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Overview

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Aims and Scope

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Main subjects covered include, e.g.: [1] ***Valuation of assets***: Accounting and financial reporting; Asset pricing; Stochastic models for asset and instrument prices; [2] ***Financial markets and instruments:*** Alternative investments; Commodity and energy markets; Derivatives, stocks and bonds markets; Money markets and instruments; Currency markets; [3] ***Financial institutions, services and regulation***: Banking efficiency; Banking regulation; Bank solvency and capital structure; Credit rating and scoring; Regulation of financial markets and institutions; Systemic risk; [4] ***Corporate finance and governance****:* Behavioral finance; Empirical finance; Financial applications of decision theory or game theory; Financial applications of simulation or numerical methods; Financial forecasting; Financial risk management and analysis; Portfolio optimization and trading.

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Determinants of banks' profitability and efficiency: Empirical evidence from a sample of Banking Systems

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ABSTRACT

The aim of this study is to analyze the determinants of the bank profitability and efficiency in conventional banks. This study compares accounting-based and economic-based measures of efficiency and profitability of conventional banks in fourteen countries. Accounting variables help explain cost and profit efficiency, but cost efficiency has little impact on profitability and profit efficiency. In fact, the study of profitability is crucial in assessing the health of organizations. However, profitability of the banking sector is particularly important as the soundness of the sector is closely related to the soundness of the entire economy. In this paper, banks' profitability and its determinants in Tunisia as well as in 13 different countries were investigated. The determinants of bank profitability are analyzed with the data from 110 banks over the period 1999–2012 using the panel data method generalized method of moments. Our results suggest that researchers should probably focus more on profit efficiency than cost efficiency. Almost all banks are below the optimal size.

JEL Classification: G14, G21, G32

Keywords: Bank efficiency; Bank profitability; Economy of scale.

1. INTRODUCTION

Profitability has become one of the challenges faced by the commercial banks to strengthen their financial positions in order to meet the risks associated with openness and globalization. A profitable banking sector would withstand negative shocks better and contribute to the stability of the financial system. The profitability determinants are well observed and explored, as it is increasingly important to strengthen the foundations of the domestic financial system as a way to buildup flexibility for capital flow volatility. The commercial banks profitability is affected by

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Managerial (internal) and Environmental (external) factors. The managerial factors are affected by management decisions and goals to be achieved by the bank management; such as capital ratio, credit risk, productivity growth and size of the bank performance. The environmental factors are affected by external forces such as financial market structure, trade interdependence, economic growth, inflation, market interest rates and ownership structure.

The profitability of the banking sector is a subject that has received a lot of attention in recent years. There is now a large literature which has examined the role played by management of resources in determining bank profitability. It is generally agreed that better quality the management of resources is the main factor contributing to a bank performance, as evidenced by numerous studies that have focused on the U.S. banking system (DeYoung and Rice, 2004; Stiroh and Rumble, 2006; Bhuyan and Williams, 2006; Hirtle and Stiroh, 2007; Nicolae et al., 2015) and the banking systems in the western and developed countries (Ho and Tripe, 2002; Williams, 2003; Pasiouras and Kosmidou, 2007; Kosmidou et al., 2007; Kosmidou and Zopounidis, 2008; Athanasoglou et al., 2007; Albertazzi and Gambacorta, 2008). By contrast, fewer studies have studied this topic in developing economies.

Accounting-based research of bank performance generally used comprehensive information from financial statements to characterize the determinants of bank profitability, as calculated by return on assets (ROA) or return on equity (ROE). Studies, which examined an individual country (Kosmidou et al., 2007; and Ben Naceur and Goaied, 2008) or a geographical region (Kwan, 2003; and Bonin et al., 2005), have rather analyzed bank-specific factors of profitability (e.g., size, revenue growth, risk, and control of expenses). However, the research dealing with multiple countries (Hassan and Bashir, 2003; Valverde and Fernandez, 2007; Poghosyan, 2010; Ben Naceur and Omran, 2011; Muhammad et al., 2015) has included some external factors (e.g., inflation, concentration, and GDP growth) as well as several internal factors of profitability.

Economics-based studies have concentrated on efficiency, as measured by the distance away from some ideal frontiers calculated dependent to the lowest cost or highest profit bank in the sample. Diverse research studies have used nonparametric techniques, like data envelopment analysis (DEA) that applies no functional form on the cost or production function. The most popular approach in this trend focuses on the parametric estimation of cost, production, or profit functions. Throughout the parametric approaches, the Aigner et al. (1977) stochastic frontier approach (SFA) and the Berger (1993) distribution free approach (DFA) are the most prevalent and usually provide consistent efficiency rankings among banks. Although the SFA has been used more frequently than DFA, the later has the advantage of making several assumptions about the form of the error term and the distribution error terms adopted to estimate cost or profit efficiency.

In recent years, the bank performance literature is generally either accounting-based or economics-based. A number of articles, however, joined the aspects of both approaches such as, Berger and Mester (1997), Maudos et al. (2002), Hassan (2005), Fries and Taci (2005), Yildirim and Philippatos (2007) and Staikouras et al. (2008) whose analysis showed that the accounting-based correlates with economic efficiency measures.

Following this recent literature reviews, the purpose of this paper is to estimate cost and profit efficiencies for 110 banks in 14 countries. We estimate the Translog cost and profit functions to determine the economies of scale (ES) and the technical efficiency (TE) of each bank over the period 1999-2012. Moreover, we use the generalized method of moments (GMM) econometric model that enables us to investigate the relationship between bank profitability and some internal and external determinants.

Our study differs from the existing literature in many aspects. First of all, it uses a large number of conventional banks (110) and covers a wide range of countries (14 countries) over a longer time going from 1999 to 2012 (before, during and after the 2007 financial crisis). In addition, to estimate cost and profit frontier functions, specific variables have been introduced to each country (macroeconomic variables) to take into account the variation in the banking technologies

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which can be linked to macroeconomic conditions and the banking structure from one country to another. In addition, this study compares the scores of the cost and profit efficiencies per country, and attempts to identify the possible factors explaining the differences of cost and profit efficiencies observed for banks in some countries.

The remaining of this paper is organized as follows: First, we give a brief review of the literature examining the banks efficiency according to different approaches in the second section. The third section details our methodology. Our results are presents and discusses in the fourth section. Finally, we conclude and present the main recommendations of this study.

2. LITERATURE REVIEW

Research on the determinants of bank profitability has focused on both the returns on bank assets and equity, and net interest rate margins. It has traditionally explored the impact on bank performance of bank-specific factors, such as risk, market power, and regulatory costs. More recently, research has focused on the impact of macroeconomic factors on the banking performance.

Kumbirai and Webb (2010) investigated the performance of South Africa's commercial banking sector over the period 2005-2009. The study found that overall bank performance increased considerably in the first two years of the analysis. A significant change in trend is noticed at the onset of the global financial crisis in 2007, reaching its peak during 2008-2009. This resulted in falling profitability, low liquidity, and deteriorating credit quality in the South African Banking sector.

Sufian (2010) has analyzed the determinants of the bank profitability in Korea between 1994 and 2008, and the results of his study show that the banks presenting a lower credit risk have the tendency to record higher profitability levels. Regarding the impact of the macroeconomic and banking industry specific factors, the study shows that inflation has a significant pro-cyclical impact, the GDP has a counter-cyclical influence, and the banking sector concentration has a negative impact upon the profitability of the banks, as well.

Dietrich and Wanzenried (2010) investigated the main determinants of profitability for the Swiss banking market. Their empirical analysis, which was performed on a sample of 453 commercial banks in Switzerland, from 1999 to 2008, highlights the existence of some significant differences in the banks' profitability. The results of their study show that, on the one hand, the banks which are more capitalized are also more profitable, and on the other hand, regarding the crisis impact, the authors showed that the cost-income ratio had a significant impact on the return on assets only for the period before the crisis, while during the crisis a negative impact on the profitability was exerted by the loan loss provisions relative to total loans.

Alpera and Anbar (2011) examined the bank-specific and macroeconomic determinants of the banks' profitability in Turkey over the period 2002–2010. The results showed that asset size and non- interest income have a positive and significant effect on bank profitability. However, the size of credit portfolio and loans under follow-up has a negative and significant impact on this profitability. With regard to macroeconomic variables, only the real interest rate affects the performance of banks positively. These results suggest that banks can improve their profitability through increasing the bank size and non-interest income and decreasing the credit/asset ratio. In addition, a higher real interest rate can lead to higher bank profitability.

For Deger and Adem (2011), the banking profitability was measured by ROA and ROE as a function of bank-specific and macroeconomic determinants. Using a balanced panel dataset, the results showed that asset size and non-interest income have a positive and significant effect on banking profitability. However, the size of the credit portfolio and loans under follow-up has

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a negative and significant impact on this profitability. As for the macroeconomic variables, only the real interest rate affects the performance of banks positively.

Recently, Trujillo-Ponce (2013) have empirically analyzed the determining factors of banking profitability in Spain, between 1999–2009, and the differences between the performance of commercial and savings banks. The results show, in particular, that better capitalized banks have a higher level of return on assets. Regarding the exogenous variables, the study shows a positive relationship between the market concentration and the profitability of the Spanish banks, and also the importance of the economic cycle for the profitability of the banking sector. Regarding the performance of the commercial and savings banks, the study shows some important qualitative differences, in favor of the commercial ones.

Yılmaz et al. (2013) analyzed profitability and its determinants for nine emerging countries including Turkey. The results reveal that operating expenses management, capitalization, credit risk, bank size and inflation are important determinants for both returns on asset and net-interest margin dependent variables.

Makkar and Singh (2013) carried out a comparative analysis of the financial performance of the Indian commercial banks considering a sample of 37 banks (22 public sector banks and 15 private sector banks) for the period from 2006–2007 to 2010–2011. Using the t-test, the results revealed a significant difference in the capital adequacy, asset quality and earning capacity of public and private sector banks in India. On the other hand, they found no significant difference in the management, liquidity position and sensitivity to market risk of the two different banking groups. Thus, it was concluded that, in average, there was no statistically significant difference in the financial performance of the public and private sector banks in India.

To illustrate that regulations and supervisory arrangements play an important role in shaping bank efficiency and productivity, we resorted to the results of Gaganis and Pasiouras (2013) that show that efficiency decreases as the number of the financial sectors supervised by the central bank increases. Additionally, banks operating in countries with greater unification of supervisory authorities are less profit efficient. Finally, the central bank independence has a negative impact on bank profit efficiency. Perhaps, Barth et al. (2013) contribute to this assessment by examining whether bank regulation, supervision and monitoring enhance or impede bank operating efficiency. Based on an un-balanced panel analysis of 4050 banks observations in 72 countries over the period 1999–2007, Barth et al. (2013) found that tighter restrictions on bank activities are negatively associated with bank efficiency, while greater capital regulation stringency is marginally and positively associated with bank efficiency. They also reveal that a strengthening of official supervisory power is positively associated with bank efficiency only in countries with independent supervisory authorities. Moreover, market-based banks monitoring in terms of more financial transparency is positively associated with bank efficiency.

Regarding the impact of financial freedom on bank efficiency, the results of Chortareas et al. (2013) suggest that the higher the degree of an economy's financial freedom, the higher the benefits for banks in terms of cost advantages and overall efficiency. Our results also show that the effects of financial freedom on bank efficiency tend to be clearer in countries with freer political systems in which governments formulate and implement sound policies and higher quality governance.

In addition, the latest accounting-based studies generally used panel techniques to examine banking profitability. For example, Kwan's (2003) made a comparison of the performance of banks in seven Asian countries for 1992–1999. Kosmidou et al.'s (2007), however, analyzed the profitability of the Greek banks operating abroad during 1995–2001, while Ben Naceur and Goaied's (2008) examined the profitability of 14 Tunisian banks over the 1980/2000 period. Athanasoglou et al.'s (2008) analyzed the bank-specific, industry-specific, and macroeconomic determinants of profit persistence in the Greek banks over the period 1985–2001. In general, the results of most of the above mentioned studies conclude that the measures of cost are generally

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negatively correlated with profits. Larger bank size, greater dependence upon loans for revenue, higher market concentration, greater GDP growth, and higher proportions of equity capital to assets have generally been correlated with greater profitability. Higher liquidity, greater provisions for loan losses, and more reliance on debt have been indicative of lower bank profits.

Other papers like those of Sealey and Lindley (1977) forwarded the intermediation framework for analyzing banking performance whereas Aigner et al.'s (1977) examined the cost efficiency of producing banking services in various developing countries using the stochastic frontier approach (SFA). Economics-based analysis of cost efficiency starts by calculating an ideal frontier based upon the cost of production and/or input usage of the highest practice or slightest cost firms in a sample. The use of a Translog cost function enables researchers to get away from actual data points to find an estimate of the minimum cost of production for any output level, or the minimum input usage for any level of total cost. This method was developed by Berger et al. (1993) to calculate profit efficiency in which inefficiency is measured according to the most profitable firms in the sample.

Other studies, like that of Bauer et al. (1998), Yildirim and Philippatos (2007) and Weill (2004, 2009) reached results using both of SFA and DFA and concluded that both approaches provide similar rankings of efficiency across banks. The DFA, however, presents a little percentage of efficiency scores across all the banks. Yildirim and Philippatos (2007) have used a truncation distribution and found average cost efficiencies of 71% using the DFA and 77% using the SFA for banks in 12 transition economies during the 1993–2000 period. Similarly, the profit efficiency figures were 51% for the DFA and 66% for the SFA. Regarding these differences in average efficiency levels, we opted for using the DFA method since it sets fewer assumptions about the distribution of the error terms.

Goddard et al. (2004) have attempted to identify determinants of banks' profitability in Denmark, France, Germany, Italy, Spain and the UK. The empirical results consider a positive relationship between capital-assets ratio and profitability. The relationship between the importance of off-balance-sheet business in a bank's portfolio and profitability is positive for the UK, but either neutral or negative elsewhere.

Kosmidou (2007) examined how a bank's specific characteristics and the overall banking environment affect the profitability of commercial domestic and foreign banks operating in the 15 EU countries over the period 1995–2001. The results indicate that profitability of both domestic and foreign banks is affected not only by a bank's specific characteristics but also by financial market structure and macroeconomic conditions. All the variables, with the exception of concentration in the case of domestic banks profits, are significant although their impact and relation with profits is not always the same for the two types of banks.

3. METHODOLOGY

In our study, we measured cost efficiency since it is able to estimate how close bank costs are to the best practice banks producing a similar bundle of outputs and operating under the same conditions. Such efficiency is obtained by calculating a stochastic cost frontier. If we obtain the cost frontier for a sample of banks, the total cost inefficiency of this bank shows the difference between the actual production costs for a given bank and the production costs estimated on the frontier. Inefficiency cost includes the technical and allocative inefficiencies. The allocative inefficiency is a result of the use of production factors in wrong proportions considering their market prices. The technical inefficiency is caused by an under use of production factors.

It is important to estimate the frontier of the production possibilities to get an efficiency cost measure. Some econometric techniques are applied to calculate efficiency such as the nonparametric and parametric approaches.

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The non-parametric approach does not need the specification of the functional form. However, this approach misses the random noise. This is investigated as a shortfall of the method because all the asymmetric deviations from the frontier are associated with inefficiency. However, the parametric approach applies a special functional form for the cost function, but considers the random noise in the parametric frontier specification.

The stochastic frontier approach includes a random error term which is split into two components, one is asymmetric and represents the inefficiency and the other is symmetric and captures the random error. In this study, we used the SFA and applied it to the banking industry in several studies. According to a long tradition in the banking literature, we used a Translog flexible functional form to estimate cost and profit functions. Banks consider the used labor, the physical capital and the financial capital as inputs which are supposed to produce deposits and investment services.

3.1. Data, variables and samples

To analyze the determinants of banking profitability and efficiency in the 14 countries, we used a panel data of 110 banks available in the bankscope database. The external variables affecting the bank performance (e.g., inflation and GDP) were collected from the International Monetary Fund (IMF). Furthermore, these banks belong to one country [Malaysia (MAL)] in the Southeast Asia region and 8 countries [Egypt (EGY), Yemen (YMN), Sudan (SDN), Iraq (IRQ), Syria (SYR), Tunisia (TUN), Jordan (JOR) and Lebanon (LBN)] in the MENA region (Middle East and North Africa) including 5 countries [United Arab Emirates (UAE), Bahrain (BHR), Kuwait (KWT), Saudi Arabia (SAU) and Qatar (QAT)] of the GCC (Gulf Cooperation Council).

Table 1.
Description of data sample: Average total assets in sample by country and year

Country	SAU	BHR	EGY	IRQ	JOR	KWT	LBN	MAL	QAT	SDN	SYR	TUN	UAE	YMN	**Total**
Number of banks	9	12	13	1	12	5	9	12	6	9	4	4	11	3	110
GCC	yes	yes	no	no	no	yes	no	no	yes	no	no	no	yes	no	
MENA	no	no	yes	yes	yes	yes	yes	no	yes	no	yes	yes	no	no	**Average**
1999	34.01	24.65	35.87	1.08	28.42	40.70	22.36	35.79	16.62	30.12	8.30	14.04	20.84	54.45	**157.75**
2000	40.32	25.89	37.01	2.23	26.12	42.64	25.57	39.34	18.37	32.17	8.49	16.62	23.14	67.47	**160.36**
2001	48.70	28.09	37.18	2.91	27.03	44.25	27.19	42.35	19.74	27.27	8.33	16.39	26.95	8.40	**157.72**
2002	54.86	29.79	36.04	3.52	27.89	45.59	31.74	47.64	23.24	32.50	8.33	16.11	32.83	9.30	**160.09**
2003	60.30	32.33	37.77	3.94	28.55	47.20	34.68	51.67	27.16	28.18	7.86	16.83	37.92	9.87	161.82
2004	64.70	32.72	36.07	4.56	30.27	48.63	37.15	55.07	30.15	36.28	7.87	18.53	42.24	11.04	**163.95**
2005	68.83	36.30	39.05	5.52	32.17	50.47	38.21	58.35	35.31	37.68	10.60	18.77	50.02	11.79	**166.54**
2006	72.71	40.51	43.33	8.25	34.33	56.34	40.09	63.39	40.68	40.54	15.02	19.05	56.95	12.99	**170.01**
2007	80.01	44.95	47.52	11.26	36.57	67.11	44.49	70.00	50.24	37.73	18.66	19.96	66.73	14.03	**174.42**
2008	87.19	44.18	48.53	12.10	38.20	68.88	46.58	73.94	58.27	39.08	20.92	22.16	73.01	14.49	177.03
2009	87.88	41.60	49.65	13.75	39.51	68.45	50.33	75.49	61.15	40.99	23.72	22.88	76.29	14.81	**178.37**
2010	88.72	41.54	51.71	16.44	39.36	67.86	52.85	78.64	64.92	42.88	25.48	23.66	78.97	15.04	**179.87**
2011	89.58	41.54	53.91	19.67	39.34	67.30	55.56	81.94	69.08	44.90	27.40	24.51	81.85	15.28	**181.52**
2012	90.54	41.64	56.26	23.55	39.43	66.77	58.43	85.37	73.76	47.06	29.47	25.44	84.96	15.54	**183.35**

Source: Authors' estimates from the data source.

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The period of analysis stretched over 1999–2012 during which an electronic data has become available for the majority of banks. The distribution of the banks sample of the 14 countries for the years 1999–2012 is shown in Table 1.

Many variables, used in previous studies to explain the banking profitability ratios are summarized in Table 2. The internal bank characteristics belong to the first category of explanatory variables. According to Kosmidou et al. (2007), the bank's size (SIZE) is represented by the logarithm of total bank assets. It is theoretically the most frequently used accounting variable in the banking studies and the literature proposes a positive relationship between profitability and SIZE.

The loan specialization ratio (LOANS) is the net loans divided by total assets. This ratio is not usually considered as a liquidity ratio, or as an asset utilization ratio. LOANS should positively influence profitability as long as a bank is not taking on an unacceptable level of risk because loans give the maximum return of any bank asset. The security specialization ratio (SECUR) is the ratio of other earning assets to total assets. Other earning assets involve all return-bearing assets other than loans meaning various types of securities. Staikouras et al. (2008) indicate that this ratio is positively associated with profitability. Yet, this relationship becomes negative if a bank does not invest much in securities at the expense of issuing loans. The deposit specialization ratio (DEPLIAB) is the specified total deposits divided by the total liabilities. The ratio of deposits to total assets has been analyzed in several studies and shows the importance of customer's deposits as a source of bank funds. Valverde and Fernandez (2007) justify that the variable could be either positively or negatively related to profitability because the deposits are both the lowest cost and the least stable source of funds.

Accounting ratios used to measure the internal banking efficiency are like the variables used in economics-based analysis in the following sub-section. The Inefficiency Ratio (INEFF), which represents the operating expenses divided by gross income, is possibly the extended single accounting measure of cost efficiency. Valverde and Fernandez (2007) showed that INEFF is negatively linked to banking profitability. This ratio can be divided into three parts defining the efficiency in using inputs.

Some studies used two measures of risk incorporate credit risk (CRISK) as measured by the loan-loss provisions to net loans ratio, and capital strength (CAPSTR), which is equity divided by total assets. Valverde and Fernandez (2007) suggested that the ratio of loan defaults to total loans had a negative relationship with banking profitability. Moreover, Kosmidou et al. (2007) proved the same relationship between profitability and the ratio of loan loss provisions to net interest income. Many studies like that of Berger and Mester (1997) have shown a positive relationship between profitability and capital strength. Similarly, Kosmidou et al. (2007) and Staikouras et al. (2008) state that some banks might be over-capitalized.

Table 2.
Definitions of variables

Dependent variables
TC: The total cost is defined as interest and cost out of interest in the efficiency cost function.
π: Net operating profit. In the profit function, the total cost is replaced by total profit (π) to avoid differences in taxation regimes between the countries in the sample.
ROA: Return on asset, which is defined as net income divided by total assets.
ROE: Return on equity, which is net income divided by average shareholder equity.

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Independent variables
Bank size (SIZE): The natural logarithm of the bank's total assets is used as a measure of a bank size. A larger size is expected to have a positive effect on bank profitability.
Loans specialization ratio (LOANS): the ratio of loans to total assets indicates which percentage of banking assets are represented by loans. The empirical studies indicate that an increase in the level of this indicator can state a deterioration of the soundness of loan portfolio, with a negative impact on profitability.
Security specialization (SECUR): Is the ratio of other interest bearing assets (non-loans) to total assets.
Deposit specialization (DEPLIAP): Is the ratio of total deposits to total liabilities.
Inefficiency (INEFF): Is the ratio of operating expenses to gross income.
Labor cost to come (LCI): Is the ratio of personnel expenses to gross income.
Credit risk (CRISK): Is the ratio of loan loss provisions to gross loans.
Capital strength (CAPSTR): Is the ratio of equity to total assets.
External variables
Country gross domestic product (CGDP): Is the year-to-year % change in country gross domestic product deposits.
Inflation rate (INFL): Is defined as a sustained general rise in prices in an economy whereby high inflation rates are associated with higher costs as well as higher income.

The last group of explanatory variables measures the external or environmental factors generally outside the control of an individual bank. A change in gross domestic product (CGDP) represents the cyclical output. Previous studies, like that of Hryckiewicz and Kowalewski (2010), proposed that GDP growth has a positive impact on banking profitability over the business cycle. For this reason, our data are presented in nominal terms, whereas, inflation (INFL) is taken as a control variable as it might have a differential impact on outputs and inputs across banks and countries.

3.2. Measuring efficiency

Following a long tradition in the banking literature, we adopt a Translog flexible functional form to estimate banks' cost and profit functions. In Berger and Mester (1997), the intermediation approach is adopted so that assets on the bank balance sheet are treated as outputs, while liabilities and physical factors of production are treated as inputs.

Banks are assumed to use the inputs: x_1 = labor, x_2 = physical capital and x_3 = deposits to produce the outputs: y_1 = net loans, y_2 = liquid assets and y_3 = securities ratio. Deposits are the sum of all checking, savings, and time deposits at an institution measured in the Unite State dollar and its unit price (p_3) is defined as interest expense/deposits. Its share in the total cost (C) is defined as S_3 = interest expense/C, where C = interest expense + personal expenditures + depreciation and other operating expenses. The labor share of the total cost is S_1 = personnel expenditures/total cost, and its price (p_1) is the personnel's expenditures/total assets. This definition of price, as adopted by Maudos and al. (2002), can be used when data on the number of employees are not readily available. The physical capital is defined as expenditures on a plant and equipment measured by depreciation plus other capital expenses on the income statement. The capital share of the total cost is S_2 = non-labor operating expenses/C and its price is estimated by p_2 = non-labor operating expenses/fixed assets.

Cost is measured by C = total cost = operating expense + interest expense, estimated in log form by *Ln* C. Profit efficiency is calculated using the net operating profit (π), which is net income minus provisions for loan losses, as presented by Maudos et al. (2002). Following Berger and Mester (1997), the dollar value of a financial equity capital for each bank is included as a quasi-fixed net put quantity (E) in the Translog unit cost and profit functions to help control risks.

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Table 3.
Descriptive statistics: economics-based variables (measured in 1000 s of U.S. dollars)

Variable	Mean	Standard deviation	Minimum	Maximum
C = Total Cost	217.4	445.6	0.6	9918.8
π = Profit	587.7	2452.1	0.02	64255.5
E = Equity	102205.4	158128.8	100.8	1414793.0
y_1 = Loans	496038.4	888684.2	41.9	7600999.0
y_2 = Liquid assets	272130.0	728626.7	109.8	1.84 e^{+7}
y_3 = Securities	8440.1	13227.2	9.5	124081.2
S_1 = Labor's share	0.22	0.29	0.1 e^{-3}	0.99
S_2 = Physical capital's share	0.02	0.04	0	0.80
S_3 = Interest's share	0.76	0.29	0.9 e^{-3}	0.99
p_1 = Price of labor	0.02	0.05	0.04 e^{-4}	0.84
p_2 = Price of physical capital	0.01	0.02	0.01 e^{-4}	0.33
p_3 = Price of physical financial	0.05	0.15	0.01 e^{-4}	1.85

Source: Authors' estimates from the data source.

The descriptive statistics for the economics-based variables for our data set of 527 banks are shown in Table 3. Prior to the estimation of cost or profit functions, all prices, costs, outputs, and inputs are scaled by the mean value of that variable in the sample. Using the information from the previous section about accounting based determinants of profitability, the variables INFL, GCC, SIZE, DEPLIAB, CGDP, RT (risk taking) and MS (market share) are included in the formulation of the cost and profit functions. Since countries in the data sample may have different regulatory regimes and quite different operating environments, Dietsch and Lozano-Vivas (2000) and Staikouras et al. (2008) stressed the importance of including country-specific environmental variables when estimating common multi-country cost and profit frontiers.

Following the procedure adopted by Fries and Taci (2005), we introduced two dummy variables (GCC and CHOC) where the first presents a country from the Gulf Cooperation Council and the second expresses the financial crisis after 2007. It takes zero from 1999 to 2006 and one afterwards.

To measure the efficiency cost, it is necessary to estimate the frontier of the production possibilities. Cost frontiers (and later profit frontiers) are annually estimated by adopting a Translog model similar to that of Dietch and Lozano-Vivas (2000), Maudus et al. (2002) and Yildirim and Philippatos (2007). In fact, we estimated two Translog functions. The first represented the cost function and the second showed the profit function. The Translog profit frontier was calculated in the same way as the cost frontier.

These two equations are characterized by the translogarithmic function form they take. This is a class of flexible functional forms that imposes few initial restrictive conditions on the technology underlying structure. For instance, this function explicitly allows multiple productions and lends itself easily to hypothesis tests on separability, homogeneity and unattached production. This specification may relate to the determination of the relationships between the different variables (complementarity or substitutability), on the one hand, and to the different elasticities in the estimation taking into account the individual specificities, on the other.

Using the linear homogeneity restrictions in input prices of the cost function, and assuming a production banking technology based on three inputs (deposits, labor and capital), and three outputs (loans, liquid assets and securities ratio) the cost function can be written as:

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$$LnC = \alpha_0 + \sum_{i=1}^{3}\alpha_i Lnp_i + \sum_{n=1}^{3}\beta_n Lny_n + \alpha_t t + \frac{1}{2}\sum_{i=1}^{3}\sum_{j=1}^{3}\delta_{ij} Lnp_i Lnp_j + \frac{1}{2}\sum_{n=1}^{3}\delta_{nm} Lny_n.Lny_m + \sum_{i=1}^{3}\sum_{n=1}^{3}\lambda_{in} Lnp_i Lny_n$$
$$+ \gamma_E Ln\,E + \frac{1}{2}(Ln\,E)^2 + \sum_{i=1}^{3}\varphi_{Ei} LnE.Lnp_i + \sum_{n=1}^{3}\gamma_{En} LnE.Lny_n + \frac{1}{2}t^2 + \sum_{i=1}^{3}\rho_{ti} t.Lnp_i + \sum_{n=1}^{3}\rho_{tn} t.Lny_n + \gamma_{Et} t.Ln\,E \quad (1)$$
$$+ \nu_1 INFL + \nu_2 GCC + \nu_3 SIZE + \nu_4 DEPLIAB + \nu_5 RT + \nu_6 MS + \nu_7 CGDP + \nu_8 CHOC + u + v$$

The regression parameters (α_i, β_i, δ_{ij}, δ_{nm}, λ_{in}, γ_i, φ_i, ρ_{ti}, ρ_{tn}, ν_k) are estimated using Nonlinear Least Square on the system of equations that includes the cost function plus the share equations (S_1, S_2 and S_3) as follows:

$$S_i = \alpha_1 + \sum_{j=1}^{3}\delta_{1j} Lnp_j + \sum_{n=1}^{3}\lambda_{in} Lny_n + \varphi_{Ei} LnE + \rho_{ti} t + \varepsilon_i \qquad \forall\ i = 1,\ 2,3 \quad (2)$$

The optimal level of demand of each input can be derived from the cost function by applying Shephard's lemma, which states that $\partial C/\partial p_i = X_i$ where X_i is the optimal demand of the input i. The optimal cost factor is then defined by $C = \sum_{i=1}^{3} p_i.X_i$ and the share of input i in the total cost is written as $S_i = p_i.X_i/C$ with $\sum_{i=1}^{3} S_i = 1$. Since the share equations sum to one, the third share equation (S_3) for Interest is omitted. Although the cost function can be estimated by itself, the addition of the two share equations into a system of three equations improves the precision of the parameter estimates. The terms v, ε_1 and ε_2 represent the stochastic error terms for each firm, while u is a non negative term measuring potential inefficiency.

By differentiating the cost function with respect to the outputs y_1, y_2 and y_3 (and assuming that outputs are additive), a measure of scale economies (SE) for any bank is:

$$SE = \left(\sum_{n=1}^{3} S_{y_n}\right)^{-1} = \sum_{n=1}^{3}\beta_n + \sum_{n=1}^{3}\left(Lny_n.\sum_{m=1}^{3}\delta_{nm}\right) + \sum_{i=1}^{3}\left(Lnp_i.\sum_{n=1}^{3}\lambda_{in}\right) + \sum_{n=1}^{3}\gamma_{En} LnE \quad (3)$$

If $SE < 1$, it means that bank is producing in the range of increasing returns to scale and an expansion of output would decrease per unit costs. However, $SE = 1$ implies that the bank is at constant returns to scale, while $SE > 1$ refers to diseconomies of scale if a bank is too big.

To obtain an optimal solution to the system of equations, some further restrictions are commonly imposed on the estimation of the Translog cost function. First, $\sum_{i=1}^{3}\alpha_i = 1$ ensures that factor shares sum to one. Then, symmetry requires that $\delta_{ij} = \delta_{ji}$ and $\delta_{nm} = \delta_{mn}$ for all $i \neq j$ or $n \neq m$. Finally, a linear homogeneity in input prices imposes the following restrictions:

$$\sum_{j=1}^{3}\delta_{ij} = \sum_{n=1}^{3}\delta_{nm} = \sum_{n=1}^{3}\lambda_{in} = \sum_{i=1}^{3}\varphi_{Ei} = 0 \quad (4)$$

Moreover, the Translog function measures the relationship of substitutability or complementarity between inputs. They are measured by the price elasticity of demand inputs, defined by:

$$\varepsilon_{ij} = \frac{\delta_{ij} + S_i.S_j}{S_i} \qquad \forall\ i, j = 1,2,3;\ \ i \neq j \ \text{ and } \ \varepsilon_{ii} = \frac{\delta_{ii} + S_i^2 - S_i}{S_i} \qquad \forall\ i = 1,2,3 \quad (5)$$

$\varepsilon_{ij} < 0$ means that x_i and x_j are complementary. Production technology is such that when price increases, the quantity applied x_j decreases and vice versa.

$\varepsilon_{ij} > 0$ means that x_i and x_j are substitutable. When i input price increases, the quantity applied x_j increases and vice versa.

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The error term (ε) is decomposed into two components (v and u). The first one (v) is a two-sided term representing the statistical noise that accounts for uncontrollable factors. This term is assumed to follow a symmetric normal distribution $v \to N\left(0,\sigma_v^2\right)$. The second one ($u$) is a non-negative one-sided term which presents a cost inefficiency. Following Aigner et al. (1977), we assume that u_{it} are identically and independently distributed half normal random variables $u \to \left|N\left(0,\sigma_u^2\right)\right|$.

The estimation of cost and of profit inefficiency requires the estimation of their frontier functions. The frontier can be estimated using either the maximum likelihood method or the moment method. We use the moment method because we estimate the whole system i.e. the cost frontier, the cost shares, and the demand function. The idea consists in calculating of the second and the third moments of the residuals of the cost functions. If we denote by μ_2 and μ_3 the second and the third central moments of these residuals, we can write:

$$\mu_2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\varepsilon_{it} - \bar{\varepsilon}_i\right)^2 \text{ and } \mu_3 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\left(\varepsilon_{it} - \bar{\varepsilon}_i\right)^3 \tag{6}$$

Which corresponds to the following moment equation of Schmidt and Lovell (1979) and Greene (1997):

$$\mu_2 = \frac{\pi - 2}{\pi}\sigma_u^2 + \sigma_v^2 \text{ and } \mu_3 = \sqrt{\frac{2}{\pi}}\left(\frac{4}{\pi} - 1\right)\sigma_u^3 \tag{7}$$

To solve for the variance components, we have:

$$\sigma_u^2 = \left(\mu_3 \Big/ \sqrt{\frac{2}{\pi}}\left(\frac{4}{\pi} - 1\right)\right)^{\frac{2}{3}} \text{ and } \sigma_v^2 = \mu_2 - \frac{\pi - 2}{\pi}\sigma_u^2 \tag{8}$$

According to Jondrow et al. (1982), a cost inefficiency is estimated by the mean of the conditional distribution of u_{it} given ε_{it}, using the following expression:

$$E\left(u_{it}\left|\varepsilon_{it}\right.\right) = \left(\frac{\sigma_u\sigma_v}{\sigma}\right)\left[\left(\phi\left(\frac{\varepsilon_{it}\lambda}{\sigma}\right) \Big/ \Phi\left(\frac{\varepsilon_{it}\lambda}{\sigma}\right)\right) + \frac{\varepsilon_{it}\lambda}{\sigma}\right] \tag{9}$$

where $\sigma^2 = \sigma_u^2 + \sigma_v^2$, $\lambda = \sigma_u/\sigma_v$ and $\phi\left(\frac{\varepsilon_{it}\lambda}{\sigma}\right)$ and $\Phi\left(\frac{\varepsilon_{it}\lambda}{\sigma}\right)$ are the standard normal probability density and cumulative distribution functions, respectively. However, in most situations, we are rather interested in the efficiency of i-th firm, $TE_i = \exp\left(-\hat{u}_i\right)$. However, Battese and Coelli (1988) used $P\left(u_i\left|y_i\right.\right)$ to derive the alternative predictor:

$$\hat{TE}_i \equiv E\left\{\exp\left(-u_t\right)\left|\varepsilon_i\right.\right\} = \left[\Phi\left(\frac{u_i^*}{\sigma_*} - \sigma_*\right) \Big/ \Phi\left(\frac{u_i^*}{\sigma_*}\right)\right].\exp\left\{\frac{\sigma_*^2}{2} - u_i^*\right\} \tag{10}$$

where $\sigma_*^2 = \sigma_u^2.\sigma_v^2/\sigma^2$.

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4. EMPIRICAL ANALYSIS

4.1. Accounting profitability determinants

Several studies like that of Kosmidou et al. (2007) and Van Horen (2007) suggested that return on assets (ROA) is the best measure of profitability over time since assets have a direct impact on both income and expenses. Nevertheless, the ROE can be a critical measure of profit in many cases. Our sample is an unbalanced panel and the models illustrating ROA and ROE are estimated using a generalized least square panel estimator because the number of years of the data varies by bank.

The basic framework for the panel models is:

$$Y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \tag{11}$$

where Y_{it} is the dependent variable (either ROA or ROE), α_i is the firm specific intercept in fixed effect models and common intercept with random variation across banks in the random effects model, β is a vector of the regression coefficients, X_{it} is a vector of the explanatory variables described in table 2, and ε_{it} is the disturbance term which is supposed to be normally distributed with a mean of zero. However, several internal and external variables are highly correlated; where only a subset of independent variables (k) is significant in determining the best model for each profitability ratio.

Table 4.
Fixed-effects panel regressions for the determinants of profitability ratios

Independent variable	ROA	ROE
LOANS	-0.013*** (-9.32)	-0.212*** (-6.53)
INEFF	-0.033*** (-4.64)	-0.322** (-2.24)
CAPSTR	0.036*** (3.12)	-2.234*** (-9.68)
CRISK	-0.006 (-1.04)	0.204* (1.86)
INFL	-0.5 e^{-3} (-1.30)	-0.5 e^{-4} (-0.01)
CHOC	0.011*** (3.59)	0.060 (0.33)
Constant	0.179*** (10.52)	3.098*** (8.11)
Hausman test Statistic significance	39.16*** (0.00)	41.53*** (0.00)
Wald test for GroupWise heteroscedasticity Statistic significance	1.0 e^{+6}*** (0.00)	1.2 e^{+7}*** (0.00)
F-statistic Statistic significance	25.85*** (0.00)	19.94*** (0.00)

Note: t-statistics are in parenthesis below each coefficient. ***, ** and * show significance at 10%, 5% and 1%, respectively.
Source: Authors' estimates from the data source.

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The highest fixed effect models for the ROA and the ROE are shown in table 4, where each includes four independent variables that are significant at 5% level. The models present variations in ROA and ROE across banks rather than through the approximate F-statistic values of 25.85 and 19.94. In several studies, profitability decreases with the loan specialization ratio (LOANS) because a loan gives higher returns than other assets. The inefficiency ratio (INEFF) is significantly and negatively related to the ROA and the ROE considering that higher costs decrease profitability. The capital strength (CAPSTR) increases the ROA as argued in some studies. However, greater capitalization decreases risks and reduces earnings per share, that is why the ROE decreases. For this reason, our annual data are in nominal terms and inflation (INFL) acts as a control variable. It is linked neither to the ROA nor to the ROE, that is why significant results can be obtained using a time trend or the GDP growth (CGDP) variable instead of INFL. However, the credit risk (CRISK) positively affects the ROE indicator. These results are similar to those of various researchers including Sinkey and Greenwalt (1991) and Ahmed et al. (1998). Therefore, banks can effectively deal with credit and other risks that may affect bank's profitability severely. Credit risk management is a crucial part of measuring the optimizing profitability of financial institutions. A bank can improve the overall credit system by tackling asymmetrical information flow, and giving guarantee of loan repayment.

It is interesting to note that when we examine the 2008 subprime crisis, the coefficient of the variable CHOC is positive and significant suggesting an impact on the performance of the conventional banking sector during economic crisis periods. This result is not expected. However, this can be interpreted as a supporting evidence for the idea that the positive impact of financial crisis on bank efficiency is higher among the MENA countries banks as these countries were less affected by the global financial crisis.

4.2. Economic-based examination of cost and profit efficiency

The Translog cost and alternative profit functions are annually estimated using the iterative seemingly unrelated regression equations (SURE) method of Zellner (1962). As shown in table 5, the estimated average scale economies using Eq. (3) are *SE* (Cost) = 0.638 and *SE* (Profit) = 0.577. Since *SE* < 1, there are fairly substantial economies of scale which are not being exploited across most banks. Such results are consistent with the findings of other banking studies in emerging markets (Lee, 2002; Al-Muharrami et al., 2006; Turk-Ariss, 2008).

