

DOES INTERNATIONAL MONETARY POLICY INFLUENCE THE BANK RISK? EVIDENCE FROM INDIA

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ABSTRACT

This study empirically examines the impact of international monetary policy on bank risk in the Indian context. Using annual data from 64 banks and employing panel OLS and GMM techniques, this study finds that: (1) a contractionary international monetary policy increases bank risk; (2) an appreciation of the domestic exchange rate induces bank riskiness; (3) the domestic monetary policy affects bank risk through the “search for yield” channel; and (4) the international monetary policy is relatively significant in explaining the bank riskiness in the post-global financial crisis period.

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I. INTRODUCTION

This paper examines the impact of international monetary policy on the bank risk.¹ The higher liquidity due to the prolonged low interest rate in the advanced economies prior to the Global Financial Crisis (GFC), induced the commercial banks to involve in risky lending activities and which subsequently created instability in the financial system (Colletaz *et al.*, 2018). This risk-taking behavior of commercial banks was considered as one of the key reasons for the culmination of the GFC. As a healthy banking system is one of the prerequisites for economic stability, when a bank is fragile, the entire financial system becomes risky due to its integration with other banks (French *et al.*, 2015). Specifically, contagion and interconnectedness transform bank risk into systemic risk (Kabundi and De Simone, 2019). Further, the notion that “*riskier banks contribute more to systemic risk*” emphasized the significant collective role of individual sound financial institutions in building a stable financial system (Tchikand and Tatiana, 2016). Thus, information related to riskiness of the banks operate in the economy is critical in the policy perspective to maintain financial stability. It is argued that in a financially integrated world, the international monetary policies often induce commercial banks to engage in risky activities (Bruno and Shin, 2015a, 2015b). In other words, the shocks pertain to the monetary policies of the developed economies transmit to other integrated economies or *peripheral* economies, which subsequently results in fluctuations in the economic activities of later economies (Kearns *et al.*, 2018). Thus, the monetary policy of advanced economies often affects the credit lending behavior of the banks in the integrated economies (Borio and Zhu, 2012). Therefore, it is indispensable to understand the nature of the responses of the domestic banks to the international monetary policies to frame appropriate domestic policies to safeguard the economy from such international monetary policy spillover.

Theoretically, the impact of global monetary policy on bank risk is explained through the risk-taking channel and portfolio rebalancing channel. The risk-taking behavior is explained through various behavioral models such as search for yields and exchange rates.² As per risk-taking channel, an expansionary global monetary policy leads to a reduction in the global interest rate and which subsequently increase in lending activities of the banks’ in the peripheral economies and thereby involved in risk-taking activities (Bruno and Shin, 2015a, 2015b; Morais *et al.*, 2019).

¹ International monetary policy and foreign monetary policy are used interchangeably in the text.

² In the domestic context, a reduction in the policy rate leads to an increase in lending and a subsequent surge in economic activities (Kashyap *et al.*, 1993; Bernanke and Gertler, 1995; Bernanke *et al.*, 2005). This genus of modulation in lending can alter the economy’s stability, which is evident in banks’ risk-taking behavior (Rajan, 2005; Jiménez *et al.*, 2013, 2014; Dell’Ariccia *et al.*, 2014). Due to an expansionary monetary policy, banks are exposed to riskiness on both the asset and liability side. Banks’ search for yield behavior increases the proportion of risky assets on the asset side (Rajan, 2006). This will induced them to use more short-term funding (Adrian and Shin, 2010; Stein, 2012), which impacts the liability side. Thus an improvement in the valuation followed by low interest rate stimulate riskiness (Adrian and Shin, 2010). Similarly, an increase in the price level due to the expansionary monetary policy simultaneously increases the collateral values and reduces the borrowing constraints. In such a context, banks substitute safer assets with riskier assets and ultimately increase the risk of bank portfolios (Colletaz *et al.*, 2018). Thus in general, along with the quantity of credit, monetary policy also affects the quality of credit, which is a crucial factor influencing the economy’s stability.

The higher lending takes place through searching a higher yield or interest rate by the banks in the peripheral economies (Morais *et al.*, 2019). Further, increased global capital inflows due to lower global interest rate leads to the appreciation of the domestic currency, which in turn reduces the foreign currency liability of the commercial banks and thus leads to higher risk-taking (Bruno and Shin, 2015a, 2015b). However, the lower global interest rate can lead to an increase in the bank stability or reduces the level of risk due to higher availability of funds and lower foreign currency liability (Durdu and Zhong, 2019). In contrast to this preposition, the portfolio rebalancing channel states an expansionary global monetary policy reduces the availability of funds in peripheral economies. This is because of the lower global interest rate increases the net worth and collateral values of the global borrowers and thus become creditworthy (Correa *et al.*, 2018; Buch *et al.*, 2019; Hills *et al.*, 2019).

