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Article

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Shadow banking, risk-taking and monetary policy in emerging economies: A panel cointegration approach

Sheunesu Zhou^{1*} and D. D. Tewari¹

Abstract: This study investigates the nexus between shadow banking, bank risk and monetary policy in emerging economies. The importance of this topic arises from its impact on the relationship between price and financial stability objectives of the regulator. In essence, the existence of financial market channels of monetary policy distorts the dichotomy between price and financial stability objectives of central banks. We employ panel cointegration techniques and find a negative association between monetary policy and shadow banking. Specifically, an increase in the central bank policy rate results in a decrease in shadow bank asset growth. In addition, we find a positive association between shadow banking and bank risk. Monetary policy effectiveness increases when bank risk is high. In sum, our results show that shadow banks are an element of the bank risk-taking channel of monetary policy. We suggest policy coordination between monetary and macro-prudential policy, and close monitoring of shadow banking activities to reduce risky undertakings in the financial sector.

Subjects: Macroeconomics; Monetary Economics; International Economics



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PUBLIC INTEREST STATEMENT

The conduct of monetary policy cannot be isolated from developments in financial markets. This study attempts to investigate the linkages between monetary policy, bank risk-taking and shadow banking. The focus on shadow banking is necessitated by susceptibility of shadow banking activities to higher risk compared to formal banking channels. Furthermore, this study allows us to investigate if indeed there is a policy trade-off between price and financial stability. The findings of this study show that in the context of emerging economies, a hike in the policy rate results in a decrease in shadow banking. The effect of monetary policy on shadow banking is exacerbated by high risk, implying that the pass-through effect of monetary policy to shadow banks is strong when banks are relatively fragile or unstable.

Keywords: monetary policy; shadow banking; bank liquidity; panel cointegration; risk-taking

JEL classifications: C33; E44; G23

1. Introduction

The burgeoning of literature focused on the relationship between the financial sector and the monetary sector in the aftermath of the Global Financial Crisis (GFC) suggest the presents of additional channels of monetary policy through the financial sector (GAMBACORTA, 2009; XIAO, 2018). Indeed, the effect of financial dominance cannot be denied with the experience of the GFC. SMETS (2014) for instance argues that the degree of importance attached to financial sector developments is critical to the conduct of monetary policy and can determine monetary policy effectiveness. However, empirical support for these propositions largely derives from advanced economies, with little or no evidence from emerging economies and developing countries. This paper uses cross-country data to investigate the role of shadow bank growth in the monetary policy transmission mechanism. We contribute to the literature on monetary policy transmission by considering the interaction between shadow banking, monetary policy and bank risk.

Studies investigating monetary policy transmission demonstrate the existence of several channels of monetary policy. Traditional channels of monetary policy include the interest rate channel, the exchange rate channel and the asset prices channel (BOIVIN, KILEY, & MISHKIN, 2010; CECCHETTI, SCHOENHOLTZ, & FACKLER, 2015). The bank lending and balance sheet channels are classified as credit channels of monetary policy (IRELAND, 2010). Credit channels show the pass-through effect of monetary policy changes on bank credit. Recent studies have suggested the presents of other channels of monetary policy (ANGELONI & FAIA, 2013; CHEN, REN, & ZHA, 2018; DAJCMAN & TICA, 2017). BORIO & ZHU (2012) and VANHOOSE (2008) show that capital regulations levied on formal banking institutions impact the transmission of monetary policy. In fact, monetary policy pass through is high for low-capitalised banks. Furthermore, BORIO & ZHU (2012) argue for the existence of a risk-taking channel of monetary policy in which financial agents, including banks respond to changes in monetary policy rates by adjusting their risk appetite. In addition, several studies establish the presents of a shadow banking channel of monetary policy (FUNKE, MIHAYLOVSKI, & ZHU, 2015; NELSON, PINTER, & THEODORIDIS, 2018; VERONA, MARTINS, & DRUMOND, 2013; XIANG & QIANGLONG, 2014; XIAO, 2018). However, these contributions fail to reconcile shadow banking and risk-taking, instead they treat bank risk-taking as a separate channel, without accounting for the role played by shadow banking (ASHRAF, 2017; ASHRAF, ARSHAD, & HU, 2016; DE NICOLÒ, DELL'ARICCIA, LAEVEN, & VALENCIA, 2010; GAMBACORTA, 2009). We argue that risk-taking by commercial banks is directly linked to shadow banking activities.

Our study is also related to studies on the determinants of shadow banking¹ (BARBU, BOITAN, & CIOACA, 2016). ADRIAN & ASHCRAFT (2016) proffer three main theoretical reasons for shadow banking growth. Firstly, shadow banking is a form of regulatory arbitrage. This view contends that shadow banking activities are a response to stringent regulatory measures in the formal banking sector. Regulation can come in the form of micro-prudential requirements, monetary policy or macro-prudential policy. For instance, increased capital requirements of Basel III could have led to the upsurge in shadow bank activity post the GFC. In other studies, tight monetary policy has been found to be a positive driver of shadow banking (CHEN et al., 2018; FUNKE et al., 2015; NELSON et al., 2018). In both SUNDERAM (2014) and ADRIAN & ASHCRAFT (2016), shadow banking also arises due to innovations in the money supply, where the need for money like instruments increases participation of financial agents in the use of new financial products and processes. According to SUNDERAM (2014) shadow banking acts as a substitute for bank deposits, a proposition which we test in this paper. The third reason for the growth of shadow banking is problems relating to incomplete markets in financial markets. Such asymmetric information in financial markets is described in DU, LI, & WANG (2017), who notes that credit market imperfections and financial repression contribute to the growth of shadow banking.

