

## Does sectoral loan portfolio composition matter for the monetary policy transmission?

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### Abstract

**Purpose** — The paper empirically explores the conditioning role of loan portfolio diversification in the monetary policy pass-through via the bank lending and risk-taking channels.

**Methods** — Data of Vietnamese commercial banks during 2007–2019 is employed to perform regression using the two-step system generalized method of moments in dynamic panel models. For robustness, we approach different choices of monetary policy indicators, ranging from interest-based tools to quantitative-based policy, and consider a rich set of sectoral exposure measures to proxy loan portfolio diversification.

**Findings** — Lower interest rates or greater liquidity injection during monetary expansion may increase bank lending and bank risk, thus confirming the working of the bank lending and risk-taking channels of monetary policy transmission. Notably, the potency of these banking channels may be weakened for banks diversifying loan portfolios more into various economic sectors.

**Implication** — The findings call for monetary authorities to concentrate on certain types of banks, depending on their loan portfolios when setting monetary policy. When managing banking supervision, banking supervisors should also acknowledge the tradeoff between bank lending and bank risk in response to monetary shocks.

**Originality** — For the first time, this paper explores the conditional role of loan portfolio composition and thus further supports the recent upsurge in empirical studies highlighting the role of business models in monetary policy pass-through.

**Keywords** — bank diversification, interest rates, liquidity injection, loan portfolios, monetary policy.

## Introduction

Since the 2007–2009 financial crisis, a renewed interest has emerged in exploring banks' role in monetary policy transmission potency. This is specified under the bank lending channel as first Bernanke and Blinder (1988) first suggested, which asserts that monetary policy contraction cuts the number of loanable funds and potentially depresses lending activities if banks cannot gain new funds to reduce loanable ones. Besides quantity, credit quality has also received increasing attention, as monetary policy has often been one of the critical determinants of excessive bank risk-taking, despite the multifaceted causes of the crisis. Consequently, a growing line of research has referred to the monetary policy transmission through the bank risk-taking channel, which posits that

decreased interest rates may enhance banks' risk tolerance. Fundamentally, this banking channel operates in several essential mechanisms, derived from bank incentives to "search for yield" (Rajan, 2006), investment valuation effects (Adrian & Shin, 2010), and communication policies (Borio & Zhu, 2012).

This paper relates to the literature streams on the bank lending and risk-taking channels of monetary policy pass-through. It is well established that if bank incentives are the core of these banking channels' functioning, it could be anticipated that bank characteristics would drive the link between bank lending/bank risk and monetary policy. Accordingly, most papers examine the extent to which banks' characteristics (such as bank size, capital, and liquidity) shape banks' reaction to monetary policy variations (Delis & Kouretas, 2011; Kashyap & Stein, 1995; Sáiz, Azofra, Olmo, & Gutiérrez, 2018). These studies indicate that financially weaker banks (i.e., smaller, less liquid, and more poorly capitalized) are more responsive to monetary shocks because of their limited access to alternative funding. However, in the period of financial innovation, these standard variables are considered inadequate to evaluate banks' ability to make additional loans as well as banks' incentives towards risk-taking behavior. In addition to bank-level factors, some works also emphasize that reforms and changes in the financing may cause transformations in the potency of monetary policy pass-through, mainly through the bank lending channel (Hussain & Bashir, 2019; Leroy, 2014). Nevertheless, most patterns found are ambiguous and limited.

Our work aims to analyze further the interesting topics of the bank lending and risk-taking channels of monetary policy transmission by exploring the conditional role of loan portfolio diversification. Banks' loan portfolio behavior has attracted little attention in the existing monetary transmission literature. Prior research mostly examines the behavior components (for example, real estate loans, consumer loans and business loans) after monetary policy shocks (Den Haan, Sumner, & Yamashiro, 2009). In principle, banks' portfolio diversification matters for the behavior of their operations and thus could broadly influence the transmission effectiveness of monetary policy by weakening or strengthening the banking channels. The shifts towards diversified banking systems from increased market competition could ultimately lead to lower prices of financial products, better access to financing sources, and reduced informational asymmetries (Boot, 2000; Kashyap & Stein, 1995). Portfolio diversification might induce a detrimental effect on bank efficiency due to limited managerial expertise and experience, and it may force banks to engage in risk-taking strategies due to adverse selection (Acharya, Hasan, & Saunders, 2006). Moreover, banks diversify into various economic sectors to earn additional revenues and enhance their market position. Contrary to those that do not prefer diversification, they are more conservative and tend to conserve the outcomes by pursuing less risky projects (Căpraru, Ihnatov, & Pintilie, 2020).