While analyzing the existing literature, there are a plethora of studies which focussed on the impact of global monetary policy on the macroeconomic fundamentals of the integrated economies such as output, interest rate, value of currency, capital flows, global uncertainty, and equity prices (Bluedorn and Bowdler, 2011; Chinn, 2013; Bruno and Shin, 2015a; Feldkircher and Huber, 2016; Kiendrebeogo, 2016; Tillmann, 2016; Dedola *et al.*, 2017; Tong, 2017; Curcuru *et al.*, 2018; Ganelli and Tawk, 2019; Iacoviello and Navarro, 2019; Pham and Nguyen, 2019; Degaspero *et al.*, 2020; Ilzetzki and Jin, 2021). However, in the context of global monetary policy and bank risk, we could review only few studies. For instance, the evidence suggests that global monetary policy leads to higher risk-taking in Emerging Market Economies (EMEs) (Bruno and Shin, 2015a, 2015b; Morais *et al.*, 2019; Albrizio *et al.*, 2020). Similarly, in the context of level of bank risk and its stability, Cecchetti *et al.* (2017, 2020) and Tong (2017) find that the expansionary monetary policy in the United States (US) leads to bank riskiness in other advanced and EMEs. However, Hussain *et al.* (2020) find that a lower global interest rate increases bank stability in China. Whereas, Barroso *et al.* (2016) found a weak impact of foreign monetary policy on bank risk in Brazil. Even though, all these studies focus on the global monetary policy from banking sector perspective, these studies failed to have an unblemished concise on the impact of global monetary policy on the periphery economy banking stability. Similarly, none of the studies provide a clear implication of international monetary policy on bank riskiness in EMEs, and address the channels through which the international monetary policy affects the bank risk, or compared the relative importance of various channels through which bank risk-taking occurs. Apart from this, it is evident from the country-specific studies that there is a possibility of heterogeneous impact of international monetary policy on bank risk-taking across the economies. Thus, there is a need for country specific study to understand the heterogeneous impact of international monetary policy on bank risk as compared to the existing panel studies such as (Bruno and Shin, 2015a, 2015b; Cecchetti *et al.*, 2017; Tong, 2017; Albrizio *et al.*, 2020; Cecchetti *et al.*, 2020).

Finally, it is also important to know whether there is any change in the channels of risk-taking in the period of the post-GFC, during which many advanced economies aggressively followed expansionary monetary policies. Thus, this study fills the above gaps by addressing the following research questions: (1)

Does the international monetary policy affects the bank risk? (2) If yes, which are the key channels through the transmission take-place? (3) Did the GFC alter the transmission channels of bank-risk taking?

We address above research questions by considering the case of India, which is one of the leading EMEs³ in the world. The following approaches are adopted in this paper to address the above research questions. (1) We measure the riskiness of commercial banks using Z-score; (2) We estimate an empirical model of bank risk using panel framework, by including a proxy for international monetary policy, and tested various channels of risk-taking; (3) We estimate bank risk for pre- and post-GFC to examine the role of GFC. (4) Finally, we employ dynamic Generalized Method of Moments (GMM) to check the robustness of the results.

Our empirical findings show that: (1) a significant impact of foreign monetary policy on bank risk in India; (2) an expansionary global monetary policy leads to a decrease in bank risk in India, which invalidates the risk-taking channel; (3) the domestic monetary policy affects through 'search for yield' channel; (4) exchange rate channel plays an important role in bank riskiness, i.e., appreciation of the domestic currency significantly increases the bank risk; and finally, (5) the international monetary policy has a significant effect on bank risk during the post-GFC compared to the pre-crisis period.

Our study contributes to the existing literature in the following ways. First, this is one of the first attempts to empirically analyze the various theoretical channels of risk-taking in the context of international monetary policy. Second, this study compares the differential impact of foreign monetary policy on bank risk-taking during the pre and post-crisis period. Third, the present study is the first attempt to address the impact of international monetary policy on banks' risk-taking behavior in the Indian context. Fourth, our empirical findings of the role of global monetary policy and exchange rate in banking sector risk have important implications in the policy making of EMEs. Finally, our findings based on country specific analysis uncover various dynamics of bank risk in the presence of international monetary policy.

This paper is organized in the following manner. Section II summarizes the extant literature while Section III specifies the empirical model. Section IV explains the data while Section V discusses the empirical findings. Finally, Section VI concludes this study.