Table 5.
Average Efficiency and scale economies in %

Countries	ROA	ROE	Cost		Profit	
			Efficiency	Scale Economies	Efficiency	Scale Economies
Saudi Arabia	4.6	54.1	87.3	64.9	97.4	61.0
Bahrain	3.6	34.7	86.9	65.2	96.9	60.5
Egypt	3.4	44.5	88.2	66.2	96.8	61.1
Iraq	2.9	23.5	86.9	65.6	97.0	60.0
Jordan	2.6	19.2	87.6	65.4	97.0	59.7
Kuwait	2.7	17.5	87.4	64.7	97.1	58.8
Lebanon	2.7	18.1	87.2	63.5	97.3	57.5
Malaysia	2.5	16.7	88.5	63.3	97.4	57.4
Qatar	2.0	15.9	88.1	62.2	97.2	56.4

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Countries	ROA	ROE	Cost		Profit	
			Efficiency	Scale Economies	Efficiency	Scale Economies
Sudan	2.4	32.0	87.7	61.9	97.2	55.5
Syria	2.5	16.9	87.7	62.1	97.2	55.3
Tunisia	2.1	15.9	87.6	62.2	97.1	54.9
United Arab Emirates	2.5	17.7	87.2	63.0	97.0	55.1
Yemen	3.3	21.2	87.2	62.9	96.8	54.3
Total average	2.8	24.9	87.5	63.8	97.1	57.7
GCC average	3.2	30.6	87.4	63.8	97.1	58.2

Source: Authors' estimates from the data source.

From the above table 5, it is estimated that an average bank operates at about 87% cost efficiency for all the banks. The results for both cost and profit functions are similar. Generally, the cost efficiency measures are slightly higher than those of the profit efficiency.

On a country by country basis, the banks in Egypt, Malaysia and Qatar are the most cost efficient – operating at about 88% cost efficiency. The least cost efficient banks are in Bahrain and Iraq (86.9%). It should be noted that our estimates of cost efficiency are in line with the values of 85% and 93% obtained by Turk-Ariss (2008) using SFA quartile cost frontiers for Lebanese banks over the period 1990–2000.

As far as the profit efficiency is concerned, the average bank achieves about 97% of the profit practice bank. Focusing on the country estimates of profit efficiency, banks in Saudi Arabia and Malaysia reach 97.4% profit efficiency, while banks in Lebanon achieve 97.3% profit efficiency. The least profit efficient countries are Yemen and Egypt (86.8%), while the most striking difference between cost and profit efficiencies are for Egyptian banks which operate at about 88% cost efficiency and only 86.8% profit efficiency.

Our estimates of profit efficiency are somewhat larger than for developing and transition countries as reported by Maudos et al. (2002) and Yildirim and Philippatos (2007). The MENA countries banks are nearly as cost efficient as the European ones, but the difference between cost and profit efficiencies is generally found in other regions. This means that the MENA countries banks have performed relatively well in terms of profitability and profit efficiency compared to banks in other countries.

Table 6.
Average price elasticity of demands inputs in %

Country	Cost									Profit								
	ε_{11}	ε_{22}	ε_{33}	ε_{12}	ε_{13}	ε_{21}	ε_{23}	ε_{31}	ε_{32}	ε_{11}	ε_{22}	ε_{33}	ε_{12}	ε_{13}	ε_{21}	ε_{23}	ε_{31}	ε_{32}
Saudi Arabia	-0.6	7.3	61.5	-1.7	49.8	-14.3	36.2	26.0	3.2	2.6	8.2	59.4	-3.5	48.1	-17.1	30.4	26.3	3.5
Bahrain	-2.1	5.1	65.0	-1.6	50.7	-14.4	40.8	27.8	3.5	-0.2	5.8	63.3	-2.7	47.4	-17.1	38.8	27.4	3.9
Egypt	0.7	15.8	64.1	-1.3	52.7	-11.9	38.0	26.1	3.4	5.1	17.8	61.2	-2.2	52.0	-16.7	32.7	25.0	3.8
Iraq	-0.9	13.8	68.2	-1.6	55.6	-14.5	44.9	29.3	2.4	5.4	16.8	67.8	-2.2	51.1	-21.9	40.2	27.5	2.5
Jordan	6.3	13.6	65.1	-2.0	56.0	-16.7	39.9	21.0	2.4	12.6	16.2	62.3	-2.8	53.1	-27.3	38.7	21.3	3.1
Kuwait	10.6	24.9	64.7	-2.5	51.9	-22.5	35.3	28.4	1.8	15.9	26.2	62.4	-3.7	48.1	-22.7	32.7	26.1	2.3

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Country	Cost									Profit								
	ε_{11}	ε_{22}	ε_{33}	ε_{12}	ε_{13}	ε_{21}	ε_{23}	ε_{31}	ε_{32}	ε_{11}	ε_{22}	ε_{33}	ε_{12}	ε_{13}	ε_{21}	ε_{23}	ε_{31}	ε_{32}
Lebanon	11.8	22.5	67.4	-4.4	48.4	-15.9	37.2	26.3	1.3	12.0	23.7	65.0	-7.2	44.9	-18.3	34.5	26.5	1.6
Malaysia	16.2	24.0	67.9	-4.7	47.0	-16.3	26.8	24.1	2.0	16.6	22.6	66.6	-5.6	44.7	-22.0	32.5	24.5	2.8
Qatar	16.7	27.6	66.8	-4.8	48.1	-22.5	29.7	20.5	3.0	15.1	28.9	64.0	-5.4	44.3	-25.5	29.7	20.8	4.4
Sudan	12.0	23.1	67.6	-5.3	48.8	-18.6	35.1	25.8	1.0	15.6	25.1	64.7	-5.9	46.7	-25.1	33.5	26.0	1.3
Syria	10.5	20.7	71.5	-3.3	52.0	-19.2	32.7	28.2	1.1	13.9	19.2	68.9	-5.5	44.9	-25.5	27.9	27.9	1.4
Tunisia	15.8	26.0	70.9	-3.7	51.9	-18.3	32.3	27.7	1.3	14.9	26.3	68.4	-6.1	49.2	-22.7	30.4	27.9	1.6
United Arab Emirates	11.7	14.9	68.4	-4.1	48.6	-14.6	30.6	27.7	2.0	15.5	16.2	67.5	-6.2	46.5	-23.4	34.6	28.1	1.9
Yemen	10.6	10.6	70.8	-5.4	49.0	-14.7	33.5	26.5	1.6	15.2	11.8	69.3	-8.5	48.7	-22.1	38.1	26.8	1.8
Average	8.5	17.8	67.1	-3.3	50.7	-16.7	35.2	26.1	2.2	11.4	18.9	65.1	-4.8	47.8	-22.0	33.9	25.9	2.5

Source: Authors' estimates from the data source.

Table 6 shows the average price elasticity of demand inputs between the different prices. The demand price elasticity shows the relationship between price and required quantity and provides a precise calculation of the effect of a change in price on the demanded quantity. The negative sign in cost average (ε_{12} = -3.3 and ε_{21} = -16.7) indicates that P_1 (price) and P_2 (quantity) are inversely related, which is generally expected for most price/demand relationships. The same results were also found in profit average (ε_{12} = -4.8 and ε_{21} = -22.0). The positive demand elasticity for an input in its own price implies that an increase in the price of an input would result in a higher demand.

Table 7.
Spearman rank correlation between economic efficiency and accounting profitability

	ROA	ROE	Cost efficiency	Profit efficiency
ROA	1.000			
ROE	0.547***	1.000		
Cost efficiency	-0.199**	-0.076**	1.000	
Profit efficiency	-0.029*	-0.030**	0.436***	1.000

Note: ***, ** and * represent significance at 10%, 5% and 1%, respectively.
Source: Authors' estimates from the data source.

Table **7** presents the Spearman rank correlation coefficients for the four variables (cost efficiency, profit efficiency, ROE and ROA). The first result shows that cost efficiency is negatively correlated with the ROA and the ROE. This correlation reveals that cost efficiency has little impact on the overall profitability of all the banks. In the same way, profit efficiency is negatively correlated with the ROA and the ROE; yet, it is positively correlated with cost efficiency.

4.3. Comparison of accounting and economics-based profitability measures

First, to make a comparison between the economics and accounting based results, we used the cost and profit efficiency measures from the preceding estimates. Second, to be able to understand the relationship between accounting and economics-based measures of profitability, it is necessary to add the cost and profit efficiency measures as independent variables in Eq. (11)

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for the estimation of the ROA and the ROE. Nevertheless, the results in Table 8 are not similar to those of Table 4 since they are based on time series averages that lead to a single average cross sectional data set of 110 observations. Only profit efficiency is a highly significant explanatory variable for both the ROA and the ROE.

The combination of profit efficiency, loan specialization ratio (LOANS), and the Choc dummy variable (CHOC) gives 5.9%, 0.7% and 2.1% of the variation in the ROA, respectively. However, the LOANS does not explain the variation in the ROE. These results again do not confirm that economics-based measures if profit efficiency is highly correlated with accounting-based measures of profitability.

A third approach to compare economics-based and accounting-based research, as already used in many previous studies (Hassan and Bashir, 2003; Fries and Taci, 2005; Bonin et al., 2005), is used to analyze the correlation between the two approaches. This includes second stage ordinary least square regressions where the individual bank cost and profit efficiency figures from Eq. (7), as shown in Table 5, are transformed into dependent variables and the introduced accounting variables as independent variables. As presented in Table 8, the LOANS and CHOC variables explain about 1.3% and 2.4% of the variation in cost efficiency. The profit efficiency variations are not explained by a single accounting variable but also by the inefficiency ratio (INEFF), which is defined as operating expenses divided by gross income. This explains about 2.2% of the variation in cost efficiency. These relationships indicate that cost and profit efficiency already capture much of the explanatory power of the accounting variables, although some accounting variables might still be useful in a better formulation of efficiency measures. Moreover, the variation of cost efficiency is explained by the variation of CRISK and CAPSTR.

Table 8.
Impact on efficiency and performance: Dynamic panel-data system GMM estimation

	Cost Efficiency		Profit Efficiency		ROA		ROE	
Independent variable	one-step	two-step	one-step	two-step	one-step	two-step	one-step	two-step
Cost efficiency (-1)	0.692*** (6.63)	0.679*** (4.86)	-	-	-	-	-	-
Profit efficiency (-1)	-	-	0.255** (1.98)	0.221* (1.82)	-	-	-	-
ROA (-1)	-	-	-	-	0.686*** (22.96)	0.648*** (5.65)	-	-
ROE (-1)	-	-	-	-	-	-	0.450*** (12.77)	0.593*** (2.87)
Profit efficiency	-	-	-	-	0.059** (2.26)	0.034 (1.38)	2.62* (1.72)	0.606 (0.96)
LOANS	-0.013** (-2.36)	-0.008** (-2.00)	0.003*** (5.67)	0.003** (2.01)	-0.007*** (-4.04)	-0.004 (-1.55)	-0.135 (-1.62)	-0.21 (-0.54)
INEFF	-0.022** (-2.59)	-0.018 (-0.88)	0.1 e^{-3} (0.03)	0.8 e^{-3} (0.14)	-	-	-	-
CRISK	-0.022** (-2.29)	-0.019* (-1.89)	-	-	-	-	-	-
CAPSTR	0.030* (1.66)	0.045* (1.67)	-	-	-	-	-	-
CHOC	0.024** (2.54)	0.017** (2.26)	-0.38 e^{-3} ** (-2.11)	-0.005 (-1.36)	0.021*** (4.78)	0.011** (2.36)	0.254** (2.40)	0.149* (1.91)

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Independent variable	Cost Efficiency		Profit Efficiency		ROA		ROE	
	one-step	two-step	one-step	two-step	one-step	two-step	one-step	two-step
Constant	0.405*** (3.76)	0.364*** (2.88)	0.689*** (5.76)	0.717*** (6.22)	0.033 (0.96)	0.019 (0.56)	-0.737 (-1.06)	-0.297 (-0.42)
AR(1) correlation test	-5.16***	-4.36***	-5.71***	-5.17***	-2.61***	-2.13**	-1.40	-1.38
AR(2) correlation test	0.23	2.63	2.36**	2.20**	0.33	0.64	5.48***	1.46
Sargan test	9.11*	9.11*	2.26	2.26	71.01***	71.01***	114.8***	114.8***

Note: ***, ** and * represent significance at 10%, 5% and 1%, respectively.

Source: Authors' estimates from the data source.

While some accounting variables serve to describe both profitability ratios and efficiency, and even though the efficiency ranking and profitability ratios are a little correlated, the accounting-based and economics-based approaches to interpret the banking performance are not the same. They can present different rankings across banks or countries because the ROA and the ROE are measured purely per unit return on assets or equity. Cost and profit efficiencies are estimated on the basis of the principal practice bank and indicate a relative achievement of a potential profit. As shown in Table 5, the high values of profitability ratios are usually associated with high values of profit efficiency with a few exceptions. For example, Bahraini and Egyptian banks had a 2nd and 3rd rank in terms of the ROE and the ROA but 10th and 11th rank, only, in terms of profit efficiency. In general, the accounting-based and the economics-based approaches present the same measures of the relative banking performance, but they define different aspects of financial performance.

5. CONCLUSION

This paper analyzed the accounting-based determinants of profitability in some banks and compared these results with the economics-based determinants of cost and profit efficiency over the 1999/2012 period. From the accounting-based determinants of ROA and ROE, many variables related to profitability were outside the control of the bank management, like size, security, deposit and labor cost. Economics-based calculation of profit efficiency is closely related to the ROA and ROE accounting ratios. In general, our results show that the accounting-based and economics-based approaches results of interpreting a bank performance are similar in some variables.

The empirical results of our study highlight that the positive correlation between the CHOC variable and the accounting profitability and profit efficiency revealed that the impact of the financial crisis on a bank's profitability is not relevant for the MENA countries banks, in particular, Malaysia, Saudi Arabia and Qatar that have the highest percentage of Average Efficiency.

Relying on the obtained results, we deduced that most conventional banks can improve their profitability, especially by raising the quality of the assets, developing the quality of the management, increasing the non-interest income and improving the bank size.

Therefore, the authorities are recommended to better supervise banks' credit and liquidity risk and enhance banking competition. Furthermore, banks' decision makers should control the liquidity risk indicators by diversifying the income resources and optimizing the costs.

To enrich future research, we had better deepen this analysis by expanding the study period and dividing our sample into groups of countries. In addition, we should take into consideration other explanatory variables for the banking profitability, such as interest rates**,** taxation, exchange rates or financial liberalization.

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EU banks after the crisis: sinners in the hands of angry markets

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ABSTRACT

European Union banks were severely hit by the global financial crisis in 2008 and their stock prices and returns have generally not recovered since then, differently to what has been observed in other sectors (i.e., non-financial corporations) and jurisdictions (i.e., US). In this paper, we focus on three episodes of financial turmoil in EU financial markets occurring after the global financial crisis (August 2015, December 2015 and January 2016, and June 2016) and, through a series of linear regressions, with and without control variables, attempt to determine the common features of those banks which stock returns declined the most. Results of the regressions tend to suggest that size has been driving the decreases in stock returns in the three episodes. Regarding asset quality, the Texas ratio has been a decisive factor in the evolution of stock returns of EU banks in the second and third periods. Interestingly, profitability variables seem not to be statistically significant to explain the declines in stock returns, except in the third period, but only under some specifications. An evolution on the perception by financial market participants on EU banks, with a larger importance on asset quality in the latter periods, can also be observed. Lastly, on the basis of these results, further policy actions would be needed to clean-up the balance sheet of banks, as a necessary step towards full recovery after the global financial crisis.

JEL Classification: G12, G14, G32, G21

Keywords: European banks, stock returns, asset quality, profitability, global financial crisis

"[the Devil]... stands waiting for them, like greedy hungry lions that see their prey, and expect to have it..."

Sinners in the Hands of an Angry God
Jonathan Edwards, 1741

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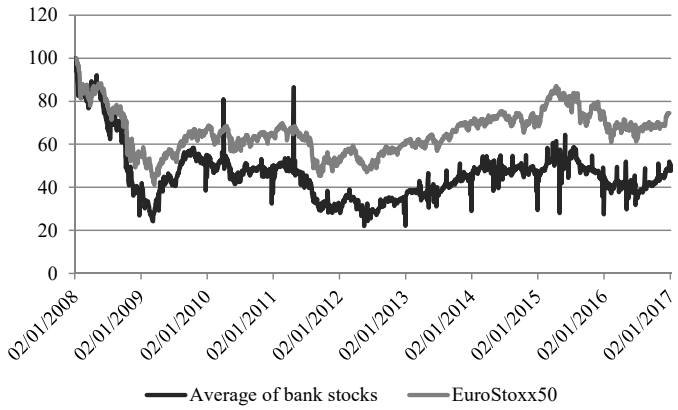
1. INTRODUCTION

European Union (EU) banks have been particularly hit by the global financial crisis. Unlike their peers in the US, there have been ongoing and continuous concerns on the sustainability of the EU banking system (International Monetary Fund, 2016), which have driven equity prices of European banks further down. Actually, equity prices of European banks are, in many cases, below their levels in 2008 (Figure 1). Weigand (2016) analyses in detail the evolution of EU, US and Japanese banks before, during and after the global financial crisis, and highlights the negative evolution of stock returns globally, and in particular in the case of EU and Japanese banks. In comparison with the evolution of the overall indexes of stock markets, EU banks seem to be among the worst performers, with a widening gap between bank stocks and indexes observed since 2012. Even in the aftermath of the global financial crisis (from mid-2012 onwards), EU banks were still subject to sharp, and usually short-lived, episodes of decreases in stock prices and returns, which were not mirrored by other EU listed corporations or by US banks. Like the sinners in the sermon by Jonathan Edwards (1741), EU banks seem to have been the prey of investors, which, almost ten years after the start of the global financial crisis, still perceive them as weak (thus, as an easy prey).

Figure 1.
Evolution of the EuroStoxx 50 and of the stock prices of a sample of EU banks (2 January 2008 = 100)



Notes: For the bank stock prices, the unweighted average of daily indexed stock prices of a sample of large EU banking groups is calculated, regardless of the stock markets where they are listed. Outliers signal days when some, but not all, financial markets in Europe were closed due to holidays.

Source: Bloomberg and author's calculations.

This paper focuses on three of the above-mentioned episodes of financial turmoil in European equity markets, which particularly affected bank stock prices and returns. These episodes took place in (i) August 2015, (ii) December 2015 and January 2016, and (iii) June 2016. August 2015 has been chosen because it was not particularly focused on banks. In the second period, comprising December 2015 and January 2016, concerns of market participants focused mostly on EU banks, with other stocks showing a less negative evolution. Finally, the third period should reflect the outcome of the UK vote regarding its EU membership, which, again, negatively affected banks across the EU. It is important to note that the three periods fall outside the global financial crisis, as an important contribution of this paper is to show how, even in the recovery phase from the global financial crisis, EU banks were still subject to intense pressure by market participants.

This paper takes a strong empirical approach and tries to identify which variables can explain why some banks saw their stock returns fell more sharply than others. The approach taken is purposely simple and departs from complex theoretical models; the idea of developing a general model for equity pricing falls clearly outside the scope of this paper. On the contrary, by using a series of linear regressions based on bank-specific variables, the paper aims at identifying

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common characteristics among the banks which saw their stock returns decline the most, in a context where the global financial crisis was already behind them.

The main input of this paper to the literature relates to the bank-specific variables which could explain stock performance of banks. As the paper is focused on three periods, it is also linked to the literature on event studies of equity performance. Differently to the majority of recent papers, the focus here is on three short episodes after the global financial crisis, not during the global financial crisis itself. Additionally, the paper can contribute to the literature stream looking at market sentiment and investor demand, in particular to the evolution of these two concepts in short periods of time (the three periods under consideration in the paper occur in less than one calendar year). Lastly, the results of the paper can also have practical implications for policy-making for banks in the EU.

The paper is organised as follows. A literature review is presented in Section 2, with the objective of setting the basis for the research carried out later in this paper. Methodology and data are described in Section 3 while results are discussed in Section 4. Section 5 concludes. An appendix with the detailed results of the regressions is included as well.

2. LITERATURE REVIEW

2.1. Main theories on the determination of stock prices

In general terms, stock prices are determined, as almost every price in economics, at the place where supply meets demand. In the case of shares, the number of shares (supply) is fixed[2], so movements in the equity prices are responding mostly to changes in the demand side. Among the main drivers of the demand for a particular stock, information on future cash-flows, market sentiment, long-term trends and seasonal behaviour are usually mentioned. While not having the objective of being exhaustive on a topic about which a rich academic literature exists, the following paragraphs will briefly describe the main arguments of the efficient market hypothesis, the discounted cash-flows models and behavioural finance.

According to the efficient markets hypothesis (EMH), stock prices always incorporate all the available information about the underlying entity and hence changes in prices can only be explained due to new information of relevance to the stock price. Fama (1970) defines a market as efficient if prices fully reflect all available information and, therefore, stock prices are supposed to follow a "random walk". The EMH comes in three forms: the weak form states that current prices fully incorporate information contained in the past history of prices only; the semi-strong form of the EMH states that current prices fully incorporate all publicly available information, which includes past prices but also other forms of possibly relevant information on fundamental or macroeconomic factors; and the strong form states that current prices incorporate all existing public and private information. The latter implies that it is not possible to generate profits in trading even when using non-public information (Clarke et al. 2001). The EMH excludes the possibility of having a speculative component in stock prices and argues that prices in efficient markets are unforecastable (Samuelson, 1965), since the only variable to determine stock prices is information. In other words, it is not possible to outperform the markets on a regular basis. The EMH reached its peak of popularity in the 1970s.

In discounted cash flows (DCF) models, the price of a stock reflects all the future profits derived from that stock, discounted to the present day using a given discount rate. The discount rate usually has two components: a risk-free part and a risk premium. Fischer (1930) and Burr Williams (1938) described the main arguments of this method, which was fairly popular after the Great Depression in

[2] Unless, of course, there is a capital increase or a similar operation.

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1929. When the DCF is applied to the price of stocks in efficient markets, their price should reflect their intrinsic long-term value, which is given by the present value of its future net cash flows, including dividend distributions and the selling price. However, the DCF is subject to substantial assumption bias and minor changes in the assumptions (for example, the discount rate or the future dividends) may fundamentally change the final result (Damodaran, 2011; Steiger, 2008).

Behavioural finance, which emerged in the 1990s, focuses on modelling human psychology in its relation to financial markets, shifting away from econometric analyses of prices, future cash flows and similar variables. Byrne and Brooks (2008) comprehensively review the many avenues of behavioural finance. One first area of work discusses whether and how investor sentiment can affect stock prices and returns. Traditional finance has typically given little attention to investment sentiment in asset pricing but several researchers have found evidence of investor sentiment affecting stock returns, in particular those which are more difficult to value (Baker and Wurgler, 2006; Tetlock, 2007). Actually, Baker and Wurgler (2007) find that stock prices of low capitalised, younger, unprofitable, highly volatile, non-dividend paying, intensively growing or distressed companies are more likely to be affected by broad waves of investor sentiment. A second relevant area of work in behavioural finance refers to the under- and overreaction of investors to information in prices of securities. Empirical evidence suggests that stock prices show short-term (up to 12 months) return continuations, also called momentum, while this trend is reversed in the longer term (Jegadeesh and Titman, 1993). Moreover, behavioural finance claims that it can explain why and how financial markets are inefficient. Even if Fama (1998) considers that markets can generally be considered efficient, behavioural economists believe that psychological factors in investors may drive prices far from their fundamental value (De Bondt et al., 2015; Schiller, 2003; Shleifer, 2000).

Behavioural finance introduces the concept of investor sentiment, which Baker and Wurgler (2007) define as a belief about future cash flows and investment risks that is not justified by the facts at hand, as one of the main factors to explain movements in stock prices. The notion of investor sentiment is close to the analysis done in this paper, which tries to determine those bank-specific variables which may be driving the demand of stocks of European banks and whether these variables can change over short periods of time. Even if at a rather modest level, this paper can contribute to this stream of academic literature.

In the search of these bank-specific variables, the future evolution of profits and dividends, as outlined by the DCF models, emerges as a significant factor to drive stock prices and returns. A second set of relevant variables are those related to asset quality. At this point, it is also necessary to refer to the probability of default of an entity, as it is directly linked with the asset quality of a bank as well as with the behaviour of investors. A key contribution in this area is that of Merton (1974), who develops a model for the pricing of bonds, according to which, the probability of default of an entity would be a non-linear function of leverage, volatility and risk-free rates. In this sense, investors in equity markets would demand certain compensation for investing in banks, which are sensitive to tail risk events. So, considering similar leverage and exogenous risk-free rates, those banks which are more affected by periods of financial turmoil (higher volatility of stock prices) would have a higher probability of default. Nagel and Purnanandam (2015) amend the Merton model as they consider that volatility of assets is not constant, as assumed by Merton, but can rise substantially following a bad asset value shock. In this sense, they highlight the importance of asset quality in the determination of the probability of default of a bank.

2.2. Determinants of bank stock prices and returns

The main contribution of this paper relates to the stream in the literature exploring the determinants of bank stock prices and returns. Hence, the following paragraphs discuss relevant papers from the academic literature in this field.

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There are numerous academic papers which look at the determinants of bank stock prices and returns from a structural point of view, covering a long period of time and using a limited set of independent variables. To name just few of the many studies available, Liadakia and Gaganis (2010) find evidence that changes in efficiency have a positive and significant impact on stocks prices. Demirgüç-Kunta and Huizinga (2013) investigate the impact of bank size and government deficits on bank stock prices and CDS spreads and find that a bank market-to-book value is negatively related to the size of its liabilities-to-GDP ratio. Castrén et al. (2006) combine the dynamic dividend-discount model with an accounting-based vector autoregression framework that allows for a decomposition of EU banks stock returns to cash-flow and expected return news components. They find that a significant part of the changes in EU banks stock returns can be explained by cash-flows, with higher importance of this factor in the case of large banks. They also find evidence suggesting that large banks could be more sensitive to market-wide news and events, as opposed to bank-specific news. Cooper at al. (2003) use bank-specific variables over a sample of US banks to check which ones determine their stock returns and find that variables related to non-interest income, impairment allowances (loan-loss reserves), earnings, leverage, and standby letters of credit are relevant to forecast bank stock returns. Surprisingly, book-to-market ratios and size are not relevant in their sample.

As said, these papers take a structural approach, as they look at the evolution of bank stock prices and returns over a long horizon. From a conjectural perspective, several authors have recently looked at variables which could explain stock performance of banks during the global financial crisis.

Beltratti and Stulz (2012) find that banks with larger funding from short-term capital markets saw their stock prices decline more than others during 2007 and 2008. Other factors, like regulation or corporate governance did not seem to be a relevant factor in the evolution of stock prices in those years. Interestingly, they do not include variables related to asset quality in their regressions. It is also worth referring to Fahlenbrach et al. (2012), who compare stock performance of US banks during the 1998 financial crisis and the global financial crisis. They find that, for each percentage point of loss in the value of its equity in 1998, a bank lost an annualized 66 basis points during the global financial crisis. These findings are consistent with the risk culture hypothesis and inconsistent with the learning hypothesis; in other words, according to the authors, there seem to be some banks which tend to continuously take on more risk and are always hit by crisis, not learning from the past experiences. Aebi et al. (2012) investigate the relation between bank stock returns during 2007 and 2008 and the governance structure of a sample of US banks. While standard governance measures do not seem to be significant factors explaining the performance of US banks during the crisis, variables related to risk governance are. Finally, Salvador (2017) compares the reaction of banks stock returns to actions by credit rating agencies before and after the global financial crisis. He finds a change in the reaction of investors to changes in the ratings of a sample of European banks after the crisis, when they become more sensitive to upgrades. He also documents different reactions to changes in ratings by different agencies.

In what concerns bank-specific variables, Filbeck et al. (2011) argue that size positively impacted stock performance of US banks before the global financial crisis, as it would provide additional resilience to changing economic conditions. Irresberger et al. (2015) examine the role of investors' sentiment indicators in the performance of the stock prices of sample of more than 400 banks, during the global financial crisis. They find that idiosyncratic bank variables as well as investors' market sentiment influenced the price dynamics of banks those years, with healthier and larger banks being less influenced by market sentiment. In this area, it is also interesting to note the findings of Cabrera et al. (2016), who argue that bank stock returns fall in response to a deterioration of governments' financial situation. When they add bank-specific variables, only the return of assets is statistically significant in their regressions, while they have little evidence on the significance of the size of banks.

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Considering the determinants of bank stock returns, the model by Yang and Tsatsaronis (2012) explains bank stock returns using three factors: differences with the broader market returns, size and value. The model is further expanded with the addition of leverage, earnings, book-to-market values and the business cycle. They find that the excess returns on bank equities are highly correlated with the business cycle (measured as deviations from GDP trends), with a relevant role played in the majority of specifications by market returns, leverage, size and earnings. In a similar vein, Chan-Lau et al. (2012) use fixed-effect panel regressions to assess the impact of growth, sovereign risk, funding stress and investor sentiment on banks' equity returns. They find that sovereign risk, purchasers' managers indexes and the VIX are relevant to explain the evolution of bank stock returns between January 2006 and October 2011. When their specification is expanded to incorporate bank-specific variables for a sample of euro area banks, they find that only leverage is statistically significant. In general terms, Chan-Lau et al. (2012) find that better capitalised banks and those with less leverage performed better during the crisis.

This paper is also indirectly related to the literature on event studies on equity performance. In this domain, Schweitzer (1989) provides an accessible and interesting introduction to the field of event studies. In relation to event studies focused on bank stock returns, it is worth referring shortly to Cao and Petrasek (2014), who analyse the factors which affect the relative performance of stocks during liquidity crises and find that abnormal stock returns during liquidity crises are strongly negatively related to liquidity risk; and to Schäfer et al. (2013), who analyse the reaction of stock returns and CDS spreads of banks from Europe and the United States to four major regulatory reforms in the aftermath of the global financial crisis and find evidence of a market reaction to the introduction of these pieces of regulation.

To sum up, this paper aims at explaining why the stock returns of a given bank fell more sharply than those of another bank in three concrete episodes of market turmoil, having, thus, a strong cross-sectional component. Therefore, bank-specific variables are of the essence, bringing the paper under the stream of literature working on determinants of bank stock returns. At the same time, as the focus is on three periods of financial turmoil, the paper also relates to the literature on event studies. Lastly, the paper tries to identify whether there has been changes in the factors driving investors demand for bank stocks, a task related to the literature on the determinants of stock prices and of investor demand over short periods of time.

3. METHODOLOGY AND DATA

3.1. Methodology

This paper purposely remains simple in the approach and does not try to define a new theoretical model to explain valuation of bank stocks. On the contrary, it takes a fully empirical approach by using publicly available bank-level information to try to explain the dynamic behaviour of stock returns in three concrete periods of financial turmoil. The choice for stock returns and not for stock prices is made in order to consider dividends and other benefits paid to shareholders.

In what regards the periods of financial turmoil, they refer to declines in stock returns observed within a month or two, occurring all of them after the global financial crisis. The first period happened in August 2015 and for the purposes of this paper it is assumed to coincide with the calendar month of August. It has been chosen because it extended to the majority of listed institutions, not particularly affecting banks. The second period covers the last days of 2015 and the first days of 2016. For the purposes of the regressions, it is expected to start on 1 December 2015 and to finish on 31 January 2016. In this case, contrary to the previous period, concerns of market participants focused mostly on EU banks, with other stocks showing a less negative evolution. Finally, we have selected as our third period the last week of June 2016, following the

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outcome of the UK vote regarding its EU membership. Even if not completely accurate but to ensure a coverage of at least one month, this period is assumed to start on 1 June 2016 and finish on 30 June 2016. Interestingly, stock returns declines in this period did not seem to be directly related with the UK, but were seen mainly as a continuation of the stock return declines in the second period.

The initial equation which we try to regress on each period t is as follows:

$$R_t - R_{t-1} = \Delta R = a_t + \beta_1 S_t + \beta_2 P_t + \beta_3 AQ_t + \varepsilon_t \quad (1)$$

where R is the monthly return of the stock, a is a constant, S refers to an indicator on the size of the bank, P is an indicator related to the profitability of the bank, AQ is an indicator referring to the asset quality, ε is the error term and β_1, β_2 and β_3 refer to the coefficients of each indicator.

The three categories of indicators (size, profitability and asset quality) have been chosen as they are typically identified as relevant, on a bank-specific basis, for the performance of bank stocks. In addition to factors like economies of scale and diversification, size could also be related to the existence of an implicit subsidy in financial markets for larger institutions, for reasons of their too-big-to-fail status. Profitability directly relates to the capability of a bank to generate returns, normally in the form of dividends, for its shareholders on a sustainable basis. Finally, asset quality variables are closely related to the macroeconomic environment of the bank and may reflect the impact of that environment on the normal course of business of banks and on its probability of default.

Instead of considering a close set of indicators, which would entail the difficult and subjective decision of choosing the most informative one, several indicators for each of the three characteristics under consideration have been considered. This would add some robustness to the results in case indicators of similar nature behave similarly in the regression.

The indicators we have considered are summarised in Table 1.

Table 1.
Indicators considered in the regressions

Size	Total assets	logs, thousands of Euros	Total assets according to accounting standards
	Total capital	logs, thousands of Euros	Total capital according to accounting standards
	Domestic exposures	percentage	Percentage of banking book exposures located in the domestic country of the bank
Profitability	Return on equity	percentage	Ratio between net profit and equity of the bank
	Net interest margin	percentage	Net interest income (interest income minus interest expense) to total assets
Asset quality	Texas ratio	percentage	Gross carrying amount of non-performing loans divided by the sum of own funds and accumulated provisions
	NPL rate	percentage	Gross non-performing loans to total gross loans, for loans to households and non-financial corporations

Source: Author's elaboration.

The seven indicators in Table 1, which would enter the regression in equation (1) as independent variables, have been selected on the basis of the following considerations:

- The three indicators related to size would cover the size of the balance sheet of the bank (total assets) as well as the capital available for the bank to withstand unexpected losses (total

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capital). In both cases, amounts are taken from the accounting domain. The third variable (domestic exposures) tries to capture the cross-border dimension of each bank, in the sense that highly interconnected banks could enjoy a certain too-big-to-fail status in comparison with entities of similar size and risk profile.

- For profitability, net interest margin would consider the ability of banks to generate profits in their core business (granting loans and accepting deposits from customers). Return on equity would put the profit generated by the bank in the broader context of the remuneration of the shareholder and of the difference with the cost of capital. In the first case, higher remunerations to shareholders would, in principle, lead to increases in stock returns, while, in the second case, positive differences with the cost of capital would point towards a sustainable path of profits into the future.
- Regarding asset quality, the NPL rate is the most common and basic indicator for comparing asset quality across banks. This indicator is complemented by the Texas ratio, which measures the portion of NPLs which are not covered by either capital or accumulated provisions. Historically, the Texas ratio has performed rather well as an indicator of banks under stress.

A basic OLS regression is run first over the cross-sectional data for a sample of 53 EU banks.[3] Each of the three episodes of financial turmoil is considered separately, allowing us to better understand the dynamics of market participants towards EU banks in each particular episode. In other words, three sets of regressions are run. In terms of the indicators in Table 1, all possible combinations of the variables in Table 1 are covered, leading to a total of 12 regressions.[4] Then, those variables which are statistically significant (according to their p-values)[5] and which have the expected sign are considered to be relevant in the explanation of the change in the stock returns of banks. Additionally, measures of goodness of fit (adjusted R squared, SE of regression, log likehood, Akaike info criterion, Schwarz criterion and Hannan-Quinn criterion) are also assessed, as they could hint at the regressions and variables with the highest explanatory power.

This is somehow a novel approach, as it relies entirely on bank-specific indicators to explain the evolution of stock returns and it gives the same consideration to all banks in the sample, regardless of their country of domicile. On the first point, it is important to note that the macroeconomic environment of each bank is indirectly present in the regressions, via the variables related to asset quality and, to a lesser extent, to profitability (there is prolific literature on the link between the macroeconomic environment and NPLs; see, for example, Beck et al., 2013). Besides, the purpose of the paper is not placed on the relation between stock returns and the macroeconomic environment, but to identify factors which investors weigh when in a period of financial stress. The main reason for non-discriminating by country is that in the three episodes it has been observed that stock returns of banks with domicile in the same country evolved differently. At the same time, introducing a series of country dummies would negative affect the degrees of freedom of the OLS regression, which are already rather constrained.

Nonetheless, for robustness purposes, a second set of regressions are run, considering only one regression per period. These regressions would, first, start with all the indicators outlined in Table 1, complemented with control variables for the macroeconomic environment, the stock market performance (index returns) and the country of the bank will be added to the regression. So, in a stylised way, equation (1) would then become:

$$R_t - R_{t-1} = \Delta R = \beta_1 S_t + \beta_2 P_t + \beta_3 AQ_t + \beta_4 ME_t + \beta_5 SI_t + \beta_6 C_t + \varepsilon_t \quad (2)$$

[3] Tests for spatial auto-correlation and for heteroscedasticity (White's) are run over each regression.

[4] These are the following: (1) total assets, net interest margin, NPL rate; (2) total assets, net interest margin, Texas ratio; (3) total assets, ROE, NPL rate; (4) total assets, ROE, Texas ratio; (5) total capital, net interest margin, NPL rate; (6) total capital, net interest margin, Texas ratio; (7) total capital, ROE, NPL rate; (8) total capital, ROE, Texas ratio; (9) domestic exposures, net interest margin, NPL rate; (10) domestic exposures, net interest margin, Texas ratio; (11) domestic exposures, ROE, NPL rate; and (12) domestic exposures, ROE, Texas ratio.

[5] For a significance level of 0.05.

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where, in addition to the variables in equation (1), ME refers to a variable capturing the macroeconomic environment, I is a stock market return index, C is a dummy variable referring to the country of domicile of each bank, and β_4, β_5 and β_6 refer to the coefficients of each indicator. The constant is dropped from this equation as it would generate collinearity with the control variables introduced.

3.2. Data

The change in stock returns is calculated as the difference between the return of a given stock at the end of the month and the return of the same stock at the beginning of the month. For the second period December 2015–January 2016, the two months are considered together. The descriptive statistics of the change in stock returns of the EU banks in the sample are provided in Table 2, while Figure 2 shows the distribution of banks in the three periods according to the changes in their stock returns. In the three periods under consideration, the stock returns at the end of the period were lower than at the beginning for approximately 90% of the 53 banks in the sample. It is worth noting that the change in stock returns in the month of August 2015 was the smallest, on average, while the decreases in stock returns in the other two periods are of a similar magnitude. The amplitude of the change in stock returns (given by the difference between maximum and minimum) are lower for the period of August 2015 and substantially higher for the other two periods, in particular for the period December 2015–January 2016.

Table 2.
Descriptive statistics of changes in stock returns

	August 2015	December 2015–January 2016	June 2016
Mean	-5.62%	-17.65%	-16.78%
Median	-5.24%	-14.31%	-18.01%
Minimum	-17.60%	-78.18%	-40.53%
Maximum	3.98%	4.63%	4.68%
Standard deviation	4.66%	16.27%	11.64%
% of stocks with a negative variation	88.24%	92.16%	92.16%
Number of banks in each interval of changes in stock returns			
> 0.05	0	0	0
[0/0.05)	8	6	6
[-0.05/0)	16	3	5
[-0.10/-0.05)	20	11	7
[-0.15/-0.10)	7	7	4
[-0.20/-0.15)	2	7	8
[-0.25/-0.20)	0	7	11
[-0.30/-0.25)	0	5	4
[-0.35/-0.30)	0	2	4
< -0.35	0	5	4

Source: Bloomberg and author's calculation.

