Bank regulation and efficiency:
Evidence from transition countries

Abstract

Given the nascent nature of banking sectors in transition countries and their unique institutional settings, this paper documents the effects of regulation on the efficiency of banks using system GMM and dynamic panel quantile regressions for 21 transition countries for the period 2002-2014. Within the system GMM estimation the paper finds bank activity restrictions to be the only regulation improving banking efficiency in these countries. However, the dynamic panel quantile results show that the regulation has different effects at different quantiles. This study provides important policy implications related to banking regulation in transition economies.

Keywords: Banking; Regulation; Transition Economies;

JEL classification: G21; G28; P30

1. Introduction

The literature on the finance-growth nexus consistently highlights the importance of a well-functioning financial sector for economic growth (e.g. King and Levine, 1993). Banking plays a key role in the financial sectors of developing countries and emerging markets, however, this research findings indicate that the observed high growth rates are unlikely to continue in the long term without major banking reform in these countries (Berger et al., 2009). But banking reform is not always effective and banks may not always contribute to economic growth. In particular, the severe impacts of the global financial crisis (2007-2009) have cast doubt on the benefits of on-going regulation in these banking systems.

Over the last two decades regulation has become a dominant area for banking research, most notably, the investigation of the effect on stability, efficiency and performance. The availability of cross-country data on banking regulation from the World Bank and the IMF has provided an opportunity for researchers and policymakers to explore the impact of regulation under various institutional environments (Gaganis and Pasiouras, 2013). However, the research examining the impact of regulation on banking efficiency has received relatively less attention. Moreover, there is no evidence of how regulation may affect efficiency in the banking sectors of transition countries over the last two decades. Indeed, only two studies, Fries et al. (2005) and Grigorian and Manole (2006), explore the impact of banking reform and regulation on efficiency in transition countries during the 1990s. However, these studies are limited in three respects. They poorly represent the former Soviet Union (FSU) countries, they tend to use old data (1994-2001 and 1995-1998 respectively), and they do not extensively investigate the efficiency effects of activity restrictions and the pillars of the Basel accords. Such omissions are significant considering that regulation is likely to affect banking sectors differently, depending on their economic and

institutional environment. This is important as many transition countries have integrated into the EU and their contribution to the world economy has increased over the last two decades. Indeed, the nature of the banking sector within these countries has changed significantly over this period.

Thus, the purpose of this paper is to contribute to the literature on banking in the countries of Central-Eastern Europe (CEE), South-Eastern Europe (SEE) banking and the FSU over the period 2002-2014. This is interesting from both a theoretical and policy perspective. In particular, the predictions of scholars on the effects of bank regulation are contradictory, despite the topic attracting significant attention following the global crisis (2007-2009). In addition, there is no strong evidence to suggest that the best system of banking regulation is effective universally, given the unique conditions of the transition countries (Ayadi et al., 2016; Barth et al., 2006). Over the last three decades, the CEE, the SEE and the FSU countries have undergone significant and complex reforms following both the collapse of the Soviet Union, and the global financial crisis. These include establishing a system of financial intermediation and consolidating their banking sectors as a result of privatization, liberalization and foreign direct investment from the West.

This study contributes to the existing literature in several respects. Firstly, it extends the studies by Pasiouras (2008), Pasiouras et al. (2009), Chortareas et al. (2012), Barth et al. (2013) and Gaganis and Pasiouras (2013) in several ways. It includes the periods pre and post crisis; it takes a system GMM approach to consider the importance of the dynamic nature of bank performance variables as well as the endogeneity of some important variables; and finally it uses dynamic quantile regression to investigate the heterogeneous efficiency effects of regulation. Secondly, this study provides more detailed aspects of the efficiency effects of bank regulation specifically in transition countries and examines them separately

from other emerging and advanced countries. In addition, this study includes the majority of the transition countries in the CEE, the SEE and the FSU some of which have been ignored in previous research. Using a sample of 319 banks from 21 transition countries over the period 2002-2014, we examine the effects of regulation on bank efficiency while controlling for various bank-, industry- and country-specific characteristics. We consider *Activity restrictions*, *Capital requirements*, *Market discipline* and *Supervisory power* from the World Bank's surveys on Bank Regulation and Supervision as bank regulation. The results show that *Activity restrictions* appear to be the only regulation that improves banking efficiency within the system GMM context. In addition, the dynamic panel quantile results indicate that regulation has different efficiency impacts at different quantiles. Finally, the banks in transition countries appear to be less efficient over the crisis period (2007-2009), but they become more efficient over the post-crisis period (2010-2014). These findings are robust across various specifications.

The remainder of the paper is organized as follows. Section 2 provides a discussion of why transition economies are different from either developing or emerging countries. Section 3 presents the theoretical foundations of the paper and develops testable hypotheses. Section 4 describes the data and variables. Section 5 presents the empirical models and discusses the results and Section 6 concludes.

2. Characteristics of Transition Economies

The Institutional Difference Hypothesis (IDH) is well established in the literature to compare institutional differences in advanced and emerging economies (Julian and Ofori-dankwa, 2013). The hypothesis states that the institutions that support the efficient functioning of product, capital and labour markets are missing in emerging economies compared to those in

advanced countries (Khanna and Rivkin, 2001). In addition, the IDH suggests that differences in institutions create unique conditions that influence desirable business activities and strategies (Guillen, 2000; Scott, 1995). Since the conditions in emerging countries vary significantly, it is reasonable to apply this hypothesis to distinguish transition economies from other emerging countries.

The focus on transition economies is motivated by the specific set of conditions that relate to this group that not observable in other emerging or developing markets. Therefore, the results obtained from existing studies on the regulation-efficiency nexus may well not apply to countries in transition to a market economy. Consistent with Haselmann and Wachtel (2007), we find that banks behave differently under different institutional settings and therefore a study focusing on bank efficiency in transition countries is able to provide new insights into this relationship. Table 1 below briefly presents some important characteristics of transition countries.

The banking sector in the majority of emerging countries has some restrictions on activities that are allowed in other financial and non-financial sectors (e.g. insurance, real estate and etc.). However, this has not been the case in transition economies as they adopted practices similar to those in the Organisation for Economic Cooperation and Development (OECD) countries despite the fact that they are largely less developed and not as robust as longer established market economies (Claessens, 2003). Moreover, the overall institutional framework in transition countries is still young and underdeveloped (Hartwell, 2015) although the World Bank, IMF and the EBRD have supported these countries in reforming their economic and financial sectors. Foreign direct investment inflows have been extensive over the last three decades, which has significantly contributed to banking sector development by the transfer of international best practice. Finally, Basel Committee (Basel I

(1988), Basel II (2004) and Basel III (2010)) regimes have served as important guidelines for financial regulators (Sbârcea, 2014; Triki et al., 2017). However, as financial and banking regulation interacts with local political, economic and institutional environments, their effects vary significantly according to context and these unique characteristics are taken into account in the paper, details of which are outlined in Table 1.