³ We consider India for this analysis due to several reason. India is one of the fastest growing emerging market economy which started liberalising its economy form early nineties onwards for better stability and growth. The financial sector contributed to the growth of the economy significantly. The banking sector have more than 60 per cent of the total assets of the Indian financial system and banks are the major source of credit in the economy (RBI, 2009). The domestic credit provided by Indian banks as a percentage of GDP is increased from 22.5% in 1995 to 52.4% in 2013 (World Development Indicators). In this scenario, perceived domestic macroeconomic and global risk is a concern for the stability of banking sector in India (RBI, 2015). Thus analysing the stability and risk structure of the Indian banks are essential for maintaining financial stability.

II. A BRIEF REVIEW OF LITERATURE

In the literature, banks' risk-taking behavior is predominantly explained by searching for yield and exchange rate channels (Brunnermeier, 2001; Rajan, 2006; Kearns and Patel, 2016; Niepmann and Schmidt-Eisenlohr, 2017). As per the search for yield channel, a reduction in interest rate reduces the banks' profit. Thus, commercial banks involve in risky investments to search for higher yields (Brunnermeier, 2001; Rajan, 2006). It is also argued that in order to retain the incentives and bonuses, the managers of the banks often divert lending to the riskier avenues when the policy rate is low. Whereas, the exchange rate channel states a decrease in global policy rate leads to an appreciation of the domestic currency, which leads to risk-taking by the banks through increasing leverage (Bruno and Shin, 2015a, 2015b). In other words, when a home currency appreciates, its value of foreign denominated liabilities falls in terms of domestic currency as compared to the assets side, which increases the net worth of the bank as a borrower and which subsequently increases leverage and risk-taking behavior (Hofmann *et al.*, 2016; Agarwal, 2019). Supportive to financial channel, Kearns and Patel (2016) argued that banks' credit quality is sensitive to exchange rate variations, especially when the banks hold high level of foreign currency-denominated debt. Further, Kalemli-Ozcan *et al.* (2018) found higher risk-taking by firms with higher foreign currency debt and compared to the tradable sector, the non-tradable sector has a higher impact. Niepmann and Schmidt-Eisenlohr (2017) studied the exchange rate's role in risk-taking and stated that the exchange rate could impact the bank credit through the agent's balance sheet.⁴

The empirical studies also show that the past policies generate moral hazards and simultaneously impact risk-taking (Gennaioli *et al.*, 2015; Thakor, 2015). The prolonged low interest rate and bailout packages of governments also encourage the banks to involve in risk-taking activities (Maddaloni and Peydró, 2011; Farhi and Tirole, 2012; Chodorow-Reich, 2014). The risk-taking behavior of banks during low interest rates is found in the case of Bolivia (Ioannidou *et al.*, 2015), Vietnam (Ha and Quyen, 2018), and Portugal (Bonfim and Soares, 2018). However, in the context of Vietnam, Dang (2020) finds no evidence of policy rate on risk-taking. Interestingly, Paligorova and Santos (2017) found that banks charge a lower risk premium on risky borrowers during easy monetary policy conditions as compared to tight monetary policy conditions in the US context. Along with the policy variables, the macroeconomic variables such as output, inflation, country's openness to the international market, and the exchange rate also affect risk-taking behavior of the banks. For instance, a higher GDP growth rate reduces bank risk (Jiménez *et al.*, 2014; Ramayandi *et al.*, 2014), and higher inflation leads to a rise in the value collateral and increases the stability of banks (Wang and Luo, 2019). On the other hand, country's openness increases competition among banks and reduces profitability, which encourages risk-taking (Luo *et al.*, 2016; Bui and Bui, 2020). However, openness may reduce the bank risk through market discipline

⁴ When a country experiences depreciation of the exchange rate due to the expansionary monetary policy. If the market agents possess foreign currency-denominated debt in their balance sheet, the depreciation of the exchange rate leads to increase the debt burden. This increased liability makes the borrower riskier, and banks will reduce lending in the economy and become risky.

(Boyd and De Nicolo, 2005; Klomp and De Haan, 2014; Bui and Bui, 2020). Apart from the above macroeconomic factors, the bank size also determines the risk-taking behavior of the banks. For instance, Bourgain *et al.* (2012), Tchikand and Tatiana (2016), and Geng *et al.* (2016) find that banks with larger sizes are associated with relatively higher risk-taking. Contrarily, Hussain *et al.* (2020) find bank size does not significantly affect the risk-taking channel in the Chinese banking sector.

In sum, from the above discussion of literature we find that focus of the literature on the impact of global monetary policy especially on risk taking is gaining attention in the recent years, and there is a lack of concise in the impact global monetary policy on the bank risk in EMEs. Apart from this lack of concise, there exists differential impact in the individual country based studies which demand further in depth exploration. Thus, our study fills this research gap and contributes to the present literature as discussed in the introduction section. We summarise the findings of relevant literature in Appendix A.