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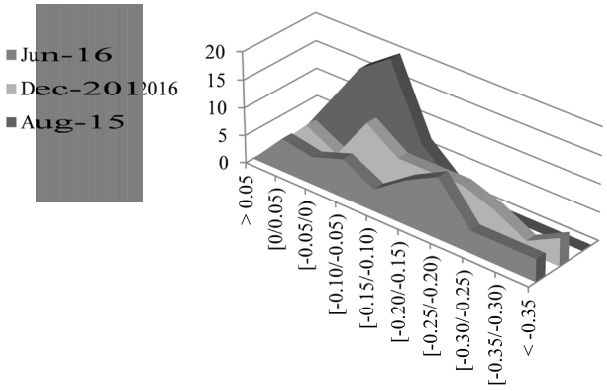
Figure 2 also visually shows how changes in stock returns over the three periods were differently distributed. Changes in stock returns in August 2015 were highly concentrated around the mean, while, for the other two periods, larger heterogeneity is observed. The bank-specific factors behind this heterogeneity in the changes in stock returns constitute the core of the analysis in this paper.

Figure 2.
Distribution of changes in bank stock returns (number of banks in each interval)



Source: Bloomberg and author's calculations.

The dataset used for the independent variables in equation (1) is mostly derived from the European Banking Authority (EBA) Transparency Exercises of years 2015 and 2016. It covers an initial sample of 53 large EU banking groups, which are also listed in equity markets. Two banks were removed from the data in the two most recent periods due to significant restructuration. The initial sample of 53 banks comprises 10 Italian banks, 9 Spanish, 4 German, 4 Swedish, 4 British, 3 Danish, 3 Dutch, 3 Irish, 2 Cypriote, 2 French, 2 Portuguese, 1 Austrian, 1 Belgian, 1 Polish, 1 Norwegian 1 Maltese, 1 Hungarian and 1 Slovenian.

The data used in the regressions for the decline in stock returns in August 2015 has a reference date of 30 June 2015. In the case of December 2015 and January 2016, and June 2016, data with reference dates 31 December 2015 and 30 June 2016 have been used, respectively. The only exception to that is the data for the percentage of domestic exposures, which is computed with a reference date of 30 June 2015 for the three cases, due to the limited availability of the necessary data to calculate them in the most recent EBA Transparency Exercise. Given the structural nature of the underlying information (the cross-border activity of a given bank), no major impact should be expected from this exception. Besides, in limited cases, data on total assets and total capital had to be proxied using leverage ratio exposures from the EBA Transparency Exercise 2015 or, in only one case, using the same data than in the previous period.

Leaving aside these exceptions, the choice of reference dates tries to ensure that the most recent data to each episode is used, even if it was not publicly available. The reasoning behind this decision is that it is assumed that stock prices and returns, as well as market participants, almost contemporaneously absorb all information from the underlying banks (more inclined, then, towards a strong EMH).

As the variable to control for the macroeconomic environment, the closest available quarterly growth rate of GDP of the country of domicile of the bank is selected. The Eurostoxx50 stock returns (already shown in Figure 1) would be the control variable for the evolution of stock markets. Finally, for the country of domicile of the bank a dummy variable is introduced, which takes the value of 1 for those banks domiciled in an EU country which was more severely hit by the global financial crisis (Hungary, Ireland, Cyprus, Portugal, Slovenia, Spain and Italy). These are countries where there has been a form of financial assistance since 2008 or where the

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banking system has been confronted with a significant peak in the levels of NPLs and widespread concerns about their banking system.

For each bank and for each reporting date, data as described in Table 3 is used in the different regressions.

Table 3.
Information on data used in the regressions

Indicator	Source	Reference dates
Stock returns (EuroStoxx 50 and banks)	Bloomberg	Changes in monthly returns in August 2015, December and January 2015, and June 2016
Total assets	SNL (if not available, leverage ratio exposures, banks' financial statements or data from previous periods)	30 June 2015, 31 December 2015 and 30 June 2016
Total capital	SNL (if not available, leverage ratio exposures, banks' financial statements or data from previous periods)	30 June 2015, 31 December 2015 and 30 June 2016
Domestic exposures	EBA Transparency Exercises 2015 and 2016, and author's calculations	30 June 2015
Return on Equity	EBA Transparency Exercises 2015 and 2016, and author's calculations	30 June 2015, 31 December 2015 and 30 June 2016
Net interest margin	EBA Transparency Exercises 2015 and 2016, and author's calculations	30 June 2015, 31 December 2015 and 30 June 2016
Texas ratio	EBA Transparency Exercises 2015 and 2016, and author's calculations	30 June 2015, 31 December 2015 and 30 June 2016
NPL rate	EBA Transparency Exercises 2015 and 2016, and author's calculations	30 June 2015, 31 December 2015 and 30 June 2016
Quarterly growth rate of GDP	Eurostat	30 September 2015, 31 December 2015 and 30 June 2016

Source: Author's elaboration.

Descriptive statistics of the bank-specific independent variables are provided in Table 4. Since the reference dates for the data used in the regressions for the three periods span over a relatively short period of time (one year, from June 2015 to June 2016), there are no major developments observable in the data. It is worth noting, though, a rather limited improvement in the variables of a more cyclical nature (return on equity and NPL rate).

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Table 4.
Descriptive statistics of bank-specific independent variables

August 2015 (reference date 30 June 2015)					
		Mean	Median	Minimum	Maximum
Total assets	thousand €	412,869,732	129,800,000	4,650,000	2,176,062,228
Total capital	thousand €	23,116,389	9,443,500	552,000	157,193,067
Domestic exposures	%	70.82%	77.43%	1.23%	100.00%
Return on Equity	%	2.53%	4.52%	-61.65%	9.42%
Net interest margin	%	1.35%	1.27%	0.35%	4.01%
Texas ratio	%	72.36%	57.10%	8.27%	204.65%
NPL rate	%	13.87%	9.62%	0.63%	60.67%
December 2015 – January 2016 (reference date 31 December 2015)					
		Mean	Median	Minimum	Maximum
Total assets	thousand €	411,717,916	144,804,937	4,246,167	2,218,570,279
Total capital	thousand €	25,164,608	10,070,235	623,073	181,854,823
Domestic exposures	%	70.82%	77.43%	1.23%	100.00%
Return on Equity	%	5.15%	6.08%	-18.26%	14.65%
Net interest margin	%	1.47%	1.35%	0.11%	5.10%
Texas ratio	%	63.42%	47.51%	6.75%	186.79%
NPL rate	%	13.29%	7.82%	0.60%	60.57%
June 2016 (reference date 30 June 2016)					
		Mean	Median	Minimum	Maximum
Total assets	thousand €	425,952,129	144,747,352	4,224,392	2,349,942,249
Total capital	thousand €	24,671,583	9,636,282	633,489	178,665,597
Domestic exposures	%	70.82%	77.43%	1.23%	100.00%
Return on Equity	%	6.72%	7.47%	-18.33%	21.11%
Net interest margin	%	1.48%	1.36%	0.10%	4.81%
Texas ratio	%	61.21%	46.40%	7.05%	178.12%
NPL rate	%	12.77%	7.15%	0.52%	57.82%

Source: EBA, SNL and author's calculation.

As explained above, together with the regressions using solely bank-specific variables, a second set of regressions is run, where variables are added to control for the macroeconomic environment: quarterly rate of growth of GDP at current prices of the country of domicile of the bank (measured in national currency, seasonally and calendar adjusted); the evolution of the general stock market index (change in monthly returns of the EuroStoxx50); and the country of domicile of the bank (dummy variable). Descriptive statistics for the first two variables are provided in Table 5 below.

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Table 5.
Descriptive statistics of independent variables used as controls

	Quarterly growth rate of GDP				EuroStoxx 50 monthly stock return – change
	Mean	Median	Minimum	Maximum	Value
August 2015	0.99%	0.74%	-0.06%	4.87%	-8.31%
December 2015 – January 2016	0.80%	0.87%	-0.19%	2.40%	-9.88%
June 2016	0.66%	0.68%	-0.27%	2.27%	-3.96%

Source: Eurostat, Bloomberg and author's calculation.

A comparison of the evolution of the changes in the stock returns of the EuroStoxx50 (Table 5) and of the stock returns for our sample of banks (Table 2) reveals that the EuroStoxx50 fell more than the banks in our sample in August 2015, with the opposite being observed in the other two periods, in particular for June 2016. Regarding the macroeconomic environment, it seems to be deteriorating as time went by.

Finally, Table 6 shows the correlations between all the variables considered in the two sets of regressions for each of the periods (with the exception of changes in EuroStoxx50 returns). Correlations amidst independent variables will be used when running the second set of regressions (those with control variables) as guidance to gain degrees of freedom by reducing the number of independent variables. Highest correlations are found between the variables of total assets and total capital, followed by the NPL rate and the Texas ratio. In general, independent variables belonging to any of the three wide categories (size, profitability, asset quality) show significant correlations among them.

Table 6.
Correlation matrixes of independent variables

August 2015									
	Total assets	Total capital	Domestic exposures	Return on Equity	Net interest margin	NPL rate	Texas ratio	GDP growth	Country
Total assets	1.0000								
Total capital	0.9514	1.0000							
Domestic exposures	-0.5979	-0.5657	1.0000						
Return on Equity	0.1127	0.1216	-0.1742	1.0000					
Net interest margin	-0.1911	-0.1346	-0.2472	-0.0434	1.0000				
NPL rate	-0.3669	-0.3354	0.4018	-0.0345	0.1501	1.0000			
Texas ratio	-0.4512	-0.4173	0.5203	-0.2054	0.0558	0.8644	1.0000		
GDP growth	-0.2568	-0.2518	-0.0147	-0.0477	0.0994	0.1269	0.1991	1.0000	
Country	-0.4056	-0.3194	0.4473	0.0419	0.1219	0.6385	0.7170	0.2617	1.0000

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December 2015 – January 2016									
	Total assets	Total capital	Domestic exposures	Return on Equity	Net interest margin	NPL rate	Texas ratio	GDP growth	Country
Total assets	1.0000								
Total capital	0.9589	1.0000							
Domestic exposures	-0.6284	-0.5829	1.0000						
Return on Equity	-0.0414	-0.0023	-0.0463	1.0000					
Net interest margin	-0.1654	-0.0838	0.0478	-0.0760	1.0000				
NPL rate	-0.3813	-0.3457	0.3797	-0.5042	0.4224	1.0000			
Texas ratio	-0.4634	-0.4253	0.5022	-0.4857	0.3018	0.8640	1.0000		
GDP growth	-0.2171	-0.1994	0.0317	0.0267	0.1679	0.0730	0.0150	1.0000	
Country	-0.4101	-0.3229	0.4343	-0.2244	0.3133	0.6096	0.7214	0.1723	1.0000
June 2016									
	Total assets	Total capital	Domestic exposures	Return on Equity	Net interest margin	NPL rate	Texas ratio	GDP growth	Country
Total assets	1.0000								
Total capital	0.9523	1.0000							
Domestic exposures	-0.6244	-0.5872	1.0000						
Return on Equity	0.0119	0.0245	-0.1095	1.0000					
Net interest margin	-0.2729	-0.1679	0.0835	0.3409	1.0000				
NPL rate	-0.3715	-0.3363	0.3791	-0.3038	0.3656	1.0000			
Texas ratio	-0.4590	-0.4188	0.4902	-0.4326	0.2157	0.8702	1.0000		
GDP growth	0.0162	0.0596	-0.1717	0.1189	0.1934	0.0742	-0.1044	1.0000	
Country	-0.4100	-0.3120	0.4343	-0.2299	0.3392	0.6055	0.7254	-0.1735	1.0000

Source: Author's calculation.

4. DISCUSSION OF RESULTS

The results of the regressions run under equations (1) and (2) over the three periods of market turmoil are separately discussed in the following paragraphs, with more detailed information available in the Appendix.

4.1. August 2015

The decline in stock returns of EU banks in August 2015 has been typically attributed to concerns about certain emerging market economies, following a significant expansion of financial flows into these economies in previous years. Consequently, it could be expected that EU banks of larger size would have seen their stock returns decline more, as they would be supposed to have higher exposures to emerging economies. The sign of the relation between total assets or total capital, and the stock returns would be negative: more size would imply a lower stock return. For domestic exposures, the contrary would apply: a positive sign would be expected, indicating that stocks of those banks with more domestic activities (and less cross-border activities) would decline less.

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Table 7 below summarises the main outcome of the regressions carried out on the August 2015 stock returns.

Table 7.
Results of the regressions on changes in stock returns in August 2015 – bank specific variables

Regression	Constant	Size	Profitability	Asset quality
1	**(+)**	**(-) Total assets**	**(-) Net interest margin**	NPL
2	(+)	(-) Total assets	**(-) Net interest margin**	Texas ratio
3		**(-) Total assets**	ROE	NPL
4		**(-) Total assets**	ROE	Texas ratio
5	**(+)**	**(-) Total capital**	Net interest margin	NPL
6	(+)	(-) Total capital	Net interest margin	Texas ratio
7		**(-) Total capital**	ROE	NPL
8		**(-) Total capital**	ROE	Texas ratio
9	**(-)**	**(+) Domestic exposures**	Net interest margin	NPL
10	(+)	(+) Domestic exposures	Net interest margin	Texas ratio
11	**(+)**	**(+) Domestic exposures**	ROE	NPL
12	**(-)**	**(+) Domestic exposures**	ROE	Texas ratio

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold, together with their sign. The sign of the constant is shown only when statistically significant.

Source: Author's calculation.

From these results, it can be observed how the variable used to quantify banks size is consistently significant over the regressions, with the expected sign in all cases. Variables on asset quality are never significant, whereas net interest margin, reflecting bank profitability, is statistically significant only in two out of the twelve regressions (but with the contrary sign as expected). These results seem to validate the starting assumption that the declines in stock returns of EU banks observed in August 2015 stemmed from concerns about growth in emerging economies and affected larger banks.

In terms of measures of goodness of fit, all the considered measures perform similarly across the twelve regressions. If any, the adjusted R squared would point towards the fifth regression, where capital, net interest margin and the NPL rate are the variables considered, but only capital is statistically significant, as that with highest goodness of fit.

The regressions considering only bank-specific variables have shown that the changes in stock returns affected mostly banks of larger size and with more cross-border activities. It is interesting to compare these results with those stemming from the introduction of control variables (Table 8). The first point to note is that, in the first four columns in Table 8 (considering all bank-specific variables, all variables, and all variables except total assets or total capital), there is no variable which is statistically significant at the level of 0.05. Only when both total assets and total capital are excluded from the equation (column 5), the changes in EuroStoxx50 return and domestic exposures become significant, with positive sign in both cases, implying a positive relation between the share of domestic exposures and the changes in stock return as well as a certain co-movement between stock returns of the EuroStoxx50 and of the banks in our sample. The regression in column 5 also reveals some counterintuitive signs in some of the other variables (even if they are not statistically significant): the negative sign of GDP growth, net interest margin and return on equity, and the positive sign of the NPL rate and the Texas ratio. The exclusion of the GDP growth from the regression (column 6) does not introduce any significant change

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in the results. A regression without the Texas ratio (column 7) leads to the significance of the country dummy and the NPL rate, in addition to the changes in EuroStoxx50 return and the domestic exposures. While the country dummy reflects the expected negative sign (implying that those banks from countries more affected by the global financial crisis performed worse), the positive sign of the NPL rate seems to be sending an opposing signal. Dropping the NPL rate from the regression (column 8) makes also the country dummy not statistically significant, while leaving the coefficients of the other two statistically significant independent variables rather unchanged. Measures of goodness-of-fit suggest that regressions of columns 6 and 7 have the highest explanatory power.

Table 8.
Results of the regressions on changes in stock returns in August 2015

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth		-0.4188	-0.4278	-0.4312	-0.2623			
		0.5767	0.5720	0.5694	0.5618			
EuroStoxx50 return		-0.2293	-0.8936	-0.6856	**1.1652**	**1.1939**	1.1928	1.2500
		2.0119	1.6178	1.3729	0.3108	0.3020	0.2814	0.2921
Country		-0.0277	-0.0306	-0.0292	-0.0329	-0.0346	**-0.0345**	-0.0164
		0.0186	0.0178	0.0178	0.0178	0.0173	0.0153	0.0136
Constant	-0.0308							
	0.1648							
Total assets	0.0256	0.0099	-0.0076					
	0.0307	0.0315	0.0058					
Total capital	-0.0331	-0.0176		-0.0080				
	0.0304	0.0312		0.0058				
Domestic exposures	0.0516	0.0507	0.0452	0.0465	**0.0711**	**0.0731**	**0.0731**	0.0845
	0.0333	0.0342	0.0325	0.0311	0.0259	0.0253	0.0246	0.0252
Net interest margin	-0.7701	-0.7524	-1.0915	-0.9638	-0.5130	-0.5267	-0.5282	-0.1741
	1.2715	1.2575	1.0956	1.0499	1.0081	0.9991	0.9781	1.0065
Return on Equity	-0.0473	-0.0265	-0.0376	-0.0324	-0.0400	-0.0387	-0.0389	-0.0421
	0.0686	0.0691	0.0656	0.0657	0.0661	0.0655	0.0592	0.0617
NPL rate	0.1479	0.1068	0.0804	0.0905	0.1209	0.1257	**0.1264**	
	0.1060	0.1074	0.0959	0.0930	0.0913	0.0900	0.0557	
Texas ratio	-0.0292	0.0016	0.0076	0.0051	0.0020	0.0003		
	0.0297	0.0339	0.0320	0.0317	0.0319	0.0314		
R-squared	0.3055	0.3551	0.3504	0.3537	0.3256	0.3223	0.3223	0.2480
Adjusted R-squared	0.1975	0.2202	0.2323	0.2361	0.2206	0.2339	0.2502	0.1854
S.E. of regression	0.0417	0.0411	0.0408	0.0407	0.0411	0.0408	0.0403	0.0420
Sum squared resid	0.0783	0.0727	0.0733	0.0729	0.0760	0.0764	0.0764	0.0848
Log likelihood	97.5076	99.4718	99.2767	99.4114	98.2834	98.1554	98.1553	95.3998
Akaike info criterion	-3.3776	-3.3763	-3.4067	-3.4118	-3.4069	-3.4398	-3.4776	-3.4113
Schwarz criterion	-3.0802	-3.0045	-3.0721	-3.0772	-3.1095	-3.1796	-3.2545	-3.2254
Hannan-Quinn criter.	-3.2633	-3.2333	-3.2780	-3.2831	-3.2926	-3.3398	-3.3918	-3.3398

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold.

Source: Author's calculation.

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The introduction of control variables have revealed a positive correlation between the evolution of stock returns of banks and those of the EuroStoxx50 index, which would be in line with the assumption that declines in stock returns in this month were not only affecting the EU banking system, but were rather widespread. The significance of domestic exposures tends to suggest that international banks were more affected, in line with the expectation, given the origin of this episode of market turmoil. It is important to note also that neither profitability nor asset quality variables played any role in the evolution of stock returns of our sample of EU banks in August 2015.

4.2. December 2015 and January 2016

The second period of decline in stock returns of EU banks covers the last days of 2015 and the first weeks of 2016. In order to be as comprehensive as possible, stock returns from both months are aggregated. The observed stock returns declines were attributed to concerns by market participants on the sustainability of the EU banking system, in an environment of low growth, low interest rates and a significant amount of legacy assets from the global financial crisis. Therefore, it would be expected that those variables referring to bank profitability and asset quality would appear as statistically significant in the results of our regressions, with positive signs in the case of profitability variables (more profitability should translate into positive evolution of stock returns), and negative for asset quality variables (more NPLs and a higher Texas ratio would have a negative impact on bank stock returns). Variables related to the size of banks would then be expected not to be significant.

Similarly to Table 7, the results of these regressions are summarised in Table 9 below.

Table 9.
Results of the regressions on December 2015 and January 2016 stock returns – bank specific variables

Regression	Constant	Size	Profitability	Asset quality
1	**(+)**	**(-) Total assets**	Net interest margin	**(-) NPL**
2	**(+)**	**(-) Total assets**	Net interest margin	**(-) Texas ratio**
3	**(+)**	**(-) Total assets**	ROE	**(-) NPL**
4	**(+)**	**(-) Total assets**	ROE	**(-) Texas ratio**
5	**(+)**	**(-) Total capital**	Net interest margin	**(-) NPL**
6	**(+)**	**(-) Total capital**	Net interest margin	**(-) Texas ratio**
7	**(+)**	**(-) Total capital**	ROE	**(-) NPL**
8	**(+)**	**(-) Total capital**	ROE	**(-) Texas ratio**
9	**(-)**	Domestic exposures	Net interest margin	**(-) NPL**
10	**(-)**	Domestic exposures	Net interest margin	**(-) Texas ratio**
11	**(-)**	Domestic exposures	ROE	NPL
12	**(-)**	Domestic exposures	ROE	**(-) Texas ratio**

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold, together with their sign. The sign of the constant is shown only when statistically significant.

In this case, it can be observed how, as expected, asset quality variables tend to be relevant to explain the decreases in EU bank stock returns. Indeed, there is only one regression where the related asset quality variable is not statistically significant. On the contrary, profitability variables are not statistically significant in any of the twelve regressions, hinting at the fact

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that financial market participants were probably more concerned about asset quality than about overall profitability. Interestingly, when compared with the episode in August 2015, domestic exposures are no longer relevant in the regressions, whereas total assets and total capital still remain statistically significant. In this case, asset quality concerns started to gain prevalence in the mind of financial market participants when pricing EU banks stocks.

Contrary to the previous set of regressions, the measures of goodness of fit clearly identify some regressions as having more explanatory power than others. The regressions considering (i) total assets, net interest margin and Texas ratio, (ii) total capital, net interest margin and the Texas ratio, and (iii) total capital, ROE and the Texas ratio, are those with better values of the different measures of goodness of fit. In the three cases, total capital (or total assets) and the Texas ratio are statistically significant, while the variable to capture profitability is not. On the other extreme, those regressions where domestic exposures are introduced as an independent variable are those with lowest values of the measures of goodness of fit.

Table 10 below shows the results of the regressions under equation (2), where control variables are considered. The regression in column 1, which contains the seven independent variables but no control variable, is heteroscedastic, with the net interest margin and the Texas ratio as the only variables which are statistically significant. The introduction of control variables (column 2) makes all the variables in the regression not statistically significant, the same outcome which is found when excluding total capital (column 3), due to its strong correlation with total assets. Dropping total assets from the regression, for the same reason, brings as result that total capital and the change in EuroStoxx50 returns become significant, in both cases with negative sign (column 4). The negative sign of total capital would be counterintuitive, as it would signal that banks with more capital would be penalised by investors. However, it is important to remember that, rather than solvency, total capital reflects here the size of the bank. Besides, the negative sign of the change in the EuroStoxx50 returns may be interpreted as a divergence between the behaviour of the stock market and of bank stocks (see Table 8 for a contrast with the results on the change in stock returns in August 2015). Dropping the domestic exposures from the regression (column 5) does not meaningfully change the results. Table 6 also highlights the strong correlation between the NPL rate and the Texas ratio, so when the former is dropped from the regression, the Texas ratio becomes statistically significant (column 6). The negative sign is, in this case, expected, as banks with higher Texas ratios would perform worse than those with lower values of the ratio. In terms of goodness-of-fit, the regression in column 6 seems to perform rather well, in comparison with the others. When the Texas ratio is removed, maintaining the NPL rate, heteroscedasticity appears again (column 7). Finally, when total capital is replaced by total assets in the regression in column 6, total assets and the Texas ratio are the two variables which are statistically significant (column 8).

Table 10.
Results of the regressions on changes in stock returns in December 2015 and January 2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth		1.8753	1.9404	1.7873	1.6363	1.4720	2.8506	1.6493
		3.8761	3.9232	3.8661	3.8353	3.8413	3.8178	3.8925
EuroStoxx 50 return		-4.7006	-8.6053	**-7.8412**	**-9.1537**	**-8.5187**	**-7.7940**	**-8.9394**
		5.0979	4.3633	3.6980	3.1176	3.0708	3.0441	3.4277
Country		-0.0142	-0.0503	-0.0357	-0.0303	-0.0274	-0.0810	-0.0429
		0.0649	0.0606	0.0602	0.0592	0.0593	0.0505	0.0599
Constant	0.5030							
	0.4757							

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Total assets	0.0911	0.0878	-0.0499					-0.0495
	0.0885	0.0978	0.0194					0.0158
Total capital	-0.1462	-0.1410		-0.0545	-0.0603	-0.0557	-0.0558	
	0.0885	0.0983		0.0192	0.0171	0.0166	0.0171	
Domestic exposures	0.1055	0.1078	0.0495	0.0630				
	0.1040	0.1066	0.0998	0.0940				
Net interest margin	**7.2001**	7.0233	4.1970	5.2419	5.0213	3.8861	5.6130	2.8235
	3.3929	3.4933	2.9201	2.8677	2.8309	2.6421	2.8514	2.6946
Return on Equity	-0.5615	-0.5463	-0.4534	-0.4974	-0.4587	-0.3472	-0.3375	-0.3043
	0.3738	0.3900	0.3893	0.3853	0.3786	0.3656	0.3767	0.3690
NPL rate	-0.2156	-0.2248	-0.3542	-0.3240	-0.3562		-0.6824	
	0.3380	0.3483	0.3405	0.3295	0.3239		0.2529	
Texas ratio	**-0.2514**	-0.2342	-0.1641	-0.1900	-0.1705	**-0.2468**		-0.2300
	0.1000	0.1234	0.1147	0.1129	0.1084	0.0834		0.0833
R-squared	0.3838	0.3874	0.3574	0.3756	0.3691	0.3518	0.3336	0.3337
Adjusted R-squared	0.2857	0.2561	0.2378	0.2595	0.2687	0.2653	0.2448	0.2448
S.E. of regression	0.1372	0.1401	0.1418	0.1397	0.1389	0.1392	0.1411	0.1411
Sum squared resid	0.8288	0.8239	0.8643	0.8397	0.8484	0.8718	0.8962	0.8961
Log likelihood	33.8311	33.9846	32.7407	33.4909	33.2205	32.5155	31.7981	31.7994
Akaike info criterion	-0.9935	-0.9225	-0.9131	-0.9420	-0.9700	-0.9814	-0.9538	-0.9538
Schwarz criterion	-0.6933	-0.5472	-0.5754	-0.6042	-0.6698	-0.7187	-0.6911	-0.6912
Hannan-Quinn criter.	-0.8784	-0.7786	-0.7836	-0.8125	-0.8549	-0.8807	-0.8531	-0.8531

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold.

Source: Author's calculation.

When comparing the results of Table 10 with those in Table 9 (which exclude control variables), it can be seen how in both cases independent variables linked to the size of the bank and to asset quality are statistically significant. At the same time, and against the perception on the roots of the decline in stock returns of European banks in these months, it is worth noting that in the two sets of regressions the variables related to bank profitability are not statistically significant. There seems to be also an evolution in the variables explaining the negative investor sentiment from those which were relevant in August 2015. Actually, in this case, the declines in stock returns of EU banks seem to have affected banks of larger size and poorer asset quality, and would not match with the overall trend of the financial markets.

4.3. June 2016

The third episode of declines in stock returns of EU banks focuses on the last days of June, following the results of the referendum in the UK on the withdrawal from the EU. In order to cover at least a monthly period, as in the other regressions, stock returns have been taken for the full month of June, even if that means that some of the decreases observed in the last part of the month can be partially compensated. The rationale behind the drop of stock returns was directly linked to the consequences which the withdrawal of the UK from the EU could have, being particularly relevant in the case of banks with significant exposures to the UK. The dataset which is used in this paper does not allow having exposures to individual countries, but exposures to UK can be proxied by size variables: it can be expected that only larger non-UK banks would be

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exposed to the UK and that those with more domestic exposures would be less affected by the outcome of the referendum in the UK. Then, the expected sign to find in the regression would be negative for the variables of total assets and total capital (more exposures to UK would lead to a more negative evolution of stock returns), and positive for the variable related to domestic exposures (stock performance of banks with more domestic exposures should be better than those of banks with less domestic exposures).

The summarised results of these regressions are shown in Table 11 below.

Table 11.
Results of the regressions on changes in stock returns in June 2016 – bank specific variables

Regression	Constant	Size	Profitability	Asset quality
1		**(-) Total assets**	Net interest margin	**(-) NPL**
2	**(+)**	**(-) Total assets**	Net interest margin	**(-) Texas ratio**
3		**(-) Total assets**	**(+) ROE**	NPL
4	**(+)**	**(-) Total assets**	ROE	**(-) Texas ratio**
5		**(-) Total capital**	Net interest margin	**(-) NPL**
6	**(+)**	**(-) Total capital**	Net interest margin	**(-) Texas ratio**
7		**(-) Total capital**	**(+) ROE**	NPL
8	**(+)**	**(-) Total capital**	**(+) ROE**	**(-) Texas ratio**
9	**(-)**	Domestic exposures	Net interest margin	NPL
10	**(-)**	Domestic exposures	Net interest margin	**(-) Texas ratio**
11	**(-)**	Domestic exposures	**(+) ROE**	NPL
12	**(-)**	Domestic exposures	**(+) ROE**	**(-) Texas ratio**

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold, together with their sign. The sign of the constant is shown only when statistically significant.

Source: Author's calculation.

Even though the results from these regressions are more nuanced than those presented so far, they give rise to interesting interpretations. First, larger banks had a more negative evolution of their stock returns, without a distinction whether the exposures of these banks are domestic or cross-border. Second, while, similarly to the previous regression, net interest margin is not statistically significant in any of the six regressions, ROE is a decisive variable with a positive sign. Third, in terms of the variables related to asset quality, the Texas ratio is more often statistically significant than the rate of NPLs. It is worth noting how both ROE and the Texas ratio use the capital position of banks in their computation (being thus linked to the sustainability of the bank), leading to sounder results that those ratios of a more descriptive nature (like net interest margin or the NPL rate). While the variety of results impedes posing a firm hypothesis of which banks were most affected by the outcome of the referendum in the UK at the end of June 2016, it is possible to signal how those larger banks in terms of assets and capital were more negatively affected and how markets seemed to price the adequate level of capital vis-à-vis the future sustainability challenges for banks in terms of profitability and asset quality.

A look at the values taken by the indicators of goodness of fit provides further insights in the direction hinted above. The three regressions with the lowest values of these indicators are those which combine the variable on size (assets, capital and domestic exposures) with the net interest margin and the NPL rate. That would imply that these two latter variables have limited explanatory power with regards the evolution of stock returns in June 2016. On the other side,

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there are four regressions with substantially higher values for the measures of goodness of fit. They are those using as variables (i) total assets, net interest margin and the Texas ratio, (ii) total assets, ROE and the Texas ratio, (iii) total capital, net interest margin and the Texas ratio, and (iv) total capital, ROE and the Texas ratio. In all cases, the Texas ratio is statistically significant, together with the variable to capture size of the bank. That would tend to signal the importance given to the Texas ratio by investors.

The results of the regressions using bank-specific independent variables are interestingly related to those obtained when control variables are introduced (Table 12). If all the bank-specific variables are introduced in the regression (column 1), the return on equity and the Texas ratio are the only ones which are statistically significant at a level of 0.05. When the three control variables are added (column 2), only four variables are now statistically significant: GDP growth, changes in EuroStoxx50 returns, total assets and return on equity. As it has been shown in Table 6, total assets and total capital are strongly correlated, so a natural way to reduce the number of independent variables in the regression would be to remove one of the two. This is shown in columns 3 and 4, having as a consequence that the changes in EuroStoxx50 returns becomes statistically non-significant and the Texas ratio becomes again statistically significant. Similarly to previous periods, in column 4, total capital appears with a negative sign, leading to the potentially counterintuitive conclusion that there would be a negative relation between the levels of capital and our dependent variable. Again, total capital must be interpreted here as an indicator of size, so the negative sign in column 4 for total capital should not be read in the context of regulatory capital ratios. Considering the indicators of goodness of fit, we proceed with the regression when total capital is removed. Next, the NPL rate is dropped (column 5) as Table 6 has shown its strong correlation with the Texas ratio as well as due its lack of statistical significance and its counterintuitive sign (positive, implying that more NPLs would lead to higher stock returns). As consequence of the removal of the NPL rate in the regression, the Texas ratio ceases to be statistically significant. Columns 6 and 7 show the regressions once net interest margin and domestic exposures are excluded from the regression, based on their p-values and, in the case of net interest margins, the unexpected negative sign (implying that lower net interest margin should lead to higher stock returns). Column 7 sees how the changes in the EuroStoxx50 returns are again statistically significant, with a negative sign. Finally, column 8 removes the country dummy as it was not found to be statistically significant in any of the previous regressions. That implies that the Texas ratio is again statistically significant. Values of the indicators of goodness of fit suggest that the explanatory power of the regression is improving with these actions, being the highest in column 8.

Table 12.
Results of the regressions on changes in stock returns in June 2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP growth		6.4685	5.5459	5.3356	6.1030	5.7830	5.6179	5.9211
		2.0057	1.9574	2.0079	1.9213	1.8810	1.8226	1.8018
EuroStoxx50 return		**-20.6235**	-11.6119	-6.4310	-12.7294	-10.6238	**-12.0953**	**-11.9619**
		8.6404	6.7033	5.6204	6.6924	6.2257	5.0931	5.0975
Country		-0.0339	-0.0220	-0.0200	-0.0275	-0.0374	-0.0360	
		0.0367	0.0366	0.0375	0.0366	0.0347	0.0342	
Constant	0.6923							
	0.3760							
Total assets	-0.0600	**-0.1269**	**-0.0317**		-0.0347	-0.0314	-0.0336	-0.0333
	0.0628	0.0602	0.0118		0.0116	0.0110	0.0095	0.0095

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Total capital	0.0241	0.0934		-0.0265				
	0.0598	0.0580		0.0116				
Domestic exposures	-0.0189	-0.0207	0.0216	0.0460	0.0103	0.0232		
	0.0691	0.0626	0.0578	0.0561	0.0576	0.0555		
Net interest margin	-3.0405	-5.1714	-2.3351	-1.3226	-1.7119			
	2.7983	2.6446	2.0086	1.9866	1.9618			
Return on Equity	**0.4498**	**0.4661**	**0.4573**	**0.4646**	**0.4495**	**0.3793**	**0.3766**	0.3520
	0.2117	0.1914	0.1949	0.1989	0.1961	0.1784	0.1767	0.1754
NPL rate	0.4101	0.1523	0.2651	0.3135				
	0.2234	0.2161	0.2082	0.2100				
Texas ratio	**-0.2363**	-0.1386	**-0.1663**	**-0.1721**	-0.0940	-0.0961	-0.0946	**-0.1268**
	0.0709	0.0763	0.0756	0.0775	0.0503	0.0501	0.0495	0.0390
R-squared	0.4686	0.5855	0.5600	0.5418	0.5434	0.5355	0.5337	0.5224
Adjusted R-squared	0.3840	0.4967	0.4781	0.4565	0.4707	0.4735	0.4830	0.4818
S.E. of regression	0.0904	0.0817	0.0832	0.0849	0.0838	0.0836	0.0828	0.0829
Sum squared resid	0.3595	0.2804	0.2977	0.3100	0.3089	0.3142	0.3154	0.3231
Log likelihood	55.5475	62.0120	60.4549	59.4014	59.4925	59.0464	58.9452	58.3254
Akaike info criterion	-1.8288	-2.0005	-1.9790	-1.9385	-1.9805	-2.0018	-2.0364	-2.0510
Schwarz criterion	-1.5286	-1.6252	-1.6413	-1.6008	-1.6803	-1.7391	-1.8112	-1.8634
Hannan-Quinn criter.	-1.7137	-1.8566	-1.8496	-1.8090	-1.8654	-1.9011	-1.9500	-1.9790

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold.

Source: Author's calculation.

The analysis of the eight regressions in Table 12 reveals the positive role played by the quarterly growth rate of the GDP (in line with, among others, Yang and Tsatsaronis, 2012; O'Neill et al., 2011). Besides, when considering bank-specific variables, total assets, return on equity and the Texas ratio seem to have been the most significant to drive the changes in stock returns, pointing towards the discrimination made by investors against the weakest banks: those of larger size, poorer asset quality and lower profitability, in a context where they also consider the macroeconomic environment. The change in the EuroStoxx50 returns also appears with negative sign in some of the columns in Table 12, probably indicating a divergence between the behaviour of bank stock returns and those of the financial markets in general. These results are mostly in line with those shown for the regressions without control variables (Table 11), and highlight the interesting fact that direct exposures to the UK did not seem to determine the changes in stock returns in this period, but indicators related to size and to the expected sustainability of banks.

5. CONCLUSIONS

Differently to what has been observed in other jurisdictions (i.e., US) or sectors (i.e., non-financial corporations), stock prices and returns of EU banks have not recovered to those levels they had at the onset of the global financial crisis in 2008. In this paper, three recent episodes of financial markets turmoil have been analysed, with the dual objective of identifying common characteristics among those banks which stock returns fell the most and of considering whether investor demand on EU banks has evolved or not. Each of these three episodes had different triggers and was perceived as affecting different parts of the EU banking system.

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The results of the regressions presented in this paper tend to show the existence of a common factor driving stock returns of EU banks, according to which banks of larger size have seen their stock returns decrease more than those of banks of smaller size. That was the expected result for the period of August 2015, but not necessarily for the other two episodes. The negative relation between size and stock returns contrasts with the findings of Filbeck et al. (2011) and Yang and Tsatsaronis (2012), where size plays a positive role in terms of stock performance. Whether this is a result of the different geographical and temporal scope of the samples is left open for future research.

At the same time, there has also been an evolution on the perception of EU banks by financial market participants. The first period considered (August 2015) also saw market-wide declines in stock returns while the turmoil in the other two periods (December 2015 and January 2016, and June 2016) can be characterised as focused mostly on EU bank stocks. Actually, since December 2015, the Texas ratio, as a variable capturing asset quality, has gained importance in characterising those banks which stock returns have fallen more sharply. The variables capturing profitability are only relevant in the last period (June 2016) and only to the extent that it relates to the capital position of banks (return on equity). The lack of significance of profitability variables to explain the evolution of bank stock returns may also be further explored, as it would be rather counterintuitive. Asset quality and profitability are two of the characteristics identified by Baker and Wurgler (2007) and Irresberger et al. (2015) as common to those banks more sensitive to waves of investor sentiment.

In general terms, the short period of time selected for this paper (one or two months) may explain why some of the results seem to contradict other results in the academic literature which consider longer periods of time in their analysis, like Cabrera et al. (2016), Chan-Lau et al. (2012), Filbeck et al. (2011), or Yang and Tsatsaronis (2012). Besides, contrary to the recent academic literature, which is focused on the years of highest severity of the global financial crisis, the periods under consideration in this paper are situated in a context of recovery from the most severe months of the global financial crisis. So, it is possible that the bank-specific variables driving bank stock returns are slightly different during a period of acute financial turmoil than during a more targeted period of turmoil, in a context of recovery. More research, in the line of Filbeck et al. (2011), may be conducted to check this intuition.

Finally, entering into the policy arena, in the sermon by Edwards (1741), the Devil stood ready to prey on the weakest souls. Similarly, investor demand on EU banks has evolved in a way which in June 2016 showed their distrust on those EU banks perceived to be weaker, in terms of asset quality or profitability. The necessary repair of those weak EU banks seems to be an area of further consideration by policymakers in the EU, as it seems to impede the necessary recovery from the global financial crisis. After all, the sermon by Edwards (1741) was a crucial element in the so-called "Great Awakening", which set a new frame of personal commitment in the religious domain, after decades of more relaxed attitudes.