We utilize the financial data of Vietnamese commercial banks during 2007–2019 to perform our empirical analysis. To guarantee the robustness of findings estimated by the generalized method of moments (GMM) estimator, we accept various alternative measures of crucial interest. For the diversification level of loan portfolios, we design a set of six sectoral exposure measures using the Herfindahl-Hirschman index (HHI) along with the Shannon Entropy (SE) index. We analyze both interest- and quantitative-based policy tools for monetary policy indicators, including short-term lending rates, refinancing rates, and security sales/purchases by open market operations. The growth rate of bank loan volume and the Z-score index are the fitted variables that capture bank lending and bank risk in the paper.

Vietnam displays some important features that make it an excellent laboratory to examine our research issue. First, commercial banks constantly hold a dominant position in the financial system and offer a major source of financing for the whole economy. Hence, the association between the banking sector and the monetary policy framework should be particularly conspicuous here (Dang & Dang, 2020; Dang & Huynh, 2021). Second, the State Bank of Vietnam (SBV) frequently combines many monetary policy tools to establish its multiple-goal mandate. In this regard, both interest- and quantitative-based tools are extensively utilized. Third, the influence of portfolio diversification strategies on the potency of monetary policy transmission should have taken much more attention due to the increasing reforms in Vietnam over the years. Concretely, the Vietnamese

banking system has considerably transformed from specialized segments to diversified operations, thereby reconstructing banks' exposures to all economic sectors (Huynh & Dang, 2021).

An emerging group of papers closely related to our work is Gambacorta and Marques-Ibanez (2011) and Dang and Dang (2021). They focus on the moderating role of business models in the association between monetary policy and lending activities. They reveal mixed results, i.e., the negative impact of monetary policy on bank lending is more pronounced for banks adopting a business model tilted towards non-traditional lines in advanced economies during the crisis (Gambacorta & Marques-Ibanez, 2011), whereas the potency of the bank lending channel is weaker as banks prefer non-interest segments in emerging markets during regular times (Dang & Dang, 2021). One key difference from our work is that they explore banks' revenue compositions, while we pay attention to loan portfolio diversification when approaching bank business models. Moreover, the two previous papers only study the bank lending channel. In contrast, we investigate bank lending and risk-taking behavior in reaction to monetary shocks to provide more insight into the moderating role of portfolio compositions in the pass-through mechanism.

The paper exhibits some contributions. While the existing documents favoring the bank-lending and risk-taking channels mainly focus on the conditional roles of multiple traditional bank-specific characteristics, we find no empirical evidence of these banking channels moderated by loan portfolio diversification. Our empirical paper is the first to fill in this gap and thus support the recent upsurge in empirical studies highlighting the importance of business models in the monetary policy pass-through analysis (Dang & Dang, 2021; Gambacorta & Marques-Ibanez, 2011). Additionally, we conduct more applicable to emerging economies by accounting for multiple different monetary policy tools, both interest- and quantitative-based, that the central bank employs to achieve its monetary targets. Considering a rich set of monetary policy indicators allows us to comprehensively assess the transmission effectiveness of monetary policy and the absorption of banks, as each specific policy tool might have different powers and economic outcomes (Varlik & Berument, 2017).

## Methods

### Model Specifications

In this paper, we follow the common logic of the existing literature to examine the heterogeneity across banks based on their different actions following monetary policy changes. In this vein, we specify our model as:

$$Y_{i,t} = a_0 + a_1 \times Y_{i,t-1} + a_2 \times MPI_{t-1} + a_3 \times MPI_{t-1} \times Portfolio_{i,t-1} + a_4 \times Portfolio_{i,t-1} + a_5 \times X_{i,t-1} + a_6 \times Z_{t-1} + u_{i,t} \quad (1)$$

where the subscript  $i$  capture banks and  $t$  illustrate years.  $Y$  is the dependent variable, representing bank lending and bank risk measures, separately. We utilize lagged dependent variable as a regressor to capture the persistence of bank behavior  $MPI$  stands for monetary policy indicators.  $Portfolio$  denotes the diversification degree of loan portfolios.  $X$  includes bank-specific control variables,  $Z$  consists of macroeconomic factors, and  $u_{i,t}$  is the error term. The interaction term  $MPI \times Portfolio$  is intended to indicate the marginal effects of loan portfolio composition on the monetary policy pass-through. We adopt one-period lagged macroeconomic and monetary policy variables since banks cannot react immediately to external shocks. Also, for an extra precaution, all bank-specific factors lagged by one year to defeat the potential endogeneity obstacle due to reverse causality.