This paper is mainly aimed at analysing the effect of monetary policy on shadow banking in emerging market economies within a single equation framework using a panel of 15 emerging economies. The study uses a loan demand and supply framework to develop a theoretical model in which shadow banking is determined by gross domestic product (GDP), inflation and the policy rate. Our analysis is closely related to BARBU et al. (2016)'s study, which focuses on analysing the determinants of shadow banking in the Euro. We depart from their analysis by focusing on the interaction between shadow banking, monetary policy and bank risk. The study contributes to the literature in three ways, firstly, we consider a panel of emerging economies, which have seen a surge in shadow bank growth in the past two decades. Second, we develop a theoretical framework for the determination of shadow banking in emerging economies using a loan demand and loan supply framework. The third contribution comes from analysing the linkages between shadow banking and bank risk-taking, within the monetary policy transmission mechanism.

The rest of the study proceeds as follows: Section 2 provides a brief review of the empirical literature on the determination of shadow banking and Section 3 focuses on the theoretical model used in the study. In Section 4 and 5, we provide a description of the methodology used in the study and the results from our analysis, respectively. Section 6 concludes the paper.

2. Empirical literature

Empirical literature on shadow banking is still scarce, more so is literature on the determinants of shadow banking. We review in this section literature related to determination of aggregate shadow banking and literature on the determinants of individual shadow banking instruments or processes. BARBU et al. (2016) provide the first study that investigates the macroeconomic determinants of shadow banking. Their study analyses determinants of shadow banking for the Euro area using data on the flow of funds as a proxy for shadow banking in a sample of 15 European countries. Their study establishes a negative relationship between economic growth, short-term interest rates, money supply and shadow banking. As a corollary, the contractionary monetary policy which increases the short-term rates leads to a decrease in shadow banking activity. Stock market developments and long-term interest rates are found to be positively related to shadow banking.

SUNDERAM (2014) develops a model of money creation in which both bank deposits, treasury bills and shadow bank assets respond to money demand. An increase in money demand results in a decrease in demand for treasury bills, and hence an increase in treasury bill yields. They argue that shadow bank assets increase as a substitute to treasury bills as they are both money like claims. Furthermore, their study suggests that the need to hold reserves acts as a tax for issuance of deposits leading banks to substitute deposits with shadow bank liabilities in the event of a policy rate hike. The implication of their results is that banks engage in shadow banking activities either to substitute or complement their deposits. The finding is supported by various studies which point to the importance of bank liquidity in driving shadow bank activities (AGOSTINO & MAZZUCA, 2011; NACHANE & GHOSH, 2002). Shadow bank liabilities are therefore important in indirectly driving bank credit and have the potential to stabilise banks' balance sheets in the event of increased bank withdrawals under a tight monetary policy stance.

Several studies investigate the determinants of securitisation activity (AGOSTINO & MAZZUCA, 2011; CARDONE-RIPORTELLA, SAMANIEGO-MEDINA, & TRUJILLO-PONCE, 2010; FARRUGGIO & UHDE, 2015). CARDONE-RIPORTELLA et al. (2010) use bank-specific characteristics to investigate the drives of shadow banking in Spain. Their study employs both logistic regression and descriptive statistics to analyse the impact of different variables on securitisation. They do not establish the existence of the regulatory arbitrage hypothesis. Instead, they find that securitisation is driven by the search for liquidity and the profit incentive. Their findings are supported by TANG & WANG (2015), who find that shadow banks were more profitable than formal banks in China, concluding that banks engage in shadow banking activities to increase their earnings. FARRUGGIO & UHDE (2015) investigates the determinants of securitisation for the Euro region. They use data from 1997 to 2010 for a sample of 75

banks divided into securitising and non-securitising banks. They find market factors, bank-specific factors and macroeconomic factors to influence securitisation decisions. Specifically, economic growth and high competition among banks are found to drive securitisation. Other factors include bank size, bank capitalisation, regulatory and institutional environment.

PANETTA & POZZOLO (2018) use a sample covering 1991 to 2007 for banks from over 100 countries. They employ the method of proportional hazard regression and find that banks securitise as a result of tight regulation, low operating expenditure and as a hedge against both liquidity and credit risks. Their findings validate the mainstream belief that regulatory arbitrage is the main driver of shadow banking activities. In a related study, NACHANE & GHOSH (2002) analyses the determinants of off-balance activities of banks and find that bank size and liquidity are important factors impacting the decision whether to securitise or not in India. Specifically, they argue that well capitalised and highly liquid banks have no incentive to engage in off-balance sheet activities. Bank size negatively influences securitisation decisions. Liquidity and tax incentives both have a negative influence on securitisation, showing that banks could be risk averse as they increase their pool of liquid liabilities. A related study by DUCA (2014) analyses the drivers of shadow banking in both the short run and in the long run. They use credit creation by money market funds as a proxy for shadow banking. Their study uses single equation time series regression and finds that information costs and bank capital regulation have significant effects on the growth of shadow banking in the long run. An interesting finding from this study is that short-run reductions in shadow banking followed increases in bank liquidity and increased risk in financial markets. DUCA (2014) argues for vulnerability and pro-cyclical behaviour of shadow bank liabilities, which have serious consequences for financial and macroeconomic stability.