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APPENDIX

Table 13.
Regressions on August 2015 stock returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	**0.1940**	0.1995	0.1243	**0.1328**	**0.1710**	**0.1754**	0.1214	**0.1285**	-0.0962	**-0.1005**	**-0.1058**	**-0.1068**
	0.0948	0.0960	0.0945	**0.0932**	**0.0815**	**0.0845**	0.0831	**0.0839**	0.0233	**0.0231**	**0.0161**	**0.0165**
Total assets	-0.0121	-0.0125	-0.0098	-0.0103								
	0.0047	0.0046	0.0048	0.0046								
Total capital					-0.0130	-0.0135	-0.0113	-0.0119				
					0.0047	0.0048	0.0049	0.0049				
Domestic exposures									0.0598	0.0637	0.0625	0.0670
									0.0238	0.0256	0.0227	0.0242
Net interest margin	**-2.0373**	-1.9638			**-1.8470**	-1.7396			-0.7688	-0.5788		
	0.9503	0.9536			**0.9338**	0.9339			1.0003	0.9943		
Return on Equity			-0.0666	-0.0578			-0.0554	-0.0452			-0.0540	-0.0482
			0.0619	0.0628			0.0619	0.0626			0.0604	0.0615
NPL rate	0.0432		0.0416		0.0538		0.0475		0.0576		0.0486	
	0.0516		0.0533		0.0487		0.0500		0.0494		0.0473	
Texas ratio		0.0105		0.0102		0.0125		0.0114		0.0097		0.0060
		0.0148		0.0155		0.0143		0.0149		0.0155		0.0152
R-squared	0.2402	0.2371	0.1881	0.1852	0.2510	0.2442	0.2042	0.1992	0.2340	0.2189	0.2372	0.2232
Adjusted R-squared	0.1937	0.1904	0.1384	0.1353	0.2052	0.1979	0.1555	0.1502	0.1871	0.1710	0.1905	0.1757
S.E. of regression	0.0418	0.0419	0.0432	0.0433	0.0415	0.0417	0.0428	0.0429	0.0420	0.0424	0.0419	0.0423
Sum squared resid	0.0857	0.0860	0.0915	0.0919	0.0845	0.0852	0.0897	0.0903	0.0864	0.0881	0.0860	0.0876
Log likelihood	95.1246	95.0191	93.3677	93.2731	95.5061	95.2651	93.8995	93.7331	94.9086	94.3917	95.0198	94.5398
Akaike info criterion	-3.4387	-3.4347	-3.3724	-3.3688	-3.4531	-3.4440	-3.3924	-3.3862	-3.4305	-3.4110	-3.4347	-3.4166
Schwarz criterion	-3.2900	-3.2860	-3.2237	-3.2201	-3.3044	-3.2953	-3.2437	-3.2375	-3.2818	-3.2623	-3.2860	-3.2679
Hannan-Quinn criter.	-3.3815	-3.3775	-3.3152	-3.3116	-3.3959	-3.3868	-3.3352	-3.3290	-3.3733	-3.3538	-3.3775	-3.3594

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold.

Source: Author's calculation.

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Table 14.
Regressions on December 2015 and January 2016 stock returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	0.7696	0.8404	0.9197	0.9978	0.7046	0.7968	0.7892	0.9254	-0.2444	-0.2226	-0.1730	-0.1441
	0.3211	0.3103	0.3400	0.3140	0.2819	0.2742	0.3046	0.2876	0.0720	0.0670	0.0652	0.0631
Total assets	-0.0481	-0.0480	-0.0522	-0.0528								
	0.0160	0.0151	0.0167	0.0152								
Total capital					-0.0531	-0.0542	-0.0535	-0.0574				
					0.0166	0.0157	0.0175	0.0162				
Domestic exposures									0.0885	0.1552	0.0730	0.1554
									0.0836	0.0852	0.0864	0.0893
Net interest margin	4.0603	2.5849			5.1035	3.6701			4.9451	4.4775		
	2.8144	2.6092			2.7876	2.5411			3.0552	2.7667		
Return on Equity			-0.2819	-0.3357			-0.2493	-0.3396			-0.0688	-0.2960
			0.3831	0.3558			0.3823	0.3543			0.4126	0.3939
NPL rate	-0.7589		-0.7521		-0.7510		-0.6857		-0.5358		-0.4174	
	0.1934		0.2189		0.1876		0.2086		0.1933		0.2100	
Texas ratio		-0.2398		-0.2585		-0.2413		-0.2502		-0.2110		-0.2075
		0.0536		0.0607		0.0522		0.0590		0.0580		0.0664
R-squared	0.2599	0.3104	0.2364	0.3091	0.2751	0.3309	0.2313	0.3149	0.1411	0.2190	0.0948	0.1860
Adjusted R-squared	0.2136	0.2673	0.1887	0.2659	0.2298	0.2890	0.1832	0.2721	0.0874	0.1702	0.0382	0.1351
S.E. of regression	0.1440	0.1390	0.1463	0.1391	0.1425	0.1369	0.1468	0.1385	0.1551	0.1479	0.1593	0.1510
Sum squared resid	0.9953	0.9274	1.0269	0.9291	0.9749	0.8999	1.0338	0.9214	1.1551	1.0503	1.2174	1.0947
Log likelihood	29.0692	30.9074	28.2574	30.8588	29.6093	31.6906	28.0835	31.0773	25.1992	27.6718	23.8326	26.5947
Akaike info criterion	-0.9642	-1.0349	-0.9330	-1.0330	-0.9850	-1.0650	-0.9263	-1.0414	-0.8154	-0.9105	-0.7628	-0.8690
Schwarz criterion	-0.8141	-0.8848	-0.7829	-0.8829	-0.8349	-0.9149	-0.7762	-0.8913	-0.6653	-0.7604	-0.6127	-0.7189
Hannan-Quinn criter.	-0.9067	-0.9774	-0.8754	-0.9755	-0.9274	-1.0075	-0.8687	-0.9839	-0.7578	-0.8529	-0.7052	-0.8115

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold.

Source: Author's calculation.

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Table 15.
Regressions on June 2016 stock returns

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	0.4354	**0.7234**	0.2764	**0.5789**	0.3328	**0.5574**	0.2207	**0.4617**	**-0.2095**	**-0.1982**	**-0.2318**	**-0.2121**
	0.2551	**0.2298**	0.2297	**0.2184**	0.2180	**0.1989**	0.2004	**0.1952**	**0.0520**	**0.0469**	**0.0430**	0.0431
Total assets	-0.0309	-0.0419	-0.0246	-0.0365								
	0.0125	0.0109	0.0113	0.0104								
Total capital					-0.0308	-0.0404	-0.0258	-0.0364				
					0.0127	0.0112	0.0116	0.0109				
Domestic exposures									0.0269	0.0904	0.0199	0.0665
									0.0614	0.0598	0.0553	0.0575
Net interest margin	1.7038	0.6393			2.6135	2.0153			3.1746	3.2666		
	2.1204	1.8234			2.0571	1.7524			2.1699	1.8974		
Return on Equity			**0.6145**	0.3774			0.6486	0.4451			0.7180	0.5721
			0.1928	0.1923			0.1891	0.1891			0.1955	0.2022
NPL rate	-0.3770		-0.1853		-0.3481		-0.1466		-0.2184		-0.0131	
	0.1439		0.1406		0.1391		0.1295		0.1416		0.1244	
Texas ratio		-0.1846		-0.1408		-0.1710		-0.1206		-0.1404		-0.0733
		0.0376		0.0426		0.0367		0.0402		0.0411		0.0427
R-squared	0.1677	0.3672	0.3039	0.4127	0.1644	0.3492	0.3064	0.4005	0.0648	0.2103	0.2374	0.2814
Adjusted R-squared	0.1157	0.3276	0.2604	0.3760	0.1122	0.3085	0.2630	0.3630	0.0063	0.1610	0.1898	0.2364
S.E. of regression	0.1083	0.0944	0.0990	0.0910	0.1085	0.0958	0.0989	0.0919	0.1148	0.1055	0.1037	0.1006
Sum squared resid	0.5630	0.4281	0.4709	0.3973	0.5652	0.4402	0.4692	0.4055	0.6326	0.5342	0.5158	0.4861
Log likelihood	43.8851	51.0070	48.5309	52.9481	43.7806	50.2801	48.6225	52.4133	40.8528	45.2506	46.1595	47.7015
Akaike info criterion	-1.5340	-1.8080	-1.7127	-1.8826	-1.5300	-1.7800	-1.7163	-1.8621	-1.4174	-1.5866	-1.6215	-1.6808
Schwarz criterion	-1.3839	-1.6579	-1.5626	-1.7325	-1.3799	-1.6299	-1.5662	-1.7120	-1.2673	-1.4365	-1.4714	-1.5307
Hannan-Quinn criter.	-1.4765	-1.7504	-1.6552	-1.8251	-1.4725	-1.7225	-1.6587	-1.8045	-1.3599	-1.5290	-1.5640	-1.6233

Notes: Those variables which are statistically significant at a level of 0.05 are shown in bold.

Source: Author's calculation.

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Animal Spirits and Risk in Financial Markets

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ABSTRACT

Keynes argues that a beauty contest in financial markets is a combination of rational higher-order beliefs and market psychology or animal spirits. We find that a stable equilibrium, where also market psychology is included, can be possible if uninformed investors agree to reduce their required rate of return indicating that they enlarge the risk of their investment with the animal spirits component.

JEL Classification: G11, G12

Keywords: Risk, Portfolio Choice, Asset Pricing

INTRODUCTION

Keynes (1936) writes: "professional investment may be likened to those newspaper competitions in which competitors have to pick out the six prettiest faces from a hundreds of photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole". Keynes argues that investors' decisions in financial markets are affected by higher-order beliefs and he calls this phenomenon "beauty contest in the financial markets". He argues that the beauty contest can be divided into two effects: rational higher-order beliefs and market psychology. Shiller (2014) calls the latter component "animal spirits", and he follows Keynes (1921) in defining animal spirits as a "gut feeling that rises from the ambiguity of directly unobservable probabilities of future returns."

DeLong et al. (1990), Froot et al. (1992), and Campbell and Kyle (1993), among others, analyze the effect of animal spirits on the equilibrium price of a risky asset. Their basic assumption is that technical traders coordinate their actions, which results in a stable equilibrium. Furthermore, Allen et al. (2006), Bacchetta and VanWincoop (2008) analyze only the effect of rational higher-order beliefs resulting in returns predictability in equilibrium. Ilomäki (2016a; 2016b; 2017) connects rational higher order expectations and animal spirits in the same framework, and shows that the animal spirits component reduces expected returns for investors when the beauty contest is present. However, the returns depend on crucially on the level of the risk-free rate return. In these studies, one half of the rational investors are assumed as informed and the other half

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uninformed. In this article, the proportion of informed investors is $0 < \mu < 1$ and the focus is on the risk of uninformed investors, both with and without the animal spirits component.

Samuelson (1973) argues that in efficient markets with risk-neutral investors, the following must hold:

$$P_t = V_t = E_t \sum_{s=1}^{\infty} \frac{D_{t+s}}{(1+r^f)^s},$$

where P_t is the equilibrium price, V_t is the fundamental value, D_t is dividend, E_t is the expectations operator, and r^f is the constant risk-free rate of return. In Samuelson's definition investors are assumed to be risk-neutral. In real life, however, a rational investor cares also about the risk of investment besides the reward. *The risk in financial markets can be defined as the variation of returns*, which leads to the well-known mean-variance paradigm (Markowitz 1952; Sharpe 1964). Thus, a risk premium ω should be added. Shiller (2014) argues that stock markets seem to follow

$$P_t = E_t \sum_{s=1}^{\infty} \frac{D_{t+s} + \omega A_{t+s-1}}{(1+r^f+\omega)^s}$$

where ω denotes the risk premium, and A_t denotes the animal spirits component. Note that the rational higher order expectations is absent in this model.

In this paper, the animal spirits component is specified by assuming coordinated actions of a large group of uninformed investors, and short-lived and risk-averse rational investors. The latter assumption is based on performance-based arbitrage, where the success in investing is monitored by short period intervals (Shleifer and Vishny 1997).

Our basic finding is that the animal spirits component is present in a stable Keynesian beauty contest equilibrium only if the short-lived uninformed investors accept more risk compared to the case, where when only rational higher-order beliefs are present.

Section 1 presents the model. Section 2 describes the equilibrium with only rational higher-order beliefs. Section 3 presents the equilibrium, when also market psychology is included. Section 4 concludes.

1. THE MODEL

The model follows Ilomäki (2016a; 2016b). The economy consists of rational risk-averse (CARA, with *equal* tolerance of risk v) investors who live for two periods, investing in period one, and consuming in period two. There is an infinitely lived risky asset (share of firm F) and a constant risk-free rate of return r^f. The atomistic rational investors have asymmetric information so that $0 < \mu < 1$ is the share of informed investors and $1 - \mu$ is the share of uninformed investors in every period. That is, there are four kinds of rational investors in every trading period: young informed and uninformed investors who open their positions (demand at time t) and old informed and uninformed investors who close their positions (supply at time t) Within the interval [0,1], there is a continuum of young and old investors in every period. The investors are constrained by wealth so that the young investors y at time t have the same initial wealth w_t^y. Short selling is available to young investors, and there are no transaction costs or taxes.

In the economy, the natural logarithm of the dividend D_t follows a random walk

$$\ln D_t = \ln D_{t-1} + e_t^d \qquad (1)$$

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where $e_t^d \sim WN(0,\sigma_d^2)$. We assume that firm F pays D_t to the investors at time t after trading, and that the dividend information is private. The informational advantage of the young informed investor derives from observing private information about D_t, D_{t+1}, D_{t+2} and μ. The history of equilibrium prices (P_{t-1}, P_{t-2}, P_{t-3}, …) and the risk-free rate r^f comprise information common to all investors. In addition, we assume noisy net supply of the stock by dumb traders (DU_t) distributed $e_t^{du} \sim N(0,\sigma_{du}^2)$. We assume that the dumb traders always lose money in their trading, implying that they act as liquidity providers. The market clears, when

$$\int_y x_y - \int_o s_o + e_t^{du} = 0,$$

where x is the demand for stock of young investors (y) and s is the supply of the stock by old investors (o). The equilibrium condition assures that demand per share is one in the equilibrium. Furthermore, we assume that the excess returns on the risky asset follow normal distribution. This assumption assures that the conditional variance of the excess returns is constant.

2. EQUILIBRIUM PRICE WITH RATIONAL HIGHER-ORDER BELIEFS

A risk-averse young investor, who lives for two periods, maximizes his/her utility by allocating wealth between risky and risk-free assets. The net excess return on a risky share is

$$R_{t+1} \equiv \frac{P_{t+1} - P_t + D_{t+1}}{P_t} - r^f. \tag{2}$$

The young investor solves the maximization problem.

$$Max[E(-e^{-vc_{t+1}} \mid \theta_t^y, w_t^y)],$$

where θ_t^y is the information set, v is the common coefficient of risk aversion, c is consumption, and w_t^y is the investor's initial wealth. The budget constraints read

$$c_{t+1} = x^f(1+r^f) + x^r E_t(R_{t+1}),$$

$$w_t^y = x^f + x^r,$$

where x is the amount of money. Assume normally distributed extra consumption, (because of normally distributed excess returns), take expectations in Equation (2), and plug the consumption constraint into the utility function to get

$$E_t(U(c_{t+1})) = -e^{-vx^r E_t(R_{t+1}) + \frac{v^2}{2} x^{r^2} \sigma_r^2}, \tag{3}$$

where σ_r^2 is the variance of excess returns. Since the informed investors have better information about risky assets, it must be that $\sigma_{ri}^2 < \sigma_{ru}^2$. Moreover, since the investors observe r^f, its variance is zero. Maximize (Equation 3) with respect to x^r, use Equation (2) and note that the demand per risky asset's share is *one* in the equilibrium. Thus, the first order condition for the risky asset reads

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$$\frac{E_t\left[\frac{P_{t+1}-P_t+D_{t+1}}{P_t}\right]-r^f}{v\sigma_r^2}=1 \qquad \Rightarrow \frac{E_t\left[P_{t+1}+D_{t+1}\right]}{(1+r^f+v\sigma_r^2)}=P_t. \tag{4}$$

In Equation (4),

$$E_t\left[\frac{P_{t+1}-P_t+D_{t+1}}{P_t}\right]-r^f=v\sigma_r^2=\omega \tag{5}$$

defines the risk premium. Since σ_r^2 varies between informed and uninformed investors, the risk premiums must also vary between them because of equal coefficients of risk aversion $v^i = v^u = v$. Thus, in the equilibrium, we obtain

$$\frac{\omega_i}{\sigma_{ri}^2}=\frac{\omega_u}{\sigma_{ru}^2}\Rightarrow\frac{\omega_i}{\omega_u}=\frac{\sigma_{ri}^2}{\sigma_{ru}^2}, \tag{6}$$

where the subscripts *i* and *u* refer to informed and uninformed investors, respectively. Solve Equation (4) forward by substituting out future prices. Then, as the horizon approaches infinity, Equation (4) produces

$$P_t=E_t\sum_{s=1}^{\infty}\frac{D_{t+s}}{(1+r^f+\omega)^s}. \tag{7}$$

According to the properties of random walk, the change in the dividend at time *t* is permanent. Thus, Equation (7) results in the simple perpetuity model

$$V_t=\frac{D_{t+1}}{r^f+\omega_i}, \tag{8}$$

where V_t is the fundamental value per share of stock F, and $r^f+\omega_i=r_i^n$ is the net required rate of return for an informed investor.

Recall that the young (old) informed investors have private information about D_t, D_{t+1}, D_{t+2} (D_{t-1}, D_t, D_{t+1}).Therefore, a young (old) informed investor solves the fundamental values V_{t-1}, V_t, V_{t+1} (V_{t-2}, V_{t-1}, V_t). The rational pricing rule for young and old investors is simply

$$P_t=V_t$$

because these atomistic investors have the same information and old (young) recognizes that young (old) observes this. Notice that a young informed investor chooses his/her buy or sell position according to V_{t+1}. However, the uninformed investors observe only past equilibrium prices and the constant risk-free rate r^f, resulting in the equal risk premium ω_u and the required rate of return $1+r^f+\omega_u=1+r^f+v\sigma_{ru}^2=1+r_u^n$. Thus, the pricing rule is

$$P_t=(1+r_u^n)P_{t-1}.$$

Note that the uninformed investors do not observe dividends.

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Given that μ is the share of the rational young and old informed investors and $1-\mu$ is the share of the uninformed investors, the rational choice equilibrium price in this economy is

$$P_t = \mu V_t + (1-\mu)(1+r_u^n)P_{t-1} \tag{9}$$

with the restriction of Equation (6). Thus, the larger is the proportion of informed investors among rational investors, the closer is the equilibrium price to the fundamental value.

As far as $1 > \mu > 0$, Equation (9) implies that $P_t \neq V_t$ in every step suggesting that $P_t = V_t + C_t$ where C_t describes all errors when $P_t \neq V_t$ (Shiller 2014). In this economy, C_t denotes the predictability in returns component implying that

$$P_t = \mu(V_t + C_t^i) + (1-\mu)[(1+r_u^n)P_{t-1} + C_t^u]. \tag{10}$$

Solving C_t^u from Equation (10), we obtain

$$C_t^u = \frac{\mu}{1-\mu}P_t - \frac{\mu}{1-\mu}V_t - \frac{\mu}{1-\mu}C_t^i + \Delta P_t - r_u^n P_{t-1}.$$

The uninformed investors observe only $r_u^n P_{t-1}$ on the right-hand side directly. However, assuming stationary returns, an uninformed investor infers $\mathrm{E}(\Delta P_t) = \Delta P_{t-1}$, and reducing the approximation of unobservable dividend $r_u^n P_{t-2}$, we obtain

$$C_t^u = \Delta P_{t-1} - r_u^n P_{t-2}. \tag{11}$$

For a young informed investor, Equation (11) reads $C_t^i = P_t - V_t + \frac{1-\mu}{\mu}\left(-C_t^u + \Delta P_t - r_u^n P_{t-1}\right)$ where $C_t^u = \Delta P_t - r_u^n P_{t-1}$. Then, using the cointegration results of Engle and Granger (1987), the difference $P_{t-1} - V_{t-1}$ gives the optimal forecast for C_t. Thus, we obtain

$$C_t^i = P_{t-1} - V_{t-1}. \tag{12}$$

Following Equations (9), (11) and (12), the equilibrium price series follows

$$P_t = \mu(V_t + P_{t-1} - V_{t-1}) + (1-\mu)[(1+r_u^n)P_{t-1} + \Delta P_{t-1} - r_u^n P_{t-2}] \tag{13}$$

with the restriction of Equation (2). To prove that Equations (9) and (13) produce the identical equilibrium price P_t manipulate Equation (12), to obtain

$$\Delta P_t = \mu \Delta V_t + (1-\mu)(\Delta P_{t-1} + r_u^n \Delta P_{t-1}). \tag{14}$$

Taking the difference of sequential variables from Equation (9) yields Equation (14). Thus, Equation (14) proves returns predictability (because it includes ΔP_{t-1}) in the equilibrium. This is consistent with Allen et al. (2006), Bacchetta and VanWincoop (2008) with rational higher-order beliefs.

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3. EQUILIBRIUM PRICE WITH ANIMAL SPIRITS

Following Ilomäki (2016a; 2016b), suppose that the *uninformed* investor starts to include an animal spirits component A_t in the pricing equation $(1+r_u^n+A_t)P_{t-1}$ suggesting that $C_t^u = A_t P_{t-1}$. Following DeLong et al. (1990), among others, we assume that the uninformed investors can coordinate their actions perfectly.

Additional Assumption 1: *Uninformed investors coordinate perfectly in their animal spirits component to obtain an identical product of A_t, which is the product of overreacted demand for stock per share.*

Note that the overreaction can be positive or negative. In addition, we follow Santos and Woodford (1997) by assuming that infinite bubbles are impossible in the economy. This is to say that P_t and V_t cannot drift apart forever.

Additional Assumption 2: *Infinite bubbles are impossible in the economy.*

An informed investor observes that Equation (9) does not hold at time $t-1$. Then, being rational (since P_t and V_t cannot drift apart forever), an informed investor i uses the cointegration results of Engle and Granger (1987) giving the optimal forecast for the product of A_t. Thus, we obtain

$$A_t^i P_{t-1} = P_{t-1} - V_{t-1}.$$

Then, the equilibrium price series follows

$$P_t = \mu(V_t + P_{t-1} - V_{t-1}) + (1-\mu)[(1+r_u^n + A_t)P_{t-1}]. \tag{15}$$

To find stable equilibrium conditions (Equation 15), it is useful to analyze it in $\Delta P_t / P_{t-1}$ series. By manipulation of Equation (15), we have it as

$$\frac{\Delta P_t}{P_{t-1}} = \mu \frac{\Delta V_t}{P_{t-1}} + (1-\mu)(r_u^n + A_t).$$

This shows that the actual $\Delta P_t / P_{t-1}$ is the sum of two weighted components, $\Delta V_t / P_{t-1}$ and $r_u^n + A_t$. Because an informed investor i observes V_t and V_{t-1}, then he/she recognizes that $\Delta V_t / P_{t-1} = r_i^n + e_t^v$, where $e_t^v \sim N(0, \sigma_v^2)$. For an uninformed investor u $E(\Delta P_t / P_{t-1}) = r_u^n + A_t$. Thus,

$$E\left(\frac{\Delta P_t}{P_{t-1}}\right) = \mu r_i^n + (1-\mu)(r_u^n + A_t).$$

However, according to the assumption that infinite bubbles are impossible in the economy, there has to be a long-run equilibrium (because $\Delta V_t / P_{t-1} = r_i^n + e_t^v$), in which

$$r_i^n = \mu r_i^n + (1-\mu)(r_u^n + A_t) \Rightarrow r_i^n - r_u^n = A_t. \tag{16}$$

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Equation (16) produces that $\omega_i - \omega_u = A_t$. The additional assumption (2) and Equation (6) indicate that $\omega_i - \omega_u = A_t < 0$. To see this, we plug $\omega_u = \omega_i - A_t$ into Equation (6), obtaining

$$A_t = -\frac{\omega_i\left(\sigma_u^2 - \sigma_i^2\right)}{\sigma_i^2}. \tag{17}$$

Thus, Equation (17) shows that the effect of animal spirits can only be positive if $\sigma_u^2 < \sigma_i^2$. Recall that σ^2 is the variation of excess returns. Additional assumption (2) assures that the informational advantage of informed ones produces $\sigma_u^2 > \sigma_i^2$ among subsequent generations resulting $\sigma_u^2 > \sigma_i^2$ in stable equilibrium. This implies the negative effect of A_t.

Corollary 1: *Compared to the case where only rational higher-order beliefs is present, a stable equilibrium is possible if only if uninformed investors as subsequent generations agree to reduce their required rate of return indicating that the animal spirits component creates more risk for them.*

4. CONCLUSIONS

The results indicate that if the uninformed investors add the animal spirits component in their pricing, they add risk in their investment, when the Keynesian higher order expectations already exist in the economy. This happens because infinite bubbles are impossible. This indicates clearly that it is inevitable that a future generation of uninformed investors has to suffer severe losses when the correction eventually happens.

In other words, we find that the animal spirits can be present in the equilibrium only if the uninformed investors reduce required rate of return. This suggests that rational uninformed investors ignore animal spirits in their trading when the Keynesian beauty contest is present, because the animal spirits component increases the risk of investment.

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Macroprudential Policy Effectiveness: Lessons from Southeastern Europe

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ABSTRACT

This paper presents a detailed account of the rich set of macroprudential measures (MPPs) implemented in Bulgaria, Croatia, Romania, and Serbia during their synchronized boom and bust cycles in 2002–12, and assesses their effectiveness in managing credit growth. Only strong MPPs helped contain domestic credit growth during the boom years, but circumvention via direct external borrowing offset their effectiveness to a large extent. MPPs taken during the bust had no discernible impact. The paper concludes that (i) proper calibration of MPPs is of the essence; (ii) only strong, broad-based MPPs can contain credit booms; (iii) econometric studies of macroprudential policy effectiveness should focus on concrete policy measures rather than on instruments use; and (iv) in so doing should allow for possible non-linear and state-contingent effects.

JEL Classification: G18, G28

Keywords: Macroprudential Policies, Financial Stability, Credit Growth, Southeastern Europe

1. INTRODUCTION

In the wake of the global financial crisis (GFC), interest in macroprudential policy and its ability to manage the financial cycle has grown tremendously. Such policies, aimed at reducing the risk and the macroeconomic costs of financial instability, are gaining a much more prominent role in policy frameworks, alongside fiscal and monetary policy. Given the limited experience in

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their implementation, finding out whether and how they can achieve their objectives is now high on policy-makers' agenda in most advanced and emerging market countries.

This paper assesses the effectiveness of macroprudential policy measures (MPPs) in four neighboring Southeastern European emerging economies (Bulgaria, Croatia, Romania and Serbia) during their recent synchronized financial cycle (2002–12),[2] with a view to drawing lessons for both policy-makers and researchers. The four countries were subject to a similar external macro-financial environment and were going through similar processes of economic convergence and financial deepening, including as part of the process of joining the European Union (EU), though they were at different stages of accession. Their similarity is also exemplified by banking systems that were dominated by subsidiaries of large Western European banks, and were highly euroized (see Appendix 1). They all experienced strong capital inflows and credit growth during the boom period running up to the fourth quarter of 2008, and then a sudden stop, followed by a protracted recession. Their prudential authorities actively adopted MPPs to try and manage these developments. At the same time, initial conditions in banking system sizes and monetary policy regimes differed, and the set of policy instruments deployed varied. The combination of many shared elements of context and heterogeneous policy responses makes it interesting to exploit synergies in a joint study of the four countries.[3]

During the boom years, monetary policy was mostly focused on inflation and exchange rate developments and did not explicitly target credit or asset price developments. Fiscal policy was generally pro-cyclical, at best acyclical. That left macroprudential policy in the front line to manage the financial cycle. It was implemented outside of a dedicated formal policy framework. The monetary and prudential authorities – both part of the central bank in the four countries – interpreted their mandate to include macro-financial stability objectives. The choice of instruments varied over time as conditions changed. Seen in a broader European context, the four countries were pioneers in the use of MPPs.[4]

The paper implements a case study methodology, and aims to provide a useful complement to the burgeoning econometric literature on macroprudential policy effectiveness. Indeed, the bulk of this literature often does not capture well either the diversity in MPP design or the strength of the measures taken. This latter flaw is reflected in many papers' focus on instruments (i.e. MPPs abstracted from their calibration and implementation context) and categorical conclusions about instrument effectiveness (i.e. an instrument is, or is not, effective) whereas we suspect that effectiveness crucially depends on both context and proper calibration. We therefore find it more useful to discuss *measure effectiveness*. Furthermore, the effect of MPPs can in principle be highly non-linear, but the econometric studies that take into account measure strength of which we are aware are all based on linear specifications.

A case study methodology is flexible enough to address these limitations and also allows for providing a richer context about policy motivation and implementation. In Appendix 2, we thus provide a detailed discussion of the more than twenty instruments used and the more than one hundred measures implemented, as well as their sequencing, in a cross-country comparative perspective. While we match each type of instrument with a subset of five possible intermediate macro-financial objectives, in this paper we focus on the effectiveness of the measures employed to manage two of these objectives, i.e. total credit growth as well as household credit growth.

[2] Cottarelli, Dell'Ariccia, and Vladkova-Hollar (2005) find that bank-credit-to-GDP ratios in 2002 were near equilibrium and consistent with a process of convergence and structural financial deepening, so 2002 seems a good starting point for the analysis.

[3] The choice of these four countries also reflects the outcome of a trade-off between depth and breadth. Other studies have often analyzed the case of one country in great detail, or the whole Central, Eastern, and Southeastern Europe region in a less granular way. For a broad perspective on the boom-bust cycle in Central, Eastern, and Southeastern Europe, see Bakker and Klingen (2012).

[4] The European macroprudential framework was established only in 2011 (ESRB, 2011).

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A companion working paper Dimova, Kongsamut, and Vandenbussche (2016) provides a more extensive discussion of the macroeconomic background of the four countries and assesses the effectiveness of macroprudential measures across two additional objectives (managing the share of foreign currency lending and managing banks' foreign borrowing) as well.

Assessing the effectiveness of MPPs is a challenging task fraught with as many pitfalls and challenges in a case study as in an econometric study. MPPs are most likely endogenous to macro-financial developments and policy-makers' information set and/or expectations are not observable. More broadly, what would have happened had no measures been taken cannot be observed. In particular, it may be the case that the implementation of an MPP prevents an increase in a financial stability risk metric and that as a consequence we observe no change in the relevant metrics and may conclude incorrectly that the measure was not effective. In addition, measures may have been anticipated to various extents, may work with different lags, may not be immediately binding, and may interact with each other.

Against that background, we aim to identify which measures are associated with a sign of effectiveness, i.e. credit growth (or household credit growth) visibly moving in the intended direction within a window of four quarters around the time of implementation of the measure. Because we assess one measure at a time – rather than lump all measures of the same type together – we can discriminate across directions of policy change (tightening versus easing), implementation context (e.g. boom versus bust), and strength. However, because several measures may have been taken in the same time window, our inference remains tentative.

An important aspect the paper does not address is whether the MPPs helped build sufficient capital and liquidity buffers to preserve financial stability during the bust. The banking systems of the four countries remained broadly stable and only a few small domestically-owned banks failed during the bust period (2008:Q4–2012:Q4). However, this robustness was likely partially due to the fact that many foreign-owned parent groups received capital and funding support from their own home country's governments and that this support was in part needed because of the deterioration in the outlook of these groups' operations in Central, Eastern and Southeastern Europe (CESEE). Furthermore, in the case of Romania and Serbia, macroeconomic stabilization programs with official external financing were rapidly put in place, and helped shore up confidence.

Keeping the above caveats in mind, the paper's main findings can be summarized as follows: only strong measures helped contain domestic credit growth during the boom years, but the impact of these measures was weakened because of circumvention. Turning to the specifics, key findings for the boom period are that: (1) binding marginal reserve requirements related to credit growth ("credit growth ceilings") helped contain domestic credit growth; (2) strong sectoral capital measures and (3) the introduction of meaningful loan-to-value and debt-service-to-income ceilings helped limit household credit growth; however, (4) circumvention via direct external borrowing largely offset the direct effect of (1).[5] A corollary is that the other, less strict measures (the vast majority) are not associated with a sign of effectiveness. In a few cases, less-immediately-binding loan classification and provisioning measures were taken concurrently with the strong measures we find to be effective and may have reinforced their effect. Measures taken during the bust had no discernible impact.

While optimal calibration of measures obviously depends on country circumstances, the specifics of a few measures we find effective can provide a sense of the magnitudes involved, keeping in mind that the effect of some measures may have been reinforced by other measures taken concurrently or soon afterwards. Credit growth ceilings involved marginal reserve requirements of 200 percent when quarterly credit growth exceeded 4 percent (Croatia, 2003:Q1). Risk-weights on mortgages with loan-to-value (LTV) ratio above 70 percent were increased

[5] For lack of publicly available data, we cannot assess the extent of the circumvention of (1)–(2) via borrowing from domestic nonbanks. An assessment of circumvention of (3) requires granular data, also not publicly available.

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from 50 percent to 100 percent (Bulgaria, 2005:Q3). An LTV ceiling of 75 percent was introduced (Romania, 2004:Q1). These were not trivial measures by any reasonable standard.

Our study of the experience of these four countries suggests one lesson for policy-makers and two lessons for researchers. The lesson for policy-makers is that only strong, broad-based MPPs which address possible circumvention channels have a chance to truly contain credit booms. The first lesson for researchers is that the focus of effectiveness studies should be placed on measures and their strength rather than on instruments (i.e. classes of measures) and their mere deployment. The second lesson is that the possibility of non-linear effects (e.g. the existence of thresholds or asymmetries between tightening and easing) and state-contingent effects (e.g. differences between good times and bad times) should be taken into account in econometric studies.

The rest of the paper is organized as follows. After a review of the literature in Section II, the set of macroprudential policy instruments and the set of policy objectives these instruments can help achieve is presented in Section III. Section IV assesses the effectiveness of all relevant macroprudential policy measures by analyzing the evolution of domestic credit growth and domestic household credit growth around the time of their implementation. Section V discusses to what extent circumvention can affect this assessment, by looking at the concurrent evolution of cross-border lending. Section VI concludes, and is followed by a short appendix table of selected macro-financial indicators. Appendix 2 presents the list of MPPs implemented by the four countries in full detail.

2. LITERATURE REVIEW

An analysis of the key aspects of macroprudential policy design and reviews of the burgeoning literature on the subject can be found in IMF (2013a, 2013b and 2014) and Claessens (2015). Our review centers on the smaller set of empirical studies devoted to the effect of macroprudential policy on credit growth.

Most studies covering relatively large samples of countries have usually focused on instrument effectiveness rather than measure effectiveness, thus largely ignoring the issue of instrument calibration. Lim et al. (2011) find that several instruments – LTV cap, debt-service-to-income cap (DSTI), credit growth ceiling, foreign currency lending ceiling, reserve requirements, dynamic provisioning, and countercyclical capital requirements – reduce the procyclicality of credit and/or bank leverage in a panel of 49 countries between 2000 and 2010. Focusing on the same countries and period and the same MPP dataset, but using bank-level data, Claessens, Ghosh and Mihet (2013) find that measures aimed at borrowers (LTV and DSTI), and at financial institutions (credit growth ceilings) are effective at reducing asset growth, and that countercyclical buffers are of little effectiveness through the cycle.

Dell'Ariccia et al. (2012) find that a stricter MPP stance (measured as a count of macroprudential instruments in use or as an aggregate indicator variable) reduces the incidence of credit booms and decrease the probability that booms end badly. Zhang and Zoli (2014) find that LTV, housing-related taxes, and foreign currency-related measures have helped curb credit growth, in a set of 46 countries during 2000–13. Examining MPPs in 119 countries over 2000–13, Cerutti, Claessens and Laeven (2015) find that borrower-based policies and financial-institutions-based policies are associated with lower growth in credit to households in emerging market economies. Exploiting data from 57 countries spanning more than three decades, Kuttner and Shim (2013) find that only changes in DSTI have a robust statistically significant effect on housing credit growth. Vandenbussche, Vogel, and Detragiache (2015) look at household credit growth in sixteen CESEE countries between the late 1990s and 2011 and find that, among a large set of instruments, only changes in the minimum capital adequacy ratio and credit growth ceilings had a significant effect. In contrast with the rest of the existing literature, their paper actually quantifies MPP strength and

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can therefore speak to the issue of calibration. We use their scoring methodology to produce two figures in Section III below.

Among studies that focus on a narrower set of instruments, Dassatti Camors, and Peydro (2014) and Tovar Mora, Garcia-Escribano, and Vera Martin (2012) find that credit growth has positively responded to higher reserve requirements (RRs) in Latin America, while other studies found that tightening LTV and/or DSTI together slowed housing credit growth in Hong-Kong (Ahuja and Nabar, 2011), Korea (Igan and Kang, 2012), and selected emerging market economies (Jacome and Mitra, 2015). Aiyar, Calomiris, and Wieladek (2014) estimate the quantitative effect of an increase in regulated banks' capital requirements on lending growth in the United Kingdom. They also provide evidence of partial circumvention via unregulated resident foreign branches.

Many studies of CESEE economies focus on how various types of MPPs helped regulate credit growth during the latest boom-bust cycle in individual countries[6] – Estonia (Sutt, Korju, and Siibak (2011)), Hungary (Banai, Király, and Nagy (2011)), Macedonia (Celeska, Gligorova, and Krstevska (2011)), and Poland (Kruszka and Kowalczyk (2011)). Of particular relevance to our study is Galac (2010) who finds that credit growth ceilings, MRR on foreign borrowing, foreign currency liquidity ratio measures, and high capital adequacy requirements were particularly useful in building liquidity and capital buffers, but less effective in slowing down credit growth and capital inflows. He also finds that credit growth ceilings (the so-called credit growth reserve) were successful in reducing the rate of domestic credit growth, but were largely unsuccessful in reducing the growth of total private sector debt, particularly for corporations, due to widespread circumvention via external borrowing. This finding is broadly confirmed in our study. Gersl and Jasova (2014) also document that the most common circumvention in CESEE during the recent boom was to switch to direct cross-border borrowing from the foreign parent banks or to shift to less supervised channels such as leasing companies.

Kraft and Galac (2011) fine-tune Galac (2010)'s analysis and find that while the credit growth ceilings did nothing to the growth of total non-financial corporations' debt, they did slow down the growth of total household debt. Neagu, Tatarici, and Mihai (2015) discuss Romania's experience with DSTI and LTV in detail, and confirm, as we do, that the introduction of these instruments in 2004 slowed down household credit growth. As these authors, we analyze the use and effectiveness of MPPs against the background of particular macroeconomic contexts but delve into the design and calibration of the MPPs in greater detail.

3. POLICY INSTRUMENTS AND OBJECTIVES

3.1. Policy Instruments

To obtain data on MPPs for 2002–12 and establish the list of instruments used, we complement data from the Vandenbussche, Vogel and Detragiache (2015) database (which covers 2002–10) with data from various sources, including financial stability reports and annual reports published by the four countries' central banks, for 2011 and 2012.

The key prudential instruments used by the Bulgarian National Bank, the Croatian National Bank, the National Bank of Romania, and the National Bank of Serbia during 2002–12 can be grouped into six broad categories:

1. *Capital regulation (CAP)*, including minimum capital adequacy ratio, bank-specific capital adequacy minima that depend on credit growth, risk-weights, sectoral leverage ratios, and capital eligibility (e.g. the treatment of current profits). While all four countries took CAP

[6] See also Enoch and Ötker-Robe (2007) for experiences with MPPs in CESEE during the first half of the boom.

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measures, they resorted to somewhat different strategies during the boom years, reflecting initial conditions of their banking regulation and of the size and composition of their banking sector's loan portfolio. Most banks operated in a situation of excess capital over minimum requirements; therefore, tightening measures had the goal of maintaining sufficient buffers rather than building them, and/or affecting the allocation of credit across sectors and currencies.

2. *Loan classification and provisioning rules (LCP)*, including rules for specific provisions and rules for general provisions. During the boom, the four countries made their loan classification and provisioning rules stricter so as to require banks to build thicker provisioning buffers and provide greater incentives for more careful loan underwriting. All countries changed the rules governing specific provisions, i.e. those provisions made against loan exposures that do not meet the criteria to belong to the safest category. Two countries also introduced a system of general provisions, i.e. provisions that are contingent neither on the characteristics nor on the performance of the loan and have built-in countercyclical features.
3. *Liability-based reserve requirements and liquidity ratios (LRR)*, including average reserve requirements, marginal reserve requirements on foreign liabilities, and foreign-currency liquidity ratio (FCLR). During the bust, these were among the earliest to be loosened to help relieve liquidity pressures in banking systems.
4. *Asset-based reserve requirements (ARR)*, including marginal reserve requirements related to credit growth. Croatia and Bulgaria aimed to control credit growth by deploying this category of instruments. Neither Romania nor Serbia used them.
5. *Eligibility requirements (ELI)*, including LTV caps, and DSTI caps, which constrain credit demand by placing caps on the amounts that can be borrowed. Only Romania made use of this type of instrument during the boom.
6. *Non-bank regulation (NBK)*, including regulation of leasing and consumer finance companies. Partly as a result of the stricter regulation imposed on banks, nonbank credit institutions began to thrive, although the size of these sectors remained very small relative to the size of the banking sector. Romania and Serbia brought these institutions into the regulatory perimeter during the boom period.