We employ the GMM regression with the two-step system version to estimate our proposed dynamic panel model (Blundell & Bond, 1998). This setting accordingly could well tackle the endogeneity problem and offer efficient estimates. The consistency of the GMM estimator needs some diagnostic tests to justify, including the Hansen test for the joint validity of the instrument set, and the Arellano-Bond test for the first- and second-order autocorrelation, namely AR(1) and AR(2), respectively.

## Variables

There are some concerns over using a specialized measurement for a particular type of bank risk. Consistent with the bank lending channel literature, we employ the annual percentage change of banks' customer loans as the dependent variable in the bank lending model. Next, given that a good proxy of bank risk is essential in conducting our analysis, we follow prior authors to use the Z-score index when reflecting bank risk (Beck, De Jonghe, & Schepens, 2013; Chen, Wu, Jeon, & Wang, 2017). Thus, the Z-score index comprehensively assesses a bank's financial stability or reverses overall riskiness. It is calculated by the sum of *ROA* (return-on-asset ratio) and *Capital* (equity-to-asset ratio) divided by  $\sigma(ROA)$  (standard deviation of return-on-asset ratio based on the three-year rolling time window) through the following formula specified as:

$$Z\text{-score} = \frac{ROA + Capital}{\sigma(ROA)} \quad (2)$$

We take the natural logarithm of (1+Z-score) in the regression stage to smooth higher values and evade the truncation of the Z-score index at zero.

In examining how monetary policy influences bank lending and bank risk, we apply monetary policy indicators based on two categories of interest- and quantitative-based policy tools. For the former, we employ short-term interest rates, including average lending rates and refinancing rates, which is a type of policy rate that the central bank uses to charge banks for short-term loans (Dang & Dang, 2020; Rafique, Quddoos, Ali, Aslam, & Ahmad, 2021). For the latter, we focus on the security sales/purchases through open market operations, proxied by the SBV's claims on domestic real nonfinancial sectors as suggested by the previous literature (Mamatzakis & Bermpei, 2016). Not only could the interest rate framework be altered, but the SBV could also use quantitative tools to adjust the liquidity created in the economy. We take the level values of selected interest rates to produce interest-based monetary policy indicators (with a more significant value suggesting monetary contraction). In comparison, we concretely build the quantitative-based monetary policy proxy by the SBV's claims relative to GDP (with a higher value implying monetary expansion).

As a striking point of this paper, we follow Huynh and Dang (2021) by shaping multiple proxies to estimate the diversification level of loan portfolios in Vietnam. The first proxy is the HHI, defined as follows:

$$HHI = 1 - \sum_{s=1}^n x_s^2 \quad (3)$$

The second proxy is the SE index, calculated as follows:

$$SE = \sum_{s=1}^n x_s \times \ln\left(\frac{1}{x_s}\right) \quad (4)$$

In the two equations above,  $x_s$  determines the relative exposure of each sector  $s$ , and  $n$  is the number of sectors. A higher value in these two indicators suggests a higher level of loan portfolio diversification. From an empirical perspective, we divide loan portfolios of Vietnamese banks into six sectoral exposures, containing the top five sectoral exposures (with the highest proportions), and the sixth one is the sum of all remaining exposures. To check whether the estimation results are robust to altering the number of economic sectors, we also consider alternative eight and ten sectoral exposures (see Table 1 for a specific list of alternative portfolio diversification variables).

Supported by the well-known literature on bank lending and risk determinants, we control key bank-level characteristics, including bank size, and capitalization, and liquidity levels (Vo, 2018). These variables have also been widely considered in the literature segment on the bank lending and risk-taking channels. Apart from internal variables, we also allow some macroeconomic factors to control changes in demand-side effects besides the supply-side bank lending and risk-taking channels. These macroeconomic variables introduce economic cycles, inflation, and stock markets (Chen et al., 2017; Dang & Dang, 2021). Please refer to Table 1 for the specific construction of all control variables.

## Sample Data

We obtain data on commercial banks operating in Vietnam during 2007–2019 from their annual financial reports, especially grasping statement footnotes to gain breakdowns of sectoral loan portfolios. Some banks differ in operating regimes to ensure comparability, i.e., acquired banks/banks subject to special control by the SBV are not included. As a result, we produced unbalanced panel data from 31 Vietnamese commercial banks. The monetary policy and macroeconomic data are collected from the SBV (for refinancing rates), the International Financial Statistics (for average lending rates and the SBV's claims), and the World Development Indicators (for inflation rate and GDP growth), and the Vietstock (for VNindex).

