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# Financial development and the effectiveness of monetary policy

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ABSTRACT

This paper investigates the relationship between financial development and the effectiveness of monetary policy using panel data from 41 economies. The results show that the effects of monetary policy on output and inflation are significantly and negatively correlated with financial development, indicating that the effectiveness of monetary policy declines as the financial system becomes more developed. This finding is robust across all the different specifications and estimation methods examined. Our paper provides new evidence and insights to the long-standing debate on the relationship between financial development and the effectiveness of monetary policy.



## 1. Introduction

Financial systems in most economies have witnessed an impressive development in the past two decades. This development is accompanied by a big evolution in business and policy practice. While financial development has many positive economic effects (Levine, 1997, 2005), fast growing financial systems also raise concerns. Most notably, it has a direct impact on monetary policy set by central bank.

It is well known that the financial system is crucial to the conduct of monetary policy because monetary policy targeted at certain macroeconomic variables is essentially a financial process, with the financial system as the interface linking central bank policies and the real economy through the monetary transmission mechanism. Given that monetary policy works largely through its influence on the financial system, any development that affects the structure or conditions of the financial system will have the potential to exert influence on the transmission mechanism. Thus, the effectiveness of monetary policy hinges crucially on a set of parameters that are affected by the development of the financial system. In this context, the study of the relationship between financial development and the effectiveness of monetary policy has important theoretical and policy implications for many economies, especially for those that are undergoing a rapid financial development.

Theoretically, the study of the relationship between financial development and monetary policy effectiveness may date back to Gurley and Shaw (1955, 1967), followed by Taylor (1987), Hendry and Ericsson (1991), Arestis et al. (1992), Mullineux (1994), among many others. In more recent studies, a large body of literature has focused on the credit channel theory proposed by Bernanke and Gertler (1995).[1] A main conclusion of the credit channel theory is that higher level of financial frictions is generally associated with stronger transmission mechanism of monetary policy. For example, Kashyap and Stein (2000) find that the effect of monetary policy on lending behavior is stronger for banks with less liquid balance sheets, a conclusion that supports the bank lending channel of monetary transmission. Gomez et al. (2005) show that monetary policy has lost some effectiveness in influencing real variables at least in the short run, due to the partial dilution of greater securitization, which makes the traditional bank lending channel become less important. Loutskina and Strahan (2009) also find evidence of the weakening of the bank lending channel with the advent of financial securitization. While securitization may have decreasing effect on the lending channel of monetary transmission,

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[1] The credit channel theory has been typically characterized into two channels: the bank lending channel and the balance sheet channel. The bank lending channel emphasizes the impact of monetary policy on the supply of loans to bank-dependent borrowers, while the balance sheet channel focuses on the effects of monetary policy on borrowers' net worth and debt collateral.

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there is also evidence that it reinforces the balance sheet (e.g., Ashcraft and Campello, 2007; Aysun and Hepp, 2011).[2] Mishra et al. (2010) argue that the transmission mechanism of monetary policy is likely to be dominated by the bank lending channel at lower levels of financial development. In the study of Aysun et al. (2013), the credit channel is more pronounced in economies with high levels of financial frictions, which is consistent with the credit channel theory. In a recent study, Ciccarelli et al. (2015) find that the credit channel significantly amplifies the effect of a monetary policy shock on GDP and inflation.[3]

Besides financial factors, there are also other related factors that can affect the effectiveness of monetary policy. Most notably, a large body of literature has examined how institutions may affect financial markets and the effectiveness of monetary policy. For example, given the evidence that the creditors' legal protection supports the development of credit markets (La Porta et al., 1997, 1998; Levine, 1998), some studies (e.g., Cecchetti, 1999; Djankov et al., 2007, 2008) have found that economies with better legal protection for shareholders and debtors are generally associated with less potent monetary transmission. Apart from legal factors, other institutional factors that may affect the effectiveness of monetary policy are also discussed in the literature. For example, Elbourne and de Haan (2006) have examined to what extent monetary transmission in transition economies is related to financial structure. Mishra et al. (2010) show that central bank independence (CBI) and other related institutional factors (e.g., government accountability, disclosure standards, regulatory environment) affect not just the scope for the exercise of monetary policy, but also the effectiveness and reliability of monetary policy. Alpanda and Aysun (2012) and Cetorelli and Goldberg (2012) find a significant relationship between monetary policy effectiveness and bank globalization. Aysun et al. (2013) also make a key contribution to the literature on the role of institutions on monetary policy transmission by investigating the effects of legal origin, CBI and financial market development on the effectiveness of monetary policy.[4]