The first four categories of measures affect various cost margins as well as capital, provisions and liquidity buffers. They work through the supply side of credit, while the fifth category affects the demand side of credit. The sixth category works by constraining the activity of nonbank credit intermediaries, which can be a channel of circumvention of measures targeting banks only. As indicated in the introduction, a comprehensive list of measures is provided in Appendix 2.

The four countries varied in their degree of interventionism. Generally, countries tended to tighten the macroprudential policy stance during the boom period and loosen it during the bust period (see Figures 1 and 2). During the boom, policymakers at times implemented various instruments simultaneously. This approach suggests that macroprudential authorities believed in instrument complementarity. The progression observed over time also likely reflects a sequential approach where the more intrusive measures were used only after less severe measures had been first tried and, presumably, found not to have the desired impact.

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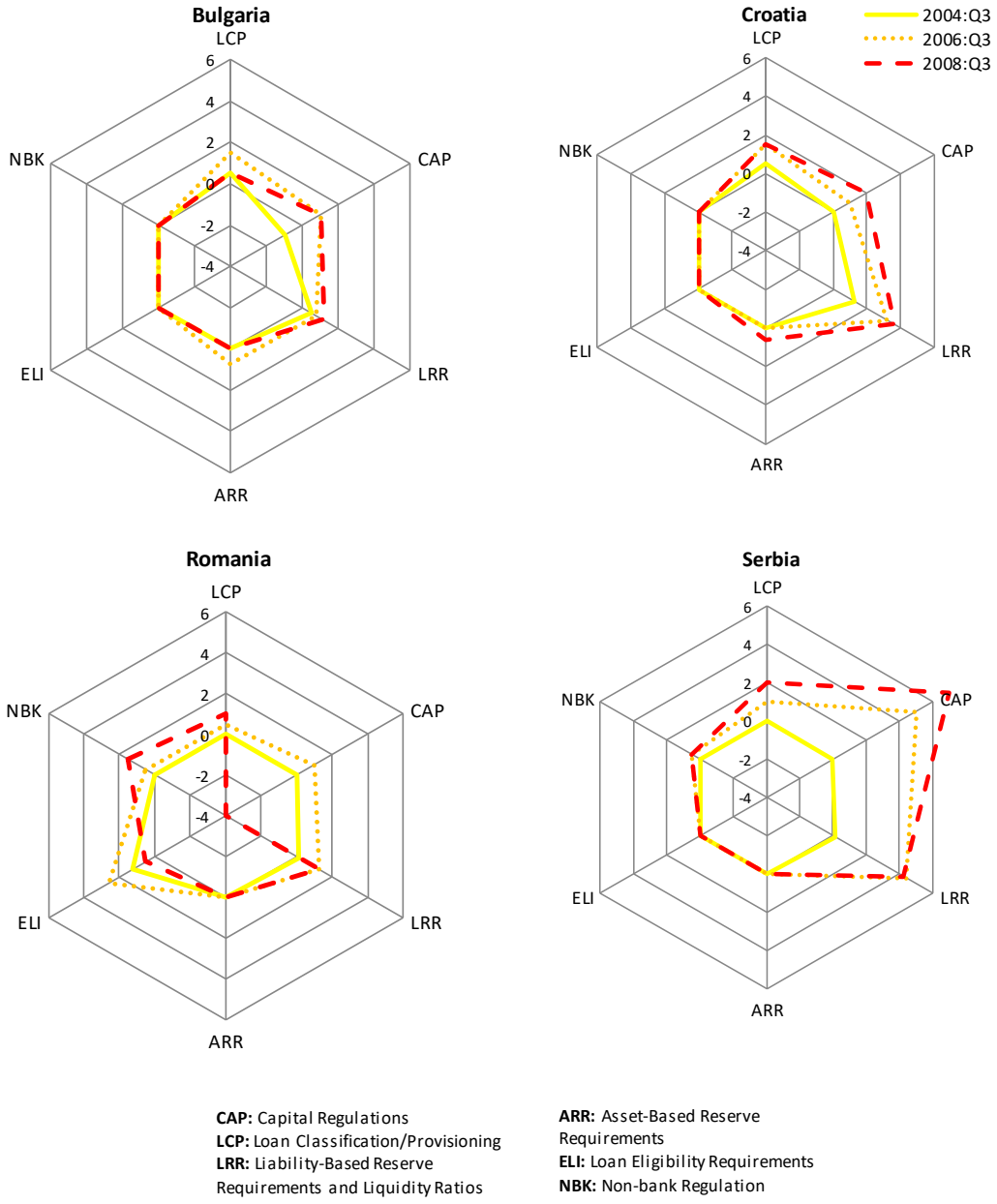
Figure 1.
Changes in Macroprudential Policy Stance during the Boom (changes relative to 2002:Q3)



Note: A higher value corresponds to a tighter stance.

Source: Authors' calculations based on scoring methodology of Vandenbussche, Vogel, and Detragiache (2015).

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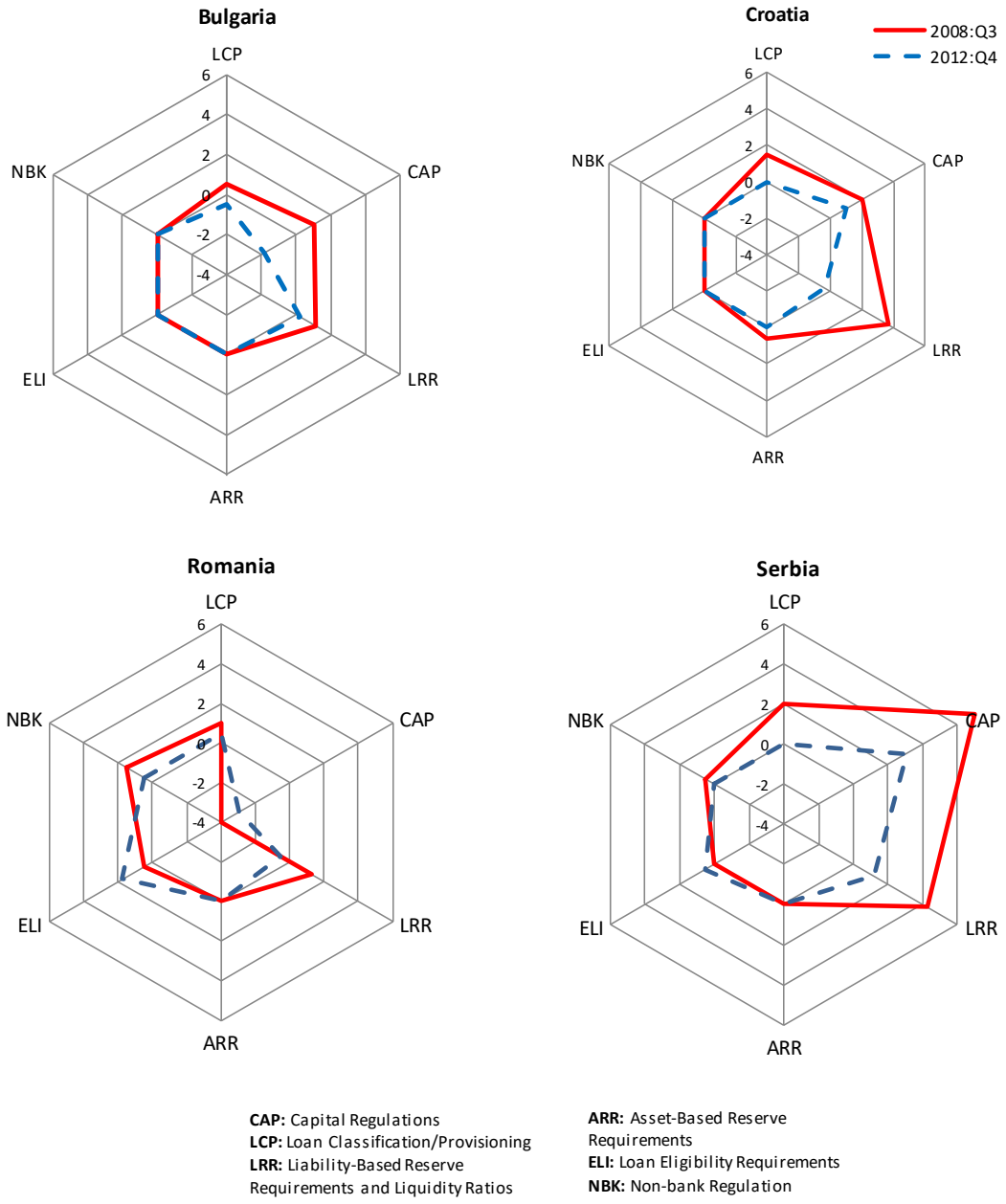
Figure 2.
Changes in Macroprudential Policy Stance during the Bust (changes relative to 2002:Q3)



Note: A higher value corresponds to a tighter stance.

Source: Authors' calculations based on scoring methodology of Vandenbussche, Vogel, and Detragiache (2015).

During the bust, the four countries reversed some of the tightening that had taken place during the boom in order to help banks withstand the global financial crisis and the ensuing recession, and thus help avoid a credit crunch. The most aggressive measures had become redundant and were dropped early. However, and perhaps surprisingly, some tightening during the bust also took place, in particular in the area of loan eligibility criteria. This likely reflects the realization that banks had failed to properly assess credit risk (including the exchange rate risk faced by unhedged borrowers) during the boom years and therefore that further regulatory constraints should be placed on their loan decision-making process.

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3.2. Policy Objectives

Though all four countries were experiencing a similar financial cycle, policymakers' perception of risks varied somewhat. Therefore, while their ultimate objective was financial stability – or, more precisely, a balance between supporting economic activity and financial stability[7] – their intermediate objectives in taking action also varied. Intermediate objectives are defined by the European Systemic Risk Board as "operational specifications of the ultimate objective."[8] Our study evaluates the effectiveness of MPPs against the stated (intermediate) objectives of policymakers in the four countries where these are made explicit, but also in some cases against what is a natural objective given the nature of the instrument (for example, domestic credit growth as an objective for broad-based LRR measures). These objectives are reported in public documents (press releases, annual reports, financial stability reports, etc.), and suggest that concerns were focused on five main intermediate objectives (Table 1). During the boom period, rapid credit growth was a concern in all four countries. Strong household credit growth was being particularly targeted in Bulgaria, Romania and Serbia, therefore we also discuss household credit growth in the context of overall credit growth below. In those same three countries, the relaxation of lending conditions was also a concern.

Table 1.
Macroprudential Policy Intermediate Objectives and Use of Instruments

MPP Intermediate Objectives	Domestic Credit Growth	o/w Household Credit Growth	Lending Conditions	Share of FC Lending	Share of Foreign Borrowing
MPP Instruments	CAP, ARR, LRR, LCP, ELI, NBK	CAP, LCP, ELI	ELI, CAP, LCP	CAP, LCP, LRR, ELI	LRR
Bulgaria	CC	CC	CC		
Croatia	CC			CC	CC
Romania	partially CC	partially CC	partially CC, then AC	partially CC	
Serbia	CC	CC	AC	partially CC	CC

Notes: AC = acyclical; CC = countercyclical; CAP = capital regulation; LCP = loan classification and provisioning rules; LRR = liability-based reserve requirements and liquidity ratios; ARR = asset-based reserve requirements; ELI = eligibility requirements; NBK = regulation of nonbank credit institutions; FC = foreign currency.

As Table 1 illustrates, the same instrument category was sometimes used for different intermediate objectives. For example, CAP and LCP measures were used for almost all objectives. Other types of measures, such as LRR, were targeted toward more specific objectives of managing the foreign borrowing of banks.

As hinted above, policymakers generally aimed for countercyclical (leaning-against-the-wind) measures. This implies that the tightening measures taken to address the concerns described above were partially or fully reversed during the bust. However, some tightening measures were acyclical in nature and presumably reflected policymakers' realization that stricter regulation was required to reduce systemic risk regardless of the position in the financial cycle. In addition, in the case of Bulgaria and Romania, some measures taken for countercyclical reasons during the boom were later reversed in the context of harmonization with EU regulation, thus limiting their overall impact.

[7] The relative weight placed on growth considerations reflected initial conditions in terms of financial sector development.

[8] See ESRB (2011).

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4. WERE CREDIT GROWTH MEASURES EFFECTIVE?

We now turn to the assessment of the measures' effectiveness by analyzing the evolution of two of the specific target variables these measures were meant to affect, namely credit growth and household credit growth. As mentioned in the introduction, an assessment of effectiveness with respect to two other target variables (foreign currency lending, and banks' foreign borrowing) can be found in Dimova, Kongsamut, and Vandenbussche (2016). As noted above, all four countries had concerns about excessive domestic credit growth, and the full range of instruments was deployed.[9] Our assessment is based on a quantitative criterion specified below and a graphical analysis supported by charts that display the evolution of the target variables over time as well as relevant MPPs that were implemented in the form of vertical lines. These lines are red for tightening measures, green for easing measures, and orange when both a tightening and an easing measure were taken in the same quarter. Shaded areas indicate measures that are deemed effective. Because the share of foreign-currency-denominated loans was high in each country, we examine credit growth adjusted for foreign currency movements to purge the credit series from valuation effects.

The analysis that follows focuses on macroprudential policies and abstracts from the role that monetary policy may have played in the evolution of credit aggregates. This seems appropriate because, to the extent an active monetary policy was pursued, it was mostly focused on inflation and exchange rate developments and generally not (or at least not explicitly) on credit developments. This is obvious in Bulgaria, where the currency board did not allow any independent monetary policy. In Croatia, monetary policy was largely geared toward maintaining exchange rate stability. In Romania, the National Bank of Romania switched to inflation targeting in August 2005 from nominal exchange rate depreciation targeting to curb growing inflation. In spite of missing inflation targets, monetary policy engineered a significant disinflation until 2007, while credit growth remained untamed. Finally, in Serbia, progress was made with disinflation and from 2006 the focus of monetary policy shifted from the exchange rate to inflation, culminating in the adoption of formal inflation targeting in 2008. In any case, we check that the diagnostics of effectiveness made for each macroprudential measure below is not hampered by a concurrent monetary policy action that would affect domestic credit in the same direction.

The criterion for effectiveness is defined as follows. A measure implemented in period t is deemed effective if the change in credit growth between period $t - 2$ and period $t + 2$ goes in the right direction and is significant. To reduce the impact of short-term volatility of credit, we use the 3-year moving average of the credit growth series when conducting the assessment. To measure "significance", we construct the series of changes in credit growth (2-period-ahead minus 2-period-behind), separating the periods up to 2007:Q3 (boom) and from 2009:Q3 (bust), i.e. excluding a 7-quarter window around 2008:Q3 (the onset of the Global Financial Crisis, a likely structural break). We then use an iterative procedure for both the boom and the bust. For the boom, we identify the quarter Q when a tightening measure was implemented that is associated with the largest decline in credit growth. We then compute the mean (m) and standard deviation (sd) of the change (between $t - 2$ and $t + 2$) in credit growth during a control period, defined as the period running up to 2007:Q3 excluding a window of seven periods around Q and all other periods previously excluded. The change at time t is deemed significant if the change in credit growth between $t - 2$ and $t + 2$ is strong enough to be smaller than the threshold $m - 1.65$ sd.[10] Assuming we find that the change around quarter Q is significant, we repeat the procedure with the quarter when a tightening measure was implemented that had the second largest negative impact on credit growth, further narrowing the control period. We stop the procedure when we have reached a measure that has an impact that is too small to be lower than the threshold based

[9] Because of data constraints for nonbank financial institutions, the effectiveness of NBK measures cannot be assessed.

[10] Ninety percent of a normal distribution of mean m and standard deviation sd is within [$m - 1.65$ sd, $m + 1.65$ sd].

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on the relevant control period. We proceed in the exact same way for the bust (using the threshold m + 1.65 sd for easing measures and m – 1.65 sd for the tightening measures), and for household credit growth during the boom and the bust.

In addition, we require that measures found to have an effect on credit growth that is both in the right direction and significant are also found to have an effect on other relevant intermediate targets as the effect on total credit growth is expected to happen via the effect on these other intermediate targets. For example, for measures targeting excessive household credit growth, we require that total credit growth does not decline more than household credit growth (so that the share of household credit in total credit does not increase).[11]

The summary results for effective measures are shown in Table 2. For each measure, we report the change in credit growth taking place around the time when the measure was put in place as well as the relevant threshold. We also indicate whether other reinforcing measures were taken concurrently or subsequently (which would positively bias the diagnostic of effectiveness) and whether the measure reinforced other measures taken earlier (which would negatively bias the diagnostic of effectiveness). In three cases, several measures going in the same direction were taken during the same quarter. We then use judgment to assess whether the policy was sufficiently strong to have been the main reason for the change in credit growth.

Table 2.
Summary of Measures Effective in Managing Domestic Credit Growth (Including measures effective in managing household credit growth)

Type	Instrument	Country	Quarter	Details	Reinforcing nature	Reinforcing measures soon afterwards	Change in credit growth	Threshold
ARR	Credit ceiling	Bulgaria	05:Q2	Marginal reserve requirements of 200 percent if qoq credit growth is larger than 6 percent (and loan book big enough)	Yes. Increase in RR in 04:Q4 and LCP in 05:Q2	Yes. CAP measures in 05:Q3 and increase in penalties in 05:Q4	–5.7	–1.6
LCP	Loan classification	Bulgaria	05:Q2	No migration back to lower risk category category for restructured exposures before 6 months	Yes. Increase in RR in 04:Q4 and ARR in 05:Q2	Yes. CAP measures in 05:Q3 and increase in penalties in 05:Q4	–5.7	–1.6
CAP	RW HH	Bulgaria	05:Q3	Increase in risk-weights on high-LTV mortgage loans	Yes. Credit ceiling since 05:Q2, capital eligibility measure in 05:Q3	Yes. Increase in credit ceiling penalties in 05:Q4	–6.0	–3.0
CAP	Capital eligibility	Bulgaria	05:Q3	Exclusion of interim profits from capital base	Yes. Credit ceiling since 05:Q2, RW measure in 05:Q3	Yes. Increase in credit ceiling penalties in 05:Q4	–4.8	–1.6
ARR	Credit ceiling	Bulgaria	05:Q4	Increase in penalty rate (up to 400 percent)	Yes. Credit ceiling since 05:Q2, CAP measures in 05:Q3, and LCP measure in 05:Q4	Yes. RW measure in 06:Q2	–3.6	–1.6

[11] The methodology used to assess effectiveness with respect to the other two targets (share of foreign currency lending, and share of foreign borrowing) is as follows. We deem a measure targeting FC lending and implemented in period t to be effective if the change in the trend of the share of FC lending in total lending around t has the right sign and is "significant". The trend "before" is the difference between the share of FC lending at time t and that at time t – 2, and the trend "after" is the difference between the share of FC lending at time t + 2 and that at time t. We use the same approach for the share of foreign borrowing.

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Type	Instrument	Country	Quarter	Details	Reinforcing nature	Reinforcing measures soon afterwards	Change in credit growth	Threshold
LCP	Provisioning HH	Bulgaria	05:Q4	Increase in provisioning rates for loans to households	Yes. Credit ceiling since 05:Q2, tightened in 05:Q4, CAP measures in 05:Q3	Yes. RW measure in 06:Q2	–6.4	–3.0
ARR	Credit ceiling	Croatia	03:Q1	Requirement to buy low-yielding central bank bills if qoq credit growth is larger than 4 percent	Yes. FCLR measure in 03:Q1	No	–3.6	–0.4
ARR	Credit ceiling	Croatia	07:Q1	Requirement to buy low-yielding central bank bills if annual credit growth is larger than 12 percent	Yes. Earlier MRR and SRR measures, FCLR measure in 06:Q4, RW and LCP measures in 06	No	–2.5	–0.4
ELI	LTV, DSTI on HH	Romania	04:Q1	Introduction of LTV and DSTI	No	No	–25.8	–9.0
LRR	RR FC, RR Foreign borrowing	Serbia	06:Q2	Increase in RR FC rate and expansion of the base	Yes. Net tightening of reserve requirements in 05	Yes. Introduction of HH leverage ratio in 06:Q3 and higher RW FC in 06:Q4	–4.6	–0.5
CAP	Sectoral HH leverage ratio	Serbia	07:Q3	Extension of the scope of the regulation to include all housing loans	Yes. Sectoral leverage ratio introduced in 06:Q3 and penalties increased in 07:Q2, Higher RW FC in 06:Q4	Yes. Tightening of the ratio in 07:Q4	–5.1	–4.7

ARR = asset-based reserve requirements, LRR = liability-based reserve requirements and liquidity ratios, CAP = capital regulation, LCP = loan classification and provisioning rules. HH = household.
Shaded rows indicate those measures that were found effective in slowing household credit growth. In Bulgaria, these measures on household credit took place at the same time as other tightening measures, and therefore likely reinforced each other (orange shading), while in Romania and Serbia, we did not identify any reinforcing measures that took place concurrently (blue shading).

Source: Authors' calculations.

4.1. ARR measures slowed down domestic credit growth while they were in place

The experience of Bulgaria and Croatia suggests that ARRs can help restrain domestic credit growth when they are binding and the marginal reserve requirement rates are very high.

The ARR measures in Bulgaria – which had an initial rate of 200 percent if quarterly credit growth exceeded 6 percent – helped reduce the growth of credit to the private sector while they were in place in 2005–06. When they were relaxed, and later abandoned upon EU accession in 2007, credit growth picked up again strongly (Figure 3, top chart). The effect of pre-announcing the ARR is evident: in the first quarter of 2005, banks raced to build up their loan books to increase the base from which the credit ceiling would be applied, and a pronounced kink is observed during

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that period.[12] Once the ceiling became implemented and binding in 2005:Q2, credit growth fell back. However, because a tightening LCP measure was taken concurrently (Figure 3, bottom chart), we cannot attribute fully the slowdown to the ARR measure. Similarly, the increase in the penalty rate later in 2005 happened together with further LCP tightening and followed a RW tightening, so the persistence of the domestic credit slowdown cannot be cleanly attributed to the ARR measure. Following the penalty reduction in 2006:Q3, credit growth accelerated, a reversal which may have been reinforced by the removal of the earlier LCP measure.

The so-called credit growth reserve was imposed in Croatia in 2003:Q1 (with a quarterly credit growth threshold of 4 percent and a penalty rate of 200 percent), was abandoned one year later, and reinstated in 2007:Q1 (with a stricter credit growth threshold of 12 percent annually, but a lower penalty rate of 50 percent). In both instances (Figure 4, top chart), credit growth slowed down. In the second instance, the penalty was likely deemed insufficient, as credit growth rebounded in 2008:Q1, which led the authorities to increase the penalty to 75 percent. Credit growth resumed its decline but this was soon compounded by the effects of the GFC, making any effectiveness assessment moot. In both instances, a LRR measure (tightening in the FCLR) took place in a nearby period, suggesting a possible reinforcing role of the measure in making it costlier to expand credit as foreign currency liquidity requirements were tightened. However, we do not find that these FCLR measures had any significant impact on the evolution of the share of foreign currency lending (using the methodology explained in footnote 11) and therefore they do not qualify as effective. Credit growth increased only several quarters after the first credit growth reserve was abandoned. Credit growth did not increase after the second credit growth reserve was abandoned either, as the measure was no longer binding at this point in the cycle.

4.2. LRR measures generally had no significant effect on domestic credit growth, except at the peak of the tightening cycle in Serbia

The effect of liability-based reserve requirements and liquidity requirement measures on domestic credit growth appears mixed at best. Policy tightening in Bulgaria (i.e. increasing the rate of reserve requirements up to 12 percent, or expanding their base) did not slow down credit growth during the boom, while small easing measures (e.g. the RR rate on domestic deposits was cut by only 2 pps) were not followed by a rebound in credit growth during the bust (Figure 3, middle chart). In Croatia, the RR measures were of very small magnitude and aren't associated with a significant movement in credit growth in the right direction in the two quarters following implementation (Figure 4, middle chart). The FCLR measures (a net tightening resulting from a reduction in the rate by 18 pps combined with an extension of the base in 2003:Q1, and the inclusion of FC-indexed liabilities in the base in 2006:Q4) mentioned in the paragraph above are, but do not meet our effectiveness criterion. In Romania, neither the increase in the rate of reserve requirement on FC liabilities (which peaked at 40 percent in 2006) nor the broadening of the base were followed by a credit growth slowdown during the boom (Figure 5, top chart). During the bust period, marginal easing of reserve requirements was not followed by any significant increase in credit growth.

The same diagnostic of ineffectiveness is generally true for Serbia, (Figure 6, top chart), although some effect can be observed at the peak of the tightening cycle: in 2006:Q2 credit growth slowed when the reserve requirement rate on FC deposits reached 40 percent, and the rate on short-term external borrowing reached 60 percent. After the first easing measure was taken later that year – a reduction of the reserve requirement rate on domestic currency deposits from 18 percent to 15 percent, which was taken concurrently with a reduction in the policy rate for monetary policy reasons in the context of the introduction of the so-called New Monetary Policy

[12] To account for this effect, we replace credit growth in 2005:Q1 and 2005:Q2 by their average.

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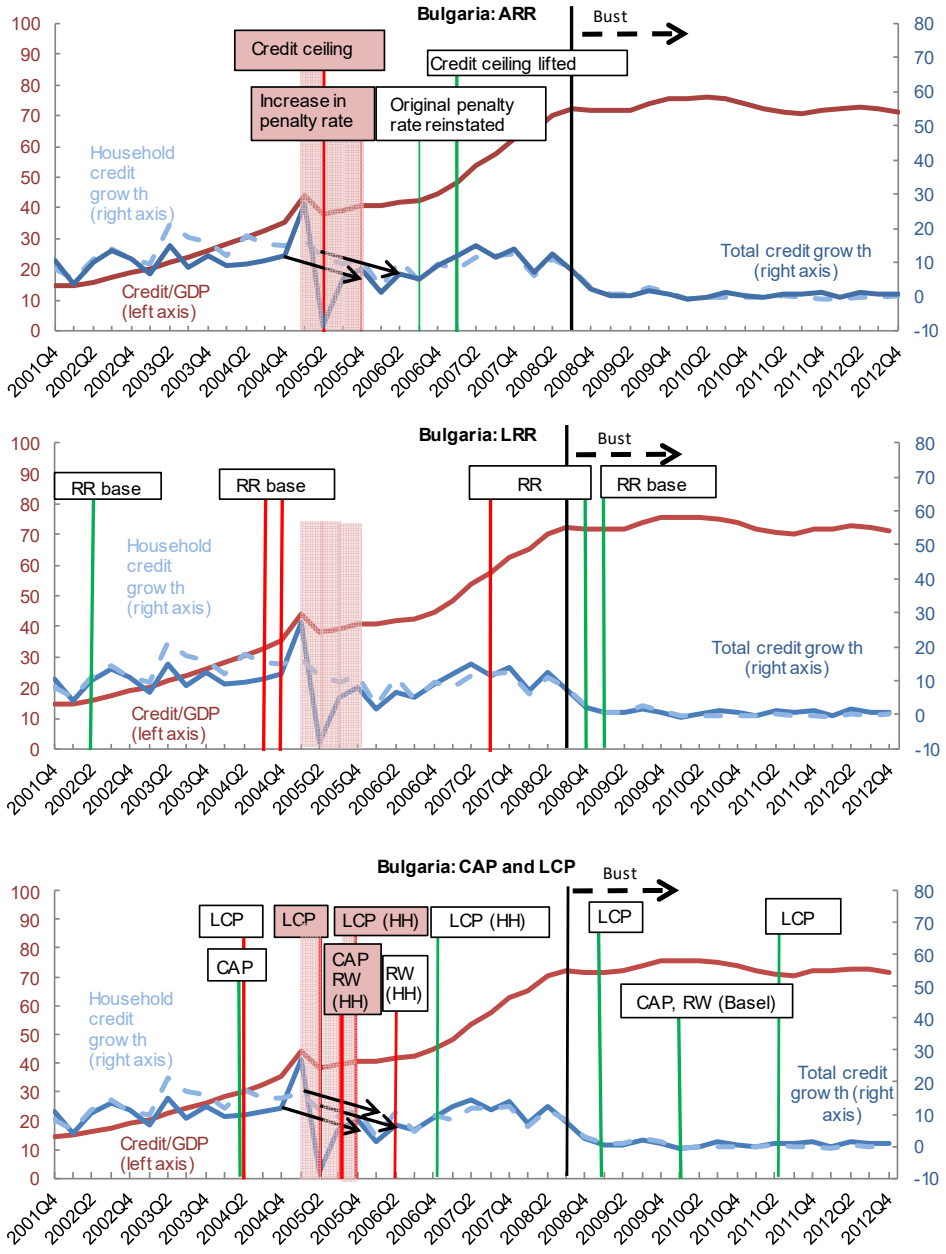
Framework, not for macroprudential reasons – credit growth rebounded and the credit-to-GDP ratio resumed its upward trend. Frequent adjustments of LRRs – although with a tightening bias – suggest that calibration was difficult during the boom. Successive easing measures (a reduction of the base, a 5 pps rate cut on the domestic currency base, a 15 pps rate cut on the foreign currency base) during the bust period were not followed by a revival of domestic credit growth.

Figure 3.
Bulgaria: Domestic Credit to Private Sector, 2001:Q4–2012:Q4 (Exchange-rate-adjusted QoQ growth rate and ratio to GDP, in percent)



Notes: a green line indicates policy loosening, a red line indicates policy tightening, and a yellow line indicates both loosening and tightening in the same quarter. Shaded text indicates effectiveness. Shaded areas indicate quarters when a measure deemed effective was implemented.
ARR = asset-based reserve requirements, LRR = liability-based reserve requirements and liquidity ratios, CAP = capital regulation, LCP = loan classification and provisioning rules.
See Appendix 2 for a full description of the measures.

Sources: Vandenbussche et al. (2015), central bank websites and publications, International Financial Statistics (IFS), and authors' calculations.

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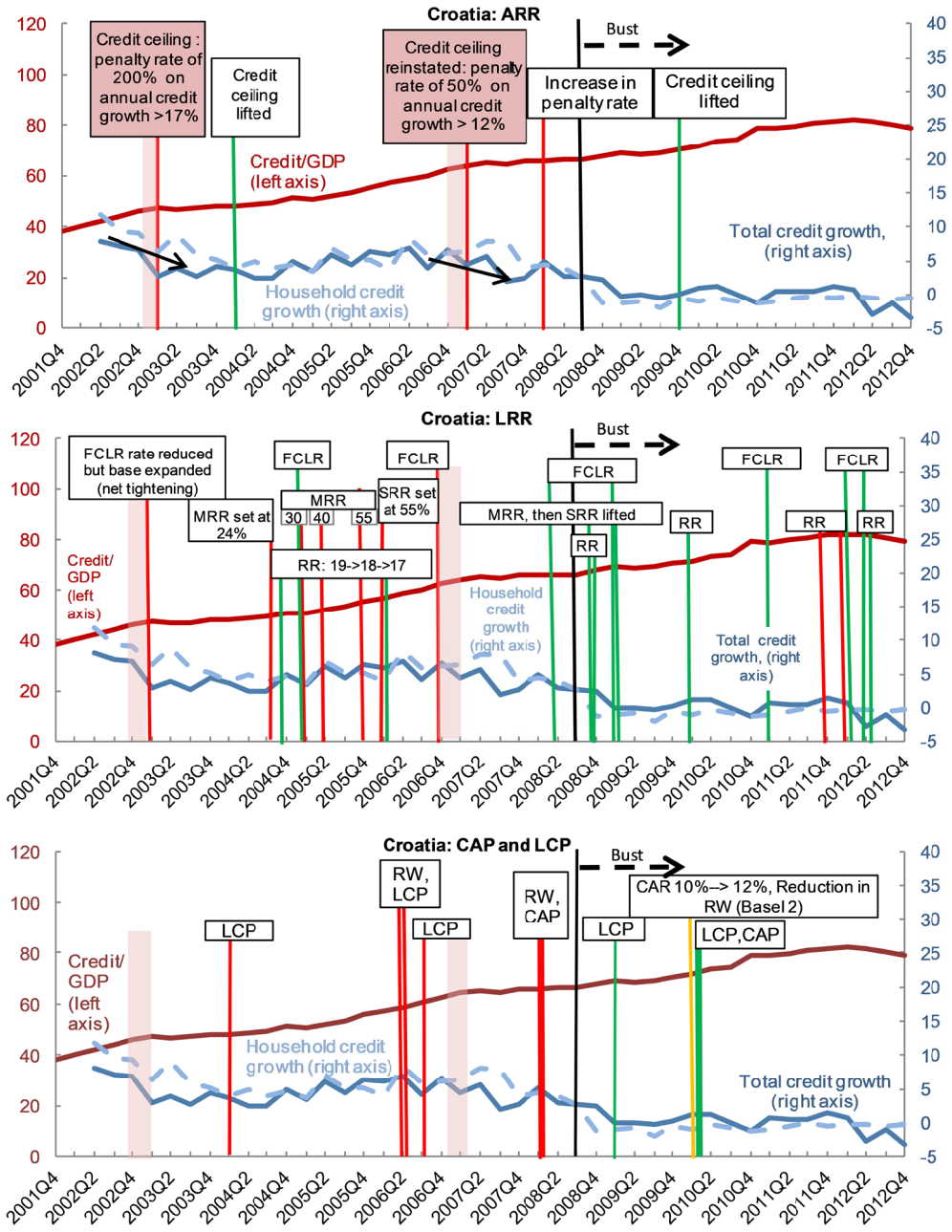
Figure 4.
Croatia: Domestic Credit to Private Sector, 2001:Q4–2012:Q4 (Exchange-rate-adjusted QoQ growth rate and ratio to GDP, in percent)



Notes: a green line indicates policy loosening, a red line indicates policy tightening, and a yellow line indicates both loosening and tightening in the same quarter. Shaded text indicates effectiveness. Shaded areas indicate quarters when a measure deemed effective was implemented.
ARR = asset-based reserve requirements, LRR = liability-based reserve requirements and liquidity ratios, CAP = capital regulation, LCP = loan classification and provisioning rules.
See Appendix 2 for a full description of the measures.

Sources: Vandenbussche et al. (2015), central bank websites and publications, International Financial Statistics (IFS), and authors' calculations.

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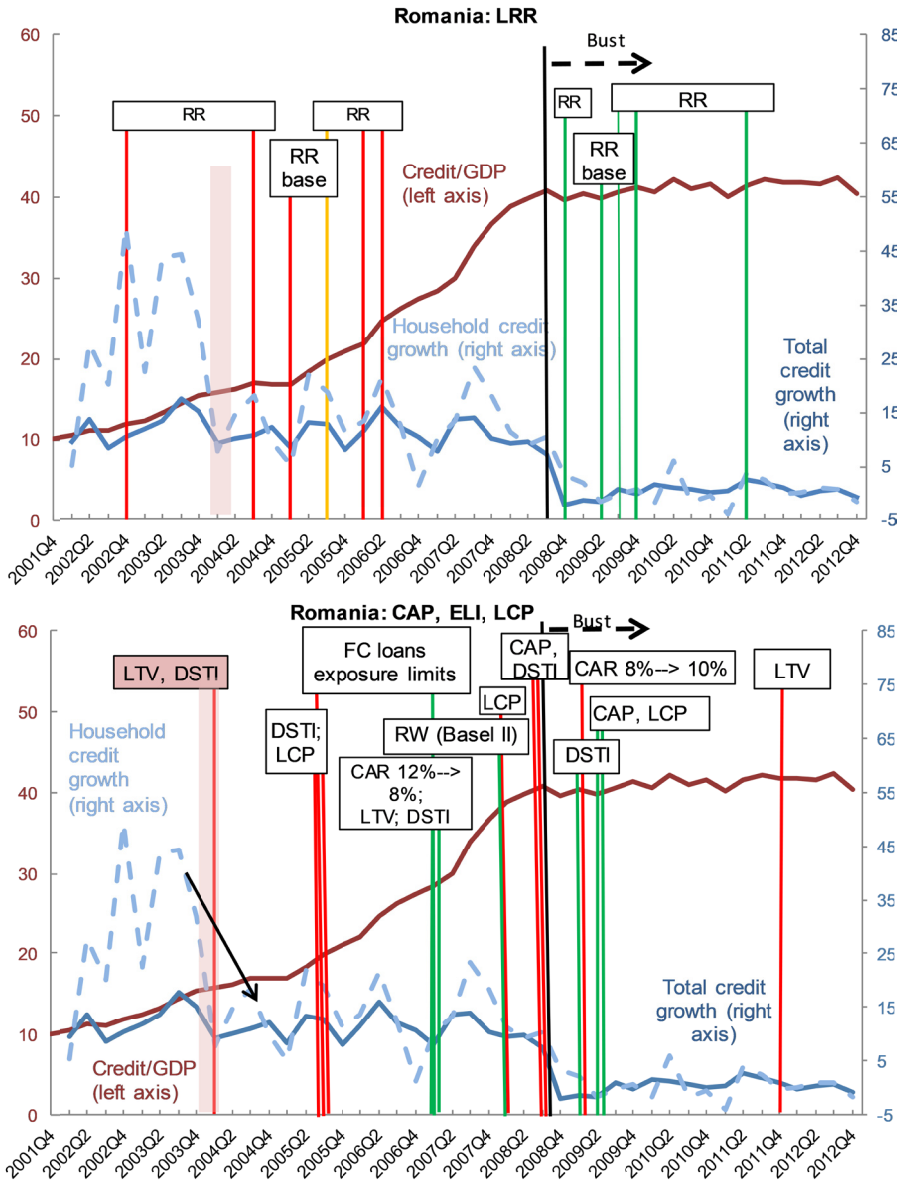
Figure 5.
Romania: Domestic Credit to Private Sector, 2001:Q4–2012:Q4 (Exchange-rate-adjusted QoQ growth rate and ratio to GDP, in percent)



Notes: a green line indicates policy loosening, a red line indicates policy tightening, and a yellow line indicates both loosening and tightening in the same quarter. Shaded text indicates effectiveness. Shaded areas indicate quarters when a measure deemed effective was implemented.
CAP = capital regulation, LCP = loan classification and provisioning rules, LRR = liability-based reserve requirements and liquidity ratios, ELI = eligibility requirements. FC = foreign currency; LC = domestic currency; HH = household.
See Appendix 2 for a full description of measures.

Sources: Vandenbussche et al. (2015), central bank websites and publications, International Financial Statistics (IFS), and authors' calculations.

