Eisenbach et al. (2017) provide insight into the supervision mechanisms and processes for large and complex financial institutions in the US. They emphasize the importance of understanding how supervision works in order to assess its impact and effectiveness.

From a theoretical perspective, bank regulation and supervision may have contradicting effects and this ambiguity is supported by empirical studies. For example, Hirtle et al. (2020) find that more supervision adds value over and above the effects of regulation. On the example of the top-ranked US banks by size within supervisory districts, these bank units that are subject to increased supervisory attention tend to hold less risky loan portfolios, are less volatile and are less sensitive to industry downturns. However, they have slower growth and less profitability. According to Bisetti (2020) agency theory predicts a positive role for regulation in reducing shareholder monitoring costs. His findings highlight a novel substitution effect between public monitoring by supervisors and private monitoring by shareholders.

The effects of bank regulation, supervision and monitoring on bank efficiency are studied using the information from worldwide surveys on banking sector regulations (Djalilov and Piesse 2019). They suggest that the oversight of banking regulations in areas of stringency of capital requirements, supervisory power and market discipline are not sufficiently effective to improve banking efficiency in the transition countries. In their study, they argue that the policymakers and supervisors need to explore the weaknesses of the on-going banking regulations and improve their effectiveness. While doing so they need to take account of the specifications of their institutions as well as business and economic environment.

Kandrac and Schlusche (2019) find that financial institutions that witnessed a reduction in supervision took on much more risk than their counterparts that were subject to identical regulations but unaffected by the change in supervisory attention. From a policy perspective, their findings underscore the importance of supervision per se as a companion to financial regulation in banking policy. They show that allocating sufficient supervisory resources has an important effect on bank behavior and is crucial for optimal banking policy and financial stability.

In more recent years, the debate has been enriched with an additional dimension concerning the geographical allocation of supervisory powers in the context of the European Banking Union and its three pillars Single Supervisory Mechanism (SSM), Single Resolution Mechanism (SRM) and pending European Deposit Insurance Scheme (EDIS), see latest discussions in Ampudia et al. (2019); Carstens (2019). Is the centralized (or supranational) supervision preferable to decentralized (or national) one? What are the relevant trade-offs to consider? These questions are especially relevant for the regulation of the multinational banks (MNBs) that are doing business outside the realm of national bank supervisors (Allen et al. 2011). Home country regulation may affect the risk-taking and lending decisions of banks operating in host countries (Ongena et al. 2013). On the contrary, a national regulator may supervise domestic and cross-border banks differently under its jurisdiction (Beck et al. 2013). Thus, the misalignment of banking structure and regulations can cause a coordination failure between national regulators. The higher degree of unification of supervision power by the central bank independence is an important element in relation between official supervision and bank stability, especially in the crisis period that is emphasized by Doumpos et al. (2015). However, Abad et al. (2020) report a pessimistic reaction of the investors on the EU stock markets. In short term, the idea of supranational supervision among investors decreases value and increases risk for the banking sector.

Our paper also relates to the stream of theoretical literature that is dealing with the analysis of supervision from the point of view of incentives of regulators for example in cross border-banking activities (Beck et al. 2013; Calzolari and Loranth 2011), in presence of variation in charged fees for supervision (Kisin and Manela 2018), analysis of the benefits and costs of the centralized and de-centralized supervision (Näther and Vollmer 2019; Schoenmaker et al. 2011).

3. Empirical methods and dataset

3.1. Identification strategy

Noting the complexity of relationships and interlinks on various levels between policies, supervision and regulations, in our empirical modelling approach, we primarily attempt to find evidence of statistical significance in the causal interactions among the proposed inputs, namely, proxies to supervision attention, measures of supervisory activities and supervision structure. With a goal to establish a potential link among these factors and bank performance, we adopt the empirical methods within the causal interaction approach of the mediation-moderation effect analysis, whereby the enhanced supervisory attention is considered as a treatment effect (T) [3].

First, to quantify the effect associated with supervision monitoring efforts, we introduce in our analysis two proxies which enable us to identify the area of higher attention for the supervision: i) status of too-big-to-fail (TBTF) as a highest ranking on the national level, and ii) capital constrained banks as

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[3] In Appendix A, we outline the economic model of the regulation and supervision, which provides the theoretical argumentation for the enhanced supervisory attention areas and proxies we employ in the empirical methods.

units in the lowest quartile of solvency ratio (CAP_low) in the country. Since the supervisory attention is endogenously related to the current and expected bank performance, it would be naive to relate such proxies of enhanced supervisory attention directly to the bank performance without the problem of misidentification. Therefore, we require some exogenous or instrumental variable that potentially relates to the treatment effect (enhanced supervision attention) but it does not influence directly the outcome. To do so, we make use of the information and data on supervisory monitoring activities on country level provided by the World Bank - Bank Regulation and Supervisory Survey to quantify the effect of supervisory intensity and efforts in respect to certain area of inspection. The external data on supervisory activities serve as a measure of monitoring efforts per country and represents an exogenous variable in continuous form – mediator (M). Under the assumptions, that the survey data on the supervisory activities, regulatory power and capital regulation stringency capture the efforts in enforcement of regulations as an objective measure, we are able to investigate the size of their contribution to the final outcome (risk-adjusted performance) through the treatment effect (supervisory attention).

The identification comes from the modelling of the causal effect in cross-time/cross-country comparison of supervisory monitoring activities in relation to the proxied areas of higher supervisory attention. Simultaneously, we control on the individual bank characteristics and country macroeconomic conditions that can endogenously affect the risk-adjusted performance of the supervised banking institutions. Under the assumption that across all geographies in our sample, the higher supervisory activities and efforts lead to the improvements in an identical manner, we are able to track down how the supervision monitoring efforts affect the final outcome of our interest i.e. economic performance in risk-adjusted terms.

In practice, the assessment of such intermediate effect corresponds to the settings of moderation-mediation analysis (Baron and Kenny 1986; Judd and Kenny 1981). In our case, the variables of the intermediate effect are the statistics and the constructed measures (indexes) of the supervisory activities, regulatory power and capital regulation stringency (mediators M). As a primary econometric method, we employ the mediation analysis approach of Baron and Kenny (1986); Judd and Kenny (1981); MacKinnon (2008) with adaptation to a formal framework of the causal inference (Hicks and Tingley 2011; Imai et al. 2010a). The advantage of such an approach is that it allows researchers to test competing theoretical explanations by identifying intermediate variables or mediators that lie in the causal pathway between the treatment and the outcome. This way it enables us to test competing theoretical explanations and empirically explore the causal mechanisms by identifying and quantifying the contribution of mediators to the treatment effect on the outcome.

Second, because of the geography of our dataset, we consider the assignment to the supervisory regime i.e. Single Supervisory Mechanism (SSM) as exogenous variable moderator (M) in the binary form of a dummy, that indicates if the bank unit is a subject to supranational supervision (SSM) or not. As robustness check of previous results, here we test if the supervision efforts are affected by the state of assignment to the certain supervisory mechanism. The theoretical and empirical findings (Calzolari and Loranth 2011; Näther and Vollmer 2019) indicate that the supervision structure matters for the supervisory monitoring efforts. The centralized or supranational and national supervision differ in terms of acquiring information and in divergent incentives of the regulators e.g. degree of supervisory lenience or regulatory shopping (Ampudia et al. 2019). Furthermore, it is different for supervision efforts contingent on the type of affiliation of bank units. For example, affiliated large subsidiaries of multinational groups or local domestic branches. Thus, we anticipate that the effect of supranational

supervision shall be heterogeneous for the risk-adjusted performance of the larger banks (proxy TBTF) and the units with lower capitalization level (proxy CAP_low).