**Table 1.** Definitions and summary statistics of variables

	Obs	Min	Max	Mean	SD	Definitions
<i>Bank lending and bank risk measures</i>						
Lending growth	391	-5.159	111.120	29.533	29.671	The annual growth rate of customer loans (%)
Overall riskiness	356	2.625	5.892	3.951	0.875	Natural logarithm of $(1 + Z\text{-score})$
<i>Portfolio indexes</i>						
HHI10	391	0.579	0.870	0.770	0.081	HHI portfolio diversification index from each bank's ten sectoral exposures
SE10	391	1.098	2.161	1.770	0.301	SE portfolio diversification index from each bank's ten sectoral exposures
HHI8	391	0.579	0.859	0.766	0.078	HHI portfolio diversification index from each bank's eight sectoral exposures
SE8	391	1.098	2.013	1.701	0.260	SE portfolio diversification index from each bank's eight sectoral exposures
HHI6	391	0.578	0.816	0.747	0.067	HHI portfolio diversification index from each bank's six sectoral exposures
SE6	391	1.098	1.737	1.549	0.182	SE portfolio diversification index from each bank's six sectoral exposures
<i>Bank-specific characteristics</i>						
Size	391	29.943	34.269	31.972	1.233	Natural logarithm of total assets
Capital	391	4.939	21.884	10.072	4.647	Equity/Total assets (%)
Liquidity	391	5.570	38.193	17.453	9.594	Liquid assets/Total assets (%)
<i>Monetary policy indicators</i>						
Lending rates	391	6.960	16.954	10.400	3.328	Average short-term lending rates (%)
Refinancing rates	391	6.000	15.000	8.042	2.547	Refinancing rates announced by the SBV (%)
Central bank assets	391	0.174	4.205	1.419	1.239	SBV's claims on domestic real nonfinancial sectors/GDP (%)
<i>Macroeconomic factors</i>						
Stock market	391	-65.953	56.761	7.425	29.655	The annual growth rate of the VNindex (%)
Inflation	391	0.631	23.115	7.495	6.226	Annual inflation rate (%)
Economic cycles	391	5.247	7.130	6.245	0.642	The annual growth rate of GDP (%)

Notes: We drop some observations for the Z-score index due to its computation applying the three-year rolling time window.

## Results and Discussion

### Preliminary Statistical Analysis Results

We report the summary statistics for our variables in Table 1. Looking into the distributions of bank-level variables, we recognize their large ranges of extreme values and high standard deviations. This note indicates substantial variations in different features across banks, especially lending expansion, risk profiles, and loan portfolio compositions of main interest. For monetary policy indicators, through their large standard deviations for both interest- and quantitative-based tools, we document

some sizable adjustments in interest rates and money supply during the research time.

We also compute the pairwise correlations between variables (not presented for brevity). For monetary policy indicators and portfolio diversification measures, high correlation coefficients emerge for the variables capturing the same aspect. This observation justifies using different diversification measures as alternative variables and confirms that the SBV combines multiple monetary tools simultaneously when setting its policy framework. For remaining independent variables, they are found not to be excessively highly correlated with each other except for the inflation rate and monetary policy interest rates. Hence, we will proceed to the regression stage without the inflation rate to assure that our estimation design does not cause severe multicollinearity.

### Estimation results for the bank lending channel

Employing different monetary policy interest rates in the bank lending model, we obtain groups of results reported in Tables 2–3. Most coefficients on both lending rates and refinancing rates are negative and statistically significant, revealing the presence of the bank lending channel: lower interest rates amid monetary policy expansion boosts banks' lending activities. Next, for the interaction term of monetary policy indicators and portfolio diversification, its coefficient is positive and statistically significant in most columns. These results imply that increased portfolio diversification in the banking market is linked with a weaker bank lending channel.