Table 1. Financial system characteristics of transition countries

	Transition countries	Emerging economies
1. History of market economy	These countries have a much shorter history of a market economy as they had a central planning system until the late 1980s and early 1990s.	Emerging economies have much longer and better established market economies.
2. History of financial sector development	Until the late 1980s and early 1990s transition economies did not have an autonomous financial system and before the collapse of the FSU financial transactions were part of the centralized programme of state planning. All investment related decisions were made centrally (i.e. by Gosplan) on ideological and political grounds. Thus, the history of the financial sectors in transition countries is short.	They have a relatively long history of market-economy oriented financial sectors.
3. History of banking sector development	Prior to the collapse of the FSU, transition countries have a monobank-type banking system, consisting of Gosbank (the State Bank) and a few specialist banks. They did not engage in activities undertaken by their counterparts in advanced and developing countries. Thus, transition countries have much shorter history of market-oriented banking sectors.	The banking sector of most emerging economies is relatively better established and more developed with a longer history of relevant legislation and jurisprudence.
4. Frequency of financial instability and crises (excluding the recent global financial crises in 2007-2009)	Most transition countries experienced financial crises over the 1990s: Romania (1990-92), Georgia (1991-95), Hungary (1991-95), Bosnia (1992-96), Estonia (1992-94), Poland (1992-94), Slovenia (1992), Macedonia (1993-95), Albania (1994), Armenia (1994), Azerbaijan (1995), Belarus (1995), Kyrgyz Republic (1995-99), Latvia (1995-96), Bulgaria (1996-97), Czech Republic (1996-2000), Russia (1998), Slovakia (1998-2002), Ukraine (1998-99). Sourced from Čihák et al. (2012).	Emerging markets have been much more stable over the last three decades (excluding the Asian crises in 1997).
5. European Union (EU) integration	The EU integration of the transition countries is strong, i.e. 11 of them are EU member states - Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. Others are preparing to join the EU in the future.	This is limited in emerging economies.

3. Literature review and hypothesis development

Banking regulation is a combination of supervisory and restrictive policies aiming to both protect the banking sector from excessive risk-taking, and minimize moral hazard (Ayadi et al., 2016). Casu et al. (2017) state that banking regulation has changed in response to the complexity, turbulence and development in the banking sector over the last decades, for example, the aim of banking supervision has changed from monitoring bank activities to

promoting internal management. In addition, bank capital requirements have significantly tightened. Market mechanisms to discipline bank activities (private monitoring) became a key objective in supervision and form the three pillars of the Basel accords.

However, questions about the effectiveness of banking regulation have always been important for researchers and policymakers, particularly following the global financial crisis (2007-2009) as some post-crisis studies indicate the weaknesses of regulation to be the key determinant of crises (Cihak et al., 2013). From a theoretical perspective, bank regulation may have contradicting effects and this ambiguity is supported by empirical studies, which is discussed further in the next section.

Barth et al. (2004) discuss two contradictory groups of theories in relation to whether regulation restricts or supports bank activities. The first group claims that the problem of conflict of interest may arise when banks are allowed to engage in a broader range of activities, such as underwriting securities and insurance. In particular, banks with strong commercial links may unload securities onto poorly informed investors to support firms with outstanding loans. This group also suggests that the moral hazard problem intensifies when banks engage in multiple activities and oppose prudential behaviour that allows unrestricted activities. In addition, it becomes difficult to monitor banks when they are engaged in a larger number of activities. This argument also supports the view that banks become significantly large and powerful when they are allowed to engage in various activities, claiming that such banks become difficult to discipline. Finally, with a broader range of activities banks become very large and this reduces competition and efficiency.

The second group of theories supports the concept of allowing banks to engage in a broader range of activities, that is, fewer restrictions allow banks to explore economies of scope and scale. As a result, the franchise value of banks increases when there are fewer restrictions and thus banks take less risk and can diversify their income sources across a

portfolio of activities. Empirical studies of these relationships also present opposing results. For example, some papers suggest that a restriction on activities decreases efficiency, while a broader range of activities can increase efficiency (Barth et al., 2013, 2001; Haque and Brown, 2017; Triki et al., 2017). However, Pasiouras (2008) finds no significant link between activity restrictions and efficiency. Furthermore, Pasiouras et al. (2009) find contradicting results, where restrictions on bank activities have negative impacts on cost efficiency, while they have opposite effects on profit efficiency.

Similarly, the level of capital requirements imposed by regulators is also controversial in the literature. According to the public interest view, the policy of capital requirements significantly reduces the level of moral hazard when the owners of banks are required to have more capital at risk. This eventually leads to more careful lending and better performance (Barth et al., 2004; Triki et al., 2017). In contrast, the private interest view believes that the public interest view ignores the costs associated with a higher capital requirements policy. In particular, the private interest view predicts the benefits from higher capital requirements will be lower than the costs. Under the conditions of higher capital requirements, owners may pursue a costly financing policy, prioritising equity over deposits (Haque and Brown, 2017). This may reduce the incentives of banks to screen and monitor lending when equity capital becomes more expensive to raise than deposits (Barth et al., 2004), ultimately leading to higher risks and lower efficiency.

These empirical studies also present contradictory results. For example, Barth et al. (2013) and Haque and Brown (2017) find capital stringency to have a positive effect on efficiency, while Triki et al. (2017) find this is only true for large banks. Pasiouras (2008) also states that capital stringency improves efficiency, but these results are not significantly robust across all specifications. Pasiouras et al. (2009) predict that capital stringency improves cost efficiency, but reduces profit efficiency. In contrast, Oino (2017) finds a

negative association between tier 1 capital and the financial performance of European banks.

According to the public interest view, powerful supervisory authorities improve the governance of banks by promoting the public interest (Levine, 2003). In particular, strong and independent supervisors can prevent a bank from engaging in excessive risk taking (Agoraki et al., 2011). Therefore, the public interest view predicts the effects of supervisory power on efficiency to be positive, while in contrast, the private interest view predicts the opposite outcome. Consistent with Beck et al. (2006), the private interest view states that if supervisors are strong enough to discipline banks, they may also use this power to force banks to support their private interests while allocating loans and resources. Although some empirical studies find positive effects (Haque and Brown, 2017; Pasiouras et al., 2009), Barth et al. (2013) show that supervisory power impacts positively on bank efficiency only in countries with independent supervisory authorities. However, the present study will argue that the effect of the supervisory authority varies under different institutional settings.

Finally, the role and importance of market discipline has significantly increased in many countries following the last global financial crisis. Market discipline in the banking sector is defined as the actions and reactions between creditors and depositors that influence the risk preferences of banks. All market participants face excessive costs when banks undertake higher risks, and in response to this depositors may require higher interest rates, or threaten to withdraw their funds to penalise banks for their risk taking behaviour (Berger, 1991; Martinez Peria and Schmukler, 2001). With respect to monitoring and disciplining banks, scholars often argue against heavy reliance on official supervision, as there are different incentives depending of the ownership stake in banks (Barth et al., 2013). Beck et al. (2006) advocate that bank supervisory policy should also force banks to produce accurate information, and improve the ability and incentives of private investors so they can monitor and discipline effectively. However, the private interest view argues that banks can pressure

politicians who could influence official supervisors to take actions in favour of the private interests of banks (Barth et al., 2013). Therefore, the presence of an efficiently functioning market discipline is important.