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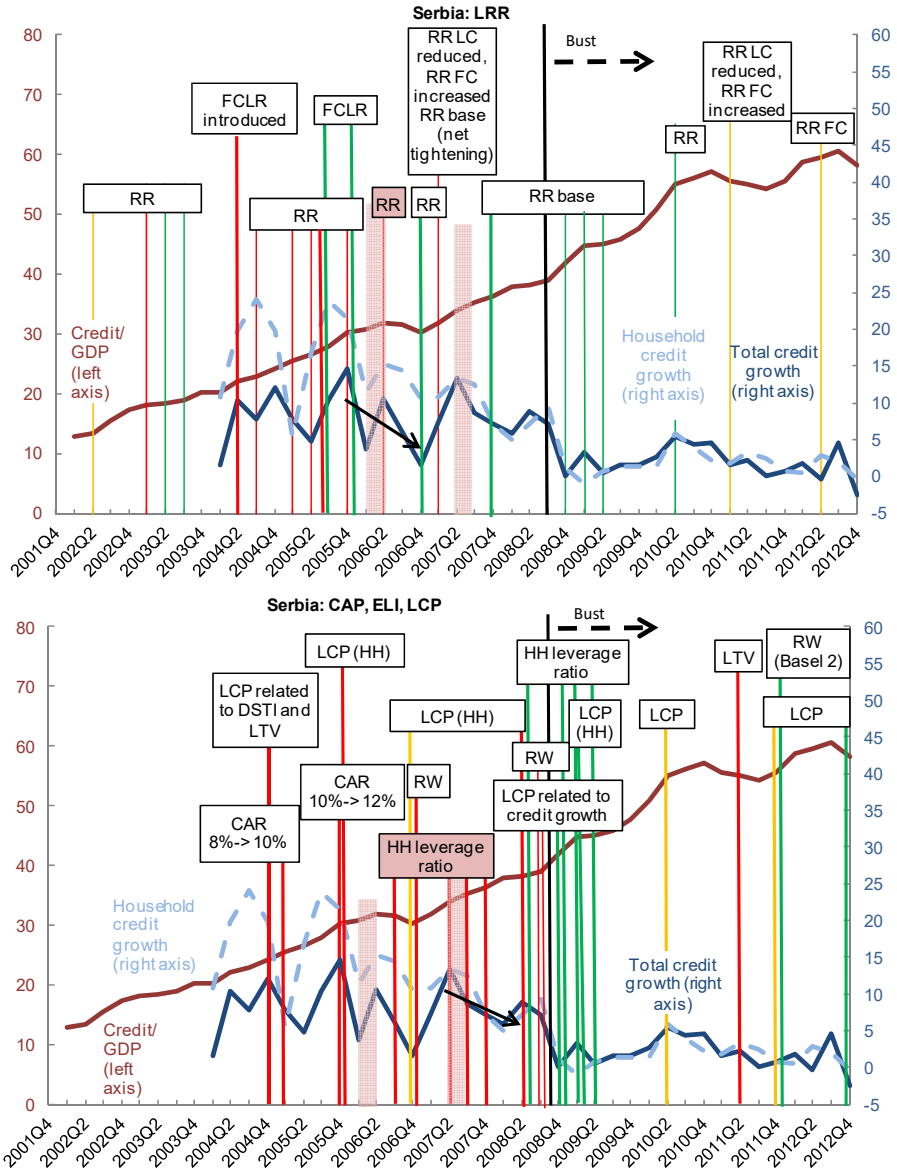
Figure 6.
Serbia: Domestic Credit to Private Sector, 2001:Q4–2012:Q4 (Exchange-rate-adjusted QoQ growth rate and ratio to GDP, in percent)



Notes: a green line indicates policy loosening, a red line indicates policy tightening, and a yellow line indicates both loosening and tightening in the same quarter. Shaded text indicates effectiveness. Shaded areas indicate quarters when a measure deemed effective was implemented.
CAP = capital regulation, LCP = loan classification and provisioning rules, LRR = liability-based reserve requirements and liquidity ratios, ELI = eligibility requirements. FC = foreign currency; LC = domestic currency; HH= household.
See Appendix 2 for a full description of measures.

Sources: Vandenbussche et al. (2015), central bank websites and publications, International Financial Statistics (IFS), and authors' calculations.

4.3. Some strong sectoral CAP measures were effective at curbing credit to households during the boom

A household credit growth slowdown took place in Bulgaria around the time when risk-weights on mortgages were increased from 50 percent to 100 percent for loans with an LTV in excess of 70 percent in 2005:Q3 (Figure 3, bottom panel). The effect of that measure was very likely reinforced by the ARR measures taken right before and right after, and by the exclusion of current profits from the regulatory capital base taken in the same quarter, but the decline in household credit growth was stronger than the decline in total credit growth (–6 percent versus –4.8 percent), suggesting that the measure had an impact over and above that of the other non-sectoral measures

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taken concurrently. A further increase of mortgage risk-weights is not associated with a further slowdown, but the effect of the measure was blurred by the easing of the credit ceilings soon after.

Serbia's use of a sectoral leverage ratio helped decrease household credit growth in the second half of 2007, once the initial measure was tightened by broadening the base (Figure 6, bottom panel). Loans to households were originally capped at 200 percent of share capital in 2006:Q3, with some exceptions (e.g. for loans for housing construction supported by the government), with the cap later tightened to 150 percent of share capital and the exceptions removed in 2007:H2. The effect of this measure was reinforced by an increase in penalties for non-compliance earlier in the year and by lowering the leverage ceiling during the following quarter. The chart suggests that the latter was effective too, but it took place too close to the onset of the GFC to be properly assessed using our methodology. The sectoral leverage ratio was loosened and then abandoned relatively soon into the bust period in 2009. Its removal had no visible impact on household credit growth.

Other CAP measures did not have a significant effect on total private sector credit growth or household credit growth in any of the four countries (Figures 3–6, bottom panels). We note, however, that the reduction in the minimum CAR from 12 percent to 8 percent (taken concurrently with an easing of ELI measures) in Romania was followed by to a steeper increase in the credit-to-GDP ratio.

4.3. Early ELI measures in Romania helped curb household credit growth during the boom

Only Romania used ELI measures during the boom. The introduction of LTV (75 percent) and DSTI ceilings (30 percent of net income for consumer credit and 35 percent for mortgage credit) weakened household credit growth after their introduction in 2004:Q1 (Figure 5, bottom panel), although the level remained very high (above 10 percent QoQ) afterwards. Surprisingly, the tightening of DSTI in 2005:Q3 does not seem to have led to a further reduction. During the bust, the reintroduction of LTV limits by currency (85 percent for domestic currency loans, 75 percent for loans in euros, and 60 percent for loans in another currency) had no significant impact. Neither did their introduction in Serbia (LTV of FC-denominated and indexed mortgage loans capped at 80 percent in 2011:Q2).

4.4. LCP measures generally had no significant effect on domestic credit growth, except perhaps in Bulgaria when taken concurrently with other measures

Though both broad-based LCP (in 2005:Q2) and sectoral LCP (in 2005:Q4) measures in Bulgaria seem effective, they took place concurrently with credit ceilings measures. The broad-based measure was too weak – a lengthening to six months of the time required for restructured exposures to migrate to a lower risk category – to have been a reason to cut credit supply. The sectoral LCP measure was concurrent with a tightening of credit ceilings and implemented shortly after risk-weights on mortgages were increased. Minimum specific provisions to cover impairment loss were raised from 10 to 20 percent for so-called watch exposures and from 50 to 75 percent for so-called substandard exposures. This measure may have had a reinforcing effect but is unlikely to have been sufficiently strong to have a significant impact by itself.

5. CIRCUMVENTION VIA CROSS-BORDER LENDING

This section examines further evidence to assess whether our claim that some strong measures were effective has to be qualified owing to circumvention. Circumvention is analyzed through cross-border lending only, as data on lending by domestic nonbanks is not sufficiently available. Also for lack of availability of more granular data, the focus is on credit to the private sector as

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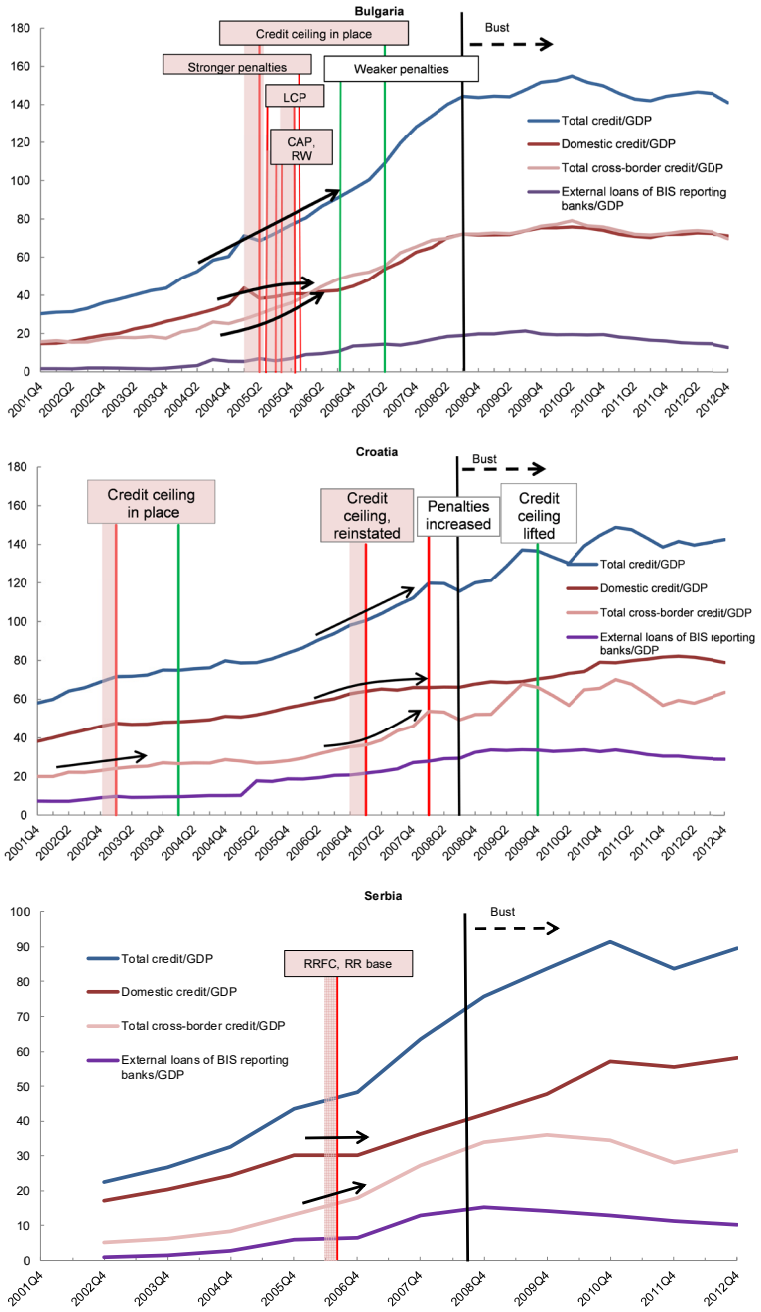
a whole.[13] For this reason, we do not examine the circumvention of measures specifically targeting household lending. The analysis covers cross-border credit from all types of lenders as reported in countries' external debt positions (sourced from IFS), and the sub-component consisting only in cross-border credit from BIS-reporting banks (sourced from the BIS). Overall, we find that circumvention offset to a considerable extent the effectiveness of the strictest measures.

Figure 7.
Bulgaria, Croatia, and Serbia: Credit Growth Measures Circumvention, 2001:Q4–2012:Q4 (private sector credit to GDP, in percent)



Notes: a green (resp. red) solid line indicates a loosening (resp. tightening). Shaded text and areas indicate effectiveness. LCP = loan classification and provisioning; CAP = capital regulation; RW = risk-weights; RR = reserve requirements; RRFC = reserve requirements in foreign currency. See Appendix 2 for a full description of measures.

Sources: Vandenbussche et al. (2015), central bank websites and publications, International Financial Statistics (IFS), BIS, and authors' calculations.

[13] However, we note that cross-border lending to households is likely to have been very limited.

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The previous section showed that ARR measures as well as two CAP measures and possibly one LCP measure had been effective in restraining domestic credit growth in Bulgaria from 2005. Looking now at the dynamics of the sum of domestic and cross-border lending, one can see that it remained broadly unchanged after the implementation of those measures as cross-border credit accelerated at the same time (Figure 7, top panel). In Croatia, a similar pattern can be observed when the credit growth ceiling was implemented for the second time from 2007:Q1 (Figure 7, middle panel). However, there is no evidence of circumvention during the first credit growth ceiling episode in 2003, perhaps reflecting the fact that the boom in the region was still nascent (and push factors not quite as powerful as they would become later on) and that the credit growth ceiling was looser in 2003 (4 percent quarterly) than in 2007 (12 percent annually). In both Bulgaria and Croatia, the shift by the private sector from domestic borrowing to cross-border borrowing was not a mere artefact of accounting changes by large (BIS-reporting) international banking groups, that is, of the predominance of foreign-owned banks in the domestic market that could have easily booked loans to local customers outside of their local bank subsidiary. In fact, the acceleration in lending by BIS-reporting banks to the private sector remained relatively modest. The large degree of circumvention likely reflected a deep financial integration of both economies with that of the EU.[14] By contrast, Serbia was relatively less integrated with the EU at the time (it was not an accession candidate). This may explain why the growth in cross-border lending did not fully offset the cooling effect of strong LRR measures on domestic credit growth in 2006 (Figure 7, bottom panel).

5. CONCLUSION

This paper has documented that macroprudential measures helped contain domestic credit growth during the boom of the mid-2000s in CESEE only if they were strong. Specifically, the analysis uncovered that during the boom period: (1) binding marginal reserve requirements related to credit growth ("credit growth ceilings") helped contain domestic credit growth; (2) strong sectoral capital measures and (3) the introduction of meaningful loan-to-value and debt-service-to-income ceilings helped limit household credit growth. However, circumvention via direct external borrowing largely offset the direct effect, particularly of measure (1). A corollary finding is that none of the other, less strict measures (the vast majority) met our criterion for effectiveness. In a few cases, less-immediately-binding loan classification and provisioning measures were taken concurrently with the strong measures we deem effective and may have reinforced their effect. Measures taken during the subsequent bust had no discernible impact.

Based on these findings, we conclude that weak-to-moderate measures are likely to lack any bite. Strong measures can be more successful in containing credit booms but their impact is likely to be offset by various forms of circumvention. Restricting these channels of circumvention from the start should be an integral part of policy design and is likely to require strong international cooperation.

Our analysis ends in 2012. Looking forward, circumvention through cross-border bank borrowing is likely to be constrained, at least to some extent, by the design of Basel III's countercyclical capital buffer (CCyB), which was introduced in recent years.[15] According to the Basel III framework, national macroprudential authorities set the level of the CCyB, and international reciprocity is mandatory for CCyBs up to 2.5 per cent (and voluntary above 2.5 percent). Only time will tell whether the calibration of the Basel III CCyB reciprocity parameters is adequate for emerging economies such as Bulgaria, Croatia, Romania and Serbia. In any case, our findings suggest that measures with a broader base – including capital flows

[14] Croatia became an EU accession candidate in 2004, and accession negotiations began in 2005.

[15] Basel III was implemented in 2014 in the European Union, and in 2016 in Serbia.

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management measures targeting nonbank flows – would have been needed to contain overall credit growth in these four economies.

The analysis also carries lessons for future research. The relationship between the strength of a macroprudential policy measure and its effect on an intermediate policy objective such as credit growth appears to be non-linear in nature. Measures seem to have a visible effect only above a certain threshold, and the effects of tightening and easing are likely asymmetric. Furthermore, the effect of macroprudential policies seem to differ between booms and busts. To speak to the key issue of instrument calibration, future econometric studies of effectiveness should allow for these non-linear and state-contingent effects.

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APPENDIX 1

1. Bulgaria, Croatia, Romania, Serbia: Selected Macro-Financial Indicators, 2002–12

	GDP per capita (EUR)		Monetary Regime	
	2002	2012	2002	2012
Bulgaria	2,164	5,489		
Croatia	6,373	10,115	Managed floating	Crawl-like arrangement
Romania	2,196	6,052	Managed floating	Floating
Serbia	1,586	3,104	Managed floating	Floating
	Private Sector Credit (percent of GDP)		Foreign Bank Ownership (percent of banking sector assets)	
	2002*	2012	2004	2009
Bulgaria	19	69	72	79
Croatia	43	72	88	91
Romania	10	38	54	85
Serbia	19	51	61	75
	BIS-Reporting Banks' Exposures to Banks (percent of GDP)		BIS-Reporting Banks' Exposures to Non-banks (percent of GDP)	
	2002	2012	2002	2012
Bulgaria	6	18	6	15
Croatia	15	32	13	32
Romania	2	18	6	12
Serbia	2	14	1	11
	Share of Private Sector Foreign Currency Deposits (percent)		Share of Private Sector Foreign Currency Loans (percent)	
	2002*	2012**	2002*	2012
Bulgaria	54	44	42	63
Croatia	72	70	81	79
Romania	44	37	66	72
Serbia	64	77	54	88

* Data for Serbia is for 2003.
** Data for Croatia is for June 2012.

Sources: WEO, IFS, AREAER, Claessens and van Horen (2013), and IMF staff calculations.

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APPENDIX 2

This appendix describes in detail the macroprudential measures taken by the four countries during the boom and bust periods (from 2002:Q1 to 2012:Q4), grouped according to the six categories of instruments discussed in the main text (CAP = capital regulation, LCP = loan classification and provisioning rules, LRR = liability-based reserve requirements liquidity ratios, ARR = asset-based reserve requirements, ELI = eligibility requirements, NBK = regulation of nonbank credit institutions). It also presents a detailed chronological listing of macroprudential measures taken by country that were included in our assessment of effectiveness discussed in the main text.

1. Use of Macroprudential Policy Instruments

The four countries varied in their degree of interventionism. Figure A1 shows the dynamics of policy action. Generally, countries tended to tighten (red cells) the macroprudential policy stance during the boom period and loosen (green cells) during the bust period. During the boom, policymakers at times implemented various instruments simultaneously, suggesting that macroprudential authorities believed in instrument complementarity. Rarely, the intended effects would move in opposite directions (yellow cells). Some easing measures were implemented to harmonize national policies with European Union (EU) regulations ahead of EU accession (shaded cells).

During the bust, the four countries reversed some of the tightening that had taken place during the boom in order to help banks withstand the global financial crisis and help avoid a credit crunch. The most aggressive measures had become redundant and were dropped early. However, and perhaps surprisingly, some tightening during the bust also took place, in particular in the area of loan eligibility criteria. This likely reflects the realization that banks had failed to properly assess credit risk (including the exchange rate risk faced by unhedged borrowers) during the boom years and therefore that further regulatory constraints should be placed on their loan decision-making process.

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Figure A1.

Use of Macroprudential Instruments, 2002–12

Notes: A green (resp. red) cell indicates an easing (resp. tightening) measure. A yellow cell indicates that both tightening and loosening measures were taken in the same period. Shading denotes measures taken for EU harmonization or Basel II implementation.
CAP = capital regulation, LCP = loan classification and provisioning rules, LRR = liability-based reserve requirements liquidity ratios, ARR = asset-based reserve requirements, ELI =eligibility requirements, NBK = regulation of nonbank credit institutions

Source: Vandenbussche, Vogel, and Detragiache (2015), central bank websites and publications.

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2. Macroprudential Measures Taken during the Boom

Countries differed in the strength of the implemented measures during the boom. Bulgaria's measures were relatively moderate, perhaps reflecting in part stricter initial conditions for the minimum capital adequacy ratio (CAR). Romania took measures to contain foreign currency (FC) exposures by tightening loan eligibility criteria and liability-based reserve requirements but scaled back loan eligibility criteria and loosened its capital regulation upon EU accession. Croatia's measures were relatively stronger, in particular in trying to curb banks' external borrowing, mainly through raising considerably liability-based reserve requirements. The focus was on slowing down banks' external debt growth and trying to manage the indirect credit risk inherent in banks' FC/FC-indexed lending through capital requirements. Serbia was the most aggressive of the four countries, tightening policies particularly in the area of capital adequacy (after starting from relatively lower minimum requirements) and liability-based reserve requirements.

A. Capital Regulation (CAP)

The following measures were adopted in the four countries:

- *Changes in minimum capital adequacy ratio*. Serbia increased it in two steps (from 8 percent to 12 percent) in 2005, as the credit boom gathered pace.[16] Romania reduced the minimum CAR from 12 percent to 8 percent as the country joined the EU in January 2007 and the authorities took steps to harmonize their capital regulation with that of the EU even though the measure was clearly procyclical. In contrast, Bulgaria kept the minimum 12 percent CAR upon EU accession, in part because of the still vivid memories of the domestic 1996–97 banking crisis.
- *Changes in specific risk-weights (RW)*. In response to the fast growth of mortgage lending, Bulgaria tightened risk-weights on mortgages twice (in 2005:Q3 and 2006:Q2) by making them a function of the loan-to-value (LTV) ratio. Romania also increased risk-weights on high-LTV (75 percent and above) loans when it adopted Basel II in 2007:Q1. Croatia increased risk-weights on foreign currency loans to unhedged borrowers twice (in 2006:Q2 and 2008:Q1) by 25 percentage points each time. While the share of FC loans and FC-indexed loans had been historically high already in Croatia, these measures seem to have been motivated in part by the rise of the share of loans indexed to the Swiss franc, the exchange rate of which against the kuna was more volatile than that against the euro. Serbia increased by 25 percentage points the risk-weights on FC and FC-indexed loans to unhedged borrowers above 10 million dinars (about €100,000) – effectively mostly targeting corporate loans – in 2006:Q3, then increased risk-weights on household FC loans by 25 percentage points two years later. The presence of FC-indexed loans in Croatia and Serbia most likely reflects attempts to circumvent earlier prudential measures on FC loans.
- *Introduction of bank-specific minimum CAR that depend on credit growth*. From January 2008, Croatia required banks to hold minimum levels of capital based on their rate of credit growth and their reliance on funding sources other than core deposits. Essentially, banks growing their loan portfolio faster than 12 percent per year had to keep their CAR above 12 percent plus 150 percent of credit growth above 12 percent.
- *Introduction of specific leverage ratios*. As the boom in household loans persisted in spite of measures taken in 2005, Serbia capped household lending at 300 percent of share capital from September 2006 onward and tightened the thresholds to 150 percent a year later.[17] This

[16] The National Bank of Serbia (NBS) explains the increase from 10 percent to 12 percent as a response to the "intensified lending activity of the banking sector" (2005 NBS Annual Report, p. 118).

[17] A bank failing to meet the requirement had to make a non-remunerated deposit of twice the gap between its household lending stock and 200 percent of share capital. At the time when the measure was introduced, four banks were not compliant (2006 NBS Annual Report, p. 73).

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instrument was fine-tuned in several instances during its first few months of existence.[18] Concerned by the fast growth of FC loans to unhedged borrowers, Romania capped the ratio of this type of loans to own funds at 300 percent from 2005:Q3 onward. However, this measure remained in place only a little more over a year as it was dropped in January 2007 when the country joined the EU.

- *Exclusion of current profits from the regulatory capital base.* Bulgaria excluded interim profits from the calculation of own funds in 2005:Q3, a little more than a year after having allowed their inclusion. This measure was also implemented by Romania just before the cycle turned (in 2008:Q3).[19]

Initial conditions of bank regulation likely played a role in the use of capital-related instruments. When Serbia increased its minimum CAR to 12 percent in 2005, it merely caught up with the other three countries which had a regulation stricter than the Basel I minimum of 8 percent already: the minimum CAR had been 12 percent in Bulgaria and Romania since 1999, and 8 percent in Croatia since 1998.

Institutional factors also played a role. While still in the acute phase of the boom, Romania lowered its minimum CAR upon joining the EU by harmonizing it with the EU minimum of 8 percent. In early 2008, it also implemented the Basel II framework as embedded in the EU's Capital Requirement Directive, which led to a reduction in risk weights for household exposures relative to the previously prevailing more conservative Basel I norms. Bulgaria took a different approach – it implemented Basel II but initially kept the Basel I risk-weights. As non-EU members Croatia and Serbia did not face similar institutional pressure. Croatia implemented Basel II from the start of 2010 while Serbia implemented it in December 2011.

Finally, initial banking sector conditions also mattered. The decision by Serbia to introduce a sectoral leverage ratio in 2006, rather than increase risk-weights on household exposures, likely reflects the fact that the CAR of Serbian banks was quite high at the time (26 percent at end-2005 and 24.7 percent at end-2006) and that a constraint on credit growth through the imposition of more conservative risk-weights would not be binding enough. By emphasizing share capital (as opposed to total regulatory capital), Serbia anticipated one of the lessons of the 2008–09 global financial crisis, i.e. the importance of the quality of capital. Romania's decision to impose a similar ratio for FC exposures to unhedged borrowers also likely reflected the fact that banks had "excess" capital by the CAR metrics (20.2 percent at end-2005) and that a change in risk-weights might not have been sufficiently binding. In contrast, Bulgaria had a CAR of 16.6 percent at end-2004 and of 14.6 percent at end-2006, making an increase of risk-weights more likely to be immediately effective. Similarly, the CAR in Croatia was 13.4 percent at end-2005, just before prudential authorities increased risk-weights on FC loans for the first time.

B. Loan Classification and Provisioning (LCP)

The four countries also made their loan classification and provisioning rules stricter so as to require banks to build thicker provisioning buffers and provide greater incentives for more careful loan underwriting. All countries changed the rules governing specific provisions, i.e. those provisions made against loan exposures that do not meet the criteria to belong to the safest category. Two countries also introduced a system of general provisions, i.e. provisions that are contingent neither on the characteristics nor on the performance of the loan and have built-in countercyclical features. The following measures were adopted:

[18] See 2006 NBS Annual Report, p. 72.

[19] The exclusion was part of the BNB's "efforts to maintain banking system stability and create conditions for gradual credit growth in the economy" (BNB 2005 Annual Report, p. 39). By contrast, the National Bank of Romania (NBR) explained that the measure was "aimed at removing from the calculation of Tier 1 capital […] the most volatile item".

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- *Loan classification and specific provisions*. Romania introduced the debtor's financial performance as a criterion for loan classification in 2003, and introduced exchange rate risk as another criterion in 2005 as part of its strategy to contain the growth of FC loans. In early 2008, it set higher provisioning rates for loans to unhedged FC borrowers. In December 2004, Serbia started requiring higher provisioning if minimum debt-service-to-income (DSTI) and LTV requirements were not met. It tightened loan classification further in 2005 but relaxed it in 2006 by only prescribing percentage bands for the calculation of special provisions and giving banks greater independence in credit risk measurement. Croatia introduced exchange rate risk as a criterion for loan classification in 2006. Bulgaria tightened classification rules in 2004 and 2005, but part of that tightening was reversed in late 2006.
- *General provisions*. Croatia introduced a system of dynamic provisioning in 2004 linking a bank's general provisions to its annual rate of credit growth. The threshold was 20 percent initially and was revised downward to 15 percent in 2006:Q3. Serbia introduced a system of dynamic provisioning similar to Croatia's (with a threshold of 15 percent) in mid-2008 just before the global crisis struck, before reversing course a few months later.

While tightening dynamic/general provisioning represents an immediately visible cost to banks, tightening specific provisioning rules during a boom does not necessarily do so, as in many cases the expense occurs only when the financial cycle has turned and asset quality starts deteriorating. Thus, it is likely that the former type of measure, if well calibrated, would be a more dissuasive measure than the latter.

C. Liability-Based Reserve Requirements and Liquidity Ratios (LRR)

The four countries also had different strategies with respect to the use of measures to manage the growth of liabilities. The following instruments were used:

- *Average reserve requirements (RR)*. In the two countries with a flexible exchange rate – Romania and Serbia – classical liability-based reserve requirements were a key instrument to manage credit growth but also to promote the use of the domestic currency. Both countries expanded the set of liabilities subject to reserve requirements and increased significantly the rate applicable to FC-denominated liabilities while keeping the rate on domestic currency deposits stable or even lowering it. In Serbia, the rate on short-term borrowing from abroad reached a peak of 60 percent during the second half of 2006. In the other two countries with no or limited exchange rate flexibility, the use of the instrument was much more limited and had a greater focus on traditional liquidity management[20], and no differentiation by currency was ever introduced. In fact, Croatia did not use the instrument for tightening purposes at all and in one instance it reduced reserve requirements rates when other instruments were tightened (Figure A2).[21]

[20] The Croatia National Bank (CNB) October 13, 2004 press release stated that "The CNB Council decision reducing the reserve requirement rate from 19 to 18 percent, adopted at this meeting, corresponds to the attempts to stabilize the external debt balance at the present level. Total amount of reserve requirements will thus be reduced by around HRK 1.8bn: by approximately 1.1bn in the kuna component and 0.7bn in the foreign exchange component of reserve requirements. In that manner, the central bank facilitates the realization of the planned issue of government bonds, by means of which the Ministry of Finance intends to replace a portion of external debt with domestic borrowing. Reserve requirement reduction ensures a satisfactory banking system liquidity level for such a transaction. Since the government intends to use the collected kuna for an immediate purchase from the central bank of foreign exchange required for the repayment of Samurai bonds falling due in mid-December, such a purchase would offset the effect of this bond issue on the domestic monetary developments. This decision is also in accordance with the long-term policy of the Croatian National Bank, aimed at a gradual reserve requirement reduction."

[21] The CNB December 7, 2005 press release states that "It is expected that with the increased marginal reserve requirement banks will have no economic interest in additional borrowing abroad. Nevertheless, they will still have ample liquidity, since the general reserve requirement rate was at the same time reduced from 18 to 17 percent. As a result of this change, which too will be applied as from the calculation date in January, banks will have 2.1 billion kuna at their disposal (of which two thirds in kuna and the remaining share in foreign exchange). The general reserve requirement rate is planned to be further reduced to 16 percent in the coming year. In this way, banks will be given room for total placements growth of over 10 percent, which will be sufficient to support economic growth and normal market demand."

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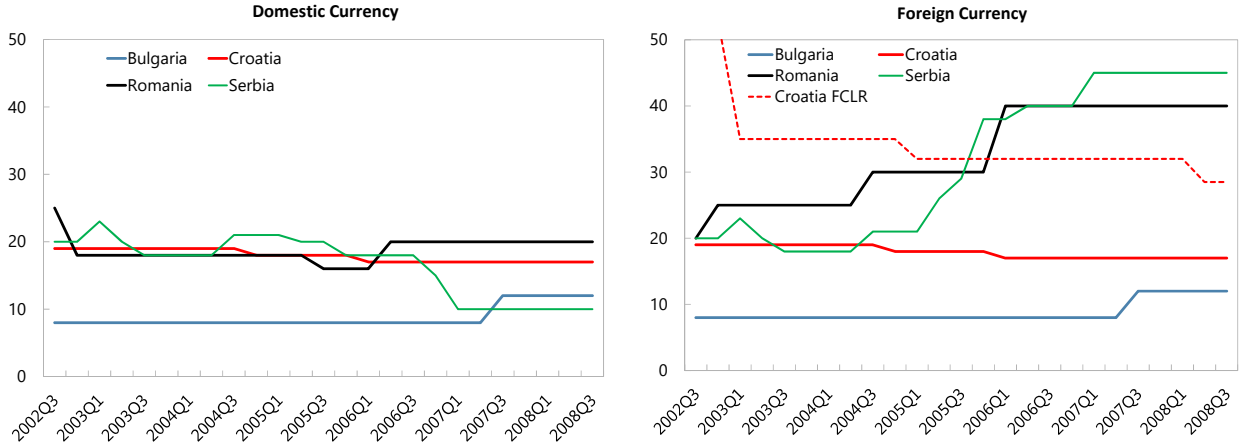
Marginal reserve requirements (MRRs) on foreign borrowing. Rather than stocks, Croatia preferred targeting specific flows. From mid-2004 until the end of the boom, it applied marginal reserve requirements on new foreign borrowing. Their rate was adjusted upwards several times, reaching 55 percent at the end of 2005 and remaining at that level until the instrument was abolished. The explicit objective was to slow down foreign borrowing of the banking sector and therefore the increase in external debt. Foreign parent banks reacted to the measure by substituting deposits and debt financing with capital injections and increasingly resorted to extending credit cross-border to Croatian corporations. A variant of MRRs on foreign borrowing called special reserve requirements (SRR) was introduced in 2006:Q1 and applied to some types of securities that banks had issued to circumvent the MRRs.

Figure A2.
Reserve Requirement Rates on Demand Deposits (Percent, 2002:Q3–2008:Q3)



Note: FCLR = foreign currency liquidity requirement.

Source: Vandenbussche, Vogel, and Detragiache (2015), central bank websites and publications.

- *Foreign currency liquidity ratio (FCLR)*. Entering the boom, Croatia and Serbia already had a regulation requiring that a large share of banks' short-term FC liabilities be covered by liquid FC claims. The purpose was to force banks to self-insure against the risk of a run on FC deposits. Croatia used that instrument during the boom by significantly reducing the rate while at the same time expanding its base. In particular, FC-indexed deposits were added to the base in late 2006 to close a circumvention channel that banks had been exploiting. Serbia marginally reduced the rate in 2004 and 2005 before dropping the instrument soon after the Serbian deposit insurance agency was created and depositor confidence got a boost. The FCLR instrument obviously interacted with the RR instrument as their rates and bases differed, making changes in one of the instruments not necessarily binding

D. Asset-Based Reserve Requirements (ARR)

A more direct way to control credit growth is to target it directly. That is what Croatia and Bulgaria did when they resorted to marginal reserve requirements related to credit growth. In Croatia, a first "credit ceiling" measure (penalizing quarterly credit growth in excess of 4 percent) was implemented during 2003. A second one, with a stricter threshold but a lower penalty rate, was implemented starting in early 2007. Bulgaria instituted similar credit ceilings in early 2005. They were to be phased out after1 year initially, but were then extended until the end of 2006. Penalties were increased in late 2005, and reduced in mid-2006. In both countries, the ARR were partly circumvented through booking with parent banks and booking with nonbank affiliates. In

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the case of Bulgaria, circumvention also took the form of extra booking before the reference date as soon as the measure was announced, which led the Bulgaria National Bank (BNB) to change the reference date ex post.

E. Loan Eligibility Requirements (ELI)

Perhaps surprisingly, only Romania made use of instruments which constrain credit demand by placing caps on the amounts that can be borrowed. They were implemented because "the identification of possible flaws in commercial banks' management of the main banking risks was a major concern of the supervisory authority.[22]" An LTV limit of 75 percent was introduced in 2004:Q1. DSTI limits by type of loans (30 percent on consumer loans, 35 percent on mortgages) were introduced at the same time, and a DSTI limit of 40 percent covering total indebtedness was implemented in 2005:Q3. Both types of measures remained in place until the country entered the EU in January 2007 and banks were then allowed to set ceilings based on internal models. From August 2008, just before the crisis struck, Romania required banks to consider interest and exchange rate risk in setting the indebtedness ceiling.

F. Regulation of Nonbank Credit Institutions (NBK)

Partly as a result of the stricter regulation imposed on banks, nonbank credit institutions (leasing companies, consumer credit companies) began to thrive. Romania and Serbia brought these institutions into the regulatory perimeter in 2006:Q1. Serbia subjected them to a 10-percent reserve requirements measure on foreign borrowing, while Romania subjected them to the same loan eligibility requirement as banks.

3. Macroprudential Measures Taken during the Bust

The four countries reversed some of the tightening taken during the boom in order to avoid a credit crunch during the global financial crisis and the ensuing extremely severe recession. The most aggressive tightening measures had become redundant and were dropped early. Bulgaria and Serbia eased their capital regulation; provisioning rules were softened in all four countries. Croatia, Romania and Serbia reduced or altogether removed liability-based reserve requirements. Yet, and perhaps surprisingly, some tightening also took place, in particular in the area of loan eligibility criteria and capital requirements in Romania. This may reflect the realization that banks had failed to properly assess credit risk or to keep adequate buffers during the boom years and therefore that further regulatory constraints should be placed on their loan decision-making process. Overall, Serbia eased the most during the bust, just as it had tightened the most during the boom.

A. Capital Regulation (CAP)

- *Changes in minimum CAR*. None of the four countries reduced its minimum CAR during the bust, although three out of the four countries technically had regulatory space to do so (relative to the relevant Basel minima). In fact, as the crisis struck and Romania entered an IMF-and-EC-supported program, the National Bank of Romania asked all banks to maintain capital ratios above 10 percent, i.e. 2 percentage points above the statutory minimum. This requirement was still in place at end-2012. Croatia increased its minimum CAR from 10 percent to 12 percent in 2010:Q1 to compensate for the reduction in risk-weights on certain exposures at the time it implemented Basel II and which led to a mechanical increase in CAR by 2 percentage points.[23]

[22] NBR 2003 Annual Report, p. 87.

[23] See CNB 2010 Annual Report, p. 2.

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- *Changes in specific risk-weights*: In 2010:Q1, Bulgaria provided capital relief to banks through a cut of RW on household exposures to the minimum required by the European Capital Requirements Directive (CRD, i.e. the EU version of Basel II). A higher risk-weight for high-LTV housing loans was retained but the threshold was increased from 50 to 70 percent. Croatia and Serbia reduced risk-weights on household exposures and abandoned the risk-weight surcharges on foreign currency loans when they adopted Basel II in early 2010 and late 2011 respectively. Both countries also introduced a higher risk-weight for high-LTV loans with a threshold set at 75 percent. Therefore, at the end of the period, all four countries had LTV-contingent risk-weights on mortgages, in line with the "substantial margin" requirement set in the EU's 2006 CRD.
- *Changes in bank-specific minimum CAR that depend on credit growth*. Croatia dropped this measure in 2010:Q1. The measure was far from binding at the time.
- *Changes in specific leverage ratios.* Serbia relaxed the quantitative limit on household lending by increasing the ceiling of the maximum ratio of household loans to share capital from 150 percent to 200 percent in 2009:Q1, and abandoned the measure altogether in the following quarter as "all objectives … were met … and it was no longer necessary to set a limit on bank household lending."[24]
- *Inclusion of current profits in the capital base:* Romania and Bulgaria reversed the measure taken in the boom and allowed the recognition of current profit or profit from the previous year as a capital base element in 2009:Q2 and 2010:Q1 respectively.[25]

B. Loan Classification and Provisioning (LCP)

Loan classification and provisioning requirements were loosened in all four countries.

- *Loan classification and specific provisions*. Bulgaria, Romania and Serbia loosened the LCP rules during 2009–11. Bulgaria first slowed the rate of downgrades by increasing the number of days within each category of the classification, and later extended the allowed term of realization of real estate collateral. Romania allowed a fraction of the collateral to be deducted from the amount of exposures. Serbia first removed low down payments as a trigger for classification in the worst loan category, and later relaxed the DSTI thresholds triggering classification in one of the worst three categories.
- *General provisions*. Very early in the bust, Serbia and Croatia revoked the regulation requiring holding general provisions related to credit growth.

C. Liability-Based Reserve Requirements and Liquidity Ratios (LRR)

These measures were among the earliest to be loosened to help relieve liquidity pressures in banking systems.

- *Standard reserve requirements*. Countries reduced their reserve requirements both in terms of rates and in terms of base to relieve liquidity pressures in the banking system. In Bulgaria, the two-point reduction of reserve requirements early in the bust also allowed local affiliates of foreign banks to repay the liquidity support that had temporarily been provided by their parents soon after the onset of the global financial crisis. Romania and Serbia, which had increased significantly the rate on the foreign currency base during the boom, decreased it by an equivalently significant amount during the bust, although less so in the case of Serbia. At the end of the 2012, only in Serbia did the rates differ radically across currencies and reflected the explicit "dinarization" strategy pursued by the authorities in the post-crisis period (Figure A3).[26]

[24] See NBS 2009 Annual Report, p. 47.

[25] The BNB described this change as part of its "anticyclical policy in regulating banks' activities" (BNB 25 February 2010 press release).

[26] See Markovic (2010).

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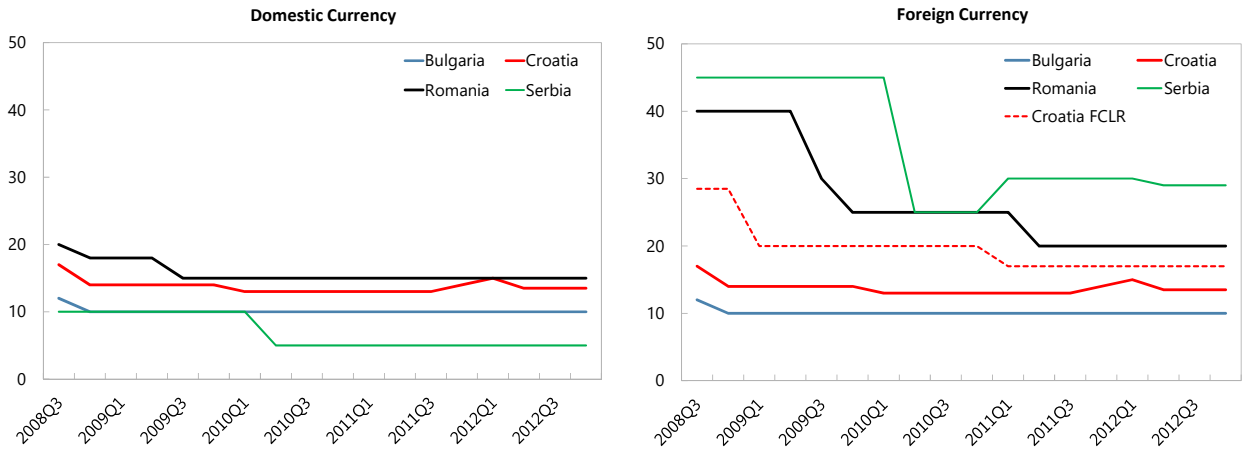
- *Marginal reserve requirements*. Croatia's MRR were completely revoked in October 2008 at the onset of the bust. SRR were lifted a few months later.
- *Foreign currency liquidity ratio*. Croatia reduced the FCLR rate from 28.5 percent to 20 percent in 2009:Q1 in the second half of 2008 at the onset of the recession. This was followed by a further reduction in 2011:Q1 to 17 percent with the aim of freeing foreign currency liquidity and stimulate investment.[27] The set of eligible assets to meet the FCLR was expanded in 2012:Q2 to include 50 percent of the amount of loans granted in the context of the "loan program for the development of the economy" sponsored by the Croatian Bank for Reconstruction and Development (HBOR, in local spelling).[28]

D. Asset-Based Reserve Requirements (ARR)

Croatia dropped the credit growth reserve at the end of 2009 in the context of anemic credit growth.

