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Bank financial stability and international oil prices: Evidence from listed Russian public banks

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Abstract

Using data on 17 listed public banks from Russia over the period 2008 to 2016, we analyse whether international oil prices affect the bank stability in an oil-dependent country. We resort to a Pool Mean Group (PMG) estimator, and we show that an increase in oil prices has a long-run positive effect on Russian public banks stability. While positive oil-price shocks contribute to bank stability in the long run, an opposite effect is recorded for negative shocks. However, no significant impact is documented in the short run. Our findings are robust to different bank stability specifications and different samples.

Keywords: bank financial stability; international oil prices; bank valuation; Russian public banks; panel data estimation.

JEL codes: C33, G21, Q43.

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1. Introduction

The large fluctuations recorded in international oil prices during the last decades have challenged the stability of banks from oil-exporting countries (Khandelwal et al., 2016; Miyajima, 2017). In the case of Russia, the plunge in global oil prices after 2014 put further strain on the state revenues (Tuzova and Qayum, 2016), increasing thus the credit risk, in particular for state-owned banks. The threats to the bank stability were amplified by the conflict with the Ukraine and the economic sanctions imposed by the Western partners, which led to a severe depreciation of the Ruble.¹ In this context, the Russian economy, which is highly responsive to oil price fluctuations, recorded a negative dynamic, the investment and consumption contracted, and the volume of non-performing loans (NPL) increased, putting thus pressure on the banking sector stability.

Starting from this evidence, the novelty of this paper is represented by an analysis of the impact of international oil prices on Russian public banks stability², considering (i) two different transmission channels of oil price fluctuations, namely the macroeconomic and the financial channel, (ii) the role of oil price shocks, and (iii) the short- and long-run effect. Ours is the first paper investigating the impact of oil prices on bank stability in Russia, one of the largest oil exporters in the world.

After 2014, the Russian banking sector was confronted with a considerable growth in credit risks and bad loans, in the context of a severe deterioration of large borrowers' financial condition, and of investors' expectations.³ The largest share of non-performing loans was recorded in the construction sector, where foreign currency denominated loans prevailed. However, according to the Bank of Russia, the decline in international oil prices generated by an increased oil production at global level, and by the United States monetary policy tightening, put additional pressure on the Russian banking system.⁴ The oil and gas industry is of crucial importance for the Russian economy, representing more than 20% of GDP, about 30% of fiscal revenues and more than 50% of exports (Simola and Solanko, 2017). In this context, the impact of oil prices on the bank financial stability cannot be neglected.

Although there is an extensive literature investigating the determinants of bank stability, only a few papers investigate the role of the international oil prices (e.g. Miyajima, 2017;

¹ Since January 2014, the Russian ruble lost in two years around 50% of its value against the US dollar (Dreger et al., 2016). Given that about half of total corporate debt of Russia was in 2016 denominated in FX (IMF, 2016), a depreciation of the Ruble threatened to harm the bank stability.

² In line with most previous papers (e.g. Nguyen, 2021), by the stability of a banking institution we understand the absence of excessive risk-taking by that institution.

³ https://www.cbr.ru/Collection/Collection/File/8376/fin-stab-2014-15_4-1_e.pdf

⁴ https://www.cbr.ru/Collection/Collection/File/8372/OFS_17-01_e.pdf

Khandelwal et al., 2016; Al-Khazali and Mirzaei, 2017; Lee and Lee, 2019).⁵ We add to this narrow strand of literature by assessing the impact of oil prices on the stability of listed Russian public banks over the period 2008 to 2016, and we contribute to the existing knowledge in the following ways.

First, we bring clarification to the oil price – bank stability relationship, making the distinction between the macroeconomic and financial market channel. Our theoretical assumptions are similar with those advanced by IMF (2015), Husain et al. (2015) and Al-Khazali and Mirzaei (2017) who state that oil prices downturns adversely affect businesses in oil-rich economies, and therefore, the quality of bank loans. More precisely, the macroeconomic channel indicates how a downturn in international oil prices contributes to a degradation of macroeconomic conditions in oil exporting economies, affecting thus the stability of banking institutions. Likewise, a decrease of international oil prices leads to a depreciation of oil-exporting countries' currencies and *vice-versa* (Beckmann and Czudaj, 2013).⁶ If banks loans are largely denominated in foreign currencies, the domestic currency depreciation amplifies the credit risk, endangering thus the bank stability. At the same time, given the importance of oil and gas revenues for the fiscal stance of an oil-exporting country, smaller international oil prices means smaller state revenues. The government is therefore constraint to search for alternative financing sources and make appeal to public bank loans. In the context of the deterioration of macroeconomic conditions, a part of these loans may become doubtful, affecting thus the bank stability. However, different from the previous studies relying on the macroeconomic mechanism only⁷, we also consider the role of financial markets in explaining the propagation of oil price shocks. This financial channel is practically unexploited in the literature. Indeed, an overwhelming number of studies address the nexus between oil and stock markets, most of them documenting a positive correlation. In this line, Huang et al. (2017) investigate the nonlinearities in this relationship and show that Russian stock market positively responds to the oil prices across all time scales. Therefore, it is very likely that a decrease in oil prices will be correlated with a decrease in the share value of listed companies and banks. Therefore, on the one hand the price to book value decreases, and hence the capacity of banks to generate sustainable earnings (Yildirim and Efthyvoulou, 2018). On the other hand, bank expend their

⁵ While the effect of international oil prices on corporate financial performances is well documented in the literature (e.g. Henriques and Sadorsky, 2008, 2011; Dayanandan and Donker, 2011), the impact on the bank financial stability is poorly investigated.

⁶ A recent paper by Fedoseeva (2018) shows that the pass-through between oil prices and the Rubble exchange rate to US dollar substantially increased during the oil price collapse in 2014. Rubble's depreciation generated a sharp increase in import prices with a positive impact on inflation, threatening thus the banking sector stability.

⁷ For a detailed description of this transmission channel, please refer to Section 2.

lending and generate more income when the stock prices increase and during economic boom periods (Hesse and Poghosyan, 2009). Conversely, when stock prices decrease, the credit activity shrinks and the profitability decreases.

Second, in line with other studies assessing the determinants of bank stability (Laeven and Levine, 2009; Jeon and Lim, 2013; Fang et al., 2014; Lee and Hsieh, 2014; Kasman and Kasman, 2015; Ahamed and Mallick, 2017; El Moussawi and Mansour, 2021; Phan et al., 2021; Wang and Luo, 2021) we use the Z-score as *proxy* for the bank stability.⁸ Starting with Hannan and Hanweck (1988) and Boyd and Runkle (1993), the Z-score is a risk measure commonly used in the empirical banking literature to reflect banks' probability of insolvency and therefore, the level of bank stability. However, different from previous works that mainly resort to the Boyd et al.'s (2006) time-varying approach to compute the Z-score, we also use for robustness purpose an alternative methodology advanced by Yeyati and Micco (2007), building upon Hannan and Hanweck (1988). This approach is also time-varying, relying on the "safety first" level of return and underlining the insolvency case (for more details, please refer to Lepetit and Strobel, 2013).