To test it, we employ the most conventional way of the moderation analysis (Baron and Kenny 1986; Judd and Kenny 1981) with a help of hierarchical multi-regression approach (Aiken and West 1991) and adopted to the causal inference (Imai et al. 2010a). We attempt to grasp a statistical interaction effect from the interaction between continuous and categorical variables, whereby introducing a moderating variable tends to change the direction or magnitude of the relationship between treatment and outcome variables (Hayes 2013).

3.2. Data and variables

To study the economic impact of supervisory monitoring efforts and supervision structure on the economic performance of the banking institutions, we opt for the geographic area of the post-communist CESEE region that is very suitable for testing our theoretical argumentation (see Appendix A). First, we consider the context of the cross-border banking activities which leads to the most heterogeneity in supervision activities and monitoring efforts on the country level. This allows us to capture the magnitude of the differences in supervision efforts on the national level more distinctly. Second, as an additional analysis, we are interested in a separate study of the impact of centralized supervision under the Single Supervisory Mechanism (SSM). Hereby we hypothesize that the SSM has a positive effect in decreasing the information asymmetries, and therefore, it is beneficial for the effectiveness of supervision and risk-adjusted performance of the banks. At last, for the sake of homogeneity in the sample, this geography, in our view, has a comparable size of the economies and banking sectors.

Our sample consists of 450 commercial banks from 20 countries of the CESEE region. The analysis distinguishes between countries: i) inside the Eurozone namely, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia; ii) inside the EU but outside the Eurozone such as Albania, Bosnia and Herzegovina, Kosovo, Macedonia and Serbia, and iii) outside the EU, such as Belarus, Moldova, Russia and Ukraine. The latter category consists of non-EU candidate countries but close to the borders of Eurozone, and these are the third countries mostly represented by former Soviet Union independent states.

The bank-level data are obtained from the database Bank Focus. The data covers a seven-year period from 2012 to 2018 that corresponds to the time after the financial crisis in 2008-2010. It allows us to reduce the effect of changes in economic cycles on the results of the analysis. The data are in the form of annual results since the quarterly information has been very deficient. The data are presented in form of the unbalanced panel and consist of the banks active in regular commercial banking activities. All are banks whose financial statements are available for at least three years during the period 2012–2018. We restrict our sample to the bank units with total assets above one hundred million by the end of the year 2018. Next, the sample is refined by manually checking and removing the bank units that report an error and inconsistent data e.g. due to the changes in consolidation, ownership or undergoing restructuring. To remove the outliers, we windsorize all financial data at the bottom 2.5% and upper 97.5%. Macroeconomic data for GDP growth, unemployment and inflation, as well as market concentration measured by Herfindahl-Hirschman Index (HHI) we acquire from the World Bank World Development Indicators.

3.2.1. The measure of economic performance (outcome variable)

We use several metrics of the economic and risk-adjusted performance taking into account risk, expected return and economic capital. For the robustness check, we use mixed metrics including the pure accounting measure. The primary measure of economic performance is a risk-adjusted return on capital (RAROC). It is commonly employed to assess the profitability of a portfolio in a financial institution taking into account the economic capital, whereby the economic capital is represented in the form of regulatory constraint. In other words, RAROC represents a risk trade-off against benefit in economic terms and in the regulatory interpretation. In the definition of Klaassen and Eeghen (2009), it can be formulated as a ratio of the expected rate of return to the economic capital:

$$RAROC_{it} = \frac{ER_{it}}{EC_{it}},$$

where ER_{it} is an expected rate of return and EC_{it} is an economic capital of the bank unit i at the time period t. The risk-adjusted performance metrics, particularly the expected rate of return ER play an important role in the analysis of the efficiency in the allocation of scarce resources (e.g. capital). However, no consensus exists on how firm-level expected return estimates should be made, or even how to evaluate the reliability of alternative proxies. Given this fact, the estimation techniques chosen by researchers vary widely across studies and mostly dependent on the objective of analysis. In our case, we adopt the approach of proxies Buch et al. (2011); Kang and Poshakwale (2019) and Lee et al. (2019), who specify the implications for estimation in the models of average treatment effect. Their approach is the closest to the goal of our assessment that is the identification using the causal interaction models.

In the prediction property of conditional expectations e.g. Angrist and Pischke (2009), expected rate of return ER has an optimal forecast that captures all ex-ante predictability (on the basis of the available information set) in returns. It can be formulated as follows:

$$ER_{it} = NI_{it-1} + \sigma_i,$$

where the expected rate of return ER_{it} for banking unit *i* at time *t* is its realized profit *NI* plus profit fluctuations σ_i which can vary across the firm and over the observation period. The economic capital EC in the denominator of the ratio is the amount of capital which is needed to secure the survival in a worst-case scenario or potential unexpected losses. That is the capital available to account for credit, market, operational and other risks. Often it is not fully disclosed in financial data by banks, and if disclosed, the comparison between banks is hardly possible. Therefore, we employ a threshold of the minimum required regulatory capital[4]. On the larger scale, here we refer also to a minimum of capital required for the banking sector in the economy to ensure its financial stability without endangering the economic growth. Thereby objective of the banking supervisor is to oversee it to balance the social and economic benefits (Dewatripont and Tirole 1992, 1994). Thus, we work with a common benchmark of minimum capital requirements and calculate the economic capital as risk-weighted assets (RWA) of the banking unit divided over the minimum required regulatory capital (CAR) threshold:

$$EC_{it} = \frac{RWA_{it}}{CAR^{reg\,min}},$$

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[4] The minimum capital requirements may vary slightly across the countries and the period 2011-2016. The exact data for calculation are obtained from the World Bank – Bank Regulation and Supervision Survey (2019), Section 3 "Capital ", Question 3.3.1.

As an alternative, we employ the second metrics of risk-adjusted performance a ratio of return on risk-weighted assets (RORWA). It is an indicator of accounting profit per unit of risk and it can be measured by profit before tax as a percentage of total risk-weighted assets. Both measures are complemented by the classic accounting metrics of the performance of investment that is measured as the ratio of net income to average equity (ROAE), where the average is calculated for two consecutive years.

3.2.2. Measures of supervisory activities (mediators)

To construct the measures of supervisory activities and scrutiny, we use a dataset of statistics on the bank regulatory and supervisory policies as of the end of 2016 from the database of the World Bank-Bank Regulation and Supervision Survey prepared and compiled by Anginer et al. (2019). The survey data provides comparable economy-level data on how banks are regulated and supervised around the world. The most recent survey was started in 2017 and completed in 2019. The data covers the information on bank regulation and supervision for 160 jurisdictions.

We extract the statistics of supervisory activities on country-level that is a basis for the measure of the supervisory activities and monitoring efforts (SUP_EFF). Supervisory activities include information about the number of onsite examinations per bank over 6 years, average man-days per inspection and frequency of onsite inspections for the given period, etc. For supplementary two metrics, we apply the methodology of Djalilov and Piesse (2019) in constructing the indices of "supervisory power" (SUP_POW) and "capital regulations stringency" (CAP_REG). The supervisory power index indicates the power and the authority to take specific preventive and corrective actions, the extent of financial system responsibilities, authorities and their mandate. The index of the capital regulations stringency indicates tougher capital requirements and larger coverage of verifiable risks. The indices are calculated by summing the answers, where "yes" equals 1 and "no" is zero.

The brief description of the supervisory measures is provided below, while the detailed information on indices including the exact survey questions, can be found in Appendix B Table B.1.

(1) *Supervisory activities (SUP_EFF)* are represented by country-level statistics covering the period of 2011-2016. It includes information about the number of onsite examinations per bank over 6 years, average man-days per inspection and frequency of onsite inspections for the given period. The index is a sum of all data in available statistics with the higher score showing higher supervisory activities and efforts.