III. EMPIRICAL MODEL

To test the impact of international monetary policy on bank risk, we estimate the following regression model:

$$Risk_{it} = \beta_0 + \beta_1 i_t^* + \beta_2 i_t + \beta_3 er_t + \beta_4 y_t + \beta_5 Infla_t + \beta_6 Asst_{it} + \epsilon_{it} \quad (1)$$

where the dependent variable $Risk_{it}$ denotes bank risk. Whereas i_t^* and i_t denote global and domestic interest rates, respectively. Similarly, er_t , y_t , $Infla_t$, $Asst_{it}$ denotes exchange rate, domestic output, inflation, and bank's assets, respectively. The subscript i stands for banks; t denotes time; β_0 is the intercept; β_1 , β_2 , β_3 , β_4 , β_5 , and β_6 are the parameters to be estimated; and ϵ_{it} stands for the error term.

The dependent variable $Risk_{it}$ measures the level of risk of the banks and is proxied using the Z-Score. A high Z-score implies lower the risk or higher the stability, and a low value Z-score implies higher the risk and lower the stability of bank. The impact of global monetary policy (i^*) on bank risk can be positive or negative. A positive effect implies that if an expansionary global monetary policy (a decline in i^*) results in an increase in lending and thereby increase in the risk indicates the presence of international bank lending channel (Morais *et al.*, 2019). The impact is negative, when the banks rebalance by shifting their lending from domestic to global investors whose creditworthiness is improved due to the reduction global interest rate, then it can reduce the risk-taking activities of the banks in the home economies and thereby increase the bank's stability (Correa *et al.*, 2018). In sum, if the international bank lending channel persists, then we expect a positive relationship between i^* and $Risk$ ($\beta_1 > 0$), whereas if portfolio rebalancing channel exists, the relationship is expected to be negative ($\beta_1 < 0$).

The variable i is expected to have a positive effect on the risk of the banks as increase in domestic interest rate leads to a decrease in risk ($\beta_2 > 0$). In other words, a reduction in the domestic policy rate increases the risk-taking through search for yield, and decreases the stability (Delis and Kouretas, 2011; Borio and Zhu, 2012; Wu *et al.*, 2017). Similarly, the er is expected to have a negative relationship

with the Z-score as an increase (appreciation) of the exchange rate leads to higher leverage and risk-taking ($\beta_3 < 0$). Likewise, y is expected to have a positive effect on Z-score, i.e. $\beta_4 > 0$, as better economic conditions raise the profitability of banks due to higher demand for credit (Kashyap *et al.*, 1993; Ramayandi *et al.*, 2014; Wu *et al.*, 2017).

The variable, *Infla*, can affect the Z-score positively or negatively. If inflation leads to an increase in nominal interest rates then it can increase stability ($\beta_5 > 0$). However, if inflation increases the cost of borrowing, thereby increasing the default risks, then it can lead to a decrease in stability, i.e., $\beta_5 < 0$ (Demirgüç-Kunt and Huizinga, 2010; De Nicolò *et al.*, 2010; Angori *et al.*, 2019). Finally, the variable, *Asst*, is expected to have a negative relationship with the Z-score as a larger size has a stronger motivation to engage in risky activities, leading to greater risk, hence $\beta_6 < 0$ (Geng *et al.*, 2016).

We conduct the empirical analysis using the following steps. First, we estimate Equation (1) using panel data regression. Based on the Hausman test result, we select the appropriate model for interpretation of findings, i.e., whether it is fixed or random effect model. Second, we estimate Equation (1) using data for the pre- and post-GFC period. Finally, we use the Generalised Method of Moments (GMM) method to ensure the dynamic relationship between the variables are robust.⁵

IV. DATA AND VARIABLE MEASUREMENT

A. Data

We utilize the annual data from 1999 to 2017.⁶ The total sample consists of 64 banks, which includes nationalized banks, private sector banks, foreign banks, and the State Bank of India and its associates. The remaining variables are obtained from the Federal Reserve Bank of St. Louise, Reserve Bank of India (RBI), the Bank of International Settlements (BIS), World Bank, and CEIC databases. A detailed description of the calculation of Z-score is explained below.