Again, the empirical results on the efficiency effects of market discipline are inconclusive. Barth (2013) and Pasiouras et al. (2009) find that market discipline is positively linked with bank efficiency, however, Triki et al. (2017) state that increased transparency reduces the efficiency of African banks. On the other hand, Barth et al. (2004) argue that private monitoring may not be effective in countries with poorly developed capital markets, weak accounting standards and incomplete legal systems. Moreover, the supervisory authorities in some countries may not be sufficiently powerful to force banks to accurately disclose their financial details in order for enable private investors to monitor and discipline effectively.

In summary, two important points on the previous studies can be highlighted. Firstly, there is no strong evidence indicating the best bank regulation that would apply universally. Secondly, the efficiency effects of banking regulation instruments vary significantly subject to the nature of the banking sectors as well as their institutional and regulatory environment. Thus, there is a need for empirical studies that will link bank regulation and efficiency in transition economies. Although these countries have already adopted the universal banking model prevalent in OECD countries and engage in a broader range of activities, weak management and a lack of experience persists (Claessens, 2003). Thus, the first hypothesis is as follows:

H1: A restriction on bank activities improves bank efficiency.

Anginer et al. (2014) show that the effect of prudential capital requirements on bank stability appears to be positive in those banking sectors with (1) relatively weak supervision

and monitoring, and (2) underdeveloped institutions, features present in the banking sectors of transition countries. On the other hand, the majority of these countries have experienced sustainable growth and low inflation rates over the last two decades. This has caused increases in the demand for bank loans as banks play a leading role in the financial systems of transition countries. Therefore, the presence of prudential capital requirements may limit the growth opportunities of banks. Thus, the second hypothesis is as follows:

H2: Prudent capital requirements lower banking efficiency.

The international organizations, such as the World Bank, the IMF and the EBRD, have provided support for transition economies and this has led to increased confidence and the transfer of best practices into the banking sector through the dominance of foreign ownership and foreign direct investment over the last three decades. However, many banks still remain politically connected with and without state ownership despite the fact that they are privatized. This suggests that these banks may coerce supervisors to act in the interest of the bank rather than remain independent. Under these circumstances, the supervisory authority is not able to exert sufficient control to ensure bank stability and efficiency. Thus, the third hypothesis is as follows:

H3: Supervisory authority does not improve banking efficiency.

Over the last two decades, the banking sectors of the transition countries have become relatively complex. However, the institutions linked to the financial systems are still underdeveloped and are faced with obstacles to the smooth conduct of business, with corruption and the enforcement of contracts. Moreover, lack of transparency in financial transactions and poor quality of information is still present. Under these circumstances, principal/agency relationships break down with severe limitations in understanding and assessing risks, making established models of corporate governance in effective (Avgouleas

and Cullen, 2014). In addition, most of these countries have poorly developed capital markets with incomplete legal systems. Thus, we do not expect market discipline to be an effective tool to improve efficiency in the banking sectors of transition economies. Therefore, the final hypothesis is as follows:

H4: Market discipline is not an effective tool to improve banking efficiency.

4. Data and Methodology

4.1 Sample

The sample consists of 319 banks from 21 transition economies: 11 are European Union (EU) member states - Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia; 3 are European but non-EU member states - Bosnia, Macedonia and Serbia; and 7 are FSU independent states - Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Moldova and Ukraine.[1] The data are an unbalanced panel, taken from *Bankscope*. All are commercial banks whose financial statements are available for at least three years during the period 2002-2014. Data for GDP growth, GDP per capita and inflation are from the World Bank World Development Indicators. The regulation data are from the World Bank Regulation and Supervision surveys, and economic freedom data are from the Heritage Foundation.

[1] We did not include the banks of the Russian Federation in the analyses as we believe that the country has a different history and needs more careful consideration. For example, the country's political regime and its power in the geopolitical arena are different from those of the other European transition countries and FSU. The financial sector, particularly banking, is hugely sensitive to raw material exports and oil price volatility. Moreover, the intensification of geopolitical sanctions as well as slow growth significantly effected on the banking sector of the country over the last decade. In addition, the level of state intervention in the banking sector is very high and exceeds that of other countries in the sample. Particularly, the state owned banks (Sberbank and VTB) account for about 60% of system assets, while top 10 banks supply about 70% of lending. Moreover, the Central Bank of the Russian Federation revoked the license of 234 banks only for the period from January 2014 to July 2016 (IMF Country Report No. 16/231, 2016). In sum, we could deliver many more specifications of the Russian banking system not observable in other banking systems of transition countries. Therefore, we believe it is reasonable not to include it in our analyses as the banking of Russia is a different story.

4.2. Bank Efficiency measurement (dependent variable)

To estimate a measure of efficiency a stochastic frontier model (SFA) as proposed by Battese and Coelli (1995) is used. Compared to Data Envelopment Analysis (DEA), the main advantage of SFA is that it allows us to distinguish between inefficiency and other stochastic shocks while calculating efficiency scores (Pasiouras et al., 2009; Semih Yildirim and Philippatos, 2007). Thus, SFA allows the measurement of inefficiency for each bank from the best-practice frontier in a single step estimation incorporating bank-, industry- and country-specific variables (Doan et al., 2018). We follow Gaganis and Pasiouras (2013) and Luo et al. (2016) in selecting input and output variables for the profit frontier and take an intermediation approach. In particular, we treat banks as financial intermediaries collecting funds (deposits) as inputs, and transforming them into loans or other assets. Two output prices are used: (1) the ratio of interest income to loans (p1), and (2) the ratio of non-interest income to other earning assets (p2). There are three input prices: (1) the cost of loanable funds estimated by the ratio of interest expenses to total deposits (w1); (2) the cost of physical capital measured by the ratio of overhead expenses to fixed assets (w2); and (3) the cost of labour calculated by the ratio of personnel expenses to total assets (w3). To control for different bank risk profiles, we include *Equity* as a quasi-fixed input following Berger and Mester (1997). We also use w3 to normalise prices and include a time trend to account for the changes in technology over time (T=0 for 2002, T=1 for 2003, to T=12 for 2014).

The profit function also includes dummy variables (Transition), GDP per capita, and an Economic Freedom variable to account for cross-country heterogeneity. Three dummy variables distinguish three groups of Transition countries: (1) 1=EU and 0 otherwise – for $Transition_1$; (2) 1=FSU and 0 otherwise - for $Transition_2$; and (3) 1=non-EU European

countries and 0 otherwise - for Transition$_3$[2]. We consider a multi-product transcendental logarithmic (translog) function to estimate the profit efficiency of banks. The translog is widely used in previous studies and provides more flexibility while investigating the efficiency frontier (Luo et al., 2016; Tabak et al., 2012). The model to estimate the frontier is as follows:

$$\begin{aligned}\ln\frac{\text{profit}}{w_3} = {} & \beta_0 + \beta_1 \ln\frac{p_1}{w_3} + \beta_2 \ln\frac{p_2}{w_3} + \beta_3 \ln\frac{w_1}{w_3} + \beta_4 \ln\frac{w_2}{w_3} + \beta_5 \frac{1}{2}\ln\left(\frac{p_1}{w_3}\right)^2 + \beta_6 \ln\frac{p_1}{w_3}\ln\frac{p_2}{w_3} \\ & + \beta_7 \frac{1}{2}\ln\left(\frac{p_2}{w_3}\right)^2 + \beta_8 \frac{1}{2}\ln\left(\frac{w_1}{w_3}\right)^2 + \beta_9 \ln\frac{p_1}{w_3}\ln\frac{w_1}{w_3} + \beta_{10} \ln\frac{p_2}{w_3}\ln\frac{w_1}{w_3} + \beta_{11} \frac{1}{2}\ln\left(\frac{w_2}{w_3}\right)^2 + \beta_{12} \ln\frac{p_1}{w_3}\ln\frac{w_2}{w_3} \\ & + \beta_{13} \ln\frac{p_2}{w_3}\ln\frac{w_2}{w_3} + \beta_{14} \ln\frac{w_1}{w_3}\ln\frac{w_2}{w_3} + \beta_{15}\ln(\text{equity}) + \beta_{16}\frac{1}{2}\ln(\text{equity})^2 \\ & + \beta_{17}\ln(\text{equity})\ln\frac{p_1}{w_3} + \beta_{18}\ln(\text{equity})\ln\frac{p_2}{w_3} + \beta_{19}\ln(\text{equity})\ln\frac{w_1}{w_3} + \beta_{20}\ln(\text{equity})\ln\frac{w_2}{w_3} \\ & + \beta_{21}\,\text{T} + \beta_{22}T^2 + \beta_{23}\,\text{T}\ln\frac{p_1}{w_3} + \beta_{24}\,\text{T}\ln\frac{p_2}{w_3} \\ & + \beta_{25}\,\text{T}\ln\frac{w_1}{w_3} + \beta_{26}\,\text{T}\ln\frac{w_2}{w_3} + \beta_{27}\,\text{T}\ln(\text{equity}) \\ & + \beta_{28}\text{Transition} + \beta_{29}\text{GDPpercapita}_{j,t} + \beta_{30}\text{Economic freedom}_{j,t} + \beta_{31}\text{NPI} - u_{i,t} + v_{i,t} \qquad (1)\end{aligned}$$

where $\nu_{i,t}$ is the random error assumed to be independent and identically distributed N(0, σ_v^2); $u_{i,t}$ is a non-negative random inefficiency term assumed to be independent but not identically distributed. The term $u_{i,t}$ follows a truncated-normal distribution with truncation (at zero) of the N($m_{i,t}$, σ_u^2). The mean is defined as $m_{i,t} = z_{i,t}\delta$, where $\mathbf{z_{i,t}}$ is a (1 x M) vector of explanatory variables associated with the technical inefficiency effects in (1), while $\boldsymbol{\delta}$ is a (M x 1) vector of unknown parameters to be estimated in (1). The coefficients of (1) are estimated in a single-step by using the maximum likelihood approach.[3].

Following Bos and Koetter (2011), we incorporate an additional independent variable, the negative profit indicator (NPI), to account for those banks who report negative profits, as the dependent variable requires the natural logarithmic transformation and this is undefined for negative values. In particular, profit is assigned a value of 1when profit≤0; then, NPI equals 1 when profit≥0 and equals the absolute value of profit when the latter is negative.

[2] We use Transition$_1$ and Transition$_2$ dummy variables (dropping Transition$_3$) while estimating the profit function.

[3]Once the point estimates of $u_{i,t}$ (inefficiency) are obtained, estimates of technical efficiency are defined as Efficiency=exp(-u).

Gaganis and Pasiouras (2013) and Luo et al. (2016) use this approach for modeling banks with negative profit.

4.3. Regulation Indices

We construct four regulatory indices following the literature (Agoraki et al., 2011; Anginer et al., 2014; Delis and Kouretas, 2011). These indices are *Activity restrictions, Capital requirements, Market discipline* and *Supervisory power,* all of which are calculated using the World Bank surveys on Bank Regulation and Supervision:

a) *Activity restrictions* is calculated by considering whether the bank is allowed to undertake securities trades, insurance and real estate activities, as well as ownership of non-financial firms. This index ranges between 1 and 12, where higher values indicate more restrictions;

b) *Capital requirements.* This index shows initial and overall capital stringency ranging between 0 and 8, where higher scores indicate more capital stringency. 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. However, overall capital stringency shows whether risk elements and value losses are considered when calculating regulatory capital;

c) *Market discipline*. This index considers whether banks are required to disclose their off-balance sheet items and risk management procedures, and whether certified/licensed auditors are compulsory. This index ranges between 0 and 8, where higher values indicate stricter requirements;

d) S*upervisory power.* This indicates whether the supervisory authorities have the power and the authority to take specific preventive and corrective actions. This index ranges from 0 to 14, where higher values indicate more power for the supervisory authorities (Appendix).

4.4. Control variables

To account for bank and cross-country heterogeneity, we use a number of variables common in the bank-performance literature (Agoraki et al., 2011; Delis and Kouretas, 2011; Tabak et al., 2012). Profitability is important as it is contributing to the efficiency levels of banks. Therefore, Return on Assets (ROA) is used as a profitability variable (Wu and Shen, 2013). Size (natural logarithm of total assets) and Liquidity *(*gross loans/total deposits) are used considering that the scale and liquidity of banks may have different efficiency preferences. Details of the data are in Table 2.

Table 2. Description and Source of Data

Variables	Description	Source
	Bank-specific variables	
Efficiency	Profit efficiencies measured through SFA (Battese and Coelli's (1995) model) is used as a proxy for *Efficiency*.	Authors' calculations
Size	Natural logarithm of total assets	Bankscope
Return on Assets	Pre-tax profit/Total Assets	Bankscope
Liquidity	Gross loans/Total deposits	Bankscope
Capital Ratio	Equity/Total Assets	Bankscope
Foreign State Private	Based on the major shareholders, we classify the ownership into three categories: (1) *Foreign* – a dummy takes 1 if the major shareholders are foreign family investors and/or foreign organisations, 0 otherwise; (2) *State* – a dummy takes 1 if the major shareholders are domestic states or public authorities, 0 otherwise; (3) *Private* – a dummy takes 1 if the major shareholders are domestic family investors, 0 otherwise.	Bank websites
	Bank regulations and competition	
Capital requirements *Supervisory power* *Activity restrictions* *Market discipline*	*Activity restrictions*,*Capital requirements*, *Market discipline* and *Supervisory power* are calculated based on the World Bank surveys on Bank Regulation and Supervision, where higher scores indicate higher restrictions on activities, higher capital stringency, higher requirements for financial disclosure as well as higher supervisory power of financial authorities. Four versions of the surveys are used - Versions I (2001) for 2000-2001, II (2003) for 2002-2004, III (2007) for 2005-2007 and IV (2012) for 2008-2014. If some countries are not featured in the current version of the survey, we use the survey response of the previous draft. Similar approaches are taken by Kim et al. (2013) and Agoraki et al. (2011).	World Bank's surveys on Bank Regulation and Supervision
Boone indicator	Boone is an indicator inversely proportional to competition, i.e. the more negative the Boone indicator is, the more competitive the banking sector.	World Bank's Global Financial Development
Too-Big-To-Fail	Total assets of three largest banks / GDP	Bankscope
	Institution	
Economic freedom	The index of Economic freedom provides a comprehensive view of economic freedom in a country. The index ranges between 0 and 100, where higher scores indicate higher economic freedom.	The Heritage Foundation
	Macroeconomic variables	
Domestic credit to private sector	Domestic credit to private sector provided by a financial sector (% of GDP)	World Bank's World Development Indicators
GDP per capita	GDP per capita in US dollars	
GDP growth	Annual percentage changes in GDP	
Inflation	Annual percentage changes in consumer prices	

Bank ownership is also important as this may reflect the behaviour of senior management. Ownership is divided into three groups with dummy variables associated with each. These are defined as Foreign, State and Private that reflect the majority of shareholders. Capital Ratio is also included, as banks are expected to trade-off higher levels of equity capital for risky assets and thus may impact on efficiency.