(2) *Supervisory power (SUP_POW).* This measure indicates whether the supervisory authorities have the power and the authority to take specific preventive and corrective actions; the extent of financial system responsibilities, authorities and their mandate; depth of coverage, etc. This index of supervisory power has a range between 12 and 23. It is reported for each country from the sample. The higher scores indicate higher supervisory power.

(3) *Capital regulation stringency (CAP_REG).* This index shows initial and overall capital regulation stringency ranging between 3 and 12, where higher scores indicate tougher capital requirements and larger coverage of verifiable risks. Initial capital stringency refers to whether the sources of funds (regulatory capital) can include assets other than cash or government securities and borrowed funds, and whether the regulatory or supervisory authorities verify these sources, the type of regimes, type of obligatory risks and metrics subject to obligatory reporting, relevant capital buffers, etc.

3.2.3. Observable characteristics

The proposed proxies of supervisory attention with the highest-ranking and low capitalization implies certain observable characteristics that we ought to take into account by the selection of the relevant covariates. First of all, we control on the asset´s size that is an important determinant of banks' risk and performance since e.g. Demsetz and Strahan (1997) find evidence that larger size bank has an advantage due to the diversification effect. The size is represented by a logarithm of total assets (TAlog). The business model and efficiency are the determining factors of the performance and riskiness of banking operations. For this, we consider relevant metrics such as net interest margin (NIM) and loan volume to total assets ratio (LOANTA) (Kuc and Teplý 2018; Teplý et al. 2015). The funding and liquidity structure are represented by ratios of customer deposits to total liabilities (DLR) and loans to deposits ratio (LDR). LDR ratio (%) is used to assess a bank's liquidity by comparing a bank's total loans to its total deposits for the same period. DLR captures the structure of funding with more safe deposits in comparison to other funding sources. LDR ratio is used to assess a bank's liquidity by comparing a bank's total loans to its total deposits for the same period. If the ratio is too high, it means that the bank may not have enough liquidity. The portfolio quality is captured by the ratio of loan loss provisions to total loans (LLPLOAN). In Table 1 we present a summary of statistics of the variables.

Table 1: Descriptive statistics of variables

Variable	n	Mean	S.D.	Min	Mdn	Max
RAROC	1,603	0.08	0.28	-0.89	0.11	0.67
RORWA	1,603	0.01	0.03	-0.09	0.01	0.08
ROAE	2,610	0.05	0.18	-0.65	0.07	0.41
TBTF	2,759	0.41	0.49	0.00	0.00	1.00
CAP_low	2,325	0.20	0.40	0.00	0.00	1.00
SUP_EFF	3,219	250.53	177.92	22.00	229.25	802.50
SUP_POW	3,219	19.51	3.66	12.00	21.00	23.00
CAP_REG	3,219	10.04	2.13	3.00	10.00	12.00
SSM_ dummy	3,191	0	0	0	0	1
TAlog	2,736	6.82	1.50	4.70	6.55	10.39
DLR	2,758	0.87	0.24	0.00	0.95	0.99
LDR	2,596	0.77	0.27	0.16	0.79	1.47
LLPLOAN	2,509	0.02	0.03	-0.02	0.01	0.14
LOANTA	2,614	0.61	0.19	0.12	0.64	0.96
NIM	1,351	3.38	1.59	0.00	3.25	7.64
GDP	3,219	1.98	2.29	-9.77	2.26	9.04
INF	3,219	4.20	6.28	-1.74	2.85	59.22
UNP	3,219	9.45	6.56	0.50	6.56	35.15
HHI	3,149	1,073	342	450	1,078	2,493
Total number of bank units	450					

Note: The data source is BankFocus Bureau van Dijk and own calculation.

Testing data for skewness and kurtosis

The results of the causal mediation analysis are very sensitive to the distributional qualities of input variables. Therefore, before conducting a baseline regression, and mostly to gauge the reliability of the findings from the causal mediation analysis, it is important to examine the linear relationship of the

dependent and the independent variables. At first, the distributional qualities and linearity were checked visually, by generating density histograms and normal Q-Q plots. To confirm the visual representation, statistical tests for normality were conducted such as the skewness and kurtosis test (D'agostino et al., 1990; Royston, 1991)[5]. The results for skewness/kurtosis for normality were robust for all variables, except a minor case of kurtosis abnormality for the index variable of supervision power (SUP_POW).

Testing data on the multicollinearity

To test for multicollinearity issues in our specifications, the Variance Inflation Factor (VIF) was computed[6]. The results of the test confirm the absence of multicollinearity issues. The results are robust for all variables (i.e. well below the suggested threshold of VIF value of 5).

4. Results

4.1. How the proxies of higher supervisory attention relate to the risk-adjusted performance of the individual banks?

We start with testing how the proxies for a signal to enhanced supervisory attention relate to the performance of the banking units in our sample. To investigate the effect of supervisory structure and efforts on the performance of banking units, we employ the ordinary least square (OLS) time effects regression on panel data as a baseline model:

$$Y_{ict} = \alpha_{i1} + \beta_1 T_{ict} + \xi_1^T X_{it} + \delta' Z_{ct} + \eta_{ct} + \varepsilon_{ict1}, \qquad (1)$$

where i, c, and t denote the bank unit, country and period respectively. Outcome variable Y_{ict} is a performance metrics that is measured by three indicators for the purpose of cross-examination and robustness: i) fully risk-based return on economic capital (RAROC) in the definition of Klaassen and Eeghen (2009); ii) semi-risk based as return on risk-weighted assets (RORWA) that is a ratio of net income to risk-weighted assets (RORWA); iii) pure accounting performance metrics (ROAE) that is a standard accounting measure of return on average equity (ROAE). T_{ict} is a treatment indicator for enhanced supervision. It takes a value 1 if the bank unit belongs to the treated group (e.g. status of TBTF on the national level or with the lowest quartile of the solvency ratio CAP_low) and 0 is assigned to the control group i.e. other remaining units in the sample. X_{it} denotes a set of the specific characteristics of the bank unit i at the period t. The bank characteristics are total assets, funding and liquidity structures, more details are discussed in Section 3.2. Z_{ct} is a set of country-specific variables that capture the macroeconomic conditions for the country c at the period t, namely, the changes in GDP, inflation and unemployment. Following Vozková and Teplý (2018), we incorporate also a market concentration index measured by Herfindahl Hirschman Index (HHI). It is important to notice that the parameters η_{ct} are dummy variables for capturing within the state endogenous variations due to the unobserved country specific and time-invariant effects, and ε_{ict} is the idiosyncratic error.

Table 2 reports the results of the specification of Equation 1. As anticipated, we observe in the sample that the specifications for the larger banks (with a proxy TBTF for a higher supervisory attention) show

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[5] STATA routine "sktest" has been employed for testing data normality.
[6] STATA routine "vif". Test results are available upon request.

a better economic performance in all types of the performance metrics (Columns 1-3), presumably utilizing the economy of scale effect and benefits of diversification. While the capital constrained banks (proxy CAP_low for a higher supervisory attention) indicate poorer performance in risk-adjusted terms (Column 4) and semi-accounting risk adjusted performance (Column 5) most likely due to the less efficient operations or existing defaults.