The study also relates to empirical papers which link shadow banking to monetary policy. Shadow banking is found to reduce the effectiveness of monetary policy (XIANG & QIANGLONG, 2014; XIAO, 2018). XIAO (2018) documents a positive relationship between the Federal reserve (fed) funds rate and growth in shadow bank assets for the US. Their study uses disaggregated data for five shadow bank entities including, broker-dealers, finance companies, funding corporations, ABCP issuers, captive and other financial institutions. They argue that a positive shock on the monetary policy rate induces an increase in shadow bank deposit creation. NELSON et al. (2018) use an autoregressive model with time-varying parameters to show that a contractionary monetary policy increases shadow banking growth but reduces growth of commercial bank assets. XIANG & QIANGLONG (2014), FUNKE et al. (2015), WANG & ZHAO (2016) and VERONA et al. (2013) analyse the impact of shadow banking on monetary policy using Dynamic Stochastic General Equilibrium (DSGE) modelling. XIANG & QIANGLONG (2014) and FUNKE et al. (2015) find that a contractionary monetary policy stance results in a decrease in commercial bank credit but leads to an increase in shadow bank credit. WANG & ZHAO (2016) also find that the net worth of commercial banks decreases due to contractionary monetary policy action. On the contrary, the net worth of shadow banks increases as a result of a hike in the policy rate.

3. Theoretical model

The theoretical model developed here follows the work of STEIN (1998), EHRMANN, GAMBACORTA, PAGÉS, SEVESTRE, & WORMS (2001) and ABDUL KARIM, AZMAN-SAINI, & ABDUL KARIM (2011). STEIN (1998) develops a model in which banks pay a premium to access market finance in the event of a monetary policy shock. They provide a foundation for investigation of the bank lending channel of monetary policy by both EHRMANN et al. (2001) and ABDUL KARIM et al. (2011) for the Euro area and Malaysia, respectively.

Assume the following identity for a bank balance sheet:

$$A_t = \mathcal{L}_t + K_t \quad (1)$$

Where A_t are bank assets, \mathcal{L}_t are bank liabilities and K_t represents bank capital. In practice, bank assets comprise cash, loan portfolio, short term and long-term securities and also property and

equipment. However, the highest proportion of bank assets comprises loans (L_i) and securities (S_i). We follow ABDUL KARIM et al. (2011) and restate the simplified identity as follows:

$$L_i + S_i = D_i + K_i + SB_i \quad (2)$$

where D_i are deposits and K_i is the bank's capital. SB_i captures shadow bank liabilities, which include financing from all other non-core bank activities. Unlike in ABDUL KARIM et al. (2011) where other sources of finance refer only to unsecured money market funding, we recognise the importance of the wider wholesale markets, including the repo market, which has been thriving in emerging countries like South Africa. In our model shadow bank liabilities SB_i can be substituted for bank deposits, D_i as in SUNDERAM (2014). In the event of a contractionary monetary policy shock, banks increase their use of market finance, resulting in increased SB_i .

In addition, shadow banking impacts the left hand side of Equation (2) through securities holdings. Thus, we allow securities holdings by banks to include both safe bonds issued by the government and municipalities and money market instruments and other short-term assets, including assets backed securities. The latter represents banks' financing of shadow banks, who are the issuers of such assets. S_i can, therefore, be decomposed as follows:

$$S_i = S_L + S_s$$

where S_L represents government securities. S_s is the short-term component of banks securities holdings and is linearly related to the bank short-term lending rate, r_i . Thus $S_s = \varphi r_i$ where $\varphi < 0$. Thus in the short term, an increase in the bank lending rate encourages bank loan supply, at the same time reducing funds available for short-term shadow bank asset holdings. The equation above can be expressed as follows:

$$S_i = S_0 - \varphi r_i \quad (3)$$

Where S_0 is a constant term accounting for long term and other securities. The level of bank deposits is also a decreasing function of the policy rate,

$$D_i = -\alpha r_i \quad (4)$$

Where α is negative for all i . As in ABDUL KARIM et al. (2011), Capital is a function of loans:

$$K_i = kL_i \quad (5)$$

Bank loan demand is determined by output y , the price level p and the interest on loans r_i as in the following equation,

$$L_i^d = \beta_1 y + \beta_2 p - \beta_3 r_i \quad (6)$$

The supply of bank loans can be derived by combining Equation (2-5) and solving for L_i . Simple manipulation will result in the following:

$$L_i^s = D_i + K_i + SB_i - S_i \quad (7)$$

$$L_i^s = D_i + kL_i^s + SB_i - (\theta_0 - \theta_1 r_i)$$

$$\text{Where } S_i = \theta_0 - \theta_1 r_i = S_0 - \varphi r_i,$$

$$L_i^s (1 - k) = D_i + SB_i + \theta_1 r_i - \theta_0$$

$$L_i^s = \frac{D_i}{(1-k)} + \frac{SB_i}{(1-k)} + \frac{\theta_1 r_i}{(1-k)} - \frac{\theta_0}{(1-k)} \quad (8)$$

If we let $\rho_i = \frac{1}{(1-k)}$ be the coefficient of D_i ; $\gamma_i = \frac{1}{(1-k)}$ be the coefficient of SB_i ; $\frac{\theta_0}{(1-k)}$ be the coefficient of r_i ; and ϕ_0 be a constant described by $\frac{\theta_0}{(1-k)}$, we can rewrite Equation (8) as:

$$L_i^s = \rho_i D_i + \gamma_i S B_i + \phi_i r_t - \phi_0 \# \quad (9)$$

EHRMANN et al. (2001) show that the parameter of D_i can be decomposed into two factors, one that is independent of bank characteristics and another factor that is dependent on bank level characteristics such as capitalisation, liquidity and size.