Third, different from previous works assessing the bank stability determinants, that usually resort to General Method of Moments (GMM) models, we employ a Pool Mean Group (PMG) estimator. On the one hand, most of our series prove to be nonstationary and integrated of order 1 (I(1)) which makes the result of GMM estimators inconsistent. On the other hand, PMG exploits the cross-sectional dimension to gain more precise estimates of average long-run parameters and deals with the omitted variable bias. Both the long- and the short-run relationship between bank stability, international oil prices and the price to book value are estimated.

Forth, inspired by the studies of Hamilton (1996, 2003), Cong et al. (2008) and Babatunde et al. (2013), we compute both the positive and negative oil-price shocks and we test their impact on the bank stability. However, different from these works, we propose an alternative approach, which allows to accommodate more shocks, and therefore to account for the effect of oil price volatility over a longer period. As in the case of reference methods, we use a rolling window to compute the shocks. Nevertheless, given our reduce time span ($T = 9$ for annual data) we compare the oil price level for a specific period with the average oil prices for the past

⁸ Data on NPL for public banks in Russia are in most of the cases unavailable. Therefore, the use of Z-scores represents a solution and a *proxy* for bank financial stability.

periods, and not with their maximum/minimum values to identify positive/negative shocks.⁹ This original approach allows us to identify the dispersion of an oil price shock over multiple periods. Consequently, we do not consider an oil shock as a sudden increase/decrease in oil prices and associate it with only one period. Instead, depending on the shock intensity, we are able to see its effects in time, over multiple periods. As far as we know this is the first study that investigates the role of shocks in international oil prices on the bank stability.

Fifth, we focus on 17 listed public banks from Russia, using FactSet data from 2008 to 2016 (annual data). There are several reasons for investigating the case of public banks sector. On the one hand, for Russia a decrease in international oil prices will first lead to a reduction of public exports, with a negative impact on the performance of public companies. Given the strong linkages between public companies and Russian public banks, we posit that in particular these banks will experience a deterioration of their financial performances and stability. On the other hand, different from other emerging markets economies, in Russia the market share of public banks is above 60% (Mamonov and Vernikov, 2017), which makes the public banks representative for the entire banking system. Finally, we consider the listed banks to test both the macroeconomic and the financial market channels throughout the oil prices influence the bank stability. The macroeconomic channel is more important for the public banks compared with the private ones, given the interaction between the public administration and public banks.

The remaining of the paper is as follows. Section 2 presents a brief literature review on bank stability determinants. Section 3 describes the data and the methodology. Section 4 shows the main empirical results while in Section 5 we present several robustness analyses. The last section concludes.

2. Bank stability determinants: a review of the literature

The literature addressing the bank stability determinants usually focuses on the role of: (i) bank competition (Keeley, 1990; Boyd and De Nicolo, 2005; Martinez-Miera and Repullo, 2010; Beck et al., 2013; Jeon and Lim, 2013; Kasman and Kasman, 2015; Fernández et al., 2016; Li, 2019), (ii) bank ownership (Berger et al., 2000; Lee and Hsieh, 2014), shareholder

⁹ Using a rolling window approach, Hamilton (2003) compares the oil price in the moment t with its maximum value over n previous periods to identify positive oil price shocks. Cong et al. (2008) compute both positive and negative oil price shocks but different from Hamilton, they identify oil price shocks by comparing the oil price in the moment t with its maximum/minimum values unregistered in all previous periods. Babatunde et al. (2013) combine these approaches and compute both positive and negative shocks, using in the same time a rolling window framework.

diversification (García-Kuhnert et al., 2015; Li, 2019; Ur Rehman et al., 2020), (iii) non-traditional banking activities (De Jonghe, 2010; Wagner, 2010; Duport et al., 2018; Fina Katmani, 2019), (iv) bank business models (Sudrajad and Hübner, 2019), (v) sovereign risk (Deev and Hodula, 2016), (vi) monetary policy uncertainty (Albulescu and Ionescu, 2018), and (vii) regulatory framework (Ahamed and Mallick, 2017). Recently, a new strand of the literature emerged, investigating the influence of international oil prices on bank stability (Khandelwal et al., 2016; Al-Khazali and Mirzaei, 2017; Miyajima, 2017; Lee and Lee, 2019) and bank performance (Adetutu et al., 2020).

Several macroeconomic transmission mechanisms explain how oil prices pass-through bank stability. A first mechanism refer to the degradation of the general macroeconomic conditions and imposes the distinction between oil-importing and oil-exporting economies. In the case of oil-importing economies, Kilian (2008) notes that positive oil price shocks negatively affect the consumption, and therefore the bank performances, through the uncertainty effect, precautionary savings effect, and the operating cost effect that lead to an increase of NPL. Nevertheless, in the case of an oil-exporting country, if oil prices increase at international level without recording a similar dynamic at national level, companies acting in the oil and gas industry, and the state, record higher revenues, with a positive effect on the banking sector (see for example Al-Khazali and Mirzaei, 2017). Therefore, the increase in international oil prices for oil-exporting countries does not necessary lead to higher production costs, reduction of purchasing power and economic growth contraction. On contrary, for oil-exporting countries a positive dynamic of oil prices might be associated with an increase of economic outcomes. In this case, banking performances improve (Demirgüç-Kunt and Huizinga, 2000; Athanasoglou et al., 2008).

A second transmission mechanism refers to the oil price impact on exchange rates (for a recent literature review, please refer to Beckmann et al., 2020). In real terms, the terms of trade theory introduced by Amano and Van Norden (1998a, b) and extended by Bénassy-Quéré et al. (2007) and Chen and Chen (2007), states that an increase in international oil prices contributes to a currency appreciation in oil-exporting countries relative to oil-importing ones. More precisely, in the case of oil-importing economies, a real oil price increase will rise the prices of tradable goods in a greater proportion than in oil-exporting economies. This will generate a higher inflation in oil-importing economies, and thereby cause a real depreciation of their currencies compared to oil-exporting ones. The opposite applies when crude oil prices record negative dynamics. In nominal terms, the portfolio and wealth effect theories advanced by Krugman (1983) and Golub (1983) and reconsidered by Bodenstein et al. (2011) explain the

impact of international oil prices on exchange rates. Likewise, the wealth effect shows that oil-exporting countries will experience in the short run a wealth transfer if oil prices increase, given the structure of their exports. This will improve the current account balance, leading to a currency appreciation. The portfolio effect manifests in the long run, being influenced by the oil exporters' relative preferences for US dollar assets (Coudert et al., 2008).

A third mechanism underlines the importance of oil and gas revenues for the fiscal stance of an oil-exporting country. A decrease of international oil prices will trigger a deterioration of the fiscal balance in these countries. For Russia, the oil sector is critical for the overall economic development (Cukrowski, 2004). As Malova and Van der Ploeg (2017) point in the case of Russia, if the chunk of oil and gas must be kept in the soil given the international agreements regarding global warming, or the lower level of international oil prices, the Russian fiscal stance needs to be tightened. Therefore, in the context of the need to maintain their political popularity after the crisis (see Khmel'nitskaya, 2017), the state authorities may look for alternative financing sources and make appeal to public bank loans. Given the deterioration of the macroeconomic aggregates, a part of these loans may become non-performing, affecting thus the bank stability.