Table 2: Proxies of higher supervision attention and individual banks´ performance

VARIABLES	(1) RAROC	(2) RORWA	(3) ROAE	(4) RAROC	(5) RORWA	(6) ROAE
TBTF	0.076***	0.007***	0.032**			
	(0.026)	(0.003)	(0.014)			
CAP_low				-0.052**	-0.006**	-0.015
				(0.023)	(0.003)	(0.013)
TAlog	0.057***	0.007***	0.020***	0.062***	0.007***	0.024***
	(0.009)	(0.001)	(0.004)	(0.007)	(0.001)	(0.004)
DLR	0.235	0.027	0.085	0.199	0.022	0.073
	(0.202)	(0.021)	(0.065)	(0.196)	(0.020)	(0.081)
LDR	0.544**	0.069***	0.148*	0.457**	0.059***	0.154
	(0.225)	(0.022)	(0.076)	(0.226)	(0.022)	(0.099)
LOANTA	-0.883***	-0.111***	-0.358***	-0.782***	-0.099***	-0.335**
	(0.273)	(0.027)	(0.107)	(0.274)	(0.028)	(0.131)
NIM	0.043***	0.005***	0.021***	0.043***	0.005***	0.023***
	(0.010)	(0.001)	(0.004)	(0.010)	(0.001)	(0.004)
GDP	-0.005	-0.000	-0.000	-0.007	-0.000	0.000
	(0.009)	(0.001)	(0.003)	(0.009)	(0.001)	(0.003)
INF	-0.013	-0.002*	-0.014***	-0.013	-0.002*	-0.013***
	(0.011)	(0.001)	(0.005)	(0.011)	(0.001)	(0.005)
UNP	0.001	0.000	0.001	0.002	0.000	0.000
	(0.008)	(0.001)	(0.004)	(0.008)	(0.001)	(0.004)
HHI	-0.000**	-0.000*	-0.000*	-0.000*	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.482	-0.066**	-0.079	-0.467	-0.064**	-0.125
	(0.299)	(0.031)	(0.140)	(0.295)	(0.031)	(0.148)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	881	881	1,209	872	872	1,123
R^2	0.302	0.336	0.237	0.298	0.334	0.246
Adjusted R^2	0.274	0.309	0.215	0.270	0.307	0.222
F test	0.000	0.000	0.000	0.000	0.000	0.000

Note: Standard errors robust to heteroscedasticity and serial correlation are shown in parenthesis. FE stands for fixed-effects. Stars indicate statistical significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

4.2. Analysis of the impact of supervision scrutiny on the bank´s risk-adjusted performance

To study an effect of enhanced supervision on the economic performance, we employ the mediation analysis approach of Baron and Kenny (1986); Judd and Kenny (1981); MacKinnon (2008) with adaptation to a formal framework of the causal inference (Hicks and Tingley, 2011; Imai et al., 2010a).

The mediation approach is designed to estimate the role of causal mechanisms that transmit the effect of a treatment variable on an outcome. The regression models are expressed in equations (2), and (3) with the corresponding steps in the calculation of Average of Causal Mediation Effect (ACME):

Step 1: fit the model for the observed outcome and mediator variables and simulate the potential values of the mediator *M:*

$$\widehat{M} = \alpha_{i2} + \beta_2 T_{ict} + \xi_2^T X_{it} + \delta' Z_{ct} + \eta_{ct} + \varepsilon_{ict2} \,, \tag{2}$$

Step 2: simulate the potential outcome given the simulated values of the mediator:

$$Y_{ict} = \alpha_{i3} + \beta_3 T_{ict} + \gamma \widehat{M} + \xi_3^T X_{it} + \delta' Z_{ct} + \eta_{ct} + \varepsilon_{ict3} \,, \tag{3}$$

Step 3: compute quantities of interest (ACME, direct effect, average total effect). In case of a continuous mediator M, binary treatment indicator T and outcome variable Y, the ACME equals to $\beta_3 * \gamma$.

In Equations (2-3) we denote mediator M as a continuous variable of the statistics and indexes on supervisory activities, regulatory power, and capital regulation stringency. The remaining outcome and controls variables are identical to the specification in the baseline model in Equation (1). These are comprised of aggregate controls on the bank-specific, market structure, macroeconomic characteristics, and supervisory structure. The mediation STATA routine[7] is employed to estimate the role of causal mechanisms that transmit the effect of the treatment variable on the outcome.

In Table 3 we report the results of the two-stage regression models in Eq. (2-3), which are presented separately for the first and second regression models for the outcome variable of performance metrics: RAROC. The statistics on the ACME as % of total mediated effect are presented in Table 4. As a robustness check, we ran a similar regression for the two alternative metrics RORWA and ROAE, whereby the final results do not deviate significantly from the main outcome metrics. The first stage regression models for both treatment variables (TBTF and CAP_low) indicate that the values for moderator variable M were fitted well that is observed in the R-squared coefficients up to 0.51-0.65 in columns 1, 3, 4 and 6. The main results from the second stage regression indicate that most coefficients are quite stable across all models (columns 1-6) and in overall re-iterate the baseline regression in Eq. (1), which implies that the treatment did not absorb the effect of mediation fully. The coefficients for the mediator variables of the supervisory effort and activities (SUP_EFF) do not show any statistical significance (Column 1 and 4) that can be interpreted it as the intensity of monitoring activities (audits, inspections, etc) does not affect the risk-adjusted performance in areas of higher supervisory attention (coefficients 0.000 in Columns 1 and 3). In other words, it is beneficial for the risk-adjusted performance of the larger institutions, since the supervision activities do not reduce the economic benefit, but on the other hand, they are not associated with the economic performance for the capital constrained banks either.

Table 3: Results of the regression models Eq (2-3) on the outcome variable RAROC

	(1)	(2)	(3)	(4)	(5)	(6)

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[7] Procedure "medeff" and "medsens", see detailed description in Hicks and Tingley (2011)

VARIABLES	TBTF SUP_EFF	TBTF SUP_POW	TBTF CAP_REG	CAP_low SUP_EFF	CAP_low SUP_POW	CAP_low CAP_REG
First stage (outcome mediator)						
TBTF	-144.137***	-1.773***	-0.546***			
	(10.189)	(0.171)	(0.075)			
CAP_low				-92.364***	-1.718***	-0.536***
				(13.673)	(0.225)	(0.094)
	Other controls coefficients are omitted from reporting					
R-squared	0.518	0.230	0.654	0.470	0.210	0.643
Adjusted- R^2	0.511	0.219	0.649	0.462	0.198	0.638
Second stage						
TBTF	0.142***	0.149***	0.146***			
	(0.038)	(0.038)	(0.038)			
CAP_low				-0.102***	-0.096***	-0.100***
				(0.029)	(0.029)	(0.029)
SUP_EFF	0.000**			0.000**		
	(0.000)			(0.000)		
SUP_POW		-0.017***			-0.015***	
		(0.004)			(0.004)	
CAP_REG			-0.034***			-0.030***
			(0.011)			(0.010)
Constant	-0.534***	-0.241	-0.208	-0.557***	-0.297*	-0.266
	(0.185)	(0.189)	(0.199)	(0.175)	(0.179)	(0.189)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	845	845	845	834	834	834
R^2	0.149	0.162	0.155	0.142	0.153	0.146
Adjusted- R^2	0.131	0.144	0.137	0.124	0.134	0.128
F test	0.000	0.000	0.000	0.000	0.000	0.000

Note: Standard errors clustered at the country level are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

In the category of the mediator variables of the capital regulation stringency (CAP_REG) and supervision power (SUP_POW), the coefficients in Columns 2,3,5 and 6 exhibit statistical significance (coefficients from -0.015 to -0.034) for both treatment variables TBTF and CAP_low. This suggests that the capital regulation stringency and the rule enforcement, for example through preventive and corrective actions or larger authority and mandates, contribute significantly to the effectiveness of supervision in areas of higher attention. For the larger banks, they slightly reduce positive effect on performance (coefficients with a negative sign in Columns 2, 3), while for the capital constrained banks they contribute to the improvements in economic performance (coefficients in Columns 5,6 also with negative sign). Alternatively, the statistical evidence could point to the presence of the positive *effect of substitution* of private monitoring (e.g. costs for internal banks audits) by public monitoring (Bisetti, 2020). The statistical strength of the present mediation effect can be assessed by observing the calculated estimates of Average Causal Mediation Effect (ACME) and percentage of total effect mediated in Table 4. The estimates of ACME indicate the average effect of the treatment variable on the outcome that operates through the mediator.