B. Variable Measurement

We measure the bank risk by calculating Z-score following (Laeven and Levine, 2009; Houston *et al.*, 2010; Chen *et al.*, 2017; Wu *et al.*, 2017; Danisman and Demirel, 2019). Z-score is an accounting-based risk measure which capture the balance-sheet vulnerability and includes both credit risk and market risk and thus represents the bank-risk taking (Brandao-Marques *et al.*, 2013; Brana *et al.*, 2019) and measure overall risk of the bank (Demirgüç-Kunt and Huizinga, 2010; Wu *et al.*, 2017; Hussain *et al.*, 2020). Larger values for the Z-score imply lower risk-taking and, thus, greater bank stability. In general, this measure reflects the probability of a bank's insolvency risk based on the amount of buffer the bank must guard against shocks to earnings (Luo *et al.*, 2016). The Z-score is formally expressed as:

⁵ We do not describe these methods in the text due to space restrictions. Please refer Hansen (1982) for GMM.

⁶ We limit the data till 2017 to incorporate the maximum number of banks into the analysis. After 1st April 2017, the number of banks operating in India has declined due to merging activities of the State Bank of India (SBI) (one of the leading banks in the country) with other state-run banks.

$$Z_{it} = \frac{RoA_{it} + EAR_{it}}{\sigma(RoA)_{it}} \quad (2)$$

where i and t represent bank and time, respectively, Z_{it} represents the Z-Score; RoA_{it} denotes the return on asset; EAR_{it} represents the equity to asset ratio; the denominator $\sigma(RoA)_{it}$ means the standard deviation of return on asset.

Similarly, the variable global interest rate is proxied by the US federal fund rate⁷ and domestic interest rate is proxied by weighted average call money rate. Exchange rate, output, and inflation are proxied by nominal effective exchange rate, growth rate of real GDP, and CPI based inflation rate, respectively. Likewise, the size of the bank is proxied by the banks' assets. Exchange rate and assets are measured in log form. Further details on data are provided in Table 1.

Table 1.
Details of Variables and Data Source

This table presents the variables description, expected sign based on the previous studies, and their sources.

Variable	Description	Expected Sign	Source
<i>Z-Score</i>	Log of Z-Score.		Authors calculation
<i>i*</i>	Federal fund rate of the US	+/-	Federal reserve bank of St. Louise
<i>i</i>	Weighted average call money rate.	+	RBI
<i>er</i>	Log of the NEER.	-	BIS
<i>y</i>	Growth rate of real GDP of India.	+	IMF
<i>Infla</i>	Inflation based on consumer price index.	+/-	WDI
<i>Asst</i>	Assets of the banks in log form.	+/-	CEIC

V. EMPIRICAL FINDINGS

We present the descriptive statistics in Table 2. We also check the multicollinearity among the variables through the Variance Inflation Factor (VIF) and report these results in Table 3. Our tabulated results confirm the absence of multicollinearity among the variables where the maximum value of VIF is 2.677. Since the VIF value is much lower than the benchmark of 10, we proceed with further analysis.

⁷ Being the world's largest economy, the US influence the global economic activities. Specifically, US monetary policy significantly impact the global variables (Rey, 2016). Supportively, Cerutti and Osorio-Buitron (2020). confirmed that US monetary policy plays more global role compared to Euro area monetary policy. Thus, following Takáts and Vela (2014), Hausman and Wongswan (2011) and Barroso *et al.* (2016), we use the US monetary policy as the proxy for global policy rate.

Table 2.
Descriptive Statistics

This table presents descriptive statistics of variables used in this study, which includes Z-score, federal fund rate (i^*), weighted average call money rate (i), exchange rate (er), output (y), inflation ($Infla$), and assets ($Asst$). Our data spans the period 1999 to 2017.

Variable	Obs	Mean	Std. Dev.	Min	Max
Z-Score	1216	2.672	0.619	-1.136	4.233
i^*	1216	1.930	2.040	0.089	6.236
i	1216	6.805	1.527	3.290	9.150
er	1216	4.587	0.171	4.316	4.796
y	1216	7.226	1.955	3.900	10.300
$Infla$	1216	6.353	2.776	2.491	11.989
$Asst$	1216	11.797	2.392	5.706	17.114

Table 3.
Correlation Table and Variance Inflation Factor Values

This table presents the correlation and Variance Inflation Factors (VIF) of variables used in this study. Variable details are provided in Table 1. VIF implies the mean VIF values of all variables.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Z-Score	1.000						
(2) i^*	-0.124	1.000					
(3) i	0.037	0.189	1.000				
(4) er	-0.112	0.731	-0.077	1.000			
(5) y	0.053	-0.036	-0.130	-0.095	1.000		
(6) $Infla$	0.072	-0.136	-0.022	0.032	-0.067	1.000	
(7) $Asst$	0.009	-0.266	0.031	-0.348	0.058	0.028	1.000
VIF	1.628	2.648	1.194	2.677	1.044	1.068	1.141