As mentioned before, only few works exploit these macroeconomic channels that show how oil prices affects the bank stability. A first analysis in this area is performed by the International Monetary Fund (IMF, 2015), showing the liquidity of banks from the Gulf Cooperation Council (GCC) countries worsens over time if oil prices remain low, amplifying thus the credit risk. With a focus on the same group of GCC countries, Khandelwal et al. (2016) use a panel VAR approach and discover a feedback loops between oil price and banks doubtful loans. In the same line, building upon Husain et al. (2015), Al-Khazali and Mirzaei (2017) verify whether oil prices shocks have any impact on NPL ratio for 2,310 commercial banks in 30 oil-exporting countries over the period 2000–2014. The authors resort to a dynamic GMM model and show that a rise (fall) in international oil prices is associated with a decrease (increase) in NPL ratio. At the same time, they note that the unfavorable impact of adverse oil prices dynamics on the quality of bank loans is more pronounced in the case of large banks. For a set of banks from the same GCC countries, Ibrahim (2019) underlines the favorable effects of positive oil price changes on bank profitability and credit growth, while underling the negative impact on NPL.

Other similar works focus on individual oil-exporting economies. For example, the paper by Miyajima (2017) resort to a panel data analysis for the period 1999 to 2014, considering 9 banks located in Saudi Arabia. The author show that a negative oil price dynamic dampens

credit and deposit growth, with a positive impact on NPLs. Opposite results are reported by Lee and Lee (2019) for the Chinese banking sector. The authors assess bank performance through a broad array of CAMEL (Capital adequacy, Asset quality, Management, Earnings, and Liquidity) indicators, and discuss whether the correlations between oil prices and banks stability change with different dimensions of country risk. Their results reveal that oil prices negatively affect the bank performance. A different approach is taken by Adetutu et al. (2020) for Kazakhstan, the authors investigating the role of international oil prices in explaining the bank performance. Their results show that oil price booms negatively influence the banks' total productivity.

Different from these works, we exploit both the macroeconomic and the financial market channels to see how oil prices and bank valuation affect the level of bank stability. In addition, we assess the bank stability using different metrics for the Z-score. Further, we focus on the Russian banking sector which has not been investigated so far.¹⁰ Finally, we test the effect of oil price returns, but also the impact of positive/negative shocks in international oil prices.

3. Data and methodology

3.1. Data

Data comes from the FactSet database, which initially include 20 listed public banks and cover a period from 2005 to 2017 (all data are expressed in US dollars). Out of the 20 banks, for three banks we have a very small amount of information¹¹ and two banks were privatized in 2017.¹² Given that our T is relatively small and we need a rolling window to compute the Z-score and oil price shocks, we have decided to cover the period 2008 to 2016, for 17 banks.¹³ Therefore, the banks that were privatized in 2017 are included in the analysis. A rolling window of four years is used for the computation of moving means ($n=4$) for Z-scores. A higher Z-score is associated with an increased bank stability (the probability for a bank to make default decreases).

¹⁰ An exception is the paper by Fungáčová and Weill (2013) which, however, investigates the role of bank competition in explaining the bank failure in Russia.

¹¹ For AK Bars Bank data are available starting with 2011, for RBC OJSC there are no data available for a series of indicators as liquidity ratio or net interest margins, and severe losses were recorded for the entire period. In addition, for the Best Efforts Bank data are available starting with 2014 only. These banks are therefore excluded from the analysis.

¹² These two banks are Promsvyazbank and Tatfondbank.

¹³ The 17 public banks retained in our sample are: Avangard Joint Stock Bank, Bank Otkritie Financial Corporation, Bank St. Petersburg, Bank Zenit, Credit Bank of Moscow, Far East Bank, Gazprombank, Joint Stock Commercial Bank Rosbank, Moscovskiy Oblastnoi Bank, OTP Bank, Bank Uralsib, Promsvyazbank, Sberbank Russia, Tatfondbank, Vozrozhdenie Bank, VTB Bank and West Siberian Commercial Bank.

The bank insolvency occurs if the sum between the capital-to-assets ratio (CAR) and the return on assets (ROA) is negative, namely $(CAR+ROA) \leq 0$. The general formula for the time-varying Z-score computation is therefore (Hanweck, 1988; Boyd and Runkle, 1993):

$$z\text{-score}_t \equiv \frac{CAR_t + \mu_{ROA,t}}{\sigma_{ROA,t}}, \quad (1)$$

where: μ is the mean and σ the standard deviation.

Starting from this general formula designed to compute the Z-score, in line with most of previous papers, we first, use the Boyd et al.'s (2006) approach (z1), which relies on the moving means $\mu_{CAR,t}(n)$, $\mu_{ROA,t}(n)$ and the standard deviation $\sigma_{ROA,t}(n)$, calculated for each period $t \in \{1 \dots T\}$. Therefore, the formula become:

$$z1_t = \frac{\mu_{CAR,t} + \mu_{ROA,t}}{\sigma_{ROA,t}}. \quad (2)$$

Nevertheless, as Lepetit and Strobel (2013) show, there are several ways to compute the banking Z-score. Although there is a high correlation between these different metrics, the way the Z-score is computed may influence the empirical findings. Likewise, for robustness purpose, we use the approach classic approach of Hanweck (1988) and Boyd and Runkle (1993) further exploited by Yeyati and Micco (2007), where the moving mean $\mu_{ROA,t}(n)$ and the standard deviation $\sigma_{ROA,t}(n)$ are calculated for each period $t \in \{1 \dots T\}$, and are afterwards combined with the current value of CAR_t .¹⁴

Therefore, the formula for the Z-score (z2) become:

$$z2_t = \frac{CAR_t + \mu_{ROA,t}}{\sigma_{ROA,t}}. \quad (3)$$

ROA is computed as the ratio between the net income and total assets. While the Z-score is the dependent variable, the main explanatory variables are represented by the oil prices¹⁵ – wti_t , by the oil price positive (wti_t^+) and negative shocks (wti_t^-), and by the price to book value ratio (pbvr).

The oil price shocks for annual data are computed as follows¹⁶:

$$wti_t^+ = IF(wti_t > \frac{\sum_{t=3}^{t-1} wti_t}{3}; wti_t - \frac{\sum_{t=3}^{t-1} wti_t}{3}; 0). \quad (4)$$

$$wti_t^- = IF(wti_t < \frac{\sum_{t=3}^{t-1} wti_t}{3}; wti_t - \frac{\sum_{t=3}^{t-1} wti_t}{3}; 0). \quad (5)$$

¹⁴ We use time-varying approaches for computing Z-scores and not static approaches (e.g. Hesse and Čihák, 2007), because we want to see how the evolution of international oil prices influence the dynamics of bank risk taking.