To control for heterogeneity in bank industries, we use competition and too-big-to-fail (total assets of three largest banks / GDP) variables following the literature (Tabak et al., 2012). As the Boone indicator is inversely proportional to competition, the more negative the measure the more competitive the banking sector is. However, we use Boone1=(-Boone), the opposite of Boone, to make it positively proportional to competition following Tabak et al. (2012). Since economic conditions impact on bank behaviour, we use Domestic credit to private sector, GDP growth and Inflation to account for the macroeconomic environment. Finally, three dummy variables are used to account for the different periods: pre-crisis (2002-2006), during-crisis (2007-2009) and post-crisis (2010-2014).

4.5. Model specification

Given the dynamic nature of bank performance (Athanasoglou et al., 2008; Djalilov and Piesse, 2016), we use system GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) and dynamic panel quantile regression (Galvao, 2011) to examine the effects of the regulation on bank efficiency in transition economies. The advantage of the system GMM is that the approach successfully addresses the problems of endogeneity. We followed Agoraki et al. (2011), and Männasoo and Mayes (2009) to identify predetermined (weakly exogenous) and endogenous variables. Bank management tends to take expected and actual performance into account when making future strategic decisions. Therefore, bank-specific variables can be considered as forward-looking. This implies that current bank performance can impact on bank-specific variables in later periods. Thus, we assume a weak form of exogeneity

(predetermined) for bank specific variables following Louzis et al. (2012). Moreover, significant economic reform, and changes in the political infrastructure have increased financial instability in transition countries over the last three decades. To attempt to reduce this turbulence the supervisory authorities repeatedly changed bank regulation and macroeconomic policy, as they reacted to instability in the current period. Therefore, we treat regulation and macroeconomic variables as endogenous, consistent with Agoraki et al. (2011) and Männasoo and Mayes (2009). System GMM assumes that the only available instruments are the lags of instrumented variables (Roodman, 2009). We test the overall validity of the instruments using the Hansen-test. The estimating equation is specified as follows:

$$\text{Efficiency}_{i,j,t} = \delta\text{Efficiency}_{i,j,t-1} + b_1\text{Bank}_{i,j,t} + b_2\text{Industry}_{j,t} + b_3\text{Macro}_{j,t} + b_4\text{Regulation}_{j,t} + \mu_{i,j,t} \quad (2)$$

for bank *i*, in country *j* and at time *t*. The coefficient δ lies between 0 and 1 and indicates the speed of adjustment. **Bank** vectors include bank-specific variables, while **Industry** vectors consider the competition in the banking sector proxied by the Boone indicator and the too-big-to-fail variable. In addition, **Macro** vectors include Domestic credit to private sector, GDP growth and Inflation control variables. Moreover, ***Regulation*** vectors capture *Activity restrictions*, *Capital requirements*, *Market discipline* and *Supervisory power*.

The first results are from system GMM, followed by those from the quantile regressions. Most previous studies investigate the impact of regulation on bank efficiency assuming the effect to be homogenous (Barth et al., 2013; Pasiouras et al., 2009). However, considering the heterogeneous nature of banks and banking industries across countries, that is, large vs. small, foreign-owned vs privately-owned, quantile regression provides a richer description of the heterogeneous effects of regulation at different locations of the bank efficiency distribution. In addition, quantile regression results are robust to outliers and distributions with heavy tails. Moreover, it avoids the restrictive assumption that the error

terms are identically distributed at all points of the conditional distribution (Klomp and De Haan, 2012).

5. Empirical results

5.1. Summary statistics

Descriptive statistics and correlations for the main variables are in Table 3. The arithmetic mean and high standard deviation of Domestic credit to the private sector (% of GDP), inflation and GDP growth indicate that they vary significantly across these countries. Also Table 3 shows that efficiency is positively correlated with the ROA, size, *Activity restrictions* and GDP growth. This may imply that banks with higher ROA and larger in size are more efficient. Moreover, this may also indicate that positive GDP growth and *Activity restrictions* improve banking efficiency in this sample. However, efficiency has negative correlations with capital ratio and *Supervisory power*. This may imply that highly capitalised banks are less efficient. In addition, this may also indicate that *Supervisory power* decreases efficiency in the banking sectors of transition countries.

Table 3. Descriptive statistics and correlation matrix of the main variables

		Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1.	Efficiency	0.44	0.24													
2.	Size	6.57	1.87	0.11***												
3.	Return on Assets	0.01	0.05	0.30***	0.03											
4.	Liquidity	1.01	2.56	-0.03	-0.07***	-0.22***										
5.	Capital ratio	0.16	0.13	-0.17***	-0.50***	0.12***	0.14***									
6.	Boone	-0.14	0.26	-0.08***	-0.01	-0.01	0.01	0.06***								
7.	Too-Big-To-Fail	0.35	0.25	-0.01	0.26***	-0.06***	0.05***	-0.23***	-0.20***							
8.	Domestic credit to private sector	47.52	18.69	-0.05**	0.20***	-0.14***	0.02	-0.17***	-0.15***	0.55***						
9.	GDP growth	2.96	5.11	0.20***	-0.14***	0.17***	-0.01	0.06***	-0.01	-0.25***	-0.49***					
10.	Inflation	5.42	6.99	-0.02	-0.11	0.01	-0.01	0.12***	-0.19	-0.20***	-0.19***	0.10***				
11.	*Activity restrictions*	6.78	2.33	0.17***	0.02	0.10***	0.00	-0.02	-0.10***	-0.04**	-0.26***	0.20***	-0.03*			
12.	*Capital requirements*	5.41	1.63	-0.05**	0.05***	-0.07***	-0.01	-0.10***	-0.21***	0.08***	0.45***	-0.27***	0.02	0.16***		
13.	*Supervisory power*	11.44	2.04	-0.12***	0.10***	-0.10***	0.01	-0.07***	-0.13***	0.38***	0.23***	-0.27***	-0.13***	-0.12***	0.01	
14.	*Market discipline*	5.90	0.92	-0.00	0.09***	-0.03	0.02	-0.09	-0.30***	0.30***	0.23***	-0.11***	-0.18***	0.26***	0.46***	0.11***

* Significant at the 0.10 level, ** significant at the 0.05 level, *** significant at the 0.01 level.

5.2. System GMM results

The main results from the system GMM are in Table 4. The table shows that the coefficients are quite stable across models, and the Hansen test indicates no evidence of over-identifying restrictions. Although Table 4 shows the presence of first-order autocorrelation, this does not imply that the estimates are inconsistent, as this would only be the case if second-order autocorrelation was present (Arellano and Bond, 1991). The Arellano-Bond (AB) test results in Table 4 indicate the absence of second-order autocorrelation.