Table 4 reports results obtained from Ordinary Least Squares (OLS), Fixed Effect (FE), and Random Effect (RE) models. Among these models, the FE model is chosen over the random effect model based on the Hausman test results. The findings from the FE model shows a significant and inverse relationship between the global interest rate (i^*) and the Z-score, which implies a decrease in global interest rate leads to an increase in bank stability. This can be due to the higher availability of funds with the banks which in turn improve the balance sheet of the banks. This finding invalidate the international risk-taking channel in the Indian context as the risk of the banks not increased due to lower global interest rate. This can be attributed to the stringent lending norms in India, which does not induce the banks to involve in risk-taking activities in the presence of higher liquidity. Further, the existence of a positive interest rate differential between India and global rates induces the capital inflow which strengthen the banks (Verma and Prakash, 2011). Further, the low risk taking in India may be attributed to portfolio rebalancing activities by banks, as a rise in the global policy rate increases the risk of lending in foreign economies⁸ as the global banks reallocate credit to relatively

⁸ Due to a decrease in the net worth and collateral values of the borrowers in the centre economy.

safer borrowers in foreign economies. A similar finding is reported by Correa *et al.* (2018), Choi and Furceri (2019), and Auer *et al.* (2019) in the EME context. Similarly, Shareef and Prabheesh (2020) find evidence of portfolio rebalancing channel while analyzing the impact of international monetary policy on foreign bank credit in India.

Table 4.
Results Based on Fixed and Random Effect Models

This table presents results of fixed and random effect models employed in this study. The dependent variable is the riskiness of banks proxied with $Z\text{-Score}_{it}$. The last rows of the table report constant, adjusted R^2 , F -statistic, and Hausman test result, and the number of observations considered for analysis, respectively. The standard error is reported in the parenthesis except for Hausman test where values in the parenthesis represent the probability value. Lastly, ** and *** denotes the statistical significance at the 5% and 1% levels, respectively.

Variables	(1)	(2)	(3)
	OLS	FE	RE
i^*	-0.033** (0.014)	-0.037*** (0.007)	-0.036*** (0.007)
i	0.026** (0.013)	0.030*** (0.007)	0.029*** (0.007)
er	-0.139 (0.168)	-0.995*** (0.126)	-0.718*** (0.117)
y	0.019** (0.009)	0.026*** (0.005)	0.024*** (0.005)
$Infla$	0.016** (0.007)	0.022*** (0.004)	0.020*** (0.004)
$Asst$	-0.010 (0.008)	-0.196*** (0.020)	-0.136*** (0.017)
Constant	3.370*** (0.785)	9.444*** (0.765)	7.479*** (0.683)
Adj R^2	0.023	0.106	
F -stat	5.696	35.400	
Hausman test		30.259 (0.000)	
Observations	1216	1216	1216

Table 4 also shows that the variable domestic policy rate (i) is positive and statistically significant in explaining Z -score, which implies that an increase in the domestic policy rate increases the bank stability. In other words, a reduction in domestic policy rate leads to a reduction in stability of banks as banks lend more and taking more risk to maintain their normal profit during low-policy rate. This finding support the “search for yield” behaviour of banks (Rajan, 2005). Our result is also in line with the findings of Geng *et al.* (2016) and Sarkar and Sensarma (2019) in the Indian context.

Similarly, the er exhibits a negative and statistically significant relationship with Z -score, implying an appreciation of the domestic exchange rate increases the banking sector risk. This can be attributed to the higher lending activities of the commercial banks in India during the period of exchange rate appreciation. When

exchange rate appreciates, the overall liability of the banks decreases, which in turn induce the banks in involving risk-taking activities. Our result is in line with the risk-taking channel of the exchange rate in the banking system (Kearns and Patel, 2016; Sehgal and Agrawal, 2017; Kalemli-Ozcan *et al.*, 2018; Agarwal, 2019). The impact of the y on stability is statistically significant and positive as expected. Thus, an increase in the level of income in the economy leads to a reduction in bank risk-taking. This relationship supports the argument that an increase in the GDP implies a rise in the income and subsequent increase in the repayment ability of the borrowers which result in the reduction of default risk of the overall banking sector in the economy (Kumar *et al.*, 2018). The variable *Infla* is also found to have a positive effect on Z-score, which implies when the inflation increases, the bank stability also increases, or riskiness decreases due to increase in the net worth. These results align with the findings of Gulati *et al.* (2019) in the Indian context.