¹⁵ As in Lee and Lee (2018) we use WTI crude oil prices from the Energy Information Administration, expressed in log-returns.

¹⁶ Figure A1 – Appendix shows how shocks spread over time.

For the investigation of oil prices' impact on bank stability we use a series of control variables extracted from FactSet and previously employed in the empirical literature. The control variables first include the bank performances' dimension and are represented by the net interest margins – nim (Fungáčová and Poghosyan, 2011; Fina Katmani, 2019), by net operating cash flow – nocf (Beaver, 1968; Clark and Weinstein, 1983; Lanine and Vennet, 2006), by the liquidity ratio – lr (FactSet) computed as the ratio between net loans and total deposits showing the maturity match (Fungáčová and Poghosyan, 2011; Lee and Lee, 2019) and by the size – ta, calculated as the natural log of total assets (Fina Katmani, 2019). For all these variables we expect a positive influence on bank stability. The macroeconomic context is represented by the GDP growth rate – gdp (World Bank statistics) whereas the banking sector competition is assessed through the bank concentration index – bc (World Bank statistics). While the economic growth should have a positive influence on the stability level, the effect of bank competition is not straightforward (see 'competition-fragility' vs. 'competition-stability' theories). Finally, the quality of institutions is considered (see for example Weill, 2011) and represented by the political risk associated with the regulatory quality¹⁷ – rq (World Bank statistics) and by the Corruption Perception Index – cpi (Transparency International). A better regulatory framework should have a positive impact on bank stability, while the opposite applies for a higher corruption level.¹⁸

3.2. General statistics and preliminary analyses

The summary statistics of our sample are presented in Table 1, showing a slightly negative dynamic oil prices between 2008 and 2016. At the same time, the negative oil price shocks are higher than the positive ones over the analyzed time span. Further, a high variability is noticed for the net operating cash-flow, but also for the Z-score. In addition, the bank competition considerably fluctuates over the analyzed period, from a minimum level of 21.58 to a maximum of 47.45.¹⁹

¹⁷ The Russian banking regulation framework recorded important changes after the banking crisis in 2014. This element may also affect the bank stability. We consider that the World Bank indicator assessing the regulatory quality captures the effect of the banking regulation reform.

¹⁸ The methodology used by Transparency International to assess the perception on corruption, associates a high value of cpi with a small level of corruption. Therefore, a positive sign for cpi is expected in our regressions.

¹⁹ The correlation matrix (Table A1 – Appendix) shows a high correlation between the two metrics of the Z-score, namely z1 and z2. A positive correlation appears between bank stability and our interest variables, as expected. In addition, bank performances are positively correlated with the Z-score (nocf represents an exception and shows a negative correlation with the Z-score). At the same time, it seems that the size is positively correlated with Z-score, indicating that larger banks are more stable. Further, bank stability is positively correlated with the economic growth, as expected, but also with cpi (a higher cpi is equivalent with a lower perception of corruption). The level of correlation of our variables seems, however, reduced (except for the two metrics of the Z-score).

Table 1. Summary statistics

	z1	z2	wti	wti ⁺	wti ⁻	pbvr	nim	nocf	lr	ta	gdp	bc	rq	cpi
Mean	22.70	22.17	-0.057	8.273	-11.43	0.798	45.04	43.04	1.148	4.596	1.149	31.66	0.697	2.544
SD	21.56	20.97	0.323	11.74	18.12	0.420	16.90	141.8	0.309	2.895	4.098	7.988	0.079	0.324
Min	-0.631	-2.182	0.320	34.66	0.000	1.642	-9.549	-36.74	0.452	-0.982	-7.820	47.56	0.773	2.100
Max	156.5	156.5	-0.650	0.000	-46.40	0.167	82.96	121.5	2.681	10.21	5.284	21.58	0.591	2.900

Note: z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

We start our empirical analysis with a series of panel unit root tests. To see what generation of tests should be applied, we first test the existence of the cross-sectional independence hypothesis (Table 2). *A priori*, given the existence of the interbank market and common exposure to oil price shocks, it is hard to accept the independence hypothesis. However, the tests (e.g. Frees, 1995; Friedman, 1937; Pesaran, 2004) do not reject the null hypothesis, showing that the first generation of panel unit root tests, which are more powerful in the presence of cross-sectional independence, should be applied.

Table 2. Cross-sectional dependence tests

Cross-sectional dependence tests			
<i>dependent variable</i>	Frees (1995)	Friedman (1937)	Pesaran (2004)
z1	0.795	13.08	0.417
z2	0.688	12.73	0.706

Notes: (i) ***, **, * means rejection of the null hypothesis of cross-sectional independence at 99%, 95% and 90% confidence level (equivalent with the existence of cross-sectional dependence); (ii) z1 and z2 are the Z-score metrics relying on Boyd et al.'s (2006) and Yeyati and Micco (2007), respectively.

The panel unit root tests show mixed evidence (Table 3).²⁰ While for z1, z2 and liquidity ratio, two out of four tests reject the null hypothesis of the presence of unit roots, only one test rejects the null hypothesis for the other variables. In the case of the regulation quality, bank competition and negative oil price shocks, all tests show the presence of unit roots. An exception is the gdp, where all tests indicates the presence of a mean reverting process.

Given that, our purpose is to analyze both short- and long-run effects of international oil prices on bank stability and because our variables are in general I(1), we will use the PMG approach for estimation.²¹

²⁰ The application of second-generation panel unit root tests (e.g. Pesaran, 2007) leads to similar findings. The author can provide these results upon request.

²¹ As noted by Pesaran et al. (1999), the PMG estimator can be used when the regressors are stationary, or when they follow unit root processes.

Table 3. Panel unit root tests

	Levin, Lin & Chu t*	Im, Pesaran and Shin W-stat	ADF - Fisher Chi-square	PP - Fisher Chi-square
z1	-3.459***	-0.895	41.21	66.75***
z2	-4.292***	-1.179	42.68	62.71***
wti	-0.865	-0.699	34.67	154.2***
wti ⁺	-0.771	-0.262	29.26	147.6***
wti ⁻	10.18	2.621	7.330	16.25
pbvr	-3.658	-0.829	45.43*	37.46
nim	0.230	1.563	22.55	46.74*
nocf	1.503	0.423	39.46	70.84***
lr	-0.642***	-0.140	38.77	103.1***
ta	-5.170***	-0.719	42.40	17.68
gdp	-7.728***	-2.196**	55.63**	97.72***
bc	5.433	4.571	2.316	14.83
rq	-0.424	2.240	8.907	10.52
cpi	-3.602***	1.794	11.07	9.877

Notes: (i) the null hypothesis for all the tests is the presence of unit roots (the t* test assumes common unit root process while the other tests assume individual unit root process); (ii) *, **, ***, mean stationarity (in level) significant at 10 %, 5 % and 1 %; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

3.3. Methodology

The PMG estimator proposed by Pesaran et al. (1999) supposes an Autoregressive Distributive Lag (ARDL) framework, designed for dynamic panel specifications (ARDL (p, q_1, \dots, q_k)):

$$z_{i,t} = \sum_{j=1}^p \lambda_{i,j} z_{i,t-j} + \sum_{j=0}^q \delta'_{i,j} X_{i,t-j} + \mu_i + \varepsilon_{i,t}, \quad (6)$$

where: z is the Z-score, i is the number of groups (banks) and t is the number of periods (years), $X_{i,t}$ is the $k \times 1$ vector of explanatory variables, $\delta'_{i,j}$ are coefficients, $\lambda_{i,j}$ are scalars, μ_i are group effects, $\varepsilon_{i,t}$ is the error term.