Table 4: Average Causal Mediation Effect (ACME) on the outcome variable RAROC

Panel A: TBTF

Effect	SUP_EFF			SUP_POW			CAP_REG		
	Mean	[95%	Conf. Interval]	Mean	[95%	Conf. Interval]	Mean	[95%	Conf. Interval]
ACME	**-0.036**	-0.052	-0.021	**0.015**	0.007	0.026	**0.010**	0.003	0.019
Direct Effect	0.099	0.058	0.139	0.048	0.008	0.086	0.053	0.014	0.092
Total Effect	0.063	0.024	0.103	0.063	0.025	0.101	0.063	0.024	0.101
% of Total Eff mediated	**-0.568**	-1.412	-0.341	**0.246**	0.154	0.621	**0.158**	0.098	0.399
Panel B: CAP_low									
	SUP_EFF			SUP_POW			CAP_REG		
Effect	Mean	[95%	Conf. Interval]	Mean	[95%	Conf. Interval]	Mean	[95%	Conf. Interval]
ACME	**-0.018**	-0.032	-0.006	**0.022**	0.011	0.036	**0.013**	0.005	0.024
Direct Effect	-0.025	-0.073	0.022	-0.065	-0.112	-0.019	-0.056	-0.103	-0.010
Total Effect	-0.043	-0.091	0.003	-0.043	-0.089	0.003	-0.043	-0.090	0.002
% of Total Eff mediated	**0.398**	-1.187	2.661	**-0.485**	-3.494	1.391	**-0.282**	-2.145	0.948

Note: in this table, we report a summary of results for the dependent variable RAROC, while the detailed results of the first and second stage regressions are presented in Table 3. ACME is equivalent to $\beta_3 * \gamma$ in Eq. (3)

In Panel A and Panel B, in Table 4 we exhibit the estimates separately for the two types of the treatment variables of supervisory attention: TBTF and CAP_low. In Panel A, for the treatment variable (TBTB), the ACME coefficients for the mediator (SUP_EFF) up-to -0.036 and percentage of total effect mediated (coefficient -0.57) signify that mediation effect has not been absorbed totally by treatment effect. In other words, we observe that the intensity of supervision activities does not affect economic performance but is associated with lower riskiness, particularly for larger banks. The calculated ACME for mediator variables of supervision power (SUP_POW) and capital stringency (CAP_REG) for the larger banks (TBTF) has a minor contribution to the total effect (with coefficients 0.015 and 0.010 respectively) and the total percentage of contribution to total treatment effect up-to 0.25.

In Panel B, for the category of the lower capitalized banks (CAP_low) the results point to the slightly positive effect of supervisor activities (SUP_EFF) with a coefficient (up-to 0.018). At the same time, we observe a significant contribution of both mediator's supervisory power SUP_POW (0.022) and capital stringency CAP_REG (0.013) to the risk-adjusted performance (outcome) through the enhanced supervision attention, with the contribution to total treatment effect (up-to 0.49). It implies that these two supervisory measures are effective for the capital constrained banks and overall bring positive economic benefits accompanied with a reduction in riskiness.

4.3. How the supervision structure affects the results?

Our dataset represents banking institutions located both in EU and non-EU countries. Financial institutions in the EU are generally subject to centralized or supranational supervision under the Single Supervisory Mechanism (SSM) and recently introduced Single Resolution Mechanism (SRM). Non-EU countries are supervised primarily by national regulators, with some individual arrangements in place for the supervision of large and systemic important subsidiaries of the multinational banking group. These are primarily negotiated within the frame of separate agreements with European Central Bank

and Vienna Initiative, particularly in the case of the countries of Southern Europe and the Balkan region. These arrangements should serve as a financial stability tool to prevent national and EU economies from negative spill-over effects and externalities.

While a number of theoretical studies provide economic and stability arguments for and against the centralized or decentralized form of supervision, most agree that the structure affects the supervision activities, for example, in a case of the cross-border banking activities (Beck et al. 2013), in presence of variations in charged fees for supervision (Kisin and Manela 2018), by regulatory forbearance (Ampudia et al. 2019). Therefore, we perform a separate analysis to explore the effect of the supervision structure on the findings from the previous model.

We adopt a hierarchical multi-regression approach of Aiken and West (1991) for the estimation of the moderation effect, which we believe, can capture the full effect of the inclusion of supervision structure. In modelling terms, it has a direct influence on both sides of the equation, on the outcome and the treatment variable simultaneously. A common approach to moderator analysis is based on multiple regressions, where we test the impact of different variables alone and together with interactions by determining whether their coefficients significantly differ from zero (Baron and Kenny 1986). In our case, we are interested in the investigation of the size of the effect of supervision structure to the final outcome Y (performance) through the treatment effect T (supervisory attention). The variable of intermediate effect (or moderator M) is a binary variable indicating whether the bank unit belongs to the country under the centralized supervisory regime (e.g. SSM) or not. The simple moderation model employed in the study is formally expressed as a series of regression equations:

$$Y_{ict} = \alpha_{i1} + \beta_1 T_{ict} + \xi_1^T X_{it} + \delta' Z_{ct} + \eta_{ct} + \varepsilon_{ict1}, \tag{4}$$

$$Y_{ict} = \alpha_{i2} + \beta_1 T_{ict} + \beta_2 M_{ct} + \xi_2^T X_{it} + \delta' Z_{ct} + \eta_{ct} + \varepsilon_{ict2}, \tag{5}$$

$$Y_{ict} = \alpha_{i3} + \beta_1 T_{ict} + \beta_2 M_{ct} + \beta_3 (T \cdot M)_{ict} + \xi_3^T X_{it} + \delta' Z_{ct} + \eta_{ct} + \varepsilon_{ict3}, \tag{6}$$

where X denotes a set of bank-specific characteristics related to the treatment effect (enhanced supervisory attention) with the indexes of unit i, time period t and country c. The specification includes macroeconomic and market controls all identical to the ones applied in the Eq (1). If the coefficients of β_1 and β_3 in the Eq (3-4) are non-zero and statistically significant, then the existence of the moderation effect can be confirmed. The interpretation of the estimates of β_1 and β_3 holds greater relevance for the moderation model. In testing the size of the moderation effect, the aim is not just to confirm that treatment T causes Y contingent on moderator M, by controlling on a set of confounders X, but also to determine whether β_3 deviates far from zero or not.

Table 5 reports the results of the hierarchical linear regressions in Eq. (4-6) on the outcome variable RAROC. For the category of the treatment indicator "too-big-too-fail" (TBTF) in the models (2-3), the estimates of β_1 and β_3 are significant and $\beta_3 \neq 0$. The results confirm the presence of a moderation effect of the supervision structure through the treatment effect (a signal for supervisory attention) on the outcome. By adding the interaction to the regression model (3), we observe that the explanatory power of the regression model does not strengthen, with a negligible increase in values of the adjusted

R^2 from 0.274 to 0.276. For the treatment indicator of the signal for supervisory attention such as a lower quartile of capitalization (CAP_low), we observe a weak association and the absence of the moderation effect. The estimate β_3 shows no statistical significance in Model (6), while the estimate of β_1 in Model (4-5) indicates a significant statistical power (-0.052**) at a 95% confidence interval. No changes in values of standard R^2 and adjusted R^2 in models 4, 5 and 6 confirm the absence of such effect too. These findings indicate that the supervision structure (i.e. centralized or de-centralized supervision of SSM) matters only for the category of the larger banks (TBTF) on the country level in the CESEE region.