**Table 2.** Estimation results for the bank lending channel using lending rates as a monetary policy indicator

	Dependent variable: Bank loan growth					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Lagged dependent variable	0.361*** (0.020)	0.360*** (0.020)	0.358*** (0.020)	0.368*** (0.019)	0.365*** (0.020)	0.359*** (0.020)
Lending rates	-3.873*** (0.379)	-3.868*** (0.380)	-3.820*** (0.382)	-3.911*** (0.363)	-3.886*** (0.369)	-3.774*** (0.378)
Lending rates*Portfolio diversification	1.138*** (0.427)	1.133*** (0.432)	1.083** (0.437)	0.524*** (0.182)	0.525*** (0.190)	0.497** (0.202)
Portfolio diversification	-23.273*** (3.647)	-25.312*** (3.719)	-32.715*** (3.124)	-6.145*** (1.452)	-7.675*** (1.538)	-11.135*** (1.340)
Size	1.760 (1.079)	1.803* (1.075)	1.875* (1.056)	1.669 (1.096)	1.768 (1.086)	1.760 (1.079)
Capital	1.740*** (0.192)	1.750*** (0.194)	1.781*** (0.189)	1.697*** (0.193)	1.720*** (0.199)	1.743*** (0.198)
Liquidity	0.854*** (0.085)	0.862*** (0.085)	0.872*** (0.084)	0.836*** (0.084)	0.848*** (0.084)	0.858*** (0.088)
Economic cycles	-5.483*** (1.106)	-5.467*** (1.087)	-5.472*** (1.034)	-5.586*** (1.145)	-5.541*** (1.090)	-5.593*** (1.006)
Stock market	-0.142*** (0.015)	-0.142*** (0.015)	-0.143*** (0.015)	-0.141*** (0.014)	-0.141*** (0.015)	-0.144*** (0.015)
Number of observations	360	360	360	360	360	360
Number of banks	31	31	31	31	31	31
Number of instruments	30	30	30	30	30	30
AR(1) test (p-value)	0.047	0.047	0.046	0.047	0.047	0.047
AR(2) test (p-value)	0.725	0.726	0.724	0.720	0.724	0.733
Hansen test (p-value)	0.326	0.318	0.303	0.350	0.337	0.321

Notes: The portfolio diversification measure (HHI and SE) is displayed at the top of each column. \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

Table 4 presents the estimation results for the bank lending model when using the central bank's assets as the monetary policy indicator. Our results exhibit a positive relationship between bank lending and liquidity injection by the SBV, as captured by the positive and statistically significant coefficient on the stand-alone monetary policy indicator. Consequently, an increase in the money supply by the central bank leads to a higher growth rate of bank loans. Further analysis with marginal effects shows that this higher loan growth could be mitigated if banks grant loans to more economic sectors since the interaction term enters all regressions negatively and significantly.

**Table 3.** Estimation results for the bank lending channel using refinancing rates as a monetary policy indicator

	Dependent variable: Bank loan growth					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Lagged dependent variable	0.225*** (0.016)	0.224*** (0.017)	0.221*** (0.017)	0.228*** (0.015)	0.226*** (0.016)	0.223*** (0.017)
Refinancing rates	-5.783*** (2.049)	-5.441** (2.163)	-2.764 (2.428)	-5.636*** (1.191)	-5.859*** (1.434)	-3.583* (1.936)
Refinancing rates*Portfolio diversification	5.514** (2.504)	5.117* (2.663)	1.785 (3.057)	2.282*** (0.615)	2.503*** (0.776)	1.364 (1.155)
Portfolio diversification	-58.459*** (18.859)	-58.318*** (19.851)	-42.502* (22.029)	-19.252*** (4.783)	-22.662*** (5.877)	-18.394** (8.339)
Size	0.670 (0.945)	0.722 (0.938)	0.891 (0.907)	0.486 (0.965)	0.604 (0.947)	0.720 (0.910)
Capital	1.299*** (0.210)	1.308*** (0.212)	1.341*** (0.211)	1.261*** (0.203)	1.282*** (0.206)	1.296*** (0.203)
Liquidity	0.496*** (0.096)	0.499*** (0.097)	0.492*** (0.097)	0.503*** (0.096)	0.514*** (0.098)	0.497*** (0.098)
Economic cycles	-7.739*** (0.806)	-7.670*** (0.813)	-7.410*** (0.831)	-7.930*** (0.771)	-7.801*** (0.783)	-7.485*** (0.798)
Stock market	-0.210*** (0.016)	-0.209*** (0.016)	-0.204*** (0.015)	-0.215*** (0.016)	-0.213*** (0.016)	-0.206*** (0.016)
Number of observations	360	360	360	360	360	360
Number of banks	31	31	31	31	31	31
Number of instruments	30	30	30	30	30	30
AR(1) test (p-value)	0.008	0.008	0.008	0.008	0.009	0.006
AR(2) test (p-value)	0.857	0.858	0.875	0.834	0.832	0.856
Hansen test (p-value)	0.192	0.193	0.201	0.192	0.192	0.202