Let x_i represents bank-specific characteristics. In our model, a higher value for x implies sound financial conditions for bank i and consequently low risk, and x_i will be treated as a risk variable. If ρ_i is the coefficient of D_i , it can be decomposed into two parts, firstly ρ_0 which describes the influence of deposits on loan supply that is independent of bank characteristics and ρ_1 which describes the influence of deposits on loan supply that is dependent on individual bank characteristics as follows:

$$\rho_i = \rho_0 - \rho_1 x_i$$

Equation (9) becomes:

$$L_i^s = (\rho_0 - \rho_1 x_i) D_i + \gamma_i S B_i + \phi_i r_t - \phi_0 \# \quad (10)$$

Equilibrating loan demand (Equation 6) and loan supply (10), and substituting D_i with $-\alpha r_p$, shadow banking is determined by output, inflation, the policy rate and bank lending as follows²:

$$S B_t = \psi_0 + \psi_1 y_t + \psi_2 p_t + \psi_3 r_t - \psi_4 r_{p_t} + \psi_5 x_i r_{p_t} + \omega_t \# \quad (11)$$

Where ψ_0 is a constant and parameters $\psi_1 - \psi_5$ account for the impact of each variable on shadow banking. The error term ω_t accounts for entity-specific reasons for participation in shadow bank activities.

Equation (11) shows that shadow banking is determined by output, the price level, the prevailing loan interest rates, bank liquidity and the monetary policy stance. The variable $x_i r_{p_t}$ is an interaction term capturing bank risk effect on the influence of monetary policy on shadow banking. Thus the model predicts a decrease in shadow banking with a contractionary monetary policy. However, the less risk, the bank, the lower the impact of monetary policy on shadow banking.

4. Methodology

The methodology followed in this paper follows the literature on non-stationary panels (BALTAGI, 2008). Ignoring the non-stationarity of panel data could lead to spurious regression and hence unusable results. The present study employs data from 15 emerging economy countries for the period 2002 to 2017.

4.1. Non-stationarity in panel data

Pooled OLS estimates for cointegrated variables are biased due to the presents of endogeneity and serial correlation. To mitigate this shortcoming, the study employs non-stationary panel methods for parameter estimation in the name of the panel Fully Modified OLS and panel Dynamic OLS methods. The panel FMOLS of Pedroni (2001) and Philips and Moon (1999) follows from the time series version FMOLS estimator of Philips and Hansen (1990). The estimator corrects for bias and endogeneity in the OLS estimator using non-parametric methods. The panel DOLS method of KAO & CHIANG (2001) follows from the time series DOLS methodology of Saikkonen (1991), which adds lags and leads of differenced independent variables to correct for bias and endogeneity. KAO & CHIANG (2001) show that the limiting distribution of the DOLS estimator is the same as the FMOLS estimator. However, through Monte Carlo simulation, they find that the DOLS estimate is superior to both the OLS and FMOLS estimates in terms of bias correction. In addition, they also show that bias in both the FMOLS and the DOLS estimators is reduced as the panel time series dimension grows compared to short T panels.

4.2. Panel unit root tests and cointegration

Panel unit root tests are important in determining the order of integration of the variables in a panel framework. BALTAGI (2008) provides an outline of the first generation and second generation panel unit root tests. This study adopts two main unit roots tests from IM, PESARAN, & SHIN (2003) and Pesaran (2007). IPS 2003 suggests a unit root test that averages individual ADF type test statistics when the error term is serially correlated but with different correlation properties across units. Pesaran (2007) suggests a unit root test that is robust to the presents of cross-sectional dependence. They propose a test in which the Dickey Fuller (DF) or Augmented Dickey Fuller (ADF) regressions are augmented using cross-sectional averaged lags of levels and first differenced individual series. Thus the unit root tests are based on cross-sectional augmented ADF statistics (CADF). Panel cointegration tests are applied to ensure that variables are cointegrated before carrying out regression estimations. The most popular cointegration tests are KAO & CHIANG (2001) cointegration test and Pedroni (2004)'s test. Due to the short time series dimension of our data, the study employs KAO & CHIANG (2001)'s cointegration test which is more suitable for shorter macro panels.

4.3. Model

The model estimated here derives from the theoretical model in section (3). However, we augment the basic model with other variables from theory and employ bank credit data instead of the lending rate. Reinstated below is the basic model of shadow bank determination:

$$SBS_{it} = \psi_0 + \psi_1 \lgdp_{it} + \psi_2 infl_{it} - \psi_3 bcred_{it} - \psi_4 pr_{pit} + \psi_5 x_{it} pr_{pit} + \omega_{it} \quad (12)$$

Where SB_{it} is shadow banking, $lgdp_{it}$ is output, $infl_{it}$ is the price level, $bcred_{it}$ is the bank credit and pr_{pit} is the policy rate of the central bank. ω_t is an error term assumed to be independently and identically distributed (iid). The $\psi_1 - \psi_5$ are parameters to be estimated.