If the variables are $I(1)$, Eq. (6) can be reparametrized into an error correction model (ECM), where additional control variables might be introduced (Blackburne and Frank, 2007):

$$\Delta z_{i,t} = \rho_i (z_{i,t-j} - \theta_i X_{i,t}) + \sum_{j=1}^{p-1} \lambda_{i,j}^* \Delta z_{i,t-j} + \sum_{j=0}^{q-1} \delta_{i,j}^* \Delta X_{i,t-j} + \sum_{j=0}^{q-1} \gamma_{i,j}^* \Delta Y_{i,t-j} + \mu_i + \varepsilon_{i,t}, \quad (7)$$

where: ρ_i is the error-correction speed of the adjustment term (which should be negative and significantly different from zero to validate the existence of a long-run relationship), θ_i is the vector that explains the long-run relationships between variables, $Y_{i,t}$ is the $k \times 1$ vector of control variables, $\lambda_{i,j}^*$, $\delta_{i,j}^*$ and $\gamma_{i,j}^*$ are short-run coefficients.

Equation 7 is therefore the tested equation. As Pesaran et al. (1999) states, even in the case of small samples as ours, the long run parameters from the ECMs are valid. However,

given the high number of control variables we use, we are forced to introduce them in the short-run relationship one by one, in order to avoid losing the degrees of freedom.²²

4. Results

Applying the PMG estimator, we test nine different models. The long-run relationship between z , wti and $pbvr$ remains the same for all models and indicate the direct, macroeconomic channel, through which oil prices influence the bank stability (wti), and the indirect, financial channel ($pbvr$), respectively. The first model is run without control variables (Model 1). Afterwards, in the short-run equation we introduce separately the control variables, namely nim (Model 2), $nocf$ (Model 3), lr (Model 4), ta (Model 5), gdp (Model 6), bc (Model 7), rq (model 8) and cpi (Model 9). We estimate these models for the oil prices returns – wti (Table 4), for the oil price positive shocks – wti^+ (Table 5), and for the oil price negative shocks – wti^- (Table 6).

The first set of results is presented in Table 4. We may notice that for all models, except for Model 4, the long-run relationship between bank stability, oil prices and bank valuation is significant. Both an increase in international oil prices and in the value of banks perceived by the investors (i.e. share prices) compared to the book value ($pbvr$), positively influence the bank stability. Nevertheless, it seems that the direct, macroeconomic channel that explains the oil-bank stability pass-through is more important compared with the financial channel in the case of Russian public banks.

Table 4. Results for the oil price returns – main ($z1$)

	$z1$	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti	10.50***	11.48***	15.14***	4.077	17.47***	10.22***	9.832***	13.74***	14.62***
	$pbvr$	0.191***	0.195***	0.179***	0.186***	0.194***	0.183***	0.192***	0.196***	0.166***
	ρ_i	-0.797***	-0.911***	-0.819***	-0.947***	-0.720***	-0.729***	-0.782***	-0.808***	-0.751***
	wti	-2.245	11.58	-1.363	-7.405*	-2.084	4.016	-3.296	-5.589	-4.431
	$pbvr$	13.39	-88.69	79.84	-111.7	19.68	158.2	1.367	15.27	217.8
	nim		-0.359							
	$nocf$			-6.548						
Short-run	lr				23.05**					
	ta					6.377				
	gdp						0.230			
	bc							-0.116		
	rq								4.321	
	cpi									9.713
	c	7.713	5.041	1.140	13.16*	9.202	12.97*	6.972	6.749	10.87
Log Likelihood		-453.3	-430.3	-421.1	-432.6	-418.3	-429.1	-440.3	-425.6	-423.2

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 136 observations; (iii) $z1$ – Z-score 1; $z2$ – Z-score 2; wti – WTI crude oil prices return; wti^+ – positive shocks in crude oil prices; wti^- – negative shocks in crude oil prices; $pbvr$ – price to book value ratio; nim – net interest margins; $nocf$ – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

²² The use of the PMG estimator usually requires large samples. However, the PMG can also be used for small samples (Pesaran et al., 1999). In fact, the use of PMG estimator for macro panel analyses is not unusual (see, for example, Martínez-Zarzoso and Bengochea-Morancho, 2004; Albulescu and Ionescu, 2018).

These results are in agreement with those reported by Khandelwal et al. (2016), showing that a decline in oil prices leads to an increase in the NPL ratio (that is, the bank instability). The adjustment coefficient from the short-run equation (ρ_i) is negative and significant in all cases, providing evidence in the favor of a significant long-run relationship. However, when we look to the short-run coefficients, we observe that in almost all the cases these coefficients are not significant, except for the Model 4, where a positive relationship appears in the short run between the liquidity ratio and bank stability. In fact, as Khandelwal et al. (2016) emphasize, in the short run the effect of oil prices might be captured by the macroeconomic variables (e.g. growth rate), which explain the loss of the significance of oil prices coefficients.

In what follows we compare the effect of positive and negative oil price shocks on the bank stability. Table 5 shows that wti^+ have a positive long-run impact on the bank stability, in all the cases (again, Model 4 represent an exception).²³ However, the effect of oil price shocks on bank stability is much more reduced compared to the effect of price returns. Notice that the approach used for the shocks' computation allows the propagation of oil price shocks in time. Therefore, the effect of a price shock can be recorded over one, two, or even three consecutive periods. These findings show that not the shock itself is important for the bank stability, but the increase in the oil price associated with a positive shock.