We apply the general-to-specific method when deciding which control variables should be included in the model, following Klomp and De Haan (2012). Initially, we estimate model 1 (Table 4) including all control variables and year dummies from 2007 to 2014 without the main variables for bank regulation. Then, we delete the least significant variable and re-estimate the model. We repeat this procedure until the model includes only significant variables at a 10% level. This means the control variables, such as size, capital ratio, too-big-to-fail, domestic credit to private sector, as well as EU membership and ownership dummies are omitted. The main variables of interest are then added individually in models 2-5, and model 6 includes all variables.

The results for the control variables indicate that return on assets, liquidity, Boone[1] and GDP growth have positive signs, while the sign is negative for inflation. This implies that more profitable and liquid banks are more efficient. The results also show that more competitive banking sectors, as well as the countries with more sustainable economic growth, measured by GDP growth, tend to have more efficient banks, consistent with Barth et al. (2013). However, higher inflation reduces profits by increasing costs and thus it appears to be statistically

significant with a negative effect on efficiency, which is consistent with Kasman and Yildirim (2006) and Pasiouras (2009). In contrast to the findings by Barth et al. (2013), our *Activity restrictions* are positively associated with efficiency implying that more stringent bank activity restrictions increase efficiency. This is consistent with Pasiouras et al. (2009) suggesting that banks may systematically fail to manage diverse activities when there is weak regulatory control. Hence, diverse activities may lower their profitability and efficiency. As for the other main variables, *Capital requirements, Market discipline* and *Supervisory power,* they do not appear to have statistically significant effects on efficiency in Table 4.

Table 4.Regulation and bank efficiency -system GMM

Variables	(1)	(2)	(3)	(4)	(5)	(6)
$Efficiency_{t-1}$	0.386***	0.373***	0.389***	0.388***	0.363***	0.362***
	(0.066)	(0.062)	(0.063)	(0.062)	(0.066)	(0.055)
Return on Assets	1.917***	1.878***	2.308***	2.231***	1.754***	1.926***
	(0.586)	(0.553)	(0.564)	(0.518)	(0.580)	(0.520)
Liquidity	0.005***	0.004**	0.006**	0.005**	0.005***	0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$Boone^1$	0.064*	0.070*	0.070*	0.058	0.069*	0.075**
	(0.038)	(0.037)	(0.038)	(0.042)	(0.039)	(0.037)
GDP growth	0.008***	0.007***	0.008***	0.007***	0.007***	0.006***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation	-0.002**	-0.002**	-0.003**	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
yr2012	0.033**	0.035**	0.037***	0.034**	0.035**	0.032**
	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)
Constant	0.231***	0.181***	0.189***	0.222**	0.356***	0.333***
	(0.029)	(0.036)	(0.038)	(0.088)	(0.060)	(0.088)
Activity restrictions		0.009**				0.008**
		(0.004)				(0.004)
Capital requirements			0.007			-0.000
			(0.006)			(0.005)
Market discipline				0.002		-0.010
				(0.015)		(0.016)
Supervisory power					-0.010**	-0.007
					(0.005)	(0.005)
Number of instruments	126	138	138	138	138	174
Hansen-test	0.373	0.326	0.453	0.492	0.465	0.321
AB test AR(1) (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
AB test AR(2) (p-value)	0.675	0.705	0.704	0.684	0.745	0.744
Observations	1,810	1,810	1,810	1,810	1,810	1,810

* Significant at the 0.10 level, ** significant at 0.05 level, *** significant at the 0.01 level. Standard errors are shown in parentheses. Boone indicator is inversely proportional to competition (implying that the more negative the measure, the more competitive the banking sector). Therefore we use $Boone^1$=(-Boone), the opposite of Boone, to make it positively proportional to competition following Tabak et al. (2012). Year dummies from 2007 to 2014 are used. The bank-specific variables are treated as weakly-exogenous (pre-determined), while the regulation and macro variables are endogenous (see Section 4.5 for more details). System GMM assumes that the only available instruments are the lags of instrumented variables (Roodman, 2009). We limit the number of instruments restricting the lag range to two.

5.3. Quantile regression results

We next consider the results from the panel quantile regression. Table 5 shows the results for lower (0.10 and 0.20), medium (0.50) and higher (0.80 and 0.90) quantiles.We estimate a model including the controls and the main variables of interest. Clustered standard errors are generated, consistent with the results of Parente-Santos Silva (2016). We reject the null hypothesis of a constant variance estimated at the 0.50 quantile, which supports the application of quantile regressions in the presence of heteroscedasticity (Machado and Silva, 2000).

Table 5. Regulation and bank efficiency - quantile

Variables	(1)	(2)	(3)	(4)	(5)
	0.10	0.20	0.50	0.80	0.90
$Efficiency_{t-2}$	0.181***	0.367***	0.574***	0.300***	0.169***
	(0.040)	(0.055)	(0.049)	(0.038)	(0.037)
Return on $Assets_{t-1}$	1.026***	1.668***	1.204*	0.803*	0.375
	(0.321)	(0.390)	(0.670)	(0.420)	(0.409)
$Liquidity_{t-1}$	-0.044	-0.031	-0.006	-0.001	-0.002***
	(0.053)	(0.057)	(0.019)	(0.000)	(0.001)
$Boone^{1}_{t-2}$	0.010	0.008	0.038	0.068**	0.042*
	(0.029)	(0.043)	(0.050)	(0.032)	(0.025)
$GDP\ growth_{t-2}$	0.001	0.001	0.000	-0.001	0.000
	(0.002)	(0.003)	(0.002)	(0.002)	(0.001)
$Inflation_{t-2}$	-0.002*	-0.004*	-0.003***	-0.001	-0.000
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
Crisis	-0.041*	-0.066***	-0.061***	-0.027**	-0.017
	(0.023)	(0.024)	(0.023)	(0.013)	(0.013)
Activity restrictions $_{t-2}$	0.011**	0.018***	0.012***	0.004	-0.000
	(0.005)	(0.006)	(0.004)	(0.004)	(0.004)
Capital requirements $_{t-2}$	-0.007	-0.004	-0.014**	-0.002	-0.003
	(0.007)	(0.008)	(0.006)	(0.005)	(0.005)
Market discipline$_{t-2}$	-0.021	-0.036**	-0.026*	-0.010	-0.009
	(0.015)	(0.016)	(0.013)	(0.009)	(0.013)
Supervisory power $_{t-2}$	-0.006	-0.002	-0.002	-0.003	-0.004
	(0.005)	(0.007)	(0.005)	(0.004)	(0.005)
Constant	0.263***	0.275***	0.381***	0.577***	0.755***
	(0.085)	(0.099)	(0.092)	(0.081)	(0.078)
Observations	1,569	1,569	1,569	1,569	1,569
R-squared	0.115	0.183	0.204	0.194	0.184
Parente-Santos Silva test (p-value)	0.005	0.000	0.000	0.000	0.000
Machado-Santos Silva test (p-value)			0.000		

* Significant at the 0.10 level, ** significant at 0.05 level, *** significant at the 0.01 level. Standard errors are shown in parentheses. Boone indicator is inversely proportional to competition (implying that the more negative the measure, the more competitive the banking sector). Therefore, we use $Boone^{1}$=(-Boone), the opposite of Boone, to make it positively proportional to competition following Tabak et al. (2012). As bank-specific (predetermined) as well as regulation and macroeconomic (endogenous) variables are instrumented with their lags in the system GMM, we use their lags in dynamic quantile regressions to make the results comparable across two approaches.