It is worth noting that although economic theory has long recognized the potential effects that financial development may have on monetary policy, empirical studies on this subject have produced mixed results. In order to shed new light on the long-standing and unresolved debate, this paper aims to undertake a systematic empirical analysis of the relationship between financial development and the effectiveness of monetary policy based on panel data analysis. Following the previous literature (e.g., Karras (1999), Aysun and Hepp, 2011), we explore several options to estimate the panel data models in our paper. As is standard in the literature, panel data regressions can be estimated by using pooled least squares (PLS), fixed effect (FE) and random effect (RE) models. While the PLS model is widely used as a benchmark in panel data regressions, the choice between the FE and RE models is usually based upon the standard Hausman test.[5] Because each estimation method has its merits, all three methods are employed in our empirical analysis. In addition, to address the potential endogeneity problems associated with dynamic panel regressions, we also use the system General Method of Moments (system-GMM) estimator of Arellano and Bond (1991) and Blundell and Bond (1998) in the estimation. Throughout the empirical analysis, we place emphasis on robustness and numerous sensitivity checks are carried out. To keep the analysis structured, we gradually escalate our investigation from simple panel regressions to more involved specifications and increasingly sophisticated estimation techniques to secure non-spurious results. Importantly, various estimation methods and robustness checks confirm our main findings and in some cases even yield stronger results.

Our main findings can be summarized as follows. First, we find that there is a strong negative correlation between financial development and the effects of monetary policy on output and inflation, indicating that the effectiveness of monetary policy tends to decline as the financial system becomes more developed. This conclusion is shown to be robust across all the different specifications and estimation methods examined, including robustness to alterative modeling strategies and methods, robustness to an extended period of time, robustness to different data frequencies, and robustness across sub-samples.

Second, by comparing the regression results using two basic components of our financial development measure (i.e., financial intermediary development and financial market development), we find that the coefficients relating to the effects of monetary policy on output and inflation are generally larger and more significant in the regressions using financial intermediary development than those using financial market development. This result indicates that the effectiveness of monetary policy may depend more on the development of the financial intermediary than that of the stock market. Considering that the relative importance of financial intermediaries and financial market varies substantially across economies, this result has important implications for the effectiveness of monetary policy in economies with different financial structures. In particular, economies with a bank-based financial system may experience a more significant decrease of monetary policy effectiveness in the process of financial development than those with a market-based financial system. In this regard, our paper contributes to the large body of literature on the role of financial development and financial structure in monetary policy (e.g., Kashyap and Stein, 1997; Cecchetti, 1999; Cecchetti and Krause, 2001; Elbourne and de Haan, 2006; Aysun and Hepp, 2011).

Third, our results also show that the effect of monetary policy on output decreases more with financial development in developing economies while the effect of monetary policy on inflation decreases more with financial development in advanced economies. This suggests that financial development may have asymmetric effects on the effectiveness of monetary policy in affecting output and inflation in different economies. In particular, as the level of financial development increases, developing and advanced economies may face a more notable weakening of monetary policy effectiveness in affecting output and inflation, respectively. As many authors have reported that monetary policy transmission differs substantially across economies (e.g., Cecchetti, 1999; Elbourne and de Haan, 2004, 2006; Aysun et al., 2013), our result indicate that this may be related to the differences in the level of financial development. In addition, this result could also support the results given by Carranza et al. (2010), who suggested a larger cumulative impact of monetary policy on the less developed financial systems, but this impact tends to "take longer time to appear than in more developed financial systems".

Finally, our paper also complements a broader literature on the effectiveness of monetary policy in crisis. For example, Mishkin

[2] Ashcraft and Campello (2007) provide evidence that the balance sheet channel is an important part of monetary policy transmission, where the status of borrowers' balance sheet plays a significant role in the overall response of bank lending to monetary policy. Aysun and Hepp (2011) show that the balance sheet channel of monetary transmission is stronger for securitizing banks because these banks are more sensitive to borrowers' balance sheets.

[3] Ciccarelli et al. (2015) also find that the impact through the bank lending channel is higher than through the demand and firm balance-sheet channels for firms. However, for household loans, the demand channel turns out to be stronger.