For the purpose of this study, we estimate two basic models, firstly we replace bank lending rate with bank credit and analyse the effect of the policy rate when controlling for bank credit. In the second model, we also control for bank liquidity and stock market prices. Furthermore to control for the effect of bank risk, we formulate an interaction term between the policy rate and the bank zscore ($prrisk = x_{it} pr_{pit}$).

4.4. Data and variable description

Data are obtained from various sources including the Financial Stability Board, the Bank for International Settlement, the World Bank data portal and IMF International financial statistics. Data used is of annual frequency covering the period 2002 to 2017. Our period sample is constrained by availability of shadow banking data from the FSB, which only starts in 2002. Preliminary data transformations in the form of log-linear transformations are done for data that is not in percentages in its original form. We use a sample of 14 emerging economy countries plus Singapore, which the MSCI classifies as an advanced economy. The countries used in the study are shown in Table 1 below.

Equation (12) shows that shadow banking determined by output, inflation rate, the policy rate, deposit rate, bank risk and also the level of bank credit. In Table 2, we provide a concise description of all variables used in the model and their economic implications. The study uses data on assets

Table 1. Country sample				
Argentina	China	Mexico	Saudi Arabia	Singapore
Brazil	Indonesia	Philippines	Turkey	Thailand
Chile	Malaysia	South Africa	Peru	India

Table 2. Variable description

Variable	Symbol	Description	A priori sign from literature
Shadow banking growth	sbs	Log of shadow bank assets	
Output	lgdp	Log of real GDP	Positive
Inflation	infl	Log of CPI index	Positive
Policy rate	pr	Central bank policy rate	Positive
Exchange rate	Reer	Real effective exchange rate	Negative
Bank liquidity	liquidity	Bank liquidity proxy is M1	Negative
Stock markets	ep	Log of Equity price index for each country	Positive
Bank credit	Bcred	Bank credit as a percentage of GDP	negative

of shadow banks as a proxy for shadow banking in the model. Thus we assume that assets issued by these firms end up on banks' balance sheet as liabilities of banks.

5. Results presentation and discussion

This section presents the results of the estimated model. For robustness purposes, we report estimates from a number of estimation techniques including OLS pooled regression, random effects method, fully modified OLS and the Dynamic OLS methods. Of interest is the persistence in the signs of the coefficients throughout all the estimated models. However, before the models are estimated, we carry out preliminary data transformations and unit root tests to avoid reporting spurious regression results. Thus, we report first descriptive statistics for each variable, stationarity tests and cointegration tests before carrying out the regressions. We take logarithms of observations collected in amounts and indexes such as real GDP and the CPI index to remove heteroscedasticity from the data and also avoid outliers. Thus, all variables enter the model either as percentages or logarithms and coefficients can be interpreted as elasticities.

5.1. Descriptive statistics

Descriptive statistics are provided in Table 3, detailing the statistical characteristics of the data on an individual series bases, which is imperative for understanding regression results (AGUNG, 2011). Of importance is the distribution of the variables as shown by the range and their standard deviations. Shorter ranges in the series should indicate the absents of extreme values in the data. Extreme values or outliers can raise problems such as heteroscedasticity and could also influence the outcome of the regression. In addition, we note that the variables resemble non-normality as reported by the significant Jarque-Bera test statistics (JB).

5.2. Correlation table

Table 4 presents the correlation matrix together with the associated t-statistics for each correlation coefficient. Correlation coefficients are important for avoidance of multicollinearity in regression models. A correlation coefficient of 0.8 or above could signify the presents of multicollinearity (MADDALA & LAHIRI, 2009). As shown below, we do not see any variables that resemble a very high correlation. We can, therefore, continue with all the variables included in running the different regression models. In addition, one can infer expected signs of regression coefficients from the correlations between the dependent variable and the independent variables.

5.3. Panel unit root tests

Various unit root tests were undertaken to ascertain the level of integration in the variables. Our findings point to mixed results from the different unit roots tests as pointed out in (BALTAGI, 2008).

Table 3. Descriptive statistics

	LZSCORE	PR	BCRED	LIQUID1	LGDP	INFL	SBS01	REER	EP
Observations	240	240	240	240	240	240	240	240	240
Mean	2.4757	0.064458	0.584,623	0.755,743	11.72,219	1.976,989	10.75,735	1.977,388	1.879,463
Median	2.6181	0.052800	0.489,375	0.682,540	11.61,929	1.988,753	10.56,853	1.983,032	1.927,905
Maximum	3.6898	0.440,833	1.568,093	2.084,584	12.97,796	2.197,073	12.98,063	2.117,535	2.749,910
Minimum	1.1537	0.000137	0.104,169	0.234,937	10.95,922	1.663,666	8.771,751	1.742,901	0.877,676
Std. Dev.	0.5405	0.062054	0.374,864	0.412,875	0.440,320	0.094933	0.697,096	0.053967	0.289,955
Skewness	-0.3627	3.097254	0.601,379	0.900,053	0.741,855	-0.405,453	0.506,744	-0.713,924	-0.716,589
Kurtosis	2.3157	15.84,100	2.112,321	3.180,650	3.021110	3.173,835	3.489,434	5.270,703	4.256,571
Jarque-Bera	9.2830	1897.123	20.85,627	30.54,815	20.55,053	6.419,346	11.82,255	67.15,187	33.90,771
Probability	0.0096	0.000000	0.000030	0.000000	0.000034	0.040370	0.002709	0.000000	0.000000
Sum	554.55	14.43,856	130.9556	169.2865	2625.770	442.8455	2409.647	442.9348	420.9997
Sum Sq. Dev.	65.14,974	0.858,701	31.33,659	38.01385	43.23,560	2.009732	108.3653	0.649,481	18.74,851