Similar to the results from system GMM, ROA appears to be positively impacting on efficiency implying that banks with higher profitability are more efficient. Although with different signs,

liquidity and competition also appear to have effects, but only for highly efficient banks. Particularly, the effect of liquidity is negative, while higher competition improves bank efficiency, consistent with the literature (Barth et al., 2013; Pasiouras, 2008).

As expected, inflation lowers efficiency, but only for medium and lower efficient banks. Perhaps, managers of highly efficient banks can manage to make the necessary adjustments in their costs and expenses before the effect of inflation takes place, and thus they can neutralise the negative effect of inflation. Similar to the previous results from system GMM, banks appear to be less efficient during the crisis (2007-2009) period. *Activity restrictions*, as before, appear to be improving efficiency, but only in medium and lower efficient banks. This implies that lower efficient banks are not good managers of a diverse set of activities, and therefore, restricting their activities may lead to higher profit efficiency, which is consistent with Pasiouras et al. (2009).

However, the results also show that *Capital requirements* and *Market discipline* decrease bank efficiency at only some quantiles. Particularly, *Capital requirements* impact only on medium efficient banks. This is consistent with the findings of Barth et al. (2004) suggesting that capital stringency may not robustly be associated with bank efficiency when other regulations are controlled. Inconsistent with the previous studies (Pasiouras et al., 2009), *Market discipline* decreases the efficiency of lower efficient banks. Perhaps, this is consistent with the argument suggested by Barth et al. (2004) that *Market discipline* may not be effective in countries with poorly developed capital markets, weak accounting standards and incomplete legal systems.

5.4. Sensitivity analysis

The results of alternative specifications for system GMM and quantile regressions are presented in Tables 6 and 7. In Table 6 we use size dummies rather than size (columns 1-3, Table 6) as

follows: Large ($\geq Size+\sigma_{Size}$), Medium ($<Size+\sigma_{Size}$ and $>Size-\sigma_{Size}$) and Small ($\leq Size-\sigma_{Size}$)[4]. In addition, we replace year dummies with pre-crisis (2002-2006), crisis (2007-2009) and post-crisis (2010-2014). The results presented in Table 6 are similar to those from Table 4. Larger banks appear to be relatively more efficient implying that their size provides better scope to improve efficiency. The results also show that banks are less efficient over the crisis period, but become more efficient over the post-crisis period.

Table 6.Sensitivity analysis - system GMM

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Activity restrictions	0.010**	0.010**	0.009**	0.009**	0.008**	0.009**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Capital requirements	-0.001	-0.001	0.000	-0.000	-0.002	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Market discipline	-0.010	-0.008	-0.011	-0.008	-0.004	-0.004
	(0.015)	(0.015)	(0.014)	(0.016)	(0.015)	(0.015)
Supervisory power	-0.006	-0.006	-0.005	-0.007	-0.008	-0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Large	0.041*					
	(0.025)					
Medium		-0.022				
		(0.022)				
Small			-0.010			
			(0.034)			
Pre-crisis				-0.011		
				(0.013)		
Crisis					-0.029**	
					(0.012)	
Post-crisis						0.029**
						(0.012)
Number of instruments	195	196	196	174	174	174
Hansen-test	0.450	0.222	0.357	0.314	0.187	0.215
AB test AR(1) (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
AB test AR(2) (p-value)	0.693	0.719	0.775	0.794	0.656	0.696
Observations	1,808	1,808	1,808	1,810	1,810	1,810

* Significant at the 0.10 level, ** significant at 0.05 level, *** significant at the 0.01 level. Standard errors are shown in parentheses. Boone indicator is inversely proportional to competition (implying that the more negative the measure, the more competitive the banking sector). Therefore we use Boone[1]=(-Boone), the opposite of Boone, to make it positively proportional to competition following Tabak et al. (2012).
The bank-specific variables are treated as weakly-exogenous (pre-determined), while the regulation and macro variables are endogenous (see Section 4.5 for more details). System GMM assumes that the only available instruments are the lags of instrumented variables (Roodman, 2009). We limit the number of instruments restricting the lag range to two. We collapse the control variables to save some space.

We add Large (columns 1-3), Medium (columns 4-6) and Small (columns 7-9) dummy variables individually to our alternative panel quantile specifications presented in Table 7. The results for all control and main variables are similar to those presented in Table 5. In addition,

[4] A similar approach was used to create dummies for competition by Tabak et al. (2012).

Table 7 shows that Large and Small impact on bank efficiency with different signs. Particularly, Large improves the efficiency of medium efficient banks only. However, Small appears to have a negative effect on the efficiency of medium and highly efficient banks.

Table 7: Sensitivity analysis - quantile

Variables	(1) 0.10	(2) 0.50	(3) 0.90	(4) 0.10	(5) 0.50	(6) 0.90	(7) 0.10	(8) 0.50	(9) 0.90
Activity restrictions $_{t-2}$	0.012**	0.013***	0.000	0.012**	0.012***	0.001	0.011**	0.012***	-0.000
	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
Capital requirements $_{t-2}$	-0.010	-0.011*	-0.003	-0.008	-0.012*	-0.003	-0.007	-0.015**	-0.003
	(0.007)	(0.006)	(0.005)	(0.007)	(0.007)	(0.005)	(0.007)	(0.007)	(0.005)
Market discipline $_{t-2}$	-0.019	-0.033**	-0.007	-0.019	-0.026**	-0.008	-0.021	-0.023*	-0.011
	(0.016)	(0.013)	(0.012)	(0.017)	(0.013)	(0.012)	(0.015)	(0.013)	(0.012)
Supervisory power $_{t-2}$	-0.005	-0.004	-0.004	-0.005	-0.003	-0.004	-0.006	-0.003	-0.004
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Constant	0.255***	0.414***	0.743***	0.272***	0.393***	0.724***	0.263***	0.391***	0.777***
	(0.085)	(0.088)	(0.076)	(0.097)	(0.093)	(0.078)	(0.084)	(0.093)	(0.077)
$Large_{t-1}$	0.056	0.033**	-0.008						
	(0.040)	(0.017)	(0.016)						
$Medium_{t-1}$				-0.029	-0.014	0.022			
				(0.021)	(0.017)	(0.014)			
$Small_{t-1}$							0.004	-0.069**	-0.038*
							(0.036)	(0.034)	(0.023)
Observations	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567	1,567
R-squared	0.108	0.208	0.176	0.111	0.205	0.166	0.109	0.206	0.181
Parente-Santos Silva test (p-value)	0.060	0.000	0.000	0.027	0.000	0.000	0.004	0.000	0.000
Machado-Santos Silva test (p-value)		0.000			0.000			0.000	

* Significant at the 0.10 level, ** significant at 0.05 level, *** significant at the 0.01 level. Standard errors are shown in parentheses. Boone indicator is inversely proportional to competition (implying that the more negative the measure, the more competitive the banking sector). Therefore we use $Boone^{1}$=(-Boone), the opposite of Boone, to make it positively proportional to competition following Tabak et al. (2012). As bank-specific (predetermined) as well as regulation and macroeconomic (endogenous) variables are instrumented with their lags in the system GMM, we use their lags in dynamic quantile regressions to make the results comparable across two approaches. We collapse the control variables to save some space

Thus, in system GMM we found *Activity restrictions* to be the only regulation that improves efficiency in the banking sectors of these countries. This finding supports Hypothesis 1, Hypothesis 3 and Hypothesis 4. However, the dynamic panel quantile results show that the bank regulation has heterogeneous effects at different quantiles. In addition, the banks in transition countries appear to be less efficient over the crisis period (2007-2009), but they become more efficient over the post-crisis period (2010-2014).