[4] The authors find that the overall impact of institutional improvement on the effectiveness of monetary policy is not clear-cut and requires further research.

[5] Theoretically, the FE model is preferred if factors are chosen arbitrarily, while the RE model would be more appropriate if factors are chosen randomly. According to Judge et al. (1985), the FE model is a better choice under more general assumptions. As a standard practice in the panel data analysis, Hausman's (1978) specification test is used to determine whether to use the FE estimator or the RE estimator in the estimation of parameters.

(2009, 2012) argues that monetary policy would be more effective by preventing adverse feedback loops in crisis periods. Gertler and Karadi (2011) find that during a financial crisis, when the balance sheet constraints on private intermediaries tighten, the benefits from adopting unconventional monetary policies would be significantly enhanced. The effectiveness of unconventional monetary policies in counteracting the negative effects of financial crisis is also reported in Quispe and Rossini (2011). Similar conclusions are also reached in Gambacorta and Marques-Ibanez (2011) and Aysun et al. (2013). Our paper adds to this broader literature by showing that financial development has an independent effect on the effectiveness of monetary policy after controlling for the effect of financial crisis.

The rest of the paper is organized as follows. Section 2 develops an econometric model that allows us to empirically test whether the effectiveness of monetary policy is affected by changes in the level of financial development. Section 3 conducts empirical analysis and discusses the estimation results. The final section concludes and discusses some extensions.

## 2. Empirical methodology and data

### 2.1. Empirical methodology

The main purpose of the paper is to examine whether financial development has a significant impact on the effectiveness of monetary policy. To that end, the effects of financial development on monetary policy must be specified within an econometric framework in a tractable way. We use the following two standard macroeconomic panel data models to demonstrate the impact of the money growth rate on output growth and inflation:

$$\Delta y_{j,t} = \beta_0 + \sum_{i=1}^{Q} \beta_i^y \Delta y_{j,t-i} + \sum_{i=0}^{R} \beta_{j,t-i}^m \Delta m_{j,t-i} + \beta^c crisis_{j,t} + u_{j,t}^y \quad (1)$$

$$\Delta p_{j,t} = \gamma_0 + \sum_{i=1}^{Q} \gamma_i^p \Delta p_{j,t-i} + \sum_{i=0}^{R} \gamma_{j,t-i}^m \Delta m_{j,t-i} + \gamma^c crisis_{j,t} + u_{j,t}^p \quad (2)$$

where $j$ indexes over countries and $t$ over time, the $\beta$ s and $\gamma$ s are coefficients, $Q$ and $R$ denote the number of lags included in the regression, $\Delta y$ is the output growth rate, $\Delta m$ is the money growth rate, $\Delta p$ is the inflation rate, *crisis* is a dummy variable capturing the impact of the 2008 global financial crisis, and $u_{j,t}^y$ and $u_{j,t}^p$ are the output and inflation shocks, respectively. As in Karras (1999), Eqs. (1) and (2) can be regarded as reduced-form expressions for output growth and inflation. The error terms are modeled as $u_{j,t}^y = u_j^y + w_{j,t}^y$ and $u_{j,t}^p = u_j^p + w_{j,t}^p$, where the $u_j^y$s and $u_j^p$s denote country fixed effects. The rate of the output growth, the inflation rate and the money growth rate are defined as follows, respectively:

$$\Delta y_{j,t} = (GDP_{j,t} - GDP_{j,t-1})/GDP_{j,t-1}$$

$$\Delta p_{j,t} = (CPI_{j,t} - CPI_{j,t-1})/CPI_{j,t-1}$$

$$\Delta m_{j,t} = (M2_{j,t} - M2_{j,t-1})/M2_{j,t-1}$$

It is easy to see that larger values of money growth coefficients in Eqs. (1) and (2) would imply larger effects of monetary policy on output and inflation. Therefore, based on the empirical setup given by Eqs. (1) and (2), we can separate the sample countries by degrees of financial development and run regressions using long-term averages of the regression variables. Then we can test the effectiveness of monetary policy by comparing the coefficient sizes of money growth rate across the subsamples featuring different levels of financial development. Specifically, if the coefficient size in the subsample of higher financial development (i.e., financially less developed countries) turns out to be smaller, a negative relationship between financial development and monetary policy effectiveness is identified, implying that the effectiveness of monetary policy will decrease as the level of financial development increases.