Table 4. Correlation matrix

Correlation t-statistic	ZSCORE	SBS	REER	PR	LGDP	INFL	BCRED
ZSCORE	1.000000						
SBS	0.280,639	1.000000					
REER	0.107,830	0.111,877	1.000000				
PR	-0.171,449	-0.060009	-0.372,073	1.000000			
LGDP	0.143,627	0.648,296	-0.057313	0.264,873	1.000000		
INFL	0.097392	0.506,339	0.169,220	-0.348,683	0.166,871	1.000000	
BCRED	0.259,968	0.278,413	0.101,234	-0.373,502	0.081103	0.304,939	1.000000

Table 5. Panel unit root tests

Variable	IPS (2003) unit root test		Pesaran (2007) unit root test		Conclusion
	Test stat	p-value	Zt-bar stat	P-value	
<i>lgdp</i>	2.196	0.986	5.181	1.000	Non-stationary
<i>infl</i>	0.231	0.591	-1.136	0.128	Non-stationary
<i>reer</i>	-0.181	0.427	-0.404	0.343	Non-stationary
<i>pr</i>	-1.325*	0.092	-0.849	0.198	Non-stationary
<i>sbs</i>	-0.372	0.355	1.151	0.875	Non-stationary
<i>bcred</i>	-0.607	0.271	0.926	0.823	Non-stationary
<i>zscore</i>	-0.718	0.236	-2.162**	0.015	Non-stationary
<i>liquid1</i>	0.513	0.696	2.212	0.987	Non-stationary
Δ <i>lgdp</i>	-1.541*	0.061	-2.199	0.014	Stationary
Δ <i>infl</i>	-2.335	0.009	-3.455	0.000	Stationary
Δ <i>reer</i>	-4.159	0.000	-2.498	0.000	Stationary
Δ <i>pr</i>	-2.926	0.001	-2.873	0.002	Stationary
Δ <i>sbs</i>	-3.854	0.000	-6.812	0.006	Stationary
Δ <i>bcred</i>	-1.719	0.042	-2.751	0.003	stationary
Δ <i>zscore</i>	-5.001	0.000	-6.174	0.000	Stationary
Δ <i>liquid1</i>	-1.831	0.033	-2.309	0.010	Stationary

***, ** and * represents 1%, 5% and 10% level of significance, respectively. The IPS test includes a trend and intercept whereas Pesaran's (2007) test includes a trend.

However, the general conclusion derived points to the presents of I (1) level of integration for all the variables. In Table 5, we present only results from two of the tests conducted IPS Im, Pesaran and Shin (2003)'s unit root test (IPS) and Pesaran (2007) unit root test. Other results are attached in the appendix.

5.4. Panel cointegration test

Table 6 present results for panel cointegration test. Due to the small sample nature of the panel, we consider KAO and CHIANG (2001)'s residual-based cointegration test. The null hypothesis of the test is that there is no cointegration against the alternative hypothesis that at least one panel is cointegrated. From the table it is evident that the ADF statistic is significant at 1% level, we therefore reject the null hypothesis of no cointegration and conclude that the series is cointegrated. The presents of cointegration implies a long-run relationship exists amongst the variables. BISPHAM (2005) indicates that using OLS regressions on non-stationary-cointegrated series will result in spurious regression. We avoid this pitfall by firstly running the pooled OLS and random

Table 6. Kao residual-based cointegration test

Null hypothesis: No cointegration		
	t-statistic	Prob.
ADF	-2.766,150	0.0028

effects models using differenced series. In our main estimations, we use cointegration methods, which provides long-run parameters for the regression equation.

5.5. Estimation results presentation and discussion

In this section, we present estimation results from panel regressions. Due to the presents of unit roots in our sample, we estimate the pooled Ordinary Least Squares (OLS) and random effects (RE) models in differences to avoid spurious regression. In addition, tests for heteroscedasticity and serial correlation and cross-sectional dependence were conducted. The results of the basic random effects and fixed effects models show that heteroscedasticity is present. We use the modified Wald test for groupwise heteroscedasticity. The final model controls for heteroscedasticity and serial correlation by using clustered and robust standard errors. Cross-sectional dependence test due to PESARAN (2004) is used

Table 7. Pesaran' s cross-sectional dependence test

Pesaran' s cross sectional dependence test		
Null hypothesis: cross sectional independence		
	t-statistic	Prob.
CSD	-1.401	0.1612