The centralized supervision scrutiny does not affect their performance, while seemingly it is associated with lower risk in this category of the bank institutions. For the bank units in lowest capitalization category (CAP_low), we find no statistical evidence that the supervisory structure contributes in any way to the effectiveness of the supervisory efforts ultimately leading to improvements in risk-adjusted-performance.

Table 5. Results of the moderation analysis for the outcome variable RAROC

VARIABLES	(1) TBTF	(2) TBTF _SSM	(3) TBTF _SSM	(4) CAP_low	(5) Cap_low _SSM	(6) Cap_low _SSM
TBTF	0.076***	0.076***	0.144***			
	(0.026)	(0.026)	(0.045)			
TBTF x M			-0.101*			
			(0.052)			
CAP_low				-0.052**	-0.052**	-0.048
				(0.023)	(0.023)	(0.048)
CAP_low x M						-0.004
						(0.055)
M		-0.179	-0.132		-0.143	-0.143
		(0.122)	(0.124)		(0.122)	(0.122)
Constant	-0.661***	-0.482	-0.539*	-0.611**	-0.467	-0.466
	(0.242)	(0.299)	(0.301)	(0.237)	(0.295)	(0.295)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	881	881	881	872	872	872
R^2	0.302	0.302	0.305	0.298	0.298	0.298
Adjusted R^2	0.274	0.274	0.276	0.270	0.270	0.269
F test	0.000	0.000	0.000	0.000	0.000	0.000

Note: Standard errors are shown in parenthesis robust to heteroscedasticity. FE stands for fixed-effects. Stars indicate statistical significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.10$.

4.4. Implications for future research

In essence, this analysis attempts to provide an initial view and is not intended to draw an explicit conclusion about the positive or negative nature of the causal relationships between supervisory activities, proposed proxies for the supervisor's attention and the outcome. So that a finding of the statistically significant evidence, helps us to identify the existence of the link between supervisory activities, supervision structure and risk-adjusted performance. Thus, it contributes to analysis of the regulatory scrutiny of banking supervision on the safety and soundness of the banking institutions in

the CESEE region. In this attempt, the study contributes to the growing body of literature, but it has also its limitations.

The effects of supervision on bank economic performance can be ambiguous for several reasons. In case of the supervision function lies within the responsibility of national central bank, then the interaction between monetary and prudential policies can have conflicting nature between the objectives of price and financial stability. It has implications for the supervision-performance relations. If the central supervisor is tougher than the local supervisor, for instance by imposing higher capital requirements for riskier but more profitable activities, then the banks' profitability may decrease over the short term. However, a certification effect arising from tougher supervision could allow banks to borrow at lower rates from foreign creditors, which would increase profit margins (Ampudia et al., 2019).

This paper leaves some important questions unanswered and therefore, provides a fruitful ground for further research. By conducting the analysis for the proxy TBTF that is represented by a group of the larger banks, the supervision structure can be vaguely defined in the form of binary indicator. In non-EU countries of the CESEE region, the banking sector is dominated by large and systemic important subsidiaries of the multinational banking groups and therefore there are individual arrangements in place for the supervision on a supranational level. A more strictly supervised bank may manage its assets better, as it benefits from the extra expertise of bank examiners. More comprehensive analysis has to be performed to get more insight into this matter. Studying the impact for two categories of enhanced supervisory attention can be extended into the further dimensions: liquidity, balance sheet structures or business models. On the other hand, the supervision governance structures can be also explored in further empirical studies to this topic.

5. Sensitivity analysis and robustness results

In this section, we perform sensitivity analysis as a robustness check of the results of the mediation analysis presented in Section 4.2. Sensitivity analysis allows us to state how an estimated quantity would change by the different degrees of violation of the key identification assumption of the causal mediation inference that is a Sequential Ignorability (SI) (Imai et al., 2010b). When linear models are used for the mediator and outcome variables, there might be concern about the functional form of the structural equations. The sensitivity analysis is based on the linear structural equation models in Eq. (2 and 3). Here a violation of the SI assumption leads to a higher correlation between ε_{ict2} and ε_{ict3}. Therefore, we test the parameter Rho[8] that explains a percentage of correlation between errors with a higher value indicating larger violation of SI. The summary of results is presented in Table 6 with corresponding graphs in Appendix Figure B.1. In Models (1-6), the Rho values are within the acceptable norm (well below 1.00) and thus it confirms that the results of main specification in Eq. (2 and 3) are robust and not distorted by strong violation of the SI assumption.

Table 6: Results of the sensitivity analysis

	TBTF			CAP_low		
Sensitivity results	SUP_ EFF	SUP_ POW	CAP_ REG	SUP_ EFF	SUP_ POW	CAP_ REG

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[8] ρ can be expressed as a function of the proportions of previously unexplained variances in the mediator and outcome regressions. More detailed about the sensitivity analysis can be found in the mediation analysis methodology description (Imai et.al 2010a; 2010b).

	(1)	(2)	(3)	(4)	(5)	(6)
Rho at which ACME = 0	0.1678	-0.1372	-0.104	0.1096	-0.1672	-0.1265
R^2_M*R^2_Y* at which ACME = 0:	0.0282	0.0188	0.0109	0.012	0.028	0.016
R^2_M~R^2_Y~ at which ACME = 0:	0.0115	0.0119	0.0033	0.0054	0.0179	0.005

Note: The results are reported for 95% confidence interval

6. Conclusion

In this paper, we investigate the effects of the supervision scrutiny and monitoring efforts on the risk-adjusted performance of the banking institutions in Central, Eastern and South-Eastern Europe in post-crisis period 2012-2018. The institutional settings of foreign-bank dominated financial systems make this region unique in comparison to the other regions. Despite a large amount of attention to the topic of supervision architecture and its importance for financial stability in the EU, the empirical support for the investigation of the supervision-performance relation has been scarce so far.

This study attempts to address this issue and contribute to the literature in several respects. First, building on broad concept of supervision and theoretical framework (Dewatripont and Tirole 1994; Eisenbach et al. 2016), we lay out the conceptual framework for empirical strategy. Second, we test it by employing a novel methodology of the causal interactions within the mediation-moderation analysis. This allows us to mitigate the endogenous relation between supervision and performance. Similar to the findings of Hirtle et al.(2020); Rezende and Wu (2014), we document a positive causal effect of supervision on the bank performance. The supervision activities reduce the riskiness of the bank's assets without negatively affecting the economic performance. However, we observe that this effect is heterogeneous between the large systemically important institutions and capital constrained banks in the region.

Our findings suggest that a higher intensity of supervision activities contributes to the decline of the riskiness of the larger banks while not affecting their economic performance. For the measures of the capital regulation stringency and supervisory power in the enforcement of regulations, we find that these subtract slightly positive effect on the economic performance for the larger and systemic important institutions. However, for the capital constrained banks, they contribute positively to the economic performance in risk-adjusted terms through the higher supervision attention.

The moderation analysis shows that the supervision structure (i.e. national or supranational of SSM) matters mostly for the larger banks with a status "too-big-to-fail" (TBTF) in the region of our interest. Seemingly, the supervision scrutiny does not affect their performance, while it is associated with lower riskiness. On the contrary, it is irrelevant for the bank institutions with a lower capitalization which in turn raise the importance of the supervision on the national level.