Notes: The portfolio diversification measure (HHI and SE) is displayed at the top of each column. \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

Considering our estimation results at face values, assuming that the SBV relaxes monetary policy associated with a one percentage point drop-in lending rates, we infer that bank lending growth tends to increase by 3.873% accordingly (column 1 of Table 2). Similarly, if the central bank's asset ratio increases by one percentage point, bank lending will likely increase by 6.957% (column 4 of Table 4). Further elaborated, these influence magnitudes might be reduced by about 0.092% ( $\sim 0.081 \times 1.138$ ) and 0.315% ( $\sim 0.301 \times 1.046$ ), respectively, when loan portfolio diversification surges by one standard deviation. These patterns highlight our findings' economic plausibility. We thus gain solid evidence that increased loan portfolio diversification makes bank lending less responsive to monetary policy adjustments. These findings could be explained as follows. When banks diversify their credit portfolios to a more significant extent, they might enjoy lower expenses of handling informational asymmetry, involved in raising loanable funds, or gaining more accessible access to substitute funding sources (Boot, 2000; Kashyap & Stein, 1995). Thus, their lending activities tend to be less dependent on the monetary policy stance relative to their specialized counterparts.

**Table 4.** Estimation results for the bank lending channel using the central bank's claims as a monetary policy indicator

	Dependent variable: Bank loan growth					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Lagged dependent variable	0.211*** (0.018)	0.209*** (0.018)	0.204*** (0.017)	0.210*** (0.019)	0.207*** (0.020)	0.200*** (0.018)
Central bank assets	6.881*** (0.405)	6.883*** (0.407)	6.888*** (0.402)	6.957*** (0.406)	6.978*** (0.409)	6.906*** (0.418)
Central bank assets*Portfolio diversification	-2.686*** (0.735)	-2.694*** (0.749)	-2.756*** (0.786)	-1.046*** (0.317)	-1.078*** (0.341)	-1.246*** (0.387)
Portfolio diversification	-13.450*** (4.859)	-15.864*** (4.866)	-24.704*** (5.198)	-1.333 (1.726)	-2.998 (1.952)	-7.446*** (2.386)
Size	-0.537 (0.673)	-0.524 (0.683)	-0.477 (0.701)	-0.954 (0.910)	-0.989 (0.926)	-0.636 (0.689)
Capital	0.712*** (0.266)	0.713*** (0.269)	0.744*** (0.267)	0.559* (0.338)	0.540 (0.343)	0.702*** (0.254)
Liquidity	-0.038 (0.065)	-0.036 (0.066)	-0.032 (0.068)	-0.058 (0.058)	-0.055 (0.062)	-0.047 (0.068)
Economic cycles	-5.145*** (0.746)	-5.153*** (0.749)	-5.178*** (0.759)	-5.125*** (0.740)	-5.143*** (0.736)	-5.091*** (0.744)
Stock market	-0.160*** (0.015)	-0.160*** (0.015)	-0.158*** (0.015)	-0.167*** (0.017)	-0.166*** (0.016)	-0.161*** (0.014)
Number of observations	360	360	360	360	360	360
Number of banks	31	31	31	31	31	31
Number of instruments	30	30	30	30	30	30
AR(1) test (p-value)	0.046	0.046	0.046	0.044	0.044	0.049
AR(2) test (p-value)	0.812	0.813	0.823	0.789	0.789	0.809
Hansen test (p-value)	0.189	0.184	0.168	0.204	0.194	0.179

Notes: The portfolio diversification measure (HHI and SE) is displayed at the top of each column. \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

### Estimation Results for the Bank Risk-Taking Channel

We check whether the association between bank risk and monetary policy varies based on different credit portfolio diversification degrees. Tables 5–6 show that the coefficient on lending and refinancing rates is significantly positive, regardless of the portfolio diversification measures employed. Table 7 reports that the central bank's claims are negatively associated with bank stability as captured by the Z-score index, mainly through SE diversification measures. We gain evidence to confirm that the bank risk-taking channel operates in Vietnam. Banks react to monetary policy relaxing, either when the central bank cuts interest rates or purchases more securities in the open market, by reducing their financial stability or, in other words, suffering more overall risks.