Table 5. Results for the oil price positive shocks – main (z1)

	z1	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti^+	0.114***	0.112***	0.749***	-0.045	0.187***	0.153***	0.093***	0.142***	2.008***
	pbvr	0.212***	0.217***	0.109***	0.177***	0.226***	0.218***	0.587***	0.076***	0.099***
	ρ_i	-0.825***	-0.784***	-0.646***	-1.033***	-0.799***	-0.772***	-0.554***	-0.892***	-0.628***
	wti^+	-0.092	-0.338	-0.219	-0.461**	-0.084	-0.226	0.118	-0.052	-0.299**
	pbvr	-13.58	-30.83	0.838	-28.42	79.52	13.90	-15.83	22.78	97.79
	nim		0.584							
	nocf			-5.565						
Short-run	lr				33.97**					
	ta					10.74				
	gdp						0.242			
	bc							0.111		
	rq								7.774**	
	cpi									3.528*
	c	6.969	-6.568	-4.671	9.447	7.496	4.917	13.47	10.56*	1.815
	Log Likelihood	-457.1	-424.7	-449.0	-426.8	-429.1	-427.0	-430.6	-416.9	-427.1

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 136 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti^- – WTI crude oil prices return; wti^+ – positive shocks in crude oil prices; wti^- – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

It is also interesting to notice the sign of wti^+ in the short-run equation, which is negative. Although these coefficients are not significant (Models 4 and 9 represents an exception), they

²³ The impact of the liquidity ratio might capture the effect of international oil prices.

suggest that the short-run impact of the shock is negative, result that explains the findings of Adetutu et al. (2020), stating that an oil price boom negatively affects the bank performances in Kazakhstan, which similar to Russia, represents an oil-exporting country. Indeed, in the short-run, the domestic consumption slows down following a sudden increase in oil prices, which in turn negatively affects companies' performances and their capacity to fulfil their financial obligations. However, in the long run, the shock is absorbed and, bringing benefits for the Russian economy, it contributes to the bank stability by raising the revenues of the state companies and ameliorating the fiscal stance.

As in the previous case (Table 4), a positive bank valuation (higher price to book ratio) contributes to the bank stability. This result shows that positive oil price shocks induce an indirect positive effect on the stock market, which contribute to a better bank valuation. Different from the previous results, for Models 8 and 9 the coefficient of the control variables is significant and have the expected sign, showing that both regulatory quality and a reduced perception of corruption enhance the stability of the public banks.

Table 6 presents the results for negative shocks in oil prices. As expected, the long-run impact is negative and significant (except for the Models 4 and 8). The pbvr has a long-run positive influence on bank stability, for all tested models. In the case of the short-run relationship, the economic growth rate influences the stability in the short-run, but this result is significant at only 90% level of confidence (Model 6). The same applies for the liquidity ratio and regulatory quality. It appears that in the short run, the initially impact of a negative shock is positive (Models 5 and 6). However, in the long run, the results clearly show the opposite.

Table 6. Results for the oil price negative shocks – main (z1)

	z1	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti	-0.054***	-0.131***	-0.069***	-0.025	-0.227***	-0.147***	-0.059***	-0.040	-0.028***
	pbvr	0.194***	0.015***	0.188***	0.176***	0.009*	0.035***	0.187***	0.063***	0.068***
Short-run	ρ_1	-0.755***	-0.584***	-0.726***	-0.981***	-0.452***	-0.612***	-0.743***	-0.755***	-0.816***
	wti	0.098	-0.113	0.101	0.017	0.224**	0.573*	0.255	0.125	0.123
	pbvr	5.397	-56.20	126.1	-22.45	-168.8	-74.32	57.18	6.600	144.4
	nim		-0.374							
	nocf			-3.795						
	lr				21.52*					
	ta					1.523				
	gdp						1.053*			
	bc							0.504		
	rq								6.859*	
cpi									7.120	
c	6.561	4.350	1.225	12.03	7.326*	3.042	6.476	8.040	9.048	
Log Likelihood	-460.6	-433.6	-435.1	-424.1	-441.3	-439.6	-443.0	-439.5	-420.1	

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 136 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

These findings confirm the previous results reported in the literature (e.g. Al-Khazali and Mirzaei, 2017; Ibrahim, 2019), providing support for asymmetric effects of oil price shocks. However, different from Ibrahim (2019), we show that both positive and negative oil price changes influence bank performance in the long run. In addition, different from Al-Khazali and Mirzaei (2017) we posit that oil price positive shocks have a greater impact on the bank stability compared with negative shocks. Long-run expectations related to oil price positive jumps might determine banks to increase the loans' volume in a favorable economic context, which allows them to make more profit and to strengthen their financial stability. In addition, positive expectations related to an increase of oil prices enhance the investors' confidence in the Russian capital market. In this context, public banks will benefit from a higher capitalization, with a positive impact on their stability.

In the short-run, the effect of both positive and negative oil price shocks on bank stability is rather non-significant. Nevertheless, our estimations might be subject to some caveats given the lack of significance for the control variables' coefficients in the short-run equation for most of the tested models, situation that requires additional investigations. Therefore, in the next section we perform two different robustness check analyses. First, we use an alternative measure for the Z-score, relying on the Yeyati and Micco's (2007) approach. Second, we drop from our data sample the Sberbank Russia. Sberbank might be considered as an outlier in our sample, being the largest bank in the Russian banking sector. Its assets in 2016 represents about 50% from the total public bank system.

5. Robustness analysis

5.1. Alternative measure for the Z-score

The robustness results using $z2$ are presented in Table 7. Similar to the main analysis, we document the existence of a long-run relationship between bank stability on the one hand, and dynamics of oil prices and bank valuation on the other hand. Both explanatory variables positively influence the stability of Russian public banks in the long run. A slight difference appears in the case of Models 6 and 8, where the sign of the oil price coefficient is either insignificant, or negative. Similar to the main results, in the short run there is no significant influence of oil prices on the bank stability, while the coefficients of control variables are not significant (except for Model 4).

Table 7. Results for the oil price returns – robustness (z2)

	z2	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti	5.888*	8.153***	18.40***	1.829	10.93***	3.107	2.653***	-1.791	14.19***
	pbvr	0.147***	0.159***	0.114***	0.130***	0.147***	0.105***	0.152***	0.107***	0.102***
	ρ_i	-0.773***	-0.897***	-0.793***	-0.893***	-0.684***	-0.660***	-0.741***	-0.716***	-0.937***
	wti	-1.748	9.130	-3.812	-1.489	0.216	4.357	-3.478	-1.296	-13.23
	pbvr	81.76	19.61	183.6	-72.91	45.89	22.58	75.07	81.48	33.05
	nim		0.303							
	nocf			-6.091						
Short-run	lr				31.23***					
	ta					-9.482				
	gdp						-0.212			
	bc							-0.236		
	rq								-1.927	
	cpi									2.107
	c	7.726	5.558	3.042	14.30*	9.049	12.45**	6.334	6.808	10.88*
	Log Likelihood	-463.5	-439.9	-429.7	-432.0	-440.7	-433.0	-438.1	-431.2	-427.7

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 136 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

The robustness results related to the impact of positive and negative oil price shocks on bank stability are presented in Appendix. Table A2 shows that positive shocks have a long run and positive effect on the bank stability, and confirm thus the main findings. The same applies for the effects of negative shocks (Table A3), which contribute to a reduction of the stability level in the long run (except for Model 5). The effect of the control variables is practically insignificant in the short-run equation. This robustness analysis confirms the previous findings, showing the absence of a significant effect of oil price shocks on the bank stability in the short run.

5.2. Re-sampling results (16 cross-sections)

The second robustness check implies the construction of a new dataset, considering 16 banks (Sberbank Russia was excluded from the original sample), for the same period 2008 to 2016 (these results are presented in Table 8). Although the long-run influence of international oil prices seems to be less important if we compare the level of coefficients, it remains positive and significant (the significance vanishes in this case for Model 8 only). At the same time, the bank positive valuation by investors contribute to increasing bank stability in the long run. Nevertheless, in the short run, no significant influence is recorded. This evidence confirms the main findings and state that the influence of oil prices on bank stability can be documented only in the long run.