The findings of our study highlight the potential areas of attention for national regulators and supervisors and therefore, contribute to designing an effective supervision mechanism in the CESEE region. In particular, they are relevant for the supervision of the largest subsidiaries of multinational banking groups that constitute a major portion of the systemic important banks in the national economies of the region.

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8. Appendices

8.1. Appendix A

The economic model of supervision

In this section, we outline a simple economic model in the spirit of the incomplete contract approach of Dewatripont and Tirole (1994, 1992); Laffont and Tirole (1986). The purpose of this conceptual part is to lay out the components of the regulation and supervision and present them in economic terms. These provide a basis for the development of our empirical strategy and substantiate the proposed proxies for enhanced supervisory attention that we employ for disentangling the intermediary effects of supervision activities.

The simplified balance sheet of financial intermediary at each time *t=0… N* includes assets A_t, deposits D_t and equity E_t . The deposits D_0 and equity E_0 are used to finance initial assets $A_0 = D_0 + E_0$ (to simplify we assume that all assets consist of loans). The loan quality can be improved, but it requires the efforts *e* to the manager at fixed costs. The efforts are observable only to managers. Contingent on the first-period repayment of the loans, the control right is allocated. At the beginning of *t=1,* the bank manager decides on whether or not to make an effort to improve the quality of the loans. Next, two pieces of information (u, v) are revealed to the world. A first repayment v is obtained, and correspondingly v denotes an observable and verifiable performance of assets. The second is a signal u that reflects the value of assets not realized at date *t=1*, which will have a potential future random value η on at date *t=2.* Both signals u and v and are independent. After observing u and v the controlling party (e.g. supervision authorities) decides if the bank will continue to operate, namely action *C* for "continuing" or if it will be restructured, action *R* for "restructuring or intervention". Cumulative distribution of η conditional on the signal u and the action $\tilde{A}$ is $H_A(\eta|u\,)$, where $\tilde{A} \in \{C, R\}$.

At date *t=2*, a bank final profit is realized in period *t=2*, then η is observed and correspondingly the liquidation value equals to $v + \eta$. Hereby, it is important to mention that action $\tilde{A}$ is noncontractible, therefore the determination of the controlling party at *t = 1* will be crucial. It is a role of the solvency regulation (Freixas and Rochet, 2008). The expected net profit (P) from continuing (C) instead of stopping or reorganizing (R) after the first period is defined as:

$$P(u) = E(\eta|u, C\,) - E(\eta|u, R\,)$$

Where the first right-hand term indicates expected profit in case of continuing and the second in case of reorganizing (or stopping). A manager's effort depends on the banking authority´s decision on interference at *t=1*. The expected profit will, therefore, be:

$$P(u) = \int_0^\infty \eta \, dH_C\,(\eta|u) - \int_0^\infty \eta \, dH_R\,(\eta|u)$$

Under the plausible assumption that $P(\cdot)$ is increasing, it is implied that it is optimal to close or reorganize the bank if $u \leq \hat{u}$ is below a critical value $\hat{u}$, by the threshold $P(\hat{u}) = 0$, and to allow it to continue if $u \geq \hat{u}$. Note, that this is the ex-post efficient closure rule. Ex-ante, the optimal closure rule intends to affect the manager's behavior at date *t=1* in such a way that a high effort level is chosen. Thus, we can conclude that in a situation of asymmetric information, a manager's effort is influenced by the policy that he/she expects from the external regulator or supervisory authorities.

Therefore, we hypothesize that the increased scrutiny or audit from the side of supervisory authorities incentivize bank managers to better monitoring efforts that ultimately lead to the decrease in the assets riskiness while at the same time it does not affect the bank's performance. A finding of evidence of a positive intermediate effect on shareholders' value (or as in our case, the economic performance proxied by risk-adjusted return on capital) could also suggest a presence of "substitution effect" (Bisetti, 2020) between the public monitoring (by regulators) and private monitoring (by shareholders).

Conceptual framework of supervision and proxies for higher supervisory attention

In constructing the proxies for a signal to the enhanced supervisory scrutiny, we closely follow the conceptual framework of Eisenbach et al. (2016). The theoretical argumentation suggests that under conditions of asymmetric information, a manager's effort is influenced by the policy that the manager expects from the regulator. The regulators exercising the supervision role can collect information about bank's actions or management efforts through costly monitoring leading to an interim signal that represents an incentive for supervisory correction actions. In differentiating supervision from regulation, (Eisenbach et al., 2016; Laffont and Tirole, 1993) posit that the regulation can only be contingent on verifiable information e.g. financial reporting data. In its purest form, regulation is written into law and can be enforced through courts, and thus it requires *verifiability* (Laffont and Tirole, 1993; Schwartz, 2000). In contrast to regulation, the supervision has a discretional nature and only requires *observability*. In case, where the observability fails, it is still possible to collect information by utilizing the higher supervisory monitoring effort, for example in form of frequent onsite inspections and higher intensity of audits (or more man-days per inspection). The bank's balance sheet variables *A (assets)*, *D (deposits)*, *E(equity)* can be thought of as verifiable information so that the regulation can impose ex-ante constraints on the balance sheet. For example, a capital regulation that requires to maintain a minimum ratio *k* between equity capital and assets, $E/A \geq k$. Besides, in analysing how a closure policy can be used to induce a bank manager to make an effort to improve the quality of loans, Dewatripont and Tirole (1994) conclude that the financial structure of banks (solvency) matters for an optimal closure or reorganization policy.

Since the recent financial crisis and the introduction of Basel III accord, the main focus of supervision has moved from sole *microprudential* supervision to complementing it with a *macroprudential* dimension designed to address systemic risk. The systemic risk is captured not only in the default risk of a single bank but also takes into account systemic effects such as spillovers of defaults on other banks and across economies (Acharya et al., 2012; Brownlees and Engle, 2017). Hence, beside the described above microprudential goal for a supervisor i.e. the solvency of the individual bank, there is a need to account for spillover effect of bank failures in the economy. The banking authority values payoffs to the bank and including its creditors, it can be formulated as *(Ar − D) + D = Ar*, where *r* denotes a return on assets. The negative effect of spillovers can be captured in the form of *(Ar−N(A)) < 0*. In this sense, the size of such an effect is directly dependent on the size of the institution in relation to the economy and the total banking sector. To formalize these areas of higher attention to supervision, we propose the following proxies from the point of view:

(1) *macroprudential* - "too-big-to-fail" (TBTF) that is represented by three largest banks by assets size i.e. the highest ranking on a single country level. On an individual bank level, the TBTF status is aligned with the definition of a large bank according to the World Bank statistics. The large bank is defined when the total assets account for larger than 20% of national GDP;

(2) *microprudential* - the lowest quartile of the solvency ratio (CAP_low) among the peers on the single country level.