Figure A3.
Reserve Requirement Rates on Demand Deposits (Percent, 2008:Q3–2012:Q4)



Note: FCLR=foreign currency liquidity requirement

Source: Vandenbussche, Vogel, and Detragiache (2015), central bank websites and publications.

E. Loan Eligibility Requirements (ELI)

As noted, this is one of the few areas in which some requirements were actually tightened during the bust period.

- Romania amended the rule it had introduced in August 2008 only two quarters later by removing the requirement to take into calculation interest rate risk and currency risk when setting the indebtedness ratio for clients taking loans backed by mortgages within city limits. In 2011:Q4, it then introduced a maximum LTV ratio by type of loan currency denomination and required specific FC shocks to be applied to determine borrowers' maximum indebtedness levels.
- In 2011:Q2, Serbia introduced a maximum LTV for foreign-currency-denominated or foreign-currency-indexed loans. The ceiling was set at 80 percent for mortgages and 70 percent for other loans.

[27] See CNB March 8, 2011 press release.

[28] See http://www.hbor.hr/hbor-promotes-new-investments-through-new-forms-of

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F. Regulation of Nonbank Credit Institutions (NBK)

- In 2009:Q4, Romania reversed the rule allowing nonbank institutions to include interim profits in the calculation of own funds. This followed a similar easing rule for banks half a year earlier.

In addition to these measures, the four countries encouraged banks to implement conservative profit retention policies in 2009 and 2010 to fight the erosion of capital cushions because of the ongoing deterioration in asset quality. They also sought comfort letters from parent banks pledging adequate liquidity and capital support for their subsidiaries. In the case of Romania and Serbia, this was achieved in the context of the so-called Vienna Initiative.

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List of Measures Taken by Country

List of Abbreviations of Macroprudential Instruments

Prudential Measure	Description
CAP: CAPITAL MEASURES	
mincap	Minimum required capital adequacy ratio
cap	Capital eligibility
cgrcap	Minimum required capital adequacy ratio as a function of credit growth
hhsc	Maximum on ratio of household loans to share capital
fcsc	Maximum on ratio of fc loans to own funds
basel	Basel II
rwmol	Risk weights / mortgage loans
rwmolfc	Risk weights surcharge/ FC mortgage loans
rwcons	Risk weights / consumer loans
rwconsfc	Risk weights surcharge/ FC consumer loans
rwcorp	Risk weights on corporate loans
rwcorpfc	Risk weights on fc corporate loans
LCP: PROVISIONING MEASURES	
gp	Rules for general provisions
dp	Rules for specific provisions
dpfc	FC-loans rules for specific provisions
LRR: LIABILITY-BASED LIQUIDITY MEASURES	
rr	Reserve requirements rate on LC deposits
rrfc	Reserve requirements rate on FC deposits
rrbase	Reserve requirements base
fclr	Foreign currency liquidity requirement
fclrbase	Foreign currency liquidity requirement base
mrr	Marginal reserve requirements
srr	Special reserve requirements
ARR: ASSET-BASED LIQUIDITY MEASURES	
cgr	Credit growth reserve
cc	Marginal reserve requirements on credit growth above a threshold
ELI: ELIGIBILITY MEASURES	
ltv	Loan-to-value ceiling
ltvfc	FC loan-to-value ceiling
dsti	Debt-service-to-income ceiling
dstifc	FC debt-service-to-income ceiling
NBK: NONBANK REGULATORY POLICY	
other	Regulatory measures on non-banks.

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List of Measures Taken in the Period 2002–12 by Country

Bulgaria: Prudential Measures

Quarter	
2002Q1	
2002Q2	**rrbase:** exclusion of borrowed funds with a maturity over two years.
2002Q3	
2002Q4	
2003Q1	
2003Q2	
2003Q3	
2003Q4	
2004Q1	
2004Q2	**dp:** evaluation and classification of risk exposures of banks was tightened as doubtful and loss exposures were consolidated into the non-performing loans category. **cap:** ordnance on the capital adequacy was amended by setting out conditions for inclusion the retained profit from previous years and the current year profit in primary capital.
2004Q3	**rrbase:** increase in reserve requirement ratio to 4% on long-term attracted resources (with maturity over two years) and repos of end-clients.
2004Q4	**rrbase:** rate on liabilities with maturity above two years raised from 4% to 8%.
2005Q1	
2005Q2	**cc:** introduction of credit ceilings: a bank is subject to marginal reserve requirements of 200% if (i) it expands credit by more than 6% per quarter on average, taking end-Q1 2005 as the base period; and (ii) the sum of its loans and the risk-weighted off-balance sheet items converted into assets, reduced by the amount of own funds, exceeds 60%. **dp:** loans overdue by more than 30 days, 60 days, or 90 days, have to remain classified as "watch," "substandard" and "non-performing," respectively, for a minimum of 6 months.
2005Q3	**cap:** regulatory minimum capital adequacy ratios must be satisfied while excluding current profits from the capital base. rwmol_threshold: amendments to Regulation 8 were introduced: mortgage credits are treated with 50% risk weight only if the amount of credit is less than 70% of the value of collateral (70% loan-tovalue ratio), otherwise the risk-weight is 100%.
2005Q4	**cc:** the penalty rate for breaching credit ceilings was temporarily increased for banks exceeding the limit by 1–2%, from 200 to 300%, and to 400% for excesses of more than 2%. **dp:** the provisioning requirements for impaired household credits was raised: from 10% to 20% for loans overdue by 30–60 days ("watch" category), and from 50% to 75% for loans overdue by 60–90 days ("substandard" category).
2006Q1	
2006Q2	**rwmol:** the risk weighting for mortgage loans used in the calculation of the capital adequacy ratio was effectively raised, by lowering the loan-to-value ratio threshold from 70% to 50%.
2006Q3	**cc:** the progressive range of additional minimum required reserves was eliminated.
2006Q4	**dp:** the six-month period of keeping problematic mortgage and consumer loans in the classification groups "watch," "substandard" and "non-performing" was abolished when the regular service of these loans has been resumed.

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Bulgaria: Prudential Measures (continued)

Quarter	
2007Q1	**cc:** end of credit limits. **basel:** the implementation of a legal framework comprising the latest European directives introducing Basel II requirements; Bulgaria acceded to the European Union introducing compliance between Bulgarian legislation and European directives on credit institutions. Risk-weights under standardized approach are unchanged.
2007Q2	
2007Q3	**rr, rrfc:** reserve requirements were increased from 8% to 12%.
2007Q4	
2008Q1	
2008Q2	
2008Q3	
2008Q4	**rr, rrfc:** reserve requirements were decreased from 12% to 10%.
2009Q1	**dp:** the loan classification and provisioning rules were loosened by increasing the number of days within each classification category; loan restructuring through maturity extensions up to two years does not lead to reclassification. **rrbase:** reducing the minimum required reserves on funds attracted by banks from abroad from 10% to 5% and removing the minimum reserve requirements on funds attracted from state and local government budgets.
2009Q2	
2009Q3	
2009Q4	
2010Q1	**cap:** the requirement to hold a general shareholders' assembly for the recognition of current profit or profit from the previous year as a capital base element was dropped. **rwmol, rwmolfc, rwcons, rwconsfc:** for banks using the standardized approach to credit risk, the risk-weight for retail exposures was reduced from 100% to 75%, and the riskweight for mortgage exposures was reduced from 50% to 35% (loan-to-value from 50% to 70%); however 100% risk weight remains in place if above the threshold.
2010Q2	
2010Q3	
2010Q4	
2011Q1	
2011Q2	**dp:** term of realization by banks of the collateral provided to them in the form of buildings or regulated land property was extended.
2011Q3	
2011Q4	
2012Q1	
2012Q2	
2012Q3	
2012Q4	

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Croatia: Prudential Measures

Quarter	
2002Q1	
2002Q2	
2002Q3	
2002Q4	
2003Q1	**cgr:** banks for which the growth of assets exceeded 4% in a given quarter (equals 17% annual growth) were required to buy low-yielding central bank paper: this rule was temporary and was kept in place only in 2003, cover 200%. **fclr, fclrbase:** foreign currency liquidity requirement reduced from 53% to 35%, but expanded base to include foreign currency long-term liabilities. Net tightening.
2003Q2	
2003Q3	
2003Q4	
2004Q1	**cgr:** credit growth reserve dropped **gp:** if growth of specific items of assets and off-balance sheet contingent liabilities exceeds 20%, banks need to form and maintain provisions, and retain profits.
2004Q2	
2004Q3	**mrr:** marginal reserve requirement rate on net foreign borrowing was initially set at 24%.
2004Q4	**rr:** reserve requirements ratio was cut to 18%.
2005Q1	**fclr:** the rate of minimum required liquid foreign currency claims was cut from 35% to 32%. **mrr:** marginal reserve requirement rate was raised to 30%.
2005Q2	**mrr:** marginal reserve requirement rate was raised to 40%; base extended during the year several times.
2005Q3	
2005Q4	**mrr:** marginal reserve requirement rate was raised to 55%.
2006Q1	**rr:** reserve requirements ratio was reduced to 17%. **srr:** special reserve requirements on securities are calculated every second Wednesday in a month, by applying a 55% rate to the prescribed base.
2006Q2	**rwmolfc, rwconsfc, rwcorpfc:** risk weights on foreign currency or foreign currency-indexed loans to unhedged borrowers in non-government increased from 50% to 75% (for mortgages) and from 100% to 125% (for others). **dpfc:** banks are obliged to monitor, analyze and assess the adjustment of debtors' foreign exchange positions and adaptability of their cash flows to any variability in their liability levels which might occur as a result of exchange rate changes.
2006Q3	**gp:** tightened growth rate on extra countercyclical provisioning measure up to 15%.
2006Q4	**fclr:** foreign currency liquidity requirement base included foreign currency indexed liabilities; final deadline for adjustment to 32%.
2007Q1	**cgr:** credit growth reserve reimposed at 12% annual growth, with cover of 50%.
2007Q2	
2007Q3	
2007Q4	

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Croatia: Prudential Measures (continued)

Quarter	
2008Q1	**rwmolfc, rwconsfc, rwcorpfc:** risk weights for unhedged borrowers were increased by a further 25 percentage points: applied weights are 100% (which replaced 75%) and 150%. **cgr:** credit growth reserve penalty was increased to 75%. **cgrcap:** banks growing faster than 12% per year have to maintain a capital requirements rato higher than 12% plus 150% of credit growth above 12%.
2008Q2	**fclr:** foreign currency liquidity requirement rate reduced to 28.5%
2008Q3	
2008Q4	**mrr:** marginal reserve requirements were abolished. **rr:** reserve requirement rate was cut from 17% to 14%.
2009Q1	**srr:** special reserve requirments were terminated. **fclr:** foreign currency liquidity requirement reduced in two steps to 20%. **dp:** measure requiring additional general provision related to credit growth was dropped.
2009Q2	
2009Q3	
2009Q4	**cgr:** credit growth reserve was dropped.
2010Q1	**rr:** reserve requirement rate was cut from 14% to 13%. **rwmol, rwmolfc, rwcons, rwconsfc, rwcorpfc, mincap:** with the adoption of Basel II the very high risk weights were dropped but minimum captial adequacy requirements was increased to 12% from 10% to compensate; from now on risk weights on mortgages are contingent on the loan-to-value ratio: for a loan-to-value up to 75% the risk weight is 35%, otherwise it is 100%. **cgrcap:** credit growth reserve cap was dropped. **dp:** available for sale assets and some off-balance sheet items were excluded from the classification.
2010Q2	
2010Q3	
2010Q4	
2011Q1	**fclr:** foreign currency liquidity requirement reduced from 20% to 17%.
2011Q2	
2011Q3	
2011Q4	**rr:** reserve requirement rate was raised from 13% to 14%.
2012Q1	**rr:** reserve requirement rate was raised from 14% to 15%. **fclrbase:** the minimum foreign currency liquidity requirement rate remained at 17%, but the definition of foreign currency claims was broadened recognizing T-bills subscribed by banks as liquid foreign currency claims.
2012Q2	**rr:** reserve requirement rate was reduced from 15% to 13.5%. **fclrbase:** the calculation of minimum required foreign currency claims will also include 50% of the amount of bank loans granted to economic entities.
2012Q3	
2012Q4	

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Romania: Prudential Measures

Quarter	
2002Q1	
2002Q2	
2002Q3	
2002Q4	**rr, rrfc:** reserve ratios were reduced to 18% for reserves in domestic currency and raised to 25% for reserves in foreign currency.
2003Q1	
2003Q2	
2003Q3	
2003Q4	
2004Q1	**ltv, dsti:** consumer credit: installments shall not exceed 30% of net incomes of the borrower and his family; downpayment of at least 25% or cosigner commitment for purchases of goods; collateral and/or cosigner commitment for other types of consumer credit; mortgage credit: credit value shall not exceed 75% of the property value; installments shall not exceed 35% of net incomes of the borrower and his family.
2004Q2	
2004Q3	**rrfc:** reserve requirement ratio on foreign currency deposits raised from 25% to 30%, reserve ratio on domestic currency deposits remains at 18%.
2004Q4	
2005Q1	**rrbase:** reserve requirements broadened to include all foreign currency liabilities carrying maturities of over two years.
2005Q2	
2005Q3	**dsti:** eligibility criteria further tightened; overall installments associated with the sum of all credit contracts shall not exceed 40% of net incomes. **rr:** reserve requirements on domestic currency liabilities reduced from 18% to 16%. **dpfc:** regulation on provisioning and loan classification was refined to take into account the foreign currency risk of the borrower. **fcsc:** foreign currency credit exposure of a credit institution arising from loans granted to unhedged individuals and legal persons shall not exceed 300% of own funds. **rrbase:** reserve requirements base broadenend to include all foreign currency liabilities carrying maturities of over two years regardless of the date at which they were raised.
2005Q4	
2006Q1	**rrfc:** reserve requirements on foreign currency liabilities raised from 30% to 35% and then to 40%. **other:** non-bank credit institutions (leasing, financial credit, etc.) enter into the regulatory perimeter.
2006Q2	**rr:** reserve requirements increased from 16% to 20% (first time in 6.5 years).
2006Q3	
2006Q4	**other:** eligibility constraints on household loans now also apply to regulated non-bank credit institutions.
2007Q1	**mincap:** following EU entry, minimum capital requirements drops from 12% to 8%. **dsti:** eligibility criteria are now defined by banks' internal models. **ltv:** loan-to-value limit was abandoned. **fcsc:** exposure limits lifted
2007Q2	
2007Q3	
2007Q4	

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Romania: Prudential Measures (continued)

Quarter	
2008Q1	**dpfc:** higher provisioning rate for loans to unhedged foreign currency borrowers. **rwmol:** with the adoption of Basel II risk weights on mortgages were made contingent on the loan-to-value ratio: for an loan-to-value up to 75% the risk weight is 35%, otherwise it is 100%. **basel:** full enforcement of Basel II regulatory framework. Lower risk-weights (standardized approach).
2008Q2	
2008Q3	**cap:** current year profits were excluded from regulatory capital. **dstifc:** banks have to consider the interest and exchange rate risk in setting the indebtedness ceiling (set on a case by case basis by using internal risk models). **other:** eliminate the possibility that non-bank financial institutions entered into the Special Register should include interim profit in the calculation of own funds.
2008Q4	**rr:** reserve requirementes on domestic currency liabilities reduced from 20% to 18%.
2009Q1	**dstifc:** requirement to take into calculation interest rate risk and currency risk when setting the indebtedness ratio for clients taking loans backed by mortgage on the home or the land within city limits was removed. **mincap:** the minimum capital adequacy ratio was set at 10% as long as the multilateral financing arrangement with the EU, the IMF and other IFIs was in place.
2009Q2	**dp:** a fraction of the collateral value (less than 25%) can be deducted from the value of "loss" (i.e. 90+ days overdue) exposures to compute provisions (under the old regulation, no deduction was allowed). **cap:** reversal of August 2008 measure. **rrbase:** reserve requirements on foreign currency liabilities with residual maturity greater than two years reduced from 40% to 0%.
2009Q3	**rr:** reserve requirements on domestic currency liabilities reduced from 18% to 15%. **rrfc:** reserve requirements on foreign currency liabilities with maturity less than two years were reduced from 40% to 35% and later to 30%.
2009Q4	**other:** regulation 20/2009 allows inclusion of interim profits in capital. **rrfc:** reserve requirements on foreign currency liabilities with maturity less than two years were reduced from 30% to 25%.
2010Q1	
2010Q2	
2010Q3	
2010Q4	
2011Q1	
2011Q2	**rrfc:** reserve requirements on foreign currency liabilities with maturity less than two years reduced from 25% to 20%.
2011Q3	
2011Q4	**ltv, ltvfc, dstifc:** introduce a loan-to-value ceiling by type of loan currency denomination, and specific foreign currency shocks to determine the maximum indebtedness level.
2012Q1	
2012Q2	
2012Q3	
2012Q4	

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Serbia: Prudential Measures

Quarter	
2002Q1	
2002Q2	**rrfc, rrbase:** base for calculating reserve requirements was increased by including foreign currency deposits. **rr, rrfc:** the reserve ratio was reduced from 24.5% to 20%.
2002Q3	
2002Q4	
2003Q1	**rr, rrfc:** reserve requirements ratio raised from 20% to 23%.
2003Q2	**rr, rrfc:** further reduction of the rr ratio to 22%, and to 20%.
2003Q3	**rr, rrfc:** required reserve ratio reduced from 20% to 18% and kept unchanged until the end of the year.
2003Q4	
2004Q1	
2004Q2	**fclr:** banks are required to deposit 47% (banks undergoing rehabilitation 100%) of citizens' foreign exchange savings with the central bank.
2004Q3	**rr, rrfc:** increase of the reserve requirement rate from 18% to 21%.
2004Q4	**dp:** if debt service-to-income exceed 30% and down-payment is less than 20%, classified as E and subject to 100% provisioning (exception: housing loans); before were subject to 25% provisioning.
2005Q1	**mincap:** minimum capital adequacy ratio was raised from 8% to 10%, and later to 12%. **rrbase:** foreign currency base is extended: inclusion of liabilities arising from foreign currency loans from foreign legal entities with maturity up to four years and liabilities arising from unchanged remunerated sterilization of dinar foreign loans registered by banks.
2005Q2	**rr, rrfc:** introduction of a differentiated reserve: 20% on dinar reserve base and 26% on foreign currency reserve base. **rrbase:** the base also included liabilities towards subsidiary and related banks abroad.
2005Q3	**rrfc:** reserve requirements on foreign exchange reserve calculation base was raised from 26% to 29%. **rrbase:** base for calculation of foreign currency reserves was expanded to include liabilities in respect of credits from foreign legal entities with contracted maturity over four years; a 7% ratio was applied on the expanded foreign exchange reserve base. **fclr:** minimum foreign currency liquidity against foreign currency savings reduced from 47% to 45%, then to 43%.
2005Q4	**rrbase:** reserve requirements calculation base was reduced by the amount of long-term housing loans insured by government, but was expanded to include funds from abroad under transactions performed by the bank in the name and for the account of third parties; a differentiated ratio of 35% was introduced and applied on foreign currency clause-indexed dinar deposits, later raised to 38%; foreign currency base is extended. **rr:** decrease of the reserve requirement rate applied to the dinar base from 20% to 18%. **rrfc:** further rise in foreign currency reserve requirement rate from 29% to 35%, and then to 38%. **dp:** household loan classified in category E if no credit bureau report. **mincap:** minimum capital adequacy ratio was raised to 12%. **fclr:** minimum foreign currency liquidity against foreign currency savings reduced from 43% to 42% in October, then to 42% in November, then dropped in December.

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Serbia: Prudential Measures (continued)

Quarter	
2006Q1	**other:** the NBS took over the authority for regulating and supervising the leasing industry (Sept. 2005) and subjected leasing companies to a 10% reserve requirement on foreign borrowing (Feb. 2006) **rrfc:** the reserve requirement ratio on foreign currency deposits and on foreign currency clauseindexed dinar deposits was raised from 38% to 40%. **rrbase:** foreign currency reserving base was expanded to include foreign currency subordinated obligations; deposits of leasing companies with banks are subject to 100% reserve requirement; the reserve requirements on foreign currency deposits and credits from abroad with repayment period of up to two years were increased from 40% to 60%.
2006Q3	**hhsc:** obligation for banks to reconcile their gross household dinar loans and their share capital, so that it is lower than or equivalent to 200% of the value of share capital; loans for housing construction supported by government were excluded but amendment that foreign currency loans also have to be included.
2006Q4	**rr:** decrease in reserve requirements on dinar reserving base from 18% to 15%. **dp:** banks receive more independence for the calculations of special provisions; new debt service-to-income criterion (including housing) included in provisioning rule: by applying criteria defined in their internal documents, banks are to classify into categories D or E all receivables from natural persons whose total monthly credit obligations, excluding obligations in respect of housing loans, exceed 30% of their regular net monthly income, or, including obligations in respect of housing loans, exceed 50% of their monthly income. **rwcorpfc:** risk weights for foreign currency lending go up with new banking regulation to 125% for unhedged borrowers if borrowing amount is larger than 10 million dinars.
2007Q1	**rr:** decrease of reserve requirements on the dinar reserving base from 15% to 10%. **rrfc:** reserve requirement ratio on the foreign currency reserving base and a portion of the dinar reserving base made up of foreign currency-indexed dinar deposits was raised from 40% to 45%. **rrbase:** reserve requirement ratio on short-term external borrowing is reduced from 60% to 40% and a uniform reserve requirement ratio on dinar obligations arising from deposits and loans received from abroad was introduced and set at the level of 45% regardless of their maturity.
2007Q2	**hhsc:** tightened penalty measures for non-compliance and ordered banks to pay interest on the difference between the prescribed and the actually deposited amount of funds; stronger penalty measures against banks for the submission of inaccurate data resulting in the miscalculation of gross household lending to share capital ratios.
2007Q3	**hhsc:** the definition of gross household lending was changed to encompass all housing loans, including those supported by government program.
2007Q4	**hhsc:** the ratio of gross household lending to share capital was prescribed not to exceed 150% at the end of any calendar month. **rrbase:** ratio on dinar liabilities under deposits with maturity of over one month was reduced to 5%.
2008Q1	
2008Q2	**dpfc:** minimum downpayment for consumer loans with foreign currency clause to avoid classification in category E increased from 20% to 30%, but exclusion of credit cards and loans without foreign currency clause. **hhsc:** extension of deadline to achieve the prescribed ratio for banks failing to comply.
2008Q3	**gp:** general provisions required if credit growth is larger than 15%. **rwmolfc, rwconsfc:** risks weights on fc-loans to households are increased by 25 pps: 75% for foreign currency-mortgage, 125% for foreign currency consumer loans.
2008Q4	**rrbase:** several easing measures regarding the calculation of the reserve requirement were taken, but ratios remained unchanged. **hhsc:** further easing measures relating to the adjustment of gross household lending to share capital of bank and penalties were taken, for certain period. **gp:** cancelled general provisions if credit growth larger than 15%.

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Serbia: Prudential Measures (continued)

Quarter	
2009Q1	**rrbase:** base for reserve requirement calculation reduced again, banks were exempted from calculation of reserve requirements on the amount of dinar- and foreign currency-denominated liabilities from deposits and credits received from abroad. **hhsc:** ratio of household lending to share capital has to be lower or equal to 200% (instead of 150%) **dp, dpfc:** suspended rule for higher provisioning if downpayment smaller than 30%.
2009Q2	**rrbase:** base for reserve requirement calculation reduced again. **hhsc:** cessation of validity of rule on ratio of household lending to share capital
2009Q3	
2009Q4	
2010Q1	
2010Q2	**rr:** reduction in the reserve requirement ratio on the dinar base to 5%. **rrfc:** reduction in the reserve requirement ratio on the foreign currency base to 25%, whilst the number of exemptions from required reserve calculation has been reduced. **rrbase:** the number of exemptions from foreign currency reserve requirements was adjusted with significant effects of increased liquidity. **dp, dpfc:** amendments to loan classification and provisioning rules by reducing provisioning for domestic currency credit and raising provisioning for foreign currency loans.
2010Q3	
2010Q4	
2011Q1	**rrfc, rrbase:** differentiated reserve ratios on both the dinar and foreign currency reserving base subject to the maturity of liabilities: dinar liabilities with maturity up to two years became subject to 5% ratio, while those with maturity over two years to 0% ratio; the ratio on foreign currency liabilities with maturity up to two years is set at 30% and that on liabilities with maturity over two years at 25%.
2011Q2	**ltvfc:** introduced a set of measures regarding foreign currency-denominated and foreign currency-indexed lending to citizens: foreign currency-denominated and foreign currencyindexed loans may be approved only subject to a down payment or placement of deposit of no less than 30% of the loan amount; the loan-to-value of foreign currency-denominated and indexed mortgage loans are limited to a maximum of 80%.
2011Q3	
2011Q4	**dp:** lowering of the provisioning percentages for categories B, C and D; another change is that banks are no longer obliged to allocate reserves from earnings for a part of the special reserve for estimated losses that is not covered by allowances for impairment. **dpfc:** prescribed that total monthly credit obligations are contracted in a considerable amount in foreign currency or in dinars with a foreign currency clause if at least 20% of those obligations are contracted in this way. **basel:** Basel II implemented in December 2011.
2012Q1	
2012Q2	**rrfc, rrbase:** cut in foreign currency reserve requirement ratios from 30% to 29% for short maturities and from 25% to 22% for long maturities. **rrbase:** raised to 50% the ratio on the portion of foreign currency reserve base comprised of foreign currency-indexed dinar liabilities.
2012Q3	
2012Q4	**dp:** regulatory easing in respect to the recognition of mortgage as adequate collateral.

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Macroeconomic Stability in Resource-rich Countries: The Role of Fiscal Policy

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ABSTRACT

Resource-rich countries face large and persistent shocks, especially coming from volatile commodity prices. Given the severity of the shocks, it would be expected that these countries adopt countercyclical fiscal policies to help shield the domestic economy, either through larger spending at times of commodity busts or lower spending during commodity booms. Taking advantage of a new dataset covering 48 non-renewable commodity exporters for the period 1970–2014, we investigate whether fiscal policy does indeed play a stabilizing role. Our analysis shows that fiscal policy tends to have a procyclical bias (mainly via expenditures) and, contrary to others, we do not find evidence that this bias has declined in recent years. Further, we find that the adoption of fiscal rules does not seem to reduce procyclicality in a significant way, but the quality of political institutions does matter. Finally, we find that non-commodity revenues tend to respond only to persistent changes in commodity prices.

JEL classification: O13, H30, C33

Keywords: commodity prices, resource-rich countries, procyclical fiscal policy, fiscal rules.

1. INTRODUCTION

The 2012 fall in energy prices once again shifted the attention of policymakers to commodity price shocks and their impact on macroeconomic stability in resource-rich countries. Movements in commodity prices affect these economies directly through the external trade balance (commodity

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exports) and the public sector budget as governments receive a large share of commodity sector revenues. There are also indirect channels, such as changes in borrowing conditions, asset prices, and investment. Given the high dependence on budgetary commodity revenues and exports, the large price fluctuations imply these countries are exposed to large external risks.

A key policy objective for resource-rich countries is to shield the economy from the high volatility of commodity prices. The traditional advice is for countries to develop stabilizing (countercyclical) fiscal policies towards helping smooth the business cycle (IMF 2015b). This is a more complex and critical challenge for non-renewable resource-rich economies. A central issue is that the economic cycle tends to be closely linked to unpredictable fluctuations in commodity prices. These can be very large and persistent and lead to disruptive large swings in the domestic economic activity, exacerbated (as has been seen in the past) by large increases in public expenditures during commodity booms and large fiscal contractions once prices fall. Furthermore, if fiscal policy is heavily procyclical during upswings – that is, governments spend a large share (or all) of temporary commodity revenue windfalls – this will have an impact on fiscal sustainability as these are exhaustible resources.

This paper aims to assess whether fiscal policy has helped manage high volatility of commodity prices. We contribute to the literature by: (i) using a new dataset starting from 1970, (ii) assessing the importance of fiscal channel in the transmission of commodity price shocks, and (iii) applying a comprehensive set of indicators to study fiscal cyclicality in resource-rich countries, which also encompass the cyclicality of non-commodity revenue.

Our results show that fiscal policy in resource-rich countries has been procyclical during the last decades. We also find no evidence of reduced procyclicality during the resource windfall in the 2000s, contrary to other studies (see below). Regression analysis also suggests that the adoption of fiscal rules does not have, on its own, a significant impact on reducing procyclicality, unless supported by strong political institutions. Through the examination of the impact of commodity prices on non-commodity revenues, we find that the revenue mobilization efforts decline with rising commodity prices. Non-commodity revenues adjust only in response to persistent changes in commodity revenues as this adjustment tends to be sluggish.

The remainder of the paper is structured as follows. Section II reviews the related literature. Section III describes the dataset. Section IV assesses the direct impact of commodity price fluctuations on the economy. Section V presents evidence on fiscal cyclicality and on the role of fiscal rules and institutions. Section VI analyzes the response of non-commodity revenues to commodity revenue shocks. The final section concludes.

2. LITERATURE REVIEW

A growing empirical literature analyzes fiscal policy responses to output fluctuations in advanced and emerging economies. Several approaches have been taken to assess fiscal cyclicality. For instance, the Fiscal Monitor (IMF 2015b) looks at the overall fiscal balance to GDP ratio and interprets the response to output fluctuations as a measure of fiscal stabilization (the sum of automatic stabilizers and discretionary fiscal policy). Similar measures have been used by Gavin and Perotti (1997) and Alesina et al. (2008). Other studies have used the cyclically adjusted fiscal balance to GDP ratios and interpreted the response to output fluctuations as discretionary fiscal policy reaction to economic shocks (e.g., Gali and Perotti, 2003). Some have focused on cyclically adjusted government spending as a measure of discretionary government spending, taking into account that automatic stabilizers mostly work on the revenue side (Kaminsky et al., 2004; Frankel et al., 2013). The most popular measure of output fluctuations is the output gap (e.g., Kaminsky et al., 2004). However, given the difficulty in measuring potential output, some studies have also used real GDP growth as a measure of output fluctuations (IMF 2015b) or used

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cointegration methodology to assess both long-run and short-run association between government spending and output (Akitoby et al., 2006).

These studies find that fiscal policies tend to be more successful in smoothing the impact of economic shocks in advanced economies than in developing or emerging economies (e.g. IMF, 2015b, Akitoby et al., 2006), even though some emerging economies have recently improved (Frankel et al., 2013).

Only a few studies analyze fiscal policy cyclicality in resource-rich countries. Given the high dependence on commodity revenues, the standard methods mentioned above cannot be applied to these countries. The main difficulty is that both fiscal policy indicators and output fluctuations are heavily affected by movements in commodity prices. For instance, a positive shock to commodity prices would result in higher output and would simultaneously improve the fiscal balance. In a regression framework, the automatic response to commodity price changes could result in a spurious association between the fiscal variable and output fluctuations.

To overcome these issues, two approaches have been proposed in the literature. One is based on measuring the reaction of government spending to changes in commodity prices (Arezki et al., 2011; Cespedes and Velasco, 2014). Acyclical fiscal policy implies that government spending dynamics should be delinked from movements in commodity prices, while procyclical fiscal policy implies a positive association between the two. Given that automatic stabilizers are mostly working on the revenue side, positive association between government spending and commodity prices can be interpreted as a procyclical discretionary policy.

Another approach is based on assessing the fiscal stance over the economic cycle after correcting for the impact of commodity prices (Villafuerte et al., 2010). This approach looks at the relationship between the non-resource fiscal balance and the output gap of the non-resource economy.[2] A positive association between cyclically adjusted non-resource balance and non-resource output gap indicates countercyclical reaction of discretionary fiscal policy (excluding its commodity component) to disturbances in the non-commodity part of the economy.

Evidence from these studies suggests that fiscal policies do tend to be procyclical, but appear to have become less so in recent years. Using a sample of 32 countries, Cespedes and Velasco (2014) argue that while fiscal policy was procyclical in many countries in the 1970s–80s, this was not the case in the 2000s resource windfall. They attribute this to improvements in institutional quality. However, their sample includes a variety of countries, and goes beyond large non-renewable commodity exporters covered in our sample. In addition, some of the results are influenced by using the overall fiscal balance (and other indicators) as a share of nominal GDP, which can distort the analysis. Abdih et al. (2010) argue that policies in 28 oil-exporting countries were procyclical on average, but many countries adopted countercyclical policies in response to the international crisis in 2009. Villafuerte et al. (2010), using a similar approach for a sample of Latin American countries, also find evidence of procyclicality. Erbill (2011) finds that between 1990 and 2009 political stability and higher quality of institutions combined with less binding financial constraints are associated with lower procyclicality of fiscal policy in oil exporters.

Our analysis contributes to the literature in several directions. First, we study whether policies have been procyclical using alternative approaches. Second, we take advantage of a longer time period, including the latest period of high commodity prices (1970–2014), and a larger sample of non-renewable resource-rich countries (both oil/gas and metals). Third, our focus is on countries which are more dependent on commodity resources and, as such, likely to be more affected by volatility in commodity prices. Finally, our dataset includes data on non-resource fiscal balances and non-resource GDP allowing a more robust assessment of the fiscal stance than some of the previous work.

[2] The non-resource fiscal balance is measured as the difference between overall balance and commodity revenues, while non-resource GDP excludes the commodity sector/production. The output gap is measured as the difference between the actual and potential output.

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3. DATA SOURCES

To assess fiscal policy responses to commodity price fluctuations through different channels, this study uses a novel dataset with annual data covering the period 1970 to 2013. The dataset combines information from multiple primary sources. For commodity prices, it uses monthly data from the IMF World Economic Outlook database for the 1957–2015 period. For other commodity related data (weights in total exports, value added…) the dataset considers the IMF *Balance of Payments Statistics* and *Direction of Trade Statistics* databases. For country specific macroeconomic variables, the dataset contains variables from the *International Financial Statistics* and *World Economic Outlook* databases of the IMF. These databases provide also data on fiscal variables which have been complemented by series from the Governance Finance Statistics database, including on the components of spending and revenue. For governance indicators, it relies on the IMF fiscal rules dataset; the World Bank's *World Development Indicators* and *World Governance Indicators*; the Macro Data Guide Political Constraint Index Dataset (POLCON); POLITY IV and *International Country Risk Guide*.

The sample comprises 48 countries that are exporters of oil, gas, and metals (such as copper, gold, iron, and silver), where these commodities represent a large share of exports (20 percent or more of total exports) or fiscal revenues (15 percent or more) on average for a five-year period (either 2007–11 or 2009–13, depending on data availability). The countries are: Algeria, Angola, Australia, Azerbaijan, Bahrain, Bolivia, Botswana, Brunei Darussalam, Cameroon, Canada, Chad, Chile, Colombia, Democratic Republic of Congo, Republic of Congo, Côte d'Ivoire, Ecuador, Gabon, Ghana, Guinea, Guyana, Indonesia, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mali, Mauritania, Mexico, Mongolia, Nigeria, Norway, Oman, Papua New Guinea, Peru, Qatar, Russia, Saudi Arabia, South Africa, Sudan, Suriname, Syria, Trinidad and Tobago, United Arab Emirates, Venezuela, Yemen, and Zambia. The dataset is an unbalanced panel as some observations are missing for the time series around the 1970s and 1980s, in particular for some developing countries.

4. THE SIZE AND IMPACT OF COMMODITY PRICE FLUCTUATIONS

Resource-rich countries face large and unpredictable commodity price fluctuations. We define phases of expansions and contractions using the Harding and Pagan (2002) algorithm[3]. Following Cashin et al. (2002), we date commodity cycles for the period 1957–2015 using a minimum duration of each phase of 12 months, and a 24-month minimum duration for a complete cycle. Commodity prices are expressed in US dollars and deflated by the US GDP deflator. We find that the average duration of commodity price upswings (downswings) is 2–4 years, but the standard deviation is large and some periods of price expansion (contraction) can last up to 10 years (Tables 1–2). The average amplitude of changes in real commodity prices during periods of booms (percentage change from trough to peak) and busts (percentage change from peak to trough) is large, ranging from 40–50 percent (e.g. for iron ore) and 80 percent (e.g. for natural gas) for booms and 35–80 percent for busts (Table 3). Some of the booms (busts) are characterized by much larger amplitude of price changes, sometimes exceeding 200 percent. The duration of booms and busts in the metals, minerals, and oil sectors tends to be relatively longer because of the longer lags between investing in new capacity and the eventual increase in supply (World Bank, 2009). The standard deviation is also large suggesting high variability of commodity prices, which makes it difficult for policy makers to predict when current price cycles would end.

[3] The algorithm identifies potential turning points as the local minima and maxima in the series. Candidate points must satisfy two conditions: minimum length of phases and minimum length of complete cycles. The minimum lengths for both are parameters to be chosen by the researcher.

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Table 1.
Descriptive statistics: commodity price growth rates

	Sample	Obs.	Mean	Median	St. Dev	Skeweness	Kurtosis
Aluminum	Feb 1957–Jan 2015	696	–0.133	–0.188	4.66	–0.504	8.380
Copper	Feb 1957–Jan 2015	696	–0.009	0.084	6.63	–0.477	6.351
Gold	Feb 1957–Jan 2015	612	0.254	–0.199	4.69	1.091	11.563
Iron Ore	Feb 1957–Jan 2015	480	0.145	–0.295	5.56	3.812	36.452
Gas (EU)	Feb 1985–Jan 2015	360	0.033	–0.206	6.43	–0.635	18.460
Gas (US)	Feb 1991–Jan 2015	288	0.063	–0.310	13.34	–0.042	3.950
Tin	Feb 1957–Jan 2015	696	0.008	–0.107	4.98	–0.474	6.719
Oil (Brent)	Feb 1957–Jan 2015	696	0.146	–0.243	8.38	4.354	65.932
Oil (texas)	Feb 1957–Jan 2015	696	0.099	–0.279	7.11	2.088	34.853

Note: Reported are descriptive statistics for real m-o-m growth rates

Source: IMF World Economic Outlook.

Table 2.
Duration in months of commodity price expansions and contractions

		Mean	Median	St.Dev	Freq.	Min	Max
Aluminum	Expansions	29.3	18.0	24.4	11	11	86
	Contractions	34.1	34.0	14.6	11	12	65
Copper	Expansions	38.5	24.5	33.0	8	17	112
	Contractions	43.2	44.0	26.9	9	12	81
Gold	Expansions	36.4	26.0	38.7	8	3	125
	Contractions	40.3	33.5	22.1	8	17	79
Iron Ore	Expansions	29.2	13.0	34.6	6	12	99
	Contractions	43.7	47.0	20.9	7	11	72
Gas-EU	Expansions	30.8	24.5	23.9	6	7	76
	Contractions	29.3	27.0	13.6	6	15	53
Gas-US	Expansions	23.8	19.0	15.9	6	13	55
	Contractions	20.9	15.0	14.5	7	6	47

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		Mean	Median	St.Dev	Freq.	Min	Max
Tin	Expansions	25.1	23.0	8.8	11	12	38
	Contractions	35.1	19.0	46.5	12	14	179
Oil-Brent	Expansions	28.3	21.0	20.5	11	12	79
	Contractions	32.2	23.5	30.3	12	8	107
Oil-Texas	Expansions	28.3	22.5	21.3	10	12	78
	Contractions	37.6	23.0	35.1	11	8	115

Source: IMF World Economic Outlook and authors' calculations.