If we now refer to the impact of oil price shocks, Tables A4 and A5 (Appendix) show that positive oil price shocks enhance bank stability in the long run (except for Model 8), while

negative shocks have an opposite effect, as expected. Like in the main analysis, we notice that for Models 5 and 6, the short-run impact of a negative shock is positive, being associated with a cost reduction for households and companies, which favors the consumption and investment. However, in the long run, the results clearly indicate the negative impact in international oil price drops, on the Russian public banks stability.

Table 8. Results for the oil price returns – robustness (re-sampling)

	z1	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti	5.240*	12.53***	17.57***	-40.46	9.890**	14.30**	4.343*	-3.711	-9.239*
	pbvr	0.514***	0.098***	0.114***	0.750***	0.423***	0.088***	0.094***	0.076***	0.110***
	ρ_i	-0.573***	-0.861***	-0.712***	-0.660***	-0.564***	-0.632***	-0.691***	-0.759***	-0.692***
	wti	-0.017	13.44	-1.854	4.613	1.425	3.629	-3.701	1.496	3.874
	pbvr	15.99	-91.04	88.47	-15.05	-10.90	16.55	2.204	23.36	16.81
	nim		0.401							
	nocf			-6.689						
Short-run	lr				34.52**					
	ta					8.053				
	gdp						-0.236			
	bc							-0.265		
	rq								-6.310	
	cpi									11.23
	c	7.975	5.740	-0.126	15.68*	8.672	12.64**	5.203	7.441	8.562
	Log Likelihood	-436.1	-424.1	-414.0	-397.2	-417.4	-417.8	-432.2	-415.6	-409.1

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 128 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

Concisely, we reinforce the findings by Khandelwal et al. (2016), Al-Khazali and Mirzaie (2017) and Ibrahim (2019) for oil-exporting economies, reporting a significant and positive effect of oil prices on bank stability in Russia. However, different from these previous findings, we show that the oil price-bank stability pass-through is only significant in the long run, whereas the positive shocks in oil prices have a larger influence on bank stability compared with negative shocks.

6. Conclusions

This paper adds to the literature investigating the determinants of bank stability, with a focus on the role of international oil prices. For this purpose, complementary to previous works, we exploit two channels throughout the oil prices dynamics may influence the bank stability, namely the macroeconomic and the financial market channel. Different from previous studies on this subject, we test not only the influence of international oil price returns, but also the

effect of positive and negative shocks in oil prices, on the bank stability. We propose a novel approach to compute the oil price shocks, allowing for a shock dispersion in time.

To this end, we use a PMG estimator for a sample of 17 listed public banks from Russia, for the period 2008 to 2016. We show that both international oil prices and price to book value ratio have a positive impact on bank stability. Our results are in line with those reported by Husain et al. (2015) and Al-Khazali and Mirzaei (2017) which use a different proxy for the bank stability in oil-exporting countries, namely the NPLs. Nevertheless, our findings bring additional insights to the literature, showing that oil price shocks have a different impact on the stability in the short run, compared to the long run. If in the long run an increase in oil prices and positive oil price shocks enhance the bank stability in Russia, in the short run, the effect is in general not significant and rather negative. This means that in the short-run, a sudden increase of oil prices generates higher costs and negatively affects the consumer behavior, with a negative impact on bank performance and stability. However, the macroeconomic channel underlines the importance of oil price increases for the Russia public banks stability in the long run.

Further, our results state that not only the macroeconomic, direct channel is important for oil price pass-through bank stability, but also the indirect, financial channel. These findings are supported by the robustness analyses we perform and show, once again, the importance of the oil prices volatility for the Russian economy. The findings clearly underline the positive long run effect of an increase in international oil price on bank stability in an oil-exporting country.

Two policy implications result from our investigation. First, it is important to disentangle between the short-run and long-run effects of international oil prices on bank stability. Positive oil price shocks may contribute to better bank performances in the long run, while having an opposite effect in the short run. The same applies for the negative shocks, although the short run influence is rather insignificant. Second, the authorities from oil-exporting countries should be aware by the fact that a positive oil production shock generate a negative oil price shock on the international market, with a negative influence on the domestic banking sector stability. Therefore, it is recommended to control the production, to obtain a smooth increase of international oil prices. This strategy helps the authorities to safeguard the public bank stability and, given the importance of public banks for the Russian financial sector, the stability of the entire financial system. The control of oil production by the Russian authorities is possible given the higher concentration of this sector, where the state-own company Rosneft accounts for nearly half of Russia's oil production (Simola and Solnko, 2017). However, the Russian

authorities did not try to influence the international oil prices after 2014 by reducing the oil production.

Our results should be, however, interpreted with caution, and require additional investigations. On the one hand, in the short run, the control variables we use do not explain the level bank stability and are rather insignificant. On the other hand, our sample is relatively small, and do not allow the comparison between oil price effect on public and private banks. Finally, constrained by the length of our data sample, we use a linear framework, for a period characterized by important economic events for the economy of Russia.

Our analysis can be therefore extended considered the situation in other oil-exporting countries as the Organization of the Petroleum Exporting Countries (OPEC), or the United States (US) monetary policy actions. Indeed, the uncertainty related to US economic policies influence both global credit conditions and the international investors' risk sentiment.

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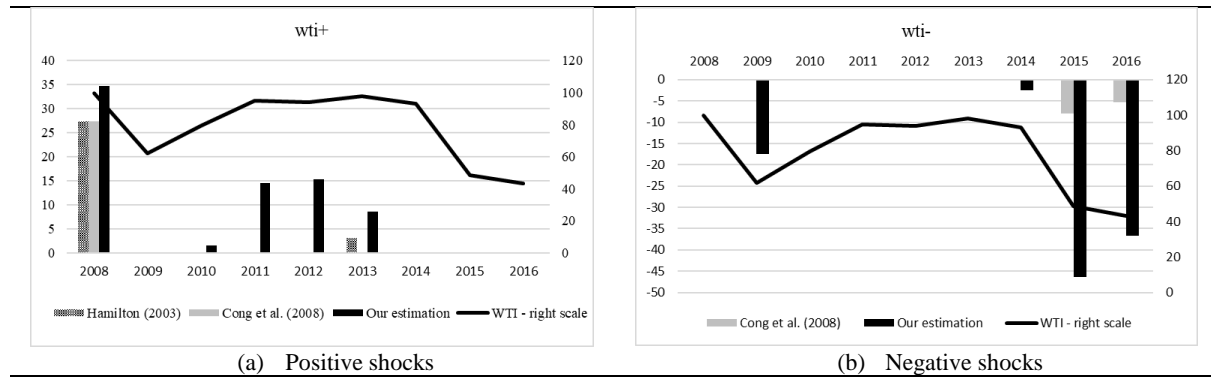
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Appendix

Figure A1. Oil price shocks



Note: Hamilton's (2003) approach is designed to compute positive shocks only.