8.2. Appendix B

*Table B.1: Information on regulatory and supervisory variables*

Type of Supervisory and Regulation Measures	Source and quantification	Questions
Supervisory Activities (SUP_EFF)	The variable is calculated by summing up the data in the questions.	12.23 How many onsite examinations per bank were performed in the last 6 years (2011-2016)? 12.23.1 What was the average man days per inspection? 12.23.2 How frequently are onsite inspections conducted in a year in the 10 largest banks by asset size?
Supervisory Power (SUP_POW)	The variable is calculated by summing up the answers scores. Yes = 1; No = 0	12.4.1 Which of the following financial system responsibilities does the mandate also include? Q12_4_1a_2016 a. Macroprudential Supervision Q12_4_1b_2016 b. Market conduct Q12_4_1c_2016 c. Consumer protection Q12_4_1d_2016 d. Prevention of financial crime (anti-money laundering / combating financing of terrorism) Q12_4_1e_2016 e. Competition/antitrust policy Q12_4_1f_2016 f. Financial market access/development Q12_4_1g_2016 g. Deposit insurance Q12_4_1h_2016 h. Bank restructuring/resolution 12.3 Are there any deposit taking institutions that are not under any prudential supervision? 12.4 Does the banking supervisory agency have a specific mandate set out in written form? 12.5 Can the banking supervisory authority force a bank to change its internal organizational structure? 12.12 Can individual banking supervisory staff be held personally liable for damages to a bank caused by their actions or omissions committed in the good faith exercise of their duties? 12.13 Can the supervisory agency be held legally liable for damages to a bank caused by its actions? 12.14 Is a formal consultation process with the industry and the public required prior to the introduction of new regulations? 12.15 If an infraction of any prudential regulation is found in the course of supervision, must it be escalated (i.e., reported to higher levels)? 12.16 Are there mandatory actions that the banking supervisor must take if an infraction of any prudential regulation is found? 12.20 Is the intensity and frequency of supervisory activities explicitly linked to the bank's risk rating? 12.21 Is the risk rating disclosed to the bank's Board? 12.25 Is the banking supervisor responsible for macroprudential supervision? 12.25.1.1 Is there a specialized department in the banking supervisor dealing with financial stability and systemic supervision? 12.27 Does the banking supervisor conduct stress test as part of the process of assessing systemic stability?

		12.27.1 At what level are stress tests performed? a. At the bank level b. At the system wide level c. Other 3.6.1 Do you require banks to perform an internal assessment of their capital adequacy against their eco0mic capital (i.e., the economic capital is computed by banks according to their own internal assessment of the true amount of capital needed to cover overall risk exposures)? 3.6.2 Do you review the internal assessments performed by banks? 3.7 Does the banking supervisor have the legal authority to require banks to hold "higher capital levels" than the minimum required if deemed necessary? 3.8 Does the banking supervisor have the legal authority to require additional capital for Pillar 2 risks (e.g., interest rate risk in the banking book, business and strategic risk)?
Capital regulations stringency (CAP_REG)	The variable is calculated by summing up the answer scores. Yes = 1; No = 0	3.1 Which regulatory capital adequacy regimes did you use as of end of 2016 and for which banks does each regime apply to (if using more than one regime, select all regimes currently in use)? In the space provided below each option please specify which bank types - commercial banks, state-owned commercial banks, state-owned development banks, mutual banks, foreign banks, bank-holding companies - fall under which regime. a. Basel I (please specify for which bank type) b. Basel II (please specify for which bank type) c. Basel III (please specify for which bank type) d. Leverage ratio (please specify for which bank type) 3.11 What variants are offered to banks in calculating capital requirements for credit risk? a. Simplified standardized approach (SSA) b. Standardized approach (SA) c. Foundation internal ratings-based approach (F-IRB) d. Advanced internal ratings-based approach (A-IRB) 3.13 Do you have in place capital conservation buffers? 3.14 Do you have in place a countercyclical capital buffer? 3.18 Are off-balance sheet items included (in notional amounts using credit conversion factors) in assets when calculating the leverage ratio? 3.2 Which risks are covered by the current regulatory minimum capital requirements in your jurisdiction? Please select each risk that applies. a. Credit risk b. Market risk c. Operational risk d. Other risks (please explain)
Minimum Capital Requirements per Country (2011-2016)		3.3.1 What was the minimum required risk-based regulatory capital ratio (i.e., as a percent of risk-weighted assets) as of the end of the year …?

Source: The World Bank - Bank Regulation and Supervisory Survey (2019)

Figure B.1: Sensitivity analysis

The graphs depict the sensitivity parameter ρ for two categories of treatment variable: TBTB (Too-Big-To-Fail) and CAP_low (lowest quartile of solvency ratio) and mediator variables: SUP_EFF (supervisory activities), CAP_REG (capital regulations stringency) and SUP_POW (supervisory power) respectively.
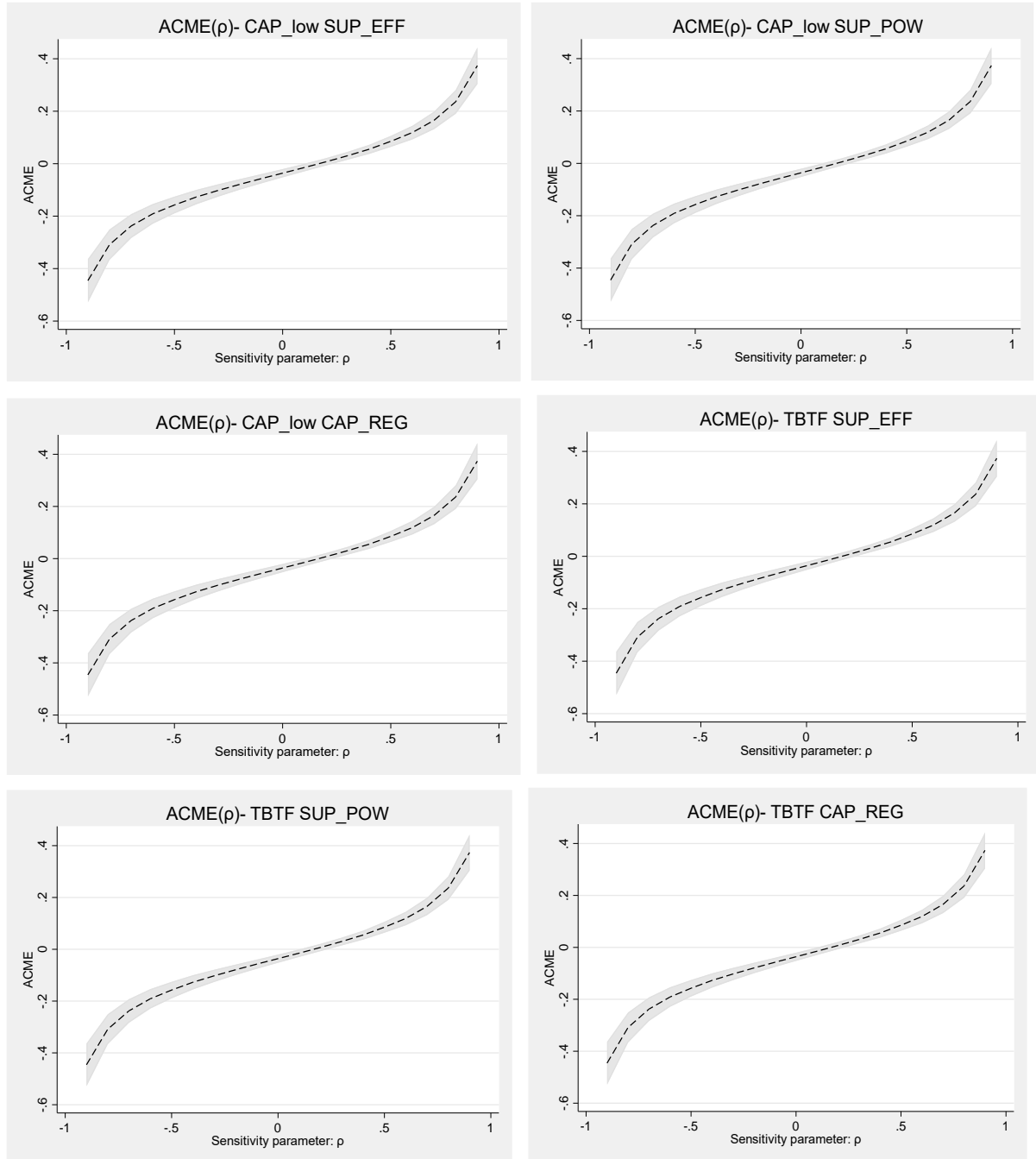
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