Table 8. Estimation results—static model

Dependent variable: Δsbs

Independent variables	Coefficients			
	Pooled OLS (1)	Pooled OLS (2)	Random effects (1)	Random effects (2)
$\Delta l g d p$	2.91*** [3.46]	2.81*** [3.17]	2.82*** [3.17]	2.74*** [3.03]
$\Delta i n f l$	-1.10 [-1.48]	-1.41* [-1.84]	-1.43* [-1.81]	-1.62** [-2.04]
$\Delta r e e r$	0.93** [2.14]	1.03** [2.29]	0.99** [2.30]	1.09** [2.40]
$\Delta p r$	-0.67** [-2.03]	-1.89*** [-3.17]	-0.63** [-1.95]	-1.88*** [-3.17]
$\Delta p r r i s k$		0.18** [2.43]		0.19** [2.47]
$\Delta b c r e d$	-0.00034 [-1.19]	-0.0002 [-1.00]	-0.0003 [-1.33]	-0.0003 [-1.08]

Note: ***, **, * represents significant at 1%, 5% and 10% levels, respectively. Robust and clustered standard errors are used in the random effects estimation to remove heteroscedasticity and serial correlation. Thus the values in parenthesis t-stats for OLS regression and z-stats for random effects model. Δ refers to the first difference of the variable.

to test for cross-sectional dependence and we establish that there is no cross-sectional dependence in the model in Table 7.

The regression results are presented in Table 8. We present first the OLS and random effects results from differenced data. In each case, the first regression shows the impact of the central bank policy rate and other variables on shadow banking growth. The second regression contains an interaction term between the policy rate pr and bank risk as measured by the bank zscore ($lzscore$). We interpret the differenced estimation results to indicate short-run effects of each explanatory variable on shadow banking.

Due to the presents of cointegration as pointed out by Kao's cointegration test, the study also employs panel cointegration techniques to estimate long run coefficients. The results for both panel Dynamic Ordinary Least Squares and panel Fully Modified Ordinary least squares are presented in Table 9. Our results are distinguished by the decision to control for either bank credit or bank liquidity. The second regression in each case includes an interaction term between the policy rate and the bank zscore, a measure of bank risk. Other control variables are used to improve the estimated models.

The results in Tables 8 and 9 show that there is a negative and significant relationship between the central bank policy rate (pr) and shadow bank growth (sbs). Thus both in the short-run and long-run, the policy rate has a negative effect on shadow banking. Specifically, model 3 in Table 9 shows that a 1% increase in the policy rate results in a 0.37% decrease in shadow banking. The sign is persistent in all the estimated models although it is not significant in model (1) of Table 9. We conclude that monetary contraction through an increase in the policy rate is negatively related to shadow banking as envisaged in our theoretical model. Shadow banking in emerging economies decreases with a contraction in money supply derived from an interest rate hike. This result contradicts findings from previous studies which argue for an increase in shadow bank activity after monetary contraction (NELSON et al., 2018; XIANG & QIANGLONG, 2014). Our results show that contractionary monetary policy reduces shadow bank growth, which may imply very close interconnectedness between shadow banking and commercial banks in emerging economies compared to advanced economies. The results could also be showing the dominance of the risk-taking channel, where banks consider increases in the policy rate to be a signal for high risk. Thus, they respond by cutting on their risky activities, thereby reducing participation in shadow banking activities.

Further, the results provide insight into the relationship between monetary policy, bank risk and shadow banking. Firstly, we control for bank risk using the logarithm of the bank zscore index for each country in our FMOLS regression. Bank zscore is found to be positively associated with shadow banking, implying that an improvement in bank risk results in increased shadow banking activity. We interpret this to confirm the proposition by BORIO & ZHU (2012) who suggested that reduced risk perceptions by banks encouraged them to take higher risk. In relating interest rates to risk-taking by financial agents, BORIO & ZHU (2012) argue that lower interest rates may signal low-risk exposure and make banks to increase their risk appetite, consequently increasing their participation in high-risk activities. In line with this proposition, our results could suggest that banks and other financial agents increase participation in high-risk shadow banking activities when bank risk is perceived to be low.

In addition, we use an interaction term between the policy rate and the bank z-score to analyse the effect of changes in bank risk on the impact of monetary policy on shadow banking. Our results in both Tables 8 and 9 show persistent positive sign on the interaction term. An increase in the bank zscore, which shows improvement in bank risk in a given country, results in a decrease in the negative impact of pr on sbs . The impact of monetary policy on shadow banking becomes less pronounced when bank risk is low. Our results support the proposition of XIAO



(2018) who suggest that monetary policy effects work more effectively through high-risk entities. Thus, high-risk banks pass through more policy rate changes to the shadow banking sector compared to low-risk commercial banks. By construct, we also argue that the effects of monetary policy on the financial sector are low during periods of financial stability. Thus several studies relating monetary policy to financial stability during the GFC could have been biased as a result of increased instability during the GFC, which increased the impact of monetary policy on financial sector variables.