Turning to the estimation results of interest, as most columns of Tables 5–6 indicate, the coefficients on the interaction terms between interest rates and portfolio diversification are significantly negative. In contrast, the interaction terms of the central bank assets and loan portfolios are significantly positive in Table 7. The signs of all these interaction terms are opposite to those of stand-alone monetary policy indicators. The two categories of monetary policy tools collectively provide complementary evidence that bank credit portfolio diversification undermines the working of the bank risk-taking channel. From an economic standpoint, the significance of our interaction terms' results is also appropriate. For instance, the coefficients in column 2 (Table 6) and column 5 (Table 7) suggest that a one standard deviation rise in loan portfolio diversification measure could alleviate the impacts of a one-percentage-point change in refinancing rates on bank risk by approximately 0.022% ( $\sim 0.078 \times 0.278$ ), and also diminish the effects of a variation of one percentage point in the central bank's asset ratio on bank risk by approximately 0.032% ( $\sim 0.260 \times 0.124$ ), respectively.



**Table 5.** Estimation results for the bank risk-taking channel using lending rates as a monetary policy indicator

	Dependent variable: The natural logarithm of (1 + Z-score)					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Lagged dependent variable	0.424*** (0.020)	0.419*** (0.020)	0.411*** (0.019)	0.438*** (0.026)	0.432*** (0.024)	0.420*** (0.021)
Lending rates	0.110*** (0.041)	0.122*** (0.045)	0.175*** (0.068)	0.025 (0.032)	0.042 (0.028)	0.088** (0.037)
Lending rates*Portfolio diversification	-0.130** (0.053)	-0.147** (0.058)	-0.222** (0.089)	-0.011 (0.018)	-0.021 (0.016)	-0.052** (0.023)
Portfolio diversification	1.916*** (0.294)	2.091*** (0.309)	2.940*** (0.446)	0.327** (0.148)	0.461*** (0.116)	0.863*** (0.138)
Size	0.048* (0.026)	0.048* (0.027)	0.043 (0.028)	0.060** (0.027)	0.057** (0.028)	0.051* (0.027)
Capital	0.009 (0.006)	0.009 (0.006)	0.006 (0.006)	0.014** (0.006)	0.012** (0.006)	0.009 (0.006)
Liquidity	0.003 (0.003)	0.003 (0.003)	0.003 (0.002)	0.002 (0.003)	0.002 (0.003)	0.003 (0.003)
Economic cycles	0.244*** (0.043)	0.241*** (0.043)	0.230*** (0.045)	0.230*** (0.040)	0.228*** (0.039)	0.228*** (0.040)
Stock market	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)
Number of observations	325	325	325	325	325	325
Number of banks	31	31	31	31	31	31
Number of instruments	30	30	30	30	30	30
AR(1) test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (p-value)	0.182	0.162	0.115	0.194	0.163	0.142
Hansen test (p-value)	0.570	0.567	0.536	0.521	0.533	0.541

Notes: The portfolio diversification measure (HHI and SE) is displayed at the top of each column. \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

**Table 6.** Estimation results for the bank risk-taking channel using refinancing rates as a monetary policy indicator

	Dependent variable: The natural logarithm of (1 + Z-score)					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Lagged dependent variable	0.429*** (0.016)	0.426*** (0.017)	0.427*** (0.018)	0.438*** (0.016)	0.433*** (0.016)	0.432*** (0.016)
Refinancing rates	0.245*** (0.081)	0.252*** (0.088)	0.329*** (0.124)	0.116*** (0.040)	0.127*** (0.043)	0.195*** (0.066)
Refinancing rates*Portfolio diversification	-0.267*** (0.103)	-0.278** (0.112)	-0.388** (0.162)	-0.045** (0.023)	-0.053** (0.025)	-0.102** (0.042)
Portfolio diversification	2.132*** (0.682)	2.246*** (0.706)	3.079*** (0.816)	0.425*** (0.128)	0.553*** (0.142)	0.975*** (0.212)
Size	0.049** (0.023)	0.049** (0.024)	0.047* (0.026)	0.052** (0.022)	0.046** (0.023)	0.041* (0.024)
Capital	0.004 (0.006)	0.004 (0.006)	0.003 (0.006)	0.007 (0.006)	0.006 (0.006)	0.004 (0.006)
Liquidity	0.000 (0.003)	0.000 (0.003)	0.000 (0.002)	0.000 (0.003)	0.000 (0.002)	0.001 (0.002)
Economic cycles	0.248*** (0.049)	0.246*** (0.049)	0.236*** (0.049)	0.247*** (0.047)	0.242*** (0.047)	0.235*** (0.047)
Stock market	0.002*** (0.001)	0.002*** (0.001)	0.003*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.003*** (0.001)
Number of observations	325	325	325	325	325	325