Table 3.
Amplitude of commodity price expansions and contractions

		Mean	Median	St.Dev	Freq.	Min	Max
Aluminum	Expansions	40.9	52.4	35.0	11.0	1.6	107.1
	Contractions	–51.6	–49.6	42.2	11.0	–140.0	–6.2
Copper	Expansions	78.6	70.2	45.6	8.0	25.2	172.0
	Contractions	–72.4	–85.4	34.5	9.0	–113.1	–17.1
Gold	Expansions	63.3	28.9	64.3	8.0	7.3	166.1
	Contractions	–47.5	–48.5	24.4	8.0	–91.1	–9.9
Iron Ore	Expansions	50.4	14.4	96.0	6.0	0.9	245.6
	Contractions	–35.9	–27.3	35.5	7.0	–107.6	–5.9
Gas-EU	Expansions	63.6	54.2	58.7	6.0	3.0	168.8
	Contractions	–63.4	–58.7	30.5	6.0	–113.0	–21.5
Gas-US	Expansions	80.1	84.3	25.1	6.0	33.7	110.5
	Contractions	–78.9	–69.5	49.3	7.0	–154.9	–14.4
Tin	Expansions	50.6	49.3	34.2	11.0	9.0	117.1
	Contractions	–47.8	–44.6	48.2	12.0	–192.2	–12.3
Oil-Brent	Expansions	63.0	57.3	51.5	11.0	4.2	175.4
	Contractions	–57.8	–51.2	43.6	12.0	–162.7	–2.9
Oil-Texas	Expansions	65.5	63.0	50.6	10.0	0.4	166.7
	Contractions	–51.8	–45.7	40.1	11.0	–138.6	–9.3

Source: IMF World Economic Outlook and authors' calculations.

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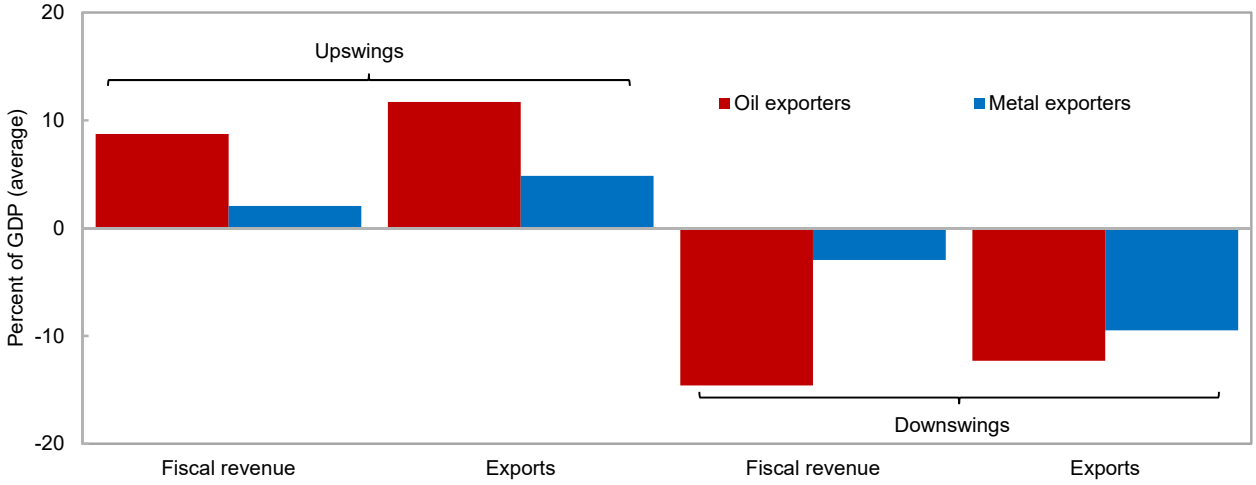
The volatility in commodity prices can have a large impact on the external current and fiscal accounts. The average direct impact can be estimated based on the average amplitude of commodity price changes and applying it to exports and fiscal revenues of resource-rich countries.

As illustrated in Figure 1, the average impact can be large, ranging from 8–13 percent of GDP for exports and 2–10 percent of GDP for fiscal revenue during upswings and a negative impact between 3–16 percent of GDP for revenue and 9–13 for exports during downswings. The relatively larger impact on fiscal revenues in oil exporters suggests that transmission of commodity price shocks to the economy mostly works through the fiscal channel. This is in line with results of Husain et al. (2008). There is also evidence of asymmetry across phases of the commodity price cycle, with the impact being stronger in downswings compared to upswings.

Figure 1.
Impact of commodity price swings on fiscal revenues and exports



Source: IMF World Economic Outlook and authors' estimates.

Past and recent experiences also show that shocks can be very large for the budget and the economy. Typically, economic activity and external and fiscal balances deteriorate (improve) during commodity price downswings (upswings).[4] These price fluctuations can have a significant impact on growth. The bar chart in figure 2 reports the median of the growth rate of real revenue and expenditure for resource rich countries that experienced revenue increases over the 1973–80 boom. It indicates that during the 1970s–80s boom and bust, many countries experienced revenue increases of close to 10 percent a year in real terms during the boom and subsequent falls in the bust. This led to large increases in public expenditures and economic activity. But, after the bust, many commodity exporters experienced a long period of negative or stagnant growth. Similarly, many commodity exporters – after experiencing large revenue windfalls in the 2000s – had subsequently to manage a large fall in commodity prices.

[4] See April 2012 IMF World Economic Outlook.

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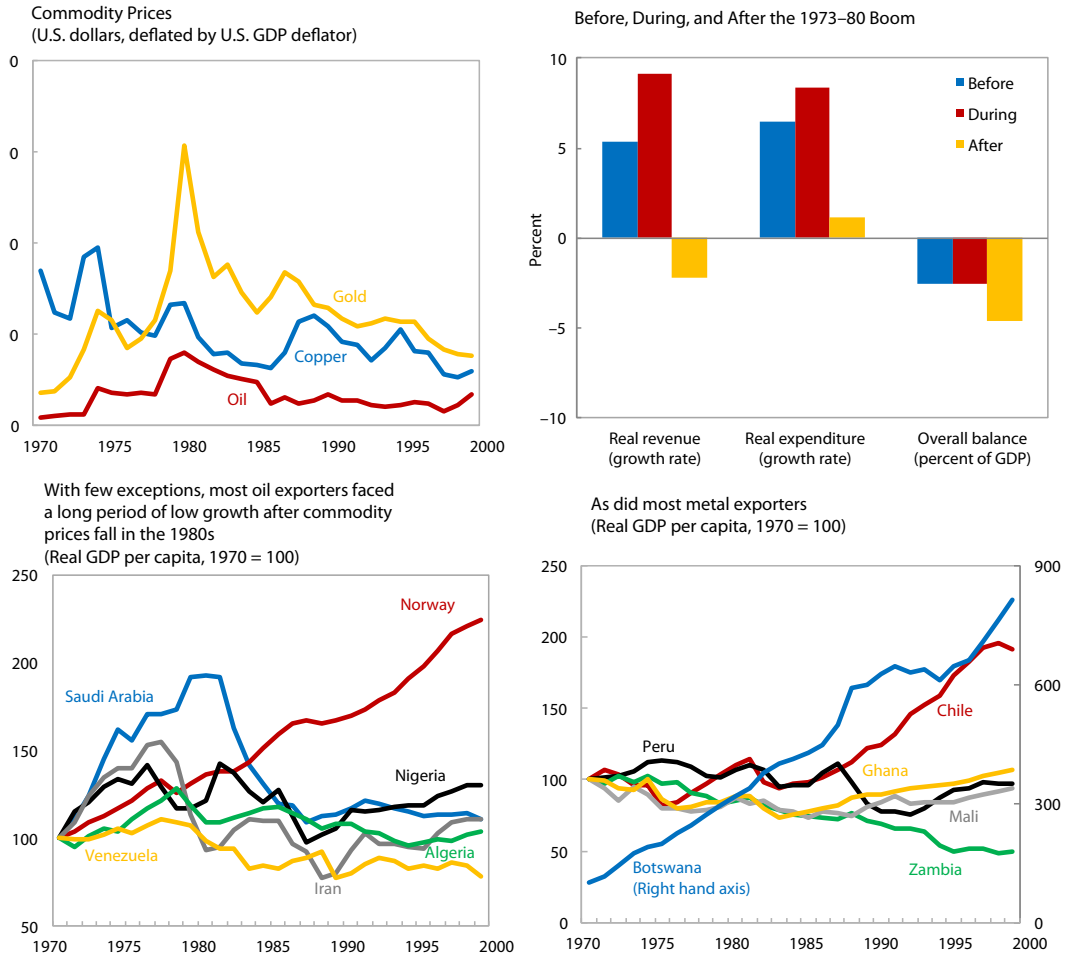
Figure 2.
The 1970s–80s boom-bust and its impact on growth



Note: For panel 2, before = 1971–72, during = 1973–80, after 1982–83.

Source: IMF World Economic Outlook and authors' calculations.

5. FISCAL CYCLICALITY

As shown in the literature, by exacerbating output volatility, procyclical fiscal policy could dampen economic growth. Fatas and Mihov (2003) show that aggressive use of discretionary fiscal policy adds to economic volatility and lowers economic growth. The Fiscal Monitor (IMF 2015b) finds that an increase in fiscal stabilization could boost long-run annual growth rates of developed economies significantly. Van der Ploeg and Poelhekke (2008) also show that volatility hurts growth among commodity exporters, with the former partially explained by volatile government expenditures.

Resource-rich countries should benefit from countercyclical policies to a greater extent than other countries. As the large volatility in prices is transmitted to the economy, this could lead to large swings in the economy. Fiscal policy can help stabilize the economy, especially as the government usually receives a large share of commodity receipts. However, evidence seems to suggest that fiscal policy, in many cases, has exacerbated the impact of volatile prices (Gelb and associates, 1998). Some argue policies have become less procyclical (or even countercyclical) in recent years (Frankel et al., 2013; Cespedes and Velasco, 2014). However, many countries raised expenditures massively during the revenue windfall of the 2000s and were forced to large procyclical expenditure cuts during the 2012 slump (IMF 2015a).

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We revisit the evidence on fiscal cyclicality and whether it has changed over time, especially during the resource boom of the 2000s, taking advantage of our new data. In order to formally answer these two questions, we apply two different approaches. The first measures the responsiveness of public expenditure growth rates to year-to-year changes in commodity prices. The second assesses how fiscal policy is reacting to the business cycle in the non-resource sector. This section outlines these methods and their results.

5.1. Empirical strategy

The first approach entails estimating the relationship between commodity prices and fiscal policy. Following Kaminsky et al. (2004), we use government expenditures as our measure of fiscal policy. This is particularly relevant for resource-rich countries, as historical experience shows fiscal policy tends to react to movements in commodity prices mainly via expenditures. A positive association indicates that fiscal policy is procyclical, as government spending would increase in periods of economic expansion fueled by growing commodity prices. The advantage of this approach is that commodity prices are exogenous to domestic economic cycles and spending policies, which alleviates endogeneity issues.

The empirical specification takes the following form:

$$\Delta \log(RG_{it}) = \alpha_i + \beta \Delta \log(P_{it}) + \varepsilon_{it}, \tag{1}$$

in which *RG* is the real government spending. *P* is the country-specific commodity price index. We use a fixed effects panel to estimate the coefficient β, our indicator of cyclicality. It measures the elasticity of government expenditures to the commodity price index. A positive value of β implies procyclical behavior.

P is measured as:

$$P_{it} = \sum_{j \in J} P_{ijt} * w_{ij}, \tag{2}$$

in which *i* is the country, *j* is the commodity type (oil, gas, gold, tin, zinc, lead, aluminum, nickel, copper, and silver), *P* is the real commodity price (deflated by the U.S. consumer price index, CPI), and *w* is the commodity weight (commodity export share in GDP).

By using changes of government spending and commodity price variables we are abstracting from the possible long-run correlation of their levels. In addition, we found no evidence of a long-term relationship between the two.[5] Changes of these variables proxy cyclical movements and positive association between changes is an indication of procyclicality. We also assess whether there are differences in procyclicality across expansionary and contractionary phases of the cycle, by interacting commodity price changes with a dummy variable indicating the cyclical phase. We also study whether the relationship differs between total and capital expenditure, as capital expenditure tends to be the first to adjust to shocks.

The second approach examines the relationship between output gap and cyclically adjusted fiscal balances. If this relationship is negative, then fiscal policy is procyclical. As mentioned above, for resource-rich countries, an appropriate indicator of the fiscal stance is the non-resource fiscal balance as a share of the non-resource GDP. Using the overall balance would lead to a bias when measuring fiscal cyclicality (Villafuerte et al., 2010).[6] The empirical specification takes the following form:

[5] The long-term relationship could be positive as countries could afford higher (lower) spending when prices are higher (lower). However, panel cointegration tests (Westerlund, 2007) suggest the two series are not cointegrated, which further supports our empirical approach of focusing on changes in expenditures and prices.

[6] Overall fiscal balances and GDP are heavily influenced by movements in commodity prices and as such should notcannot be used to assess how policies are changed in response to prices. For example, an improvement in fiscal balances when commodity prices rise does not imply there was a tightening of the fiscal stance (the opposite may be true). Similarly, governments may react to a rise in prices by boosting expenditures and lead to a strong fiscal impulse to the domestic economy, even when the overall fiscal balance improves – thanks to a large increase in commodity revenue (originated from rising export receipts)..

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$$\frac{CA\_BAL\_NC_{it}}{GDP\_NC_{it}} = \alpha_i + \beta GAP\_NC_{it} + \varepsilon_{it}, \quad (3)$$

in which *CA_BAL_NC* is the cyclically adjusted non-resource balance (assuming elasticities of 1 for revenues and 0 for expenditures), *GDP_NC* is the non-resource GDP, and *GAP_NC* is the non-resource GDP gap. Coefficient b captures the degree of fiscal cyclicality (a negative coefficient implies procyclicality). Models parameters are estimated using the fixed effects regression. As a test of robustness, non-resource GDP growth is used instead of the non-resource output gap, given the high uncertainty when measuring economic cycles.

5.2. Results

The results of a fixed effects panel suggest that commodity prices have a positive impact on government spending (Table 4), implying a procyclical fiscal policy. A 10 percent increase (fall) in commodity prices leads to a 1.2 percent increase (fall) in real expenditure growth. This means that, for example, if oil prices fall by 50 percent, as in the second half of 2014, expenditures would contract by 6.5 percent on average at a time when economic growth is rapidly decelerating. As suspected, capital spending is even more procyclical compared to total spending (the coefficient is 0.15 and increases to 0.17 when controlling for dependence on resource revenue), suggesting that indeed such variable bears the brunt of adjustments to commodity price shocks. The results are robust when we control for the degree of dependence on resource revenue (measured as the value added to GDP of the commodity). When distinguishing between different stages of the cycle, the results suggest that procyclicality is stronger during commodity price expansions, indicating that a large part of the windfall is spent at times of booms.

Table 4.
Estimation results: government spending and commodity prices

	I	II	III	IV	V	VI	VII	VIII
	total expenditure (*RG*) growth rate				capital expenditure growth rate			
D l comm. prices *(P)*	0.119** [0.052]		0.121** [0.057]		0.147* [0.081]		0.169** [0.086]	
D log comm. p *(P)**Dummy (= 1 expansions)		0.148** [0.059]		0.157** [0.065]		0.205** [0.095]		0.223** [0.101]
D log comm. p *(P)**Dummy (= 1 contractions)		0.073 [0.068]		0.070 [0.072]		0.074 [0.103]		0.102 [0.108]
Comm. value added in GDP			0.004*** [0.001]	0.004*** [0.001]			0.006*** [0.001]	0.006*** [0.001]
Constant	0.124** [0.058]	0.038 [0.045]	–1.193 [1.281]	–1.198 [1.245]	0.055 [0.058]	0.017 [0.054]	0.029 [1.145]	0.034 [1.153]
Observations	902	902	824	824	1346	1346	1239	1239
N. of countries	41	41	41	41	38	38	38	38
R^2	0.079	0.080	0.107	0.109	0.079	0.080	0.102	0.103

Note: Dependent variables are growth rates of real total expenditure (columns I–IV) and capital expenditure (columns V–VIII). Estimations are performed using the fixed effects estimator with AR(1) residuals and time effects. Robust standard errors are in brackets. *, **, and *** denote significance at 10, 5, and 1 percent levels, respectively.

Source: IMF World Economic Outlook and authors' calculations.

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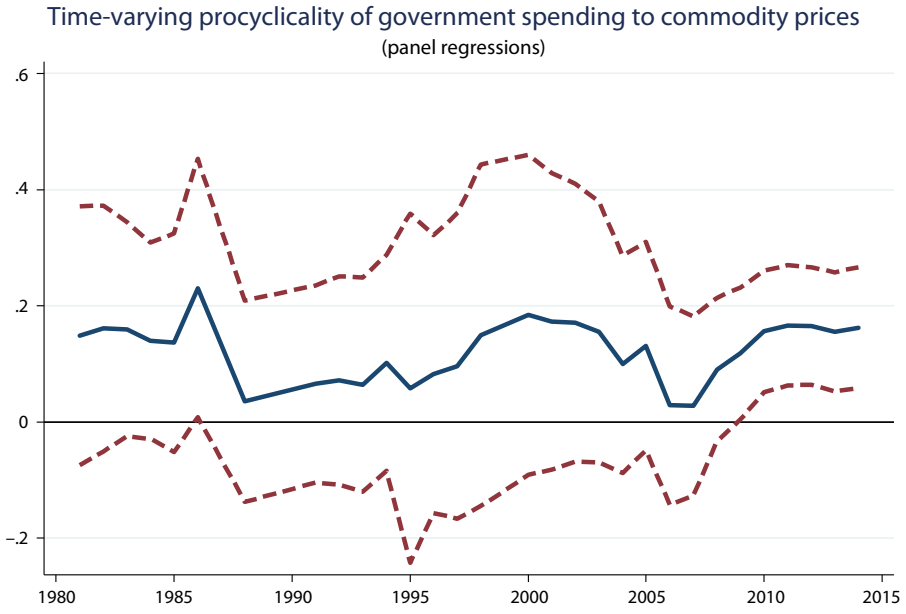
Has this procyclicality changed over time? To answer, we run the same panel regression (equation 1) repeatedly for a 10-year rolling window and obtain a time varying coefficient reported in Figure 3. We do not find robust evidence that average procyclicality has declined since 1970. The estimated coefficients for 1980–2015 show that average procyclicality in recent years is similar to levels seen in past decades. Our result is consistent with the evidence that many resource-rich countries accelerated significantly public expenditures during the 2000s, at a time when commodity prices were exceptionally high (or rising fast). In some countries public expenditures (in real terms) more than tripled during that period (IMF 2015a).

Figure 3.
The degree of procyclicality appears to have been stable over time



Note: Estimations are performed using 10 year rolling windows. Dashed lines represent 10 percent confidence intervals.

Source: Authors' calculations.

The results of the fixed effects panel using the second approach confirms the procyclical bias of fiscal policy. The results in Table 5, show that governments tend to loosen the fiscal stance when the domestic non-resource economy strengthens, and tighten the fiscal stance when the economy weakens. A 1 percentage point improvement in the non-resource output gap leads to a 1 percentage point deterioration of the cyclically adjusted non-resource balance as a share of potential non-commodity GDP. Replacing the output gap with real GDP growth rates (for the non-resource economy) does not alter the negative association. Moreover, the results suggest commodity exporters tend to be more procyclical than other emerging economies. Notably, IMF (2015b) found that emerging markets and developing economies also tend to act procyclically in expansions, but with a coefficient half of the size of the figure found here for commodity exporters (around 0.5).

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Table 5.
Estimation results: non-commodity output gap and cyclically-adjusted non-commodity balance

	I *CA_BAL_NC*	II *CA_BAL_NC*
Non-commodity output gap (*GAP_NC)*	–0.945*** [0.225]	
Non-commodity GDP (*GDP_NC*) growth		–0.215*** [0.011]
Constant	–0.266*** [0.039]	–0.254*** [0.039]
Observations	770	765
Number of countries	41	41
R^2	0.14	0.279

Note: Dependent variable is cyclically-adjusted non-commodity balance. Estimations are performed using the fixed effects estimator with time effects. Robust standard errors are in brackets. *, **, and *** denote significance at 10, 5, and 1 percent levels, respectively.

Source: IMF World Economic Outlook and authors' calculations.

Why fiscal policies tend to be procyclical if this leads to volatility and potentially much weaker growth? Given that commodity price shocks can be very persistent, public expenditures may be increased significantly if revenues are expected to remain high for long. Once prices disappoint, there is a need for expenditure cuts. While the decision to respond in a procyclical fashion to movements in prices may be consistent with affordability arguments (if richer, it could be optimal to raise spending), it is not so when considering stabilization objectives. As the commodity windfall is likely to boost the domestic economy, accelerating public spending may be destabilizing.[7] Furthermore, countries may expand spending beyond what is feasible. For example, Manzano and Rigobon (2001) argue that the problems faced by resource-rich countries mainly reflect debt overhang as countries borrow during booms and need to adjust during busts. This, at least in part, reflects the weak political institution argument which identifies these economies as more prone to rent-seeking in the face of large commodity windfalls (Tornell and Lane, 1999).

5.3. Can institutions help reduce procyclicality?

In an attempt to restrict fiscal policy, many countries have adopted fiscal rules and resource funds (or sovereign wealth funds), more generally defined as special fiscal institutions. These aim at constraining the fiscal management of commodity revenues either for sustainability or stability reasons.[8] In this section we look at the impact of these rules and resource funds on procyclicality.

For our analysis, we consider only rules that have been strictly designed to regulate the accumulation or use of resource revenues, including rules that are established for the functioning of a fund (either saving or stabilization fund). In some cases, funds have been established without a legally binding rule for the accumulation and withdrawal of assets. Hence, the estimation below features both a dummy for fiscal rules and a dummy for when a fund is in place (with or without a rule). To complement the analysis, we also examine the impact of broader political

[7] The large scaling up of public spending could also have a negative impact on its quality and effectiveness. See IMF (2015a) for more discussion on this.

[8] These fiscal rules are different from the more common rules aimed at restricting fiscal policy at large and adopted also by countries other than resource rich (for a description of the latter see Schaechter et al., 2012, and the IMF database http://www.imf.org/external/datamapper/FiscalRules/map/map.htm). Other types of special fiscal institutions include stabilization funds, saving funds, and investment funds when the latter are related to the investment of resource receipts (see table A.1 in the appendix with the rules and institutions considered in this paper).

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institutions. We use some of the World Governance Indicators and the International Risk Group databases; notably bureaucratic quality, corruption, political risk and strength of the institutional and legal setting. The Polity variable comes from the Polity IV dataset and captures the quality of democratic institutions and rule of law. For these variables, a higher value means a better institutional quality.

To assess the impact of the different institutions, the empirical strategy involves interacting the commodity price index with measures of institutional quality and fiscal rules/resource funds. The empirical specification takes the following form:

$$\Delta \log(RG_{it}) = \alpha_i + \beta \Delta \log(P_{it}) + \gamma \Delta \log(P_{it}) * I_{it} + \varepsilon_{it}, \quad (4)$$

in which I is a measure of institutional quality. We use two types of institutional quality measures: an index of institutional quality (a continuous variable) and the existence of a fiscal rule or a resource fund in place (a dummy variable). Coefficient g measures the extent to which institutions and rules/funds can affect procyclicality (a negative coefficient would imply a reduction in procyclicality in countries with better institutions and fiscal rules/resource funds). We use a fixed effects panel regression to estimate the parameters.

The results suggest that experience with resource funds and fiscal rules has been mixed (Table 6). While the interaction term is negative, consistent with the hypothesis of a reduction in procyclicality following the adoption of fiscal rules/resource funds, it is not statistically significant. These findings are in line with the experience of many countries, with possibly the exception of cases like Botswana, Chile and Norway.

Table 6.
Impact of fiscal rules on fiscal procyclicality

	I	II	III	IV	V
D l comm. prices *(P)*	0.119** [0.052]	0.143** [0.066]	0.164** [0.069]	0.151** [0.063]	0.176** [0.070]
D l comm. prices *(P)**Savings fund dummy		–0.022 [0.071]			
D l comm. prices *(P)**Stabilization fund dummy			–0.058 [0.064]		
D l comm. prices*(P)**Fiscal rule dummy				–0.078 [0.088]	
D l comm. prices *(P)**Fiscal rule or savings/stabilization fund dummy (*I*)					–0.075 [0.063]
Constant	0.124** [0.058]	0.123* [0.073]	0.125* [0.073]	0.125* [0.073]	0.128* [0.073]
Observations	902	718	718	718	718
Number of countries	41	34	34	34	34
R^2	0.079	0.083	0.084	0.084	0.085

Note: Dependent variable is real expenditure growth rate. Estimations are performed using the fixed effects estimator with AR(1) residuals and time effects. Robust standard errors are in brackets. *, **, and *** denote significance at 10, 5, and 1 percent levels, respectively.

Source: IMF World Economic Outlook and authors' calculations.

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The reasons for this lack of success are varied. The existence of a fiscal rule or fiscal fund does not necessarily indicate *a de facto* compliance with the rule. Many rules tend to be breached especially in bad times. Lack of compliance could be due to several factors, such as lack of political will, poor design of the rule and absence of monitoring and enforcement bodies. In Nigeria, for example, the rule was repeatedly undermined by weak enforcement. In other countries, like Chad, Ecuador, and Timor Leste, rules were breached as they became incompatible with budget and developmental priorities. In some other cases, due to the rule design, governments embarked in extra-budgetary operations which made the rules ineffective and weakened budgetary control. In other cases, lack of *coordination* between the activities related to a resource fund and ordinary budgetary operations resulted in accumulation of financial assets in funds at times when governments had to borrow expensively to finance deficits (Ghana and Trinidad and Tobago).[9]

There is empirical support, however, that the quality of political institutions helps limit the procyclical bias in spending.[10] In some cases the impact can be highly significant as shown in Table 7. For example, procyclicality would be eliminated in countries with the degree of bureaucratic quality or quality of institutional and legal setting around two standard deviations above the mean. In part, this reflects the fact that the average quality of institutions tends to be weaker in resource-rich countries than in other countries (Figure 4). This evidence also suggests that the lack of success of rules and funds in some countries may owe more to the underlying weaknesses of their institutional frameworks than to the rules themselves.

Table 7.
Impact of institutions on fiscal procyclicality

	I	II	III	IV	V	VI
D l comm. prices *(P)*	0.119** [0.052]	0.142* [0.076]	0.341*** [0.090]	0.214** [0.095]	0.609*** [0.178]	0.266** [0.115]
D l comm. prices *(P)* *Polity		–0.008 [0.006]				
D l comm. prices *(P)* *Bureaucratic quality			–0.087*** [0.029]			
D l comm. prices *(P)* *Corruption				–0.027 [0.024]		
D l comm. prices *(P)* *Political risk					–0.007*** [0.002]	
D l comm. prices *(P)* *Institutional and legal setting						–0.003* [0.001]
Constant	0.124** [0.058]	0.155* [0.086]	0.05 [0.055]	0.039 [0.056]	0.034 [0.028]	0.127** [0.060]
Observations	902	464	805	805	804	716
Number of countries	41	22	41	41	41	33
R^2	0.079	0.101	0.089	0.079	0.088	0.092

Note: Dependent variable is real expenditure growth rate. Estimations are performed using the fixed effects estimator with AR(1) residuals and time effects. Robust standard errors are in brackets. *, **, and *** denote significance at 10, 5, and 1 percent levels, respectively.

Source: IMF World Economic Outlook and authors' calculations.

[9] See Ossowski et al. (2008) and Sugawara (2014) for a review.

[10] These results are similar to those found in earlier studies (Ossowski et al., 2008). Frankel et al. (2013) also stress the importance of quality of institutions, while Akitoby et al. (2004) argue strengthening checks and balances can also help reduce the cyclicality of government expenditures.

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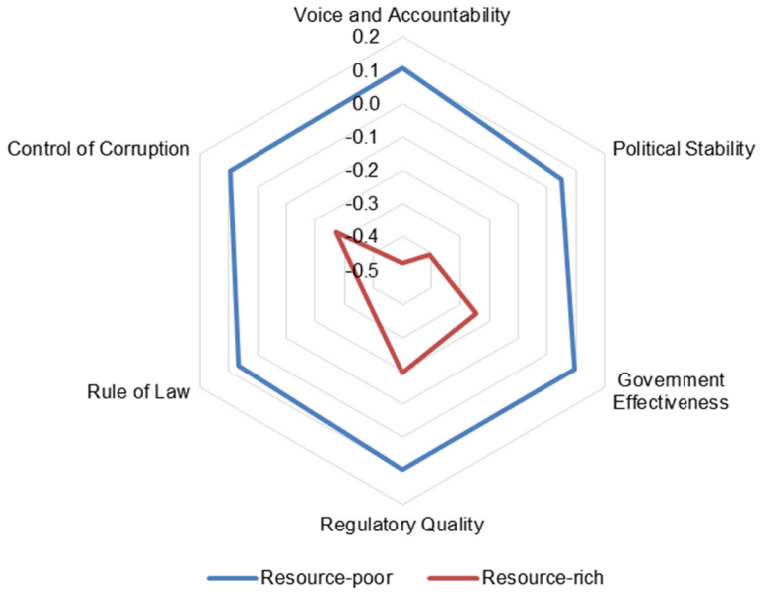
Some countries have been successful in limiting the negative impact of the commodity prices volatility and promote sustainable economic growth. Namely, the quality of institutions in Norway, Chile, and Botswana is higher than among their peers, which helped support fiscal policy and achieve stronger higher long-term growth (see Figure 2). They also show that fiscal rules or resource funds can help achieve policy objectives if they are supported by strong institutions and political commitment, are well-designed, and are closely linked to broader policy objectives. The examples of Chile and Norway show that the rules can both help discipline policies and allow for flexibility to respond to economic conditions – thanks to large financial buffers built during resource booms and strong market credibility.[11, 12]

Figure 4.
Institutional quality in resource-rich countries is weaker than in other countries



Note: The chart shows average levels of institutional quality for resource-rich and resource-poor countries with the same level of GDP per capita (sample average for resource-rich countries). Larger numbers indicate higher institutional quality. Sample period: 1996–2014.

Source: Worldwide Governance Indicators (World Bank) and authors' estimates.

6. HOW DO NON-RESOURCE REVENUES RESPOND TO COMMODITY REVENUE SHOCKS?

In this section we analyze how non-resource revenues react to fluctuations in commodity revenues (heavily influenced by commodity prices). Most of previous studies on how resource-rich countries react to commodity price shocks have focused on expenditure – as, indeed, it tends to be the main channel. However, countries can also respond to shocks by changing their tax effort.

[11] The strong institutional framework allowed Chile to react in a countercyclical fashion to the sudden and large 2008–09 commodity price fall. During the commodity boom, Chile increase their net financial assets significantly. This allowed a large easing of fiscal policy in 2008–09 in response to the global financial crisis (went from a 8 percent overall surplus in 2007 to a 4 percent fiscal deficit in 2009). See also Frankel (2011) for further discussion on Chile.

[12] The Norwegian fiscal framework is anchored on a strong political commitment to a non-oil balance target. Oil/gas revenue is saved in an oil fund and only the returns from financial investments are used to fund the budget. Under the framework, the non-oil deficit should average 4 percent of the assets in the oil fund over the economic cycle. The rule allows to insulate the budget from yearly movements in the oil and gas prices. Norway's framework has not only resulted in the buildup of large financial savings, but also helped sustain GDP per capita growth above most other resource-rich countries over the last 4 decades.

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The existing studies assess the reaction of non-resource revenues to persistent changes in commodity revenues in oil/gas exporters (see Bornhorst et al., 2009; Thomas and Trevino, 2013; Crivelli and Gupta, 2014). They find that countries tend to offset rising commodity revenue by a reduction in non-resource tax effort.[13]

We expand the analysis in two main directions: (i) we use a broader set of commodity exporters and scale the commodity and non-commodity revenues by the non-commodity GDP to alleviate the endogenous impact of commodity price changes on the denominator, and (ii) we analyze both long-run and short-run reaction to changes in commodity revenues using the Pooled Mean Group (PMG) estimator of Pesaran et al. (1999). The empirical specification is:

$$\Delta\left(\frac{R_{it}^{NC}}{Y_{it}}\right) = \phi_i\left[\frac{R_{it}^{NC}}{Y_{it}} - \alpha - \beta\frac{R_{it}^{C}}{Y_{it}}\right] + \delta_i\Delta\left(\frac{R_{it}^{C}}{Y_{it}}\right) + \mu_i + \varepsilon_{it}, \quad (5)$$

in which i and t indexes denote country and time, Y is the nominal GDP (non-commodity), R is government non-commodity (NC) and commodity (C) revenues, μ is the country-specific fixed effect, and ε is an *i.i.d.* error term. The term in the squared bracket is the error-correction term measuring the extent of the deviation of the non-commodity revenue from its long-run equilibrium value. β measures the *long-run* reaction of non-commodity revenues to a permanent change in commodity revenues and corresponds to the coefficient estimates in Bornhorst et al. (2009) and Crivelli and Gupta (2014). Similarly, δ measures the *short-term* effect of non-commodity revenue to a temporary change in non-commodity revenue. ϕ is the speed of adjustment of non-commodity revenue to its long-run equilibrium: the larger is the coefficient (in absolute terms), the faster is the adjustment. Finally, the country-specific fixed effects included in the specification capture unobserved heterogeneity of non-commodity revenue across different countries.

Our results suggest that resource-rich countries adjust tax effort in response to persistent changes in commodity revenues, but there is limited reaction to temporary changes. Table 8 shows that a permanent increase in commodity revenues by 1 percent of non-commodity GDP tends to reduce non-commodity revenues by 0.03–0.04 percent of non-commodity GDP. Temporary changes in commodity revenues (up to 3 years lag) do not have a significant impact on non-commodity revenues. Countries do not seem to change non-commodity revenue effort in response to temporary commodity revenue shocks, letting the automatic stabilizers work. In addition, half of the deviation from the long run association between commodity and non-commodity revenues is corrected in 4 years, providing further evidence on the sluggish adjustment of non-commodity revenues.

Table 8.
Impact of commodity revenue shocks on non-commodity revenues

	I	II	III
Long-run coefficients			
Comm. revenue/non-comm. GDP $\left(\frac{R_{it}^{C}}{Y_{it}}\right)$ (1 lag)	–0.033*** [0.007]	–0.035*** [0.008]	–0.040*** [0.007]
Constant	19.576*** [0.412]	19.829*** [0.463]	20.006*** [0.380]

[13] A 1 percent of GDP increase in hydrocarbon revenues leads to about 0.2 percent reduction of non-hydrocarbon revenues over the long-run (Bornhorst et al., 2009).

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	I	II	III
Short-run coefficients			
Speed of adjustment	–0.156*** [0.042]	–0.150*** [0.044]	–0.169*** [0.045]
D Comm. revenue/non-comm. GDP $\left(\frac{R_{it}^{C}}{Y_{it}}\right)$	–0.072 **[0.075]**	–0.046 [0.102]	–0.085 [0.150]
D Comm. revenue/non-comm. GDP $\left(\frac{R_{it}^{C}}{Y_{it}}\right)$ (1 lag)		–0.057 [0.207]	–0.071 [0.132]
D Comm. revenue/non-comm. GDP $\left(\frac{R_{it}^{C}}{Y_{it}}\right)$ (2 lags)			–0.244 [0.175]
Observations	744	703	676
Log likelihood	–1545.3	–1432.0	–1321.0
Half life (years)	4.1	4.3	3.7

Note: Dependent variable is the change in non-commodity revenue ratio. Estimations are performed using the Pooled Mean Group (PMG) estimator. *, **, and *** denote significance at 10, 5, and 1 percent levels, respectively.

Source: authors' calculations.

7. CONCLUSIONS

Using a novel dataset for resource-rich economies, this study aims at providing a comprehensive analysis on fiscal policy responses to the commodity price fluctuations. It does so by examining several channels through which fiscal policy can react to commodity price shocks. First, it provides evidence of the impact that commodity price shocks (both upswings and downswings) have on exports and fiscal revenue of a resource-rich country. Second, it examines three sets of policy responses. First, it focuses on the way total and capital expenditures react to commodity prices. Second, it assesses the implication of price changes on the non-resource fiscal balances; and third, it looks at the response to price shocks of non-resource revenues, as an additional countercyclical measure that can be adopted by the government.

We find that fiscal policy in resource-rich countries tends to be procyclical and more so than for other economies. Contrary to other studies, we do not find evidence that procyclicality has declined over time. Such procyclicality is found when looking at the reaction of expenditure and of the non-resource balance to commodity prices. We also find some tax effort in response to changes in commodity revenues, but only when these changes are persistent. Finally, we find that adoption of fiscal rules or resource funds do not have a significant impact on fiscal cyclicality, but general political institutions do help. The lack of progress on these likely partly explains why fiscal procyclicality, on average, has not declined in recent years.

Our results have important policy implications. First, more efforts are needed to establish a comprehensive fiscal policy framework in resource-rich countries that can help cope with heightened uncertainty and volatility. These frameworks should be based on a solid long-term anchor to guide fiscal policy and should explicitly incorporate commodity price uncertainty. This means putting more emphasis on building precautionary savings during good times to help weather shocks in a countercyclical fashion. Next, further efforts to improve the institutional framework are needed, including enhancing transparency and accountability. Tax policies aimed at diversifying the revenue base would reduce government's overdependence on commodity revenues and improve its ability to run countercyclical policies. Finally, efforts to diversify the economy beyond the commodity sector are also critical.

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APPENDIX

Table A1.
Resource Funds and Rules

	SWF*	Saving Fund		Stabilization Fund		Fiscal Rule	
	Yes = 1; No = 0	Yes = 1; No = 0	Dates	Yes = 1; No = 0	Dates	Yes = 1; No = 0	Dates
Algeria	1	0		1	2000	0	
Angola	1	1	2012	1	2012	0	
Azerbaijan	1	1	1999	1	1999	1	1999
Bahrain	1	0		1	2000	0	
Bolivia	0	0		0		0	
Botswana	1	1	1993	1	1972	1	1994
Brunei Darussalam	0	0		0		0	
Cameroon	0	0		0		0	
Chad	1	1	2008	1	2008	0	
Chile	1	1	1985	1	1985	1	2006
Colombia	1	0		1	1995	0	
Congo	0	0		0		0	
Congo DRC	0	0		0		0	
Cote D'Ivoire	0	0		0		0	
Equatorial Guinea	1	1	2002	0		1	2002
Ecuador	1	1	2005	1	1999–2007	1	2002
Gabon	1	1	1998	0		1	1998
Ghana	1	1	2011	1	2011	1	2011
Guinea	0	0		0		0	
Guyana	0	0		0		0	
Indonesia	0	0		0		0	
Iran	1	0		1	2000	0	
Iraq	0	0		0		0	
Kazakhstan	1	1	2000	1	2000	1	2000
Kuwait	1	1	1960	1	1960	0	
Libya	1	1	1995	0		0	
Mali	0	0		0		0	
Mauritania	1	0		1	2000	0	
Mexico	1	0		1	2000	0	
Mongolia	1	0		1	2011	0	
Mozambique	0	0		0		0	
Niger	0	0		0		0	

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	SWF*	Saving Fund		Stabilization Fund		Fiscal Rule	
	Yes = 1; No = 0	Yes = 1; No = 0	Dates	Yes = 1; No = 0	Dates	Yes = 1; No = 0	Dates
Nigeria	1	1	2011	1	2004	0	
Norway	1	1	1985	1	1985	1	2002
Oman	1	1	1980	0		0	
Papua New Guinea	1	0		1	1974–2001	0	
Peru	1	0		1	1999	0	
Qatar	1	0		1	2000	0	
Russia	1	0		1	2004	1	2008
Saudi Arabia	0	0		0		0	
Sudan	1	0		1	2002	0	
Suriname	0	0		0		0	
Syria	0	0		0		0	
Timor Leste	1	1	2005	1	2005	1	2005
Trinidad and Tobago	1	1	1999	1	2005	1	2007
UAE	0	0		0		0	
Venezuela	1	1	1999	0		1	2000
Yemen	0	0		0		0	
Zambia	0	0		0		0	

* Sovereign Wealth Funds (SWF) here capture only saving and stabilization funds.

Source: IMF internal dataset.

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