Following the previous literature (e.g., Demirgüç-Kunt and Levine, 1996; Levine, 2002; Beck et al., 2006; Demirgüç-Kunt et al., 2011), we use the following three measures of financial development:

$$fd_1 = (Domestic\ Credit + Stock\ Market\ Capitalization)/GDP$$

$$fd_2 = Domestic\ Credit/GDP$$

$$fd_3 = Stock\ Market\ Capitalization/GDP$$

where the *Domestic Credit* denotes the value of financial intermediary credits to the public and private sector, and the *Stock Market Capitalization* denotes the total value of listed shares. Therefore, $fd_1$ measures the overall development of the financial sector (i.e., the level of development of banks, nonbanks, and financial (stock) markets), $fd_2$ measures the level of financial intermediary development, while $fd_3$ measures the level of financial (stock) market development. It is easy to see that larger values of $fd$ represents higher level of financial development.

Apart from the above baseline empirical setup, for robustness we also use an alternative empirical setup where the variable of financial development is explicitly included in the regression equation. Specifically, following the previous literature (e.g., Karras, 1999; Berument and Dogan, 2003), to allow for the impact of financial development on the effects of money on output and inflation, an interaction term for financial development is introduced in the following way:

$$\beta_{j,t-i}^m = \theta_i^m + \theta_i^{fd} fd_{j,t-i} \quad (3)$$

$$\gamma_{j,t-i}^m = \phi_i^m + \phi_i^{fd} fd_{j,t-i} \quad (4)$$

where $fd_{j,t}$ denotes financial development in country $j$ at time $t$, $\theta$s and $\phi$s are parameters. By incorporating Eq. (3) into Eq. (1), we obtain the *output equation* that measures the effect of financial development on the relationship between money growth and output growth:

$$\Delta y_{j,t} = \beta_0 + \sum_{i=1}^{Q} \beta_i^y \Delta y_{j,t-i} + \sum_{i=0}^{R} (\theta_i^m \Delta m_{j,t-i} + \theta_i^f fd_{j,t-i} + \theta_i^{fm} fd_{j,t-i} \Delta m_{j,t-i}) + \beta^c crisis_{j,t} + u_{j,t}^y \quad (5)$$

where the dependent variable $\Delta y_{j,t}$ denotes the output growth of country $j$ in period $t$, $\Delta m_{j,t}$ denotes the money growth rate of country $j$ in period $t$, $fd_{j,t}$ is the measure of financial development of country $j$ at time$t$, $fd_{j,t}m_{j,t}$ is the interaction term for financial development, $crisis_{j,t}$ is a dummy variable capturing the impact of the 2008 global financial crisis on output, and $u_{j,t}^y$ is the output shock.

Similarly, by incorporating Eq. (4) into Eq. (2), we obtain the following *inflation equation* which measures the effect of financial development on the relationship between money growth and inflation rate:

$$\Delta p_{j,t} = \gamma_0 + \sum_{i=1}^{Q} \gamma_i^p \Delta p_{j,t-i} + \sum_{i=0}^{R} (\phi_i^m \Delta m_{j,t-i} + \phi_i^f fd_{j,t-i} + \phi_i^{fm} fd_{j,t-i} \Delta m_{j,t-i}) + \gamma^c crisis_{j,t} + u_{j,t}^p \quad (6)$$

where the dependent variable $\Delta p_{j,t}$ denotes the inflation rate of country $j$ in period $t$, $fd_{j,t}m_{j,t}$ is the interaction term for financial development, $crisis_{j,t}$ is a dummy variable capturing the impact of