The following relationship between the policy rate, bank risk and shadow banking is envisaged:

An increase in the policy rate increases bank risk. Banks react by reducing their risk-taking, which in turn lead to a decrease in shadow banking activity. By construct, a decrease in the policy rate should result in an increase in shadow banking through the following channel:



Table 9 also shows that an increase in liquidity (money supply) results in an increase in shadow banking in the short-run. Thus ideally, a negative shock in the policy rate which raises bank liquidity results in more shadow banking activities. The results dispute the proposition by SUNDERAM (2014) that shadow banking is a substitute for bank deposits. We re-instate here our strong inclination towards the intuition that banks in emerging market economies are more connected to shadow banking activities and are the drivers of shadow bank activities compared to their advanced economies counterparts. Thus bank liquidity compliments shadow bank activity. The negative sign on the coefficient of $\Delta bcred$ could imply a trade-off between shadow banking and bank credit in the short-run. The finding supports MAZELIS (2014) and XIAO (2018) who also find that shadow bank credit moves in opposite direction to bank credit. In the long term, however, $bcred$ shows a positive association with sbs . This may show that in general the growth in bank assets over time is positively associated with the growth in shadow banking activities. In other words, the larger the banking system, the larger the shadow bank sector.

Other variables take expected signs, with both inflation and GDP having significant and positive coefficients in the long-run. Whilst inflation shows a negative association with shadow banking in the short-run, the results are not strongly significant, demonstrating a weak short-run relationship between the two. In the long-run, the size of the economy as measured by GDP significantly influences the growth of shadow banking. This relationship could be driven by both demand for loan or supply-side factors such as the search for higher returns by investors leading to increased supply of funds to shadow banks.

It is important however to note that our study has several limitations which could have impacted the results discussed. Firstly, our data have a shorter time series component which limit the reliability of our estimates. To overcome this challenge, the study uses four estimation techniques to ensure that changes in regression coefficients could be noted. However, no consequential changes can be identified. The second limitation arises from the use of a panel framework in analysing monetary policy. We recognise that different countries conduct monetary policy differently and countries in the sample have different monetary policy regimes. Whilst this could impact on our results, we include emerging economies, which share several economic characteristics including the level of economic growth and development of shadow banking in our sample.

6. Conclusion and policy recommendations

This paper presents an empirical analysis of the impact of monetary policy on shadow banking in emerging economies. We control for bank risk, liquidity, bank credit and macroeconomic factors and establish a negative impact of monetary policy on shadow banking. We find that monetary

Table 9. Long-run coefficients

Independent variables	Coefficients							
	PFMOLS (1)	PFMOLS (2)	PFMOLS (3)	PFMOLS (4)	PDOLS (5)	PDOLS (6)	PDOLS (7)	PDOLS (8)
<i>dp</i>	0.85*** (8.21)	0.74*** (6.76)	0.79*** (50.79)	0.71*** (39.10)	0.72*** (12.9)	0.96*** (9.71)	0.73 (0.75)	0.81 (0.70)
<i>infl</i>	1.50*** (3.29)	1.75*** (3.83)	1.63*** (24.19)	1.79*** (3.73)	1.28*** (4.56)	6.62*** (4.77)	5.48*** (4.24)	4.93*** (3.81)
<i>reer</i>	-1.22*** (-2.06)	-0.87 (-1.48)	-1.06*** (-12.19)	-0.70*** (-7.24)		-1.85*** (-3.44)		
<i>pr</i>	-1.12 (-1.03)	-3.00*** (-2.16)	-0.37*** (-2.41)	-2.76*** (-12.04)	-2.17*** (-3.53)	-3.80** (-2.01)	-6.04*** (-3.73)	-6.02*** (-3.57)
<i>pr * risk</i>		0.26 (2.23)		0.26*** (13.81)		0.22* (1.95)	0.49** (2.38)	0.38* (1.72)
<i>bcred</i>	0.41*** (3.17)	0.41*** (3.27)					0.001 (1.33)	
<i>lzscore</i>	0.17*** (2.08)		0.02*** (13.31)					
<i>ep</i>							-1.10*** (-3.77)	-1.03*** (-3.39)
<i>liquidity</i>			0.002*** (15.24)	0.003*** (15.94)				0.001 (0.68)

***, **, and * represent 1%, 5% and 10% significance level, respectively. The lags and leads (lag/leads) for the DOLS method are set at (1/1) for models (5) and (6), and (3/1) for the models (7) and (8) respectively. The PFMOLS uses the pooled estimator for all models. Results are robust to using the weighted estimator, which uses cross section-specific long-run covariances to reweight the data before carrying out the estimations.

contraction decreases shadow bank growth. Whilst the result is contrary to previous studies, we argue that it suggests the dominance of commercial banks in shadow banking activities of emerging countries. Furthermore, we find that reduction in bank risk increases shadow banking and reduces that pass-through effect of monetary policy to shadow banks. We interpret this to imply the effect of bank risk-taking on both monetary policy and shadow banking. In addition, the study reveals the short-term behaviour of the trade-off between bank credit and shadow banking. Therefore, monetary policy authorities should factor in financial market developments in conducting monetary policy.

Our results have important implications for regulation, pointing firstly to the need to consider risk factors in analysing monetary policy effectiveness. Pass-through strength of monetary policy rates through the non-bank financial sector and the banking sector is affected by the resilience of the financial sector. The impact of monetary changes is most felt in countries with a relatively unstable financial sector. Further studies can explore this channel of monetary policy using disaggregated data.

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Notes

1. The Financial Stability Board (FSB) defines shadow banking as, “credit intermediation involving entities and activities (fully or partly) outside the regular banking system”. The study adopts this definition.
2. Complete Mathematical derivation is available on request. The model is however simple to follow.

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