Table A1. Correlation matrix

	z1	z2	wti	wti ⁺	wti ⁻	pbvr	nim	nocf	lr	ta	gdp	bc	rq	cpi
z1	1.000													
z2	0.990	1.000												
wti	0.286	0.284	1.000											
wti ⁺	0.133	0.122	0.061	1.000										
wti ⁻	-0.092	-0.077	-0.072	-0.049	1.000									
pbvr	0.250	0.240	0.020	0.044	-0.026	1.000								
nim	0.117	0.146	0.277	0.246	0.326	-0.013	1.000							
nocf	-0.018	-0.015	-0.051	-0.088	0.096	-0.058	0.151	1.000						
lr	0.200	0.275	0.207	0.349	0.192	0.130	-0.121	-0.017	1.000					
ta	0.101	0.089	-0.034	-0.062	-0.052	0.237	0.149	0.490	0.131	1.000				
gdp	0.129	0.120	0.902	0.615	-0.624	0.004	0.252	-0.046	0.152	0.008	1.000			
bc	-0.217	-0.216	-0.634	-0.633	-0.907	0.060	-0.325	0.115	-0.246	0.088	-0.456	1.000		
rq	0.052	0.062	0.330	0.470	0.533	-0.078	0.229	-0.122	0.128	-0.106	0.256	-0.759	1.000	
cpi	0.011	0.012	-0.391	-0.374	0.048	0.095	-0.183	0.119	-0.168	0.116	-0.166	0.715	-0.869	1.000

Note: z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

Table A2. Results for the oil price positive shocks – robustness (z2)

	z2	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti ⁺	0.718***	1.205***	0.165***	-0.202***	0.742***	0.685***	0.041	0.004	0.774***
	pbvr	0.166***	0.263***	0.132***	0.095***	0.174***	0.145***	0.147***	0.093***	0.190***
	ρ_i	-0.597***	-0.425***	-0.826***	-0.924***	-0.570***	-0.529***	-0.760***	-0.779***	-0.699***
	wti ⁺	-0.146	-0.468**	-0.185	-0.418**	-0.066	-0.385*	-0.239	-0.084	-0.148
	pbvr	33.39	15.61	93.68	50.03	24.20	51.60	89.35	77.64	16.70
	nim		0.442							
	nocf			-5.467						
Short-run	lr				39.32***					
	ta					-6.190				
	gdp						0.470			
	bc							0.430		
	rq								3.971	
	cpi									1.488
	c	2.636	-10.58	-1.075	12.15	4.843	0.415	-0.030	8.077	3.924
	Log Likelihood	-460.2	-443.3	-446.0	-428.7	-433.1	-434.0	-436.1	-422.7	-400.8

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 136 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

Table A3. Results for the oil price negative shocks – robustness (z2)

z2		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti	-0.026	-0.064***	-0.309***	-0.082***	0.432***	-440.8***	0.014***	-0.028*	-0.008
	pbvr	0.154***	0.164***	0.100***	0.132***	0.202***	0.030***	0.141***	0.075***	0.204
Short-run	ρ_i	-0.728***	-0.662***	-0.855***	-0.955***	-0.488*	-0.591***	-0.708***	-0.665***	-0.467*
	wti	0.077	-0.312	-0.059	0.012	-0.017	0.510	0.081	0.082	0.141
	pbvr	77.56	6.740	32.19	-16.07	-37.16	-3.759	129.8	66.46	27.61
	nim		0.213							
	nocf			-0.761						
	lr				24.21**					
	ta					1.649				
	gdp						0.997*			
	bc							0.271		
	rq								-3.866	
	cpi									22.71
	c	6.352	0.827	7.436	11.84	7.440	3.745	6.328	6.994	9.364
Log Likelihood		-460.3	-432.5	-424.3	-428.7	-416.3	-440.8	-427.6	-425.5	-419.2

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 136 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti+ – positive shocks in crude oil prices; wti- – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

Table A4. Results for the oil price positive shocks – robustness (re-sampling)

z1		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti+	0.668***	0.699***	0.776***	0.579***	0.181**	0.150***	-0.537***	-0.144	2.230***
	pbvr	0.123***	0.127***	0.104***	0.179***	0.418***	0.113***	0.092***	0.076***	0.100***
Short-run	ρ_i	-0.643***	-0.570***	-0.607***	-0.675***	-0.649***	-0.675***	-0.513***	-0.818***	-0.592***
	wti+	-0.182*	-0.439**	-0.240	-0.451*	-0.057	-0.271	-0.355	-0.054	-0.301**
	pbvr	-37.05	28.63	2.096	-52.55	84.56	15.48	95.64	24.54	110.0
	nim		0.560							
	nocf			-5.699						
	lr				29.77*					
	ta					11.57				
	gdp						0.267			
	bc							-1.071*		
	rq								8.164**	
	cpi									-3.583*
	c	2.603	-6.706	-5.952	4.082	7.372	3.079	-5.549	8.742	1.808*
Log Likelihood		-436.3	-426.3	-423.2	-404.7	-413.6	-413.5	-418.3	-393.5	-403.5

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 128 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti+ – positive shocks in crude oil prices; wti- – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.

Table A5. Results for the oil price negative shocks – robustness (re-sampling)

	z1	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Long-run	wti	0.024	-0.131***	0.031	-0.061*	-0.227***	-0.155***	0.519***	-0.061**	-0.028***
	pbvr	0.081***	0.015***	0.077***	0.732***	0.009	0.035***	0.079***	0.050***	0.066***
	ρ_i	-0.710***	-0.537***	-0.638***	-0.758***	-0.389**	-0.555***	-0.671***	-0.700***	-0.751***
	wti	0.128	-0.135	0.116	-0.062	0.227**	0.599*	-0.022	0.143	0.131
	pbvr	4.764	-59.68	13.53	-22.35	-17.93	-77.70	49.08	6.558	15.33
	nim		0.370							
	nocf			-5.637						
Short-run	lr				22.49					
	ta					0.151				
	gdp						1.111*			
	bc							0.057		
	rq								7.656*	
	cpi									8.462
	c	6.276	3.020	-0.110	17.93*	6.255	1.310	11.48*	7.267	7.464
	Log Likelihood	-444.2	-408.1	-414.7	-411.2	-415.1	-413.8	-422.8	-415.0	-397.5

Notes: (i) ***, **, * indicates significance at 1%, 5% and 10%; (ii) 128 observations; (iii) z1 – Z-score 1; z2 – Z-score 2; wti – WTI crude oil prices return; wti⁺ – positive shocks in crude oil prices; wti⁻ – negative shocks in crude oil prices; pbvr – price to book value ratio; nim – net interest margins; nocf – net operating cash flow; lr – liquidity ratio; ta – natural log of total assets; gdp – economic growth rate; bc – bank concentration; rq – regulatory quality; cpi – corruption perception index.