**Table 1**
Sample means over 2005Q1–2011Q4.

| Country | $\overline{\Delta y}$ | $\overline{\Delta p}$ | $\overline{\Delta m}$ | $\overline{fd}_1$ | $\overline{fd}_2$ | $\overline{fd}_3$ |
|---|---|---|---|---|---|---|
| 1. Argentina | 1.782% | 3.769% | 4.952% | 0.510 | 0.281 | 0.229 |
| 2. Australia | 0.678 | 0.730 | 2.892 | 2.435 | 1.248 | 1.187 |
| 3. Austria | 0.403 | 0.524 | 1.356 | 1.669 | 1.307 | 0.362 |
| 4. Belgium | 0.326 | 0.598 | 1.274 | 1.803 | 1.112 | 0.692 |
| 5. Brazil | 1.048 | 1.273 | 4.428 | 1.451 | 0.848 | 0.603 |
| 6. Bulgaria | 0.663 | 1.465 | 3.858 | 0.844 | 0.558 | 0.285 |
| 7. Canada | 0.375 | 0.478 | 1.771 | 2.730 | 1.513 | 1.217 |
| 8. China | 2.725 | 0.794 | 4.613 | 2.099 | 1.295 | 0.804 |
| 9. Colombia | 1.226 | 1.108 | 3.582 | 0.762 | 0.340 | 0.422 |
| 10. Czech Republic | 0.652 | 0.650 | 2.111 | 0.816 | 0.526 | 0.289 |
| 11. Denmark | 0.041 | 0.549 | 1.145 | 2.690 | 2.000 | 0.690 |
| 12. France | 0.223 | 0.456 | 1.648 | 2.031 | 1.215 | 0.816 |
| 13. Germany | 0.427 | 0.453 | 1.237 | 1.732 | 1.295 | 0.436 |
| 14. Greece | −0.265 | 0.817 | 1.076 | 1.705 | 1.192 | 0.512 |
| 15. Hong Kong, China | 1.030 | 0.679 | 2.414 | 6.101 | 1.525 | 4.576 |
| 16. Hungary | 0.032 | 1.227 | 1.787 | 0.994 | 0.730 | 0.264 |
| 17. India | 2.064 | 2.088 | 4.425 | 1.438 | 0.650 | 0.787 |
| 18. Indonesia | 1.468 | 1.885 | 3.771 | 0.687 | 0.362 | 0.325 |
| 19. Ireland | 0.124 | 0.293 | 1.153 | 2.454 | 1.962 | 0.492 |
| 20. Israel | 1.126 | 0.642 | 2.368 | 1.660 | 0.710 | 0.950 |
| 21. Italy | −0.025 | 0.567 | 2.391 | 1.637 | 1.284 | 0.353 |
| 22. Japan | 0.063 | −0.061 | 0.539 | 3.145 | 2.274 | 0.871 |
| 23. Korea Republic | 0.954 | 0.780 | 2.214 | 1.829 | 0.987 | 0.843 |
| 24. Latvia | 0.188 | 1.542 | 3.139 | 0.910 | 0.819 | 0.091 |
| 25. Lithuania | 0.555 | 1.164 | 3.001 | 0.762 | 0.548 | 0.213 |
| 26. Mexico | 0.580 | 1.019 | 2.746 | 0.625 | 0.322 | 0.303 |
| 27. Netherlands | 0.332 | 0.418 | 1.728 | 2.842 | 1.955 | 0.887 |
| 28. Norway | 0.219 | 0.497 | 2.046 | 1.810 | 1.198 | 0.612 |
| 29. Peru | 1.789 | 0.704 | 3.711 | 0.764 | 0.159 | 0.605 |
| 30. Portugal | 0.066 | 0.533 | 2.239 | 2.154 | 1.744 | 0.410 |
| 31. Russia | 0.937 | 2.398 | 6.530 | 0.931 | 0.247 | 0.684 |
| 32. Singapore | 1.682 | 0.724 | 2.750 | 2.523 | 0.730 | 1.793 |
| 33. South Africa | 0.833 | 1.384 | 2.843 | 2.852 | 0.795 | 2.057 |
| 34. Spain | 0.186 | 0.637 | 2.761 | 2.889 | 1.994 | 0.895 |
| 35. Sweden | 0.480 | 0.412 | 2.174 | 2.373 | 1.302 | 1.070 |
| 36. Switzerland | 0.524 | 0.165 | 1.543 | 3.999 | 1.765 | 2.233 |
| 37. Thailand | 0.758 | 0.829 | 2.131 | 1.737 | 1.077 | 0.661 |
| 38. Ukraine | 0.497 | 3.065 | 6.429 | 0.932 | 0.593 | 0.339 |
| 39. United Kingdom | 0.126 | 0.743 | 2.102 | 2.749 | 1.509 | 1.240 |
| 40. United States | 0.238 | 0.611 | 1.478 | 2.174 | 0.963 | 1.210 |
| 41. Vietnam | 1.712 | 2.880 | 6.434 | 1.099 | 0.931 | 0.167 |

*Note:* $\Delta y$ is the real growth rate of GDP (%), $\Delta p$ is the CPI inflation rate (%), $\Delta m$ is the growth rate of M2 (%), $fd_1$ is the sum of private credit plus stock market capitalization as a fraction of GDP, $fd_2$ is private credit as a fraction of GDP, $fd_3$ is stock market capitalization as a fraction of GDP.

the 2008 global financial crisis on inflation, and $u^y_{j,t}$ is the inflation shock. Other variables in Eq. (6) are the same as defined before.