Exploring the impact of the *Asst* on their risk-taking, we find a statistically significant and negative relationship between the size of the banks and their risk-taking. Specifically, larger banks are characterized by higher risk-taking. This finding contradicts the argument of large banks' ability to portfolio diversification and economies of scale, reducing their risk exposure (Abedifar *et al.*, 2013; Tan, 2016). At the same time, our finding aligns with Brana *et al.* (2019), which supports that those larger institutions and banks' concentration ultimately reflect risk-taking in Europe. Similarly, De Nicolò *et al.* (2010) provided evidence that a reduction in the policy rate leads to higher risk-taking by the highly capitalized banks in comparison to the low capitalized banks and also support the argument of Sehgal and Agrawal (2017) that large-sized banks in India are more exposed to equity risk.

Table 5 reports the findings from sub-sample analysis, i.e., the pre- and post-GFC, 2008. It can be observed that during the pre-GFC, the impact of the global interest rate is not significant on Z-score. Whereas during the post-GFC, the impact is negative and statistically significant, implying a reduction in global interest rate decrease the bank risk. These findings clearly reveal that the risk-taking behavior of the banks has been altered by the GFC. The decrease in risk-taking behavior of the banks during the post-GFC can be attributed to the reduction in the global interest rate and increased global liquidity due to the expansionary monetary policies of the advanced economies. This significant negative relationship during post-GFC period can be attributed to the flight to quality concern where, an expansionary foreign monetary policy leads to rebalancing towards the less risky global borrowers and simultaneous increase in the global liquidity.

Table 5.
Pre and Post-crisis Based Results

This table reports results of fixed and random effect models using two sub-sample periods: pre-crisis (1999-2007) and post-crisis (2008-2017) periods. The dependent variable is the $Z\text{-Score}_{it}$. The last rows of the table report constant, adjusted R^2 , F-statistic, Hausman test result, and the number of observations considered for analysis, respectively. Finally, ** and *** denote the statistical significance at the 5% and 1% levels, respectively, and values in parenthesis indicate standard errors except for Hausman test where values in the parenthesis represent the probability value.

Variables	(1)	(2)
	Pre-Crisis (FE)	Post-Crisis (FE)
i^*	-0.036 (0.039)	-0.096*** (0.026)
i	0.077 (0.074)	-0.007 (0.007)
er	-3.037** (1.459)	-0.295** (0.126)
y	0.012 (0.03)	-0.024*** (0.009)
$Infla$	0.003 (0.026)	-0.002 (0.004)
$Asst$	-0.252*** (0.041)	-0.218*** (0.032)
Constant	19.806*** (7.202)	7.001*** (0.892)
Adj R^2	0.050	0.077
F-stat	16.549	20.408
Hausman test	21.805 (0.001)	23.774 (0.001)
Observations	576	640

A. Robustness Check with GMM Method

Table 6 summarises the dynamic relationship between the variables analyzed with the help of the GMM method. Our robustness check findings further confirm the significant effect of international monetary policy on the risk-taking of the Indian banks and corroborate with the findings from the earlier section.

Table 6.
The Robustness Check Results

This table reports results obtained using the dynamic GMM approach. The dependent variable is $Z\text{-Score}_{it}$. Other variables considered in the model includes the following: lagged value of Z-score ($Z\text{-Score}_{it-1}$), federal fund rate, call money rate, exchange rate output, inflation, assets, and constant. The respective t -statistics are reported in the parenthesis. The number of observations included in the model and the diagnostic test results such as Autocorrelation (AR) and Sargan tests are reported in the subsequent rows in the above order. Finally, *** denotes statistical significance at the 1% level.

Variables	Coefficient
$Z\text{-Score}_{it-1}$	0.553*** (83.670)
$i^{\wedge*}$	-0.022*** (-18.540)
i	0.015*** (17.460)
er	-0.477*** (-21.240)
y	0.011*** (13.910)
$Infla$	0.013*** (33.860)
$Asst$	-0.125*** (-27.370)
Constant	4.834*** (33.580)
Number of observations	1088
AR	0.476 (0.713)
Sargan test	62.734 (1.000)

VI. CONCLUSION

The world witnessed the integration of economies in diverse fields over the past couple of decades. As a result of this integration, events in these economies are also intertwined. This scenario encouraged the policymakers to widen their decision-making information set by incorporating events in the foreign economies. One such event is the foreign monetary policy and its impact. Thus, in this study, we analyze the impact of international and domestic monetary policy on banks' risk-taking in India - one of the major emerging market economies. We employed various panel data regression methodologies, such as fixed and random effect models and GMM using annual data over the period 1999 to 2017. This study finds that international monetary policy significantly impacts the risk-taking of banks in India. Thus, while managing the banking sector's riskiness in the economy, policymakers should also consider the international monetary policy. The risk that emerges from the global fund flows due to global monetary policy conditions abroad should be observed for their potential to ignite bank risk-taking in the economy. Simultaneously, evidence of the search for the yield channel of the domestic policy rate is also stated. Our findings also establish a significant role of the exchange rate in the banks' risk-taking. Thus, the policy information set for the stability of banks in the country should be enriched by incorporating both international and domestic monetary policy and exchange rates in the economy.