	Dependent variable: The natural logarithm of (1 + Z-score)					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Number of banks	31	31	31	31	31	31
Number of instruments	30	30	30	30	30	30
AR(1) test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (p-value)	0.331	0.322	0.291	0.353	0.312	0.302
Hansen test (p-value)	0.771	0.759	0.735	0.714	0.688	0.677

Notes: The portfolio diversification measure (HHI and SE) is displayed at the top of each column. \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

**Table 7.** Estimation results for the bank risk-taking channel using the central bank's claims as a monetary policy indicator

	Dependent variable: The natural logarithm of (1 + Z-score)					
	(1) HHI10	(2) HHI8	(3) HHI6	(4) SE10	(5) SE8	(6) SE6
Lagged dependent variable	0.443*** (0.025)	0.442*** (0.025)	0.446*** (0.023)	0.437*** (0.029)	0.435*** (0.028)	0.439*** (0.025)
Central bank assets	-0.115 (0.095)	-0.137 (0.093)	-0.056 (0.112)	-0.158** (0.080)	-0.210*** (0.076)	-0.171* (0.090)
Central bank assets*Portfolio diversification	0.146 (0.124)	0.176 (0.122)	0.069 (0.155)	0.089** (0.044)	0.124*** (0.043)	0.110* (0.060)
Portfolio diversification	0.924** (0.370)	0.931** (0.382)	1.409*** (0.445)	0.102 (0.109)	0.123 (0.121)	0.344** (0.163)
Size	0.060** (0.024)	0.060** (0.024)	0.056** (0.023)	0.067** (0.026)	0.062** (0.026)	0.058** (0.024)
Capital	0.008 (0.005)	0.008 (0.005)	0.007 (0.005)	0.008 (0.005)	0.007 (0.005)	0.007 (0.005)
Liquidity	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)	0.003 (0.003)	0.002 (0.003)
Economic cycles	0.239*** (0.043)	0.239*** (0.043)	0.237*** (0.042)	0.240*** (0.044)	0.236*** (0.043)	0.232*** (0.042)
Stock market	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)
Number of observations	325	325	325	325	325	325
Number of banks	31	31	31	31	31	31
Number of instruments	30	30	30	30	30	30
AR(1) test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) test (p-value)	0.344	0.334	0.333	0.353	0.313	0.333
Hansen test (p-value)	0.573	0.579	0.585	0.552	0.582	0.596

Notes: The portfolio diversification measure (HHI and SE) is displayed at the top of each column. \*\*\*, \*\* and \* denote the significance levels of 1%, 5% and 10%, respectively.

We could suggest some possible mechanisms of our results. First, banks with more diversified portfolios may reach more opportunities to earn higher profits; thus, they have lower incentives to search for yield by high risk high return projects, even when interest rates are decreased amid monetary policy expansion (Rajan, 2006). Second, as also implied by the literature, informational asymmetries are less severe due to increased diversification in banks' activities (Boot, 2000). So, banks could mitigate the harmful impacts of monetary policy on bank risk after the central bank injects liquidity by asset purchases or raises interest rates in the economy.

## Conclusion

We explore how bank loan portfolio diversification plays a crucial role in moderating the bank lending and risk-taking channels of monetary policy transmission in Vietnam during 2007–2019. Consistent with the theoretical and empirical works on the bank lending and risk-taking channels

of monetary policy, we find that lower interest rates or more liquidity injection during monetary expansion boost bank lending and bank risk. Furthermore, as a unique contribution of this study, we find that the potency of these banking channels may be weakened for banks diversifying their loan portfolios more into various economic sectors. These findings are robust across different choices of monetary policy indicators, ranging from interest-based tools (short-term lending rates and refinancing rates) to the quantitative-based policy (security sales/purchases by open market operations), and across a rich set of sectoral exposure measures to proxy the diversification level of loan portfolios.

Identifying the modifying condition in this paper for the link between monetary policy and bank lending/bank risk will be beneficial in deriving policy implications. Accordingly, our findings call for monetary authorities to concentrate on certain types of banks, depending on their compositions of loan portfolios that they hold when setting monetary policy using both complementary tools of interest rates and liquidity injection. They also suggest that banking supervisors should acknowledge the potential tradeoff between bank lending and bank risk in response to monetary shocks when managing banking supervision. For example, higher loan portfolio diversification is found to dampen the bank risk-taking channel, thus calling for policies to encourage more diversification in the banking sector. However, these policies should be accompanied with caution because more diversifications tend to attenuate bank lending activities when monetary policy is relaxed.

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