## 2.2. The data

To estimate the models, this study employs panel data of 41 economies over the period from 2005Q1 to 2011Q4, where the economies and time span included are determined by data availability.[6] The datasets are collected primarily from published World Bank and IMF sources, such as the World Development Indicators (WDI), the World Bank Financial Development and Structure Database, and the International Financial Statistics (IFS). Following the standard practice in the literature (e.g., Laeven and Valencia, 2010), the *crisis* dummy variable is given by a simple binary variable that equals one if a country $i$ at time $t$ experiences a financial crisis, and zero otherwise. Data for financial crises episodes are taken from Laeven and Valencia (2012). In their paper the authors provide detailed information on the starting and end date of financial crises.

**Table 2**
Descriptive statistics.

| Variable | Mean | Standard deviation | Min | Max | Observation |
|---|---|---|---|---|---|
| $\Delta y$ | 0.698 | 0.645 | −0.586 | 2.875 | 1148 |
| $\Delta p$ | 1.011 | 1.301 | −3.445 | 9.252 | 1148 |
| $\Delta m$ | 2.747 | 3.238 | −10.745 | 22.030 | 1148 |
| $fd_1$ | 1.886 | 1.142 | 0.079 | 10.551 | 1148 |
| $fd_2$ | 1.069 | 0.594 | 0.057 | 2.452 | 1148 |
| $fd_3$ | 0.817 | 0.816 | 0.042 | 9.219 | 1148 |

*Note:* $\Delta y$ is the real growth rate of GDP (%), $\Delta p$ is the CPI inflation rate (%), $\Delta m$ is the growth rate of M2 (%), $fd_1$ is the sum of private credit plus stock market capitalization as a fraction of GDP, $fd_2$ is private credit as a fraction of GDP, $fd_3$ is stock market capitalization as a fraction of GDP.

Table 1 shows the average values of regression variables of the 41 economies over the sample period while Table 2 presents the descriptive statistics. The second, third and fourth columns of Table 1 show that output, inflation and money growth all vary substantially across the economies considered. The average quarterly output growth rate ranges from −0.265% in Greece to 2.725% in China, while the quarterly average rate of inflation has ranged from −0.061% in Japan to 3.769% in Argentina. As for the quarterly average money growth rate, this is seen to range from 0.539% in Japan to 6.530% in Russia.

The last three columns of Table 1 provide the sample means of the three financial development measures, which is a main focus of this paper. Two broad patterns stand out. First, financial development differs considerably between the sample economies. The overall measure of financial development ($fd_1$) ranges from a minimum of 0.510 in Argentina to a maximum of 6.101 in Hong Kong. The development of financial intermediaries ($fd_2$) ranges from 0.247 in Russia to 2.274 in Japan, while the development of financial (stock) market ($fd_3$) ranges from 0.167 in Vietnam to 4.576 in Hong Kong. Second, the relative importance of financial intermediaries and financial (stock) market also varies substantially across economies. For example, some economies (e.g., Japan, Denmark, Netherlands, Germany) have a high value of $fd_2$ but a low value of $fd_3$, implying that the financial systems of these economies rely more on financial intermediaries (bank-based financial system). In contrast, some other economies (e.g., Hong Kong, South Africa, Singapore) have a high value of $fd_3$ but a low value of $fd_2$, implying that the financial systems of these economies rely more on financial (stock) market (market-based financial system). In this context, each of the three financial development measures used in our paper has its merits and together they can provide us with a more complete picture of the financial development in a given economy.

Overall, the sheer size of the ranges and differences in Table 1 suggests that the impact of financial development on the effectiveness of monetary policy may be very significant as it leads to very diverse output and price effects across the 41 economies considered.