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Appendix A: Selected Review of Related Papers

This table summarises the selected literature focusing on the impact of various factors on the risk-taking of banks.

Authors	Country of Focus	Methodology and Sample Period	Variables of Interest	Major Findings
Jiménez <i>et al.</i> (2014)	Spain	Maximum likely hood estimation. 1984 Q4 - 2006 Q4	GDP Short term interest rate	Higher GDP growth reduces bank riskiness. Lower short-term interest rates motivate banks to soften their lending standards and grant more loans to borrowers with a bad or no credit history.
Ramayandi <i>et al.</i> (2014)	Hong Kong, China, India, Indonesia, the Republic of Korea, Malaysia, Philippines, Singapore, Taipei, China, and Thailand.	Dynamic GMM 2000 - 2011 and 2003 Q1 - 2011 Q4.	GDP Interest rate Z score	Higher GDP reduces the overall risk of the bank. A low interest rate increases risk-taking.
Gulati <i>et al.</i> (2019)	India	Two-step system GMM. 1998 - 2013	GDP Bank size	No significant relation between credit risk and economic activity. Large Bank size increases the probability of default.
Chavan and Gambacorta (2019)	India	Dynamic GMM 2000 - 2004	GDP NPL	An increase in GDP leads to a decline in the NPL ratio. Loan growth leads to increase NPL.
Kearns and Patel (2016)	44 countries: 22 advanced economies and 22 EMEs.	ARDL 1990 Q1 - 2016 Q3	Exchange Rate	Compare financial channel and trade channel and find that financial channel partly offset the trade channel.
Agarwal (2019)	Switzerland	Difference-in-differences estimation 2011 - 2016	Exchange Rate	Appreciation leads to increase in credit supply by banks with net foreign currency liability exposure.
Kalemli-Ozcan <i>et al.</i> (2018)	China, Chinese Taipei, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand.	Dynamic system GMM and OLS Data from 2002 - 2015	Exchange Rate	Risk-taking channel of the exchange rate in EMEs. Appreciation leads to higher risk-taking by firms with higher forex debt.
Karim <i>et al.</i> (2016)	Indonesia	ARDL 1999 - 2013	Z-Score	GDP and inflation have a positive impact on stability, whereas interest rates have a negative impact.

Appendix A: Selected Review of Related Papers (Continued)

Authors	Country of Focus	Methodology and Sample Period	Variables of Interest	Major Findings
Niepmann and Schmidt-Eisenlohr (2017)	US	OLS logit and Probit models. 2014Q4 - 2016Q2	Exchange Rate	Depreciation will lead to a reduction of lending in the economy.
Bourgain <i>et al.</i> (2012)	MENA region and Turkey	OLS. 2005 - 2008.	Z-Score	Large bank size leads to high risk-taking. Financial openness of emerging countries positively impacts risk-taking.
Tchikand and Tatiana (2016)	EU-17 economies	2SLS model 1999 - 2013	Z-Score	Large bank size leads to high risk-taking. More individual bank soundness leads to more financial stability
Hussain <i>et al.</i> (2020)	China	Difference GMM method. 2002 - 2012	Z-Score	Bank size, liquidity, and Capitalization do not significantly impact risk-taking.
Geng <i>et al.</i> (2016)	China	Regression Fixed and random effect 2001 - 2012	Non-performing loans to total loans	Interbank market rate and central bank interest rates are positively correlated with bank risk. Bank level lending rate is negatively correlated. Banks with large assets significantly contribute to risk-taking.
Bui and Bui (2020)	42 emerging markets	Panel smooth transition regression (PSTR) 2004 - 2014	Z-Score Openness	Larger bank size leads to more risk-taking. Low level of openness increases risk-taking.
Luo <i>et al.</i> (2016)	140 countries	Dynamic GMM and ARDL 1999 - 2011	Z-Score Openness	Openness increases bank risk through decreasing profit efficiency.
Ha and Quyen (2018)	Vietnam	GMM methodology 2007 - 2016	Z-Score	Low interest rate leads to bank risk-taking. Banks with high market power engage in less risk-taking behavior even during the loose monetary policy. Liquidity credit level and cost inefficiency increase risk-taking. Bank size reduce risk-taking
Kasri and Azzahra (2020)	Indonesia	Two-step system-GMM September 2015 - June 2019	Z-Score	Exchange rate, financial inclusion, asset returns, and credit growth positively influence stability. Interest rates negatively affect stability.