6. Conclusion

Over the last two decades, especially following the global financial crisis (2007-2009), the assessment and the architecture of banking regulations has received renewed interest from researchers and policymakers in order to try to lessen or prevent future banking crises. Specifically, the exploration of the effects of regulations on stability, efficiency and performance has become a dominant theme in banking research. However, research examining the impact of regulations on banking efficiency has received relatively less attention.

This study explores the effects of regulation on banking efficiency in transition countries for the period 2002-2014, with both theory and policy considerations the motivation for the research. From a theoretical perspective, the predictions of scholars on the effects of bank regulations are contradictory (Ayadi et al., 2016). In addition, there is no evidence to support the view that the best set of regulations would work universally. Therefore, it is essential to shed light on the regulation-efficiency nexus in the banking sector of transition economies considering the unique conditions observed that are missing in other emerging and developing countries.

The study contributes to the existing literature in several respects. Firstly, it extends the studies by Pasiouras (2008), Pasiouras et al. (2009), Chortareas et al. (2012), Barth et al. (2013) and Gaganis and Pasiouras (2013) in a number of ways by (a) considering the post-crisis period in addition to the pre-crisis and crisis period; (b) applying system GMM to consider the importance of the dynamic nature of bank performance variables as well as the endogeneity of other important variables; and (c) applying dynamic quantile regression to investigate the heterogeneous efficiency effects of regulations. Secondly, this study provides more detailed aspects of the efficiency effects of bank regulations specifically in transition countries

investigating them separately from other emerging and advanced countries.

The results indicate that the banks in transition countries appear to be less efficient over the crisis period (2007-2009), but they become more efficient over the post-crisis period (2010-2014). In addition, *Activity restrictions* appear to be the only regulation that improves the banking efficiency within the system GMM context consistent with Pasiouras et al. (2009). Moreover, the dynamic panel quantile results indicate that the regulations have different efficiency impacts at different quantiles implying that one size does not fit all.

Overall, our findings deliver important policy implications. Particularly, the results imply that the banking regulations such as *Capital requirements*, *Market discipline* and *Supervisory power* are not sufficiently effective to improve the banking efficiency in the transition countries. This suggests 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. This is important as Allen and Gale (2004) state that the costs of financial crises are not frequent, although when they do occur they are large.

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Appendix. Information on regulatory variables

Type of regulation	Source and quantification	World Bank Guide (WBG) questions
Capital requirements	The variable is calculated by	3.1.1 Is the minimum capital-asset ratio requirement risk-weighted in line with the Basel guidelines?

	summing the answer scores. Yes = 1; No = 0 for the questions 3.1.1, 3.3, 3.9.1, 3.9.2, 3.9.3 and 1.5. Yes = 0, No = 1 for the questions 1.6 and 1.7.	Yes/No 3.3 Does the minimum ratio vary as a function of market risk? Yes/No 3.9.1 Is the market value of loan losses, which is not realised in accounting books, deducted before minimum capital adequacy is determined? Yes/No 3.9.2 Are unrealised losses in securities portfolios deducted before minimum capital adequacy is determined? Yes/No 3.9.3 Are unrealised foreign exchange losses deducted before minimum capital adequacy is determined? Yes/No 1.5 Are the sources of funds, to be used as capital, verified by the regulatory/supervisory authorities? Yes/No 1.6 Can the initial disbursement, or subsequent injections of capital, be done with assets other than with cash or government securities? Yes/No 1.7 Can the initial disbursement of capital be done with a borrowed fund?

		Yes/No
Supervisory Power	The variable is calculated by summing the answer scores. Yes = 1; No = 0 for the questions 5.5, 5.6, 5.7, 6.1, 10.4, 11.2, 11.3.1, 11.3.2, 11.3.3, 11.6, 11.7, 11.9.1, 11.9.2 and 11.9.3.	5.5 Does the supervisory agency have the right to meet with external auditors to discuss their report without the approval of the bank? Yes/No 5.6 Are auditors required by law to communicate directly to the supervisory agency any presumed involvement of bank directors or senior managers in illicit activities, fraud or inside abuse? Yes/No 5.7 Can supervisors take legal action against external auditors for negligence? Yes/No 6.1 Can the supervisory authority force a bank to change its internal organisational structure? Yes/No 10.4 Are off-balance sheet items disclosed to supervisors? Yes/No 11.2 Can the supervisory agency order the bank's directors or management to constitute provisions to cover actual or potential losses? Yes/No 11.3 Can the supervisory agency suspend the director's

		decision to distribute the following: 11.3.1 Dividends? Yes/No 11.3.2 Bonuses? Yes/No 11.3.3 Management fee? Yes/No 11.6 Can the supervisory agency supersede bank shareholder rights and declare the bank insolvent? Yes/No 11.7 Does the banking law allow the supervisory agency or any other government agency (other than the court) to suspend some or all of the ownership rights of a problem bank? Yes/No 11.9 Regarding bank restructuring and reorganisation, can the supervisory agency or any other government agency (other than court) do the following: 11.9.1 Supersede shareholders rights? Yes/No 11.9.2 Remove and replace management? Yes/No 11.9.3 Remove and replace directors?

		Yes/No
Activities restrictions	The variable is calculated by summing the answer scores. For questions 4.1, 4.2, 4.3 and 4.4,we have four different answers: Unrestricted = 1 Permitted =2 Restricted = 3 Prohibited =4	4.1 What is the level of regulatory restrictiveness for bank participation in securities activities? 4.2 What is the level of regulatory restrictiveness for bank participation in insurance activities? 4.3 What is the level of regulatory restrictiveness for bank participation in real estate activities? 4.4 What is the level of regulatory restrictiveness for bank ownership of non-financial firms?
Market discipline	The variable is calculated by summing the answer scores. Yes = 1; No = 0 for 3.5, 10.3, 10.4.1, 10.5, 10.6, 10.7 and 5.1. Yes = 0; No = 1	3.5 Is subordinated debt allowable (or required) as part of capital? Yes/No 10.3 Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries? Yes/No 10.4.1 Are off-balance sheet items disclosed to the public? Yes/No

	for 10.1.1 and 8.1.	10.5 Must banks disclose their risk management procedures to the public? Yes/No 10.6 Are directors legally liable for erroneous/misleading information? Yes/No 10.7 Are commercial banks required by supervisors to have a credit rating? Yes/No 5.1 Is an external audit by a certified/licensed auditor a compulsory obligation for banks? Yes/No 10.1.1 Does accrued, though unpaid interest/principal, enter the income statement while a loan is non-performing? Yes/No 8.1 Is there an explicit deposit insurance protection system Yes/No