## 3. Empirical results

As mentioned in the introduction, coefficients in panel data analysis can be estimated by using pooled least squares (PLS), fixed effect (FE) or random effect (RE) model. However, when the regression equation includes lagged terms of the dependent variable, coefficients estimated by the RE model will be identical to

[6] Considering that the time frame 2005Q1–2011Q4 might be too short to allow for meaningful changes in the financial development of the sample economies, we extend our sample period by bringing the start point of the sample period to an earlier date (2000Q1). However, this comes with the cost that a less number of countries can be included in our sample due to data availability. To be more specific, eleven economies (Colombia, Czech Republic, Greece, Indonesia, Japan, Latvia, South Africa, Sweden, Thailand, Ukraine and Vietnam) have to be dropped from our sample because data prior to 2005Q1 or an earlier date are not available for these economies. Thus, in the case that the regressions are estimated over the extended period 2000Q1–2011Q4, only thirty economies can be included in the analysis.

**Table 3**
Financial development and monetary policy effectiveness: baseline results.

| Dependent variable: real output growth $\Delta y_t$ | | | | Dependent variable: inflation rate $\Delta p_t$ | | | |
|---|---|---|---|---|---|---|---|
| Independent variables | HFD subsample | MFD subsample | LFD subsample | Independent variables | HFD subsample | MFD subsample | LFD subsample |
| *Constant* | 0.0037*** (5.9902) | 0.0039*** (5.3264) | 0.0038*** (6.9319) | *Constant* | 0.0041*** (6.7762) | 0.0044*** (5.3926) | 0.0042** (7.0265) |
| $\Delta y_{t-1}$ | 0.4219*** (14.3735) | 0.4540*** (13.5225) | 0.4062*** (15.6328) | $\Delta p_{t-1}$ | 0.4288*** (13.2362) | 0.4167** (14.9825) | 0.4094*** (12.6968) |
| $\Delta m_t$ | 0.0631*** (3.1264) | 0.1646*** (3.3013) | 0.3524*** (3.7727) | $\Delta m_t$ | −0.0110 (−0.3356) | −0.0216 (−0.5229) | −0.0279 (−0.2346) |
| $\Delta m_{t-1}$ | 0.0206* (1.7255) | 0.0919** (2.0239) | 0.1068** (2.3256) | $\Delta m_{t-1}$ | 0.0520*** (3.0820) | 0.0813*** (3.1607) | 0.1466*** (3.2531) |
| $\Delta m_{t-2}$ | 0.0027 (0.0216) | 0.0055* (1.7383) | 0.0095 (0.0246) | $\Delta m_{t-2}$ | 0.0102** (2.1328) | 0.0397** (2.0419) | 0.1101*** (2.7818) |
| $\Delta m_{t-3}$ | 0.0157 (0.9108) | 0.0409 (0.6482) | 0.0473 (0.8618) | $\Delta m_{t-3}$ | 0.0168 (0.3392) | 0.0188 (0.2124) | 0.0407 (0.6594) |
| $\Delta m_{t-4}$ | 0.0015 (1.0952) | 0.0075 (1.1217) | 0.0058* (1.6955) | $\Delta m_{t-4}$ | 0.0219 (1.2551) | 0.0350* (1.6964) | 0.0318* (1.7302) |
| $crisis_t$ | −0.0068*** (−2.0713) | −0.0056** (−2.0189) | −0.0047*** (−2.0616) | $crisis_t$ | 0.0027** (2.0257) | 0.0021** (2.3242) | 0.0019** (2.2062) |
| $\sum_{i=0}^{4}\theta_i^m$ | 0.1036*** (8.9178) | 0.3104*** (9.5327) | 0.5218*** (8.8043) | $\sum_{i=0}^{4}\phi_i^m$ | 0.0899*** (9.6255) | 0.1532*** (7.4812) | 0.3013*** (8.2659) |
| Number of observations | 440 | 440 | 440 | Number of observations | 440 | 440 | 440 |
| Number of countries | 10 | 10 | 10 | Number of countries | 10 | 10 | 10 |
| Significance test | 11.5629*** | 10.3745*** | 12.8126*** | Significance test | 10.7928*** | 9.2586*** | 11.6173*** |
| *F*-statistic | 46.8863*** | 48.0593*** | 49.7247*** | *F*-statistic | 45.0136*** | 47.3321*** | 45.5327*** |
| D.W. | 2.0065 | 1.9811 | 2.0257 | D.W. | 2.0209 | 1.9660 | 2.0493 |
| Adj-$R^2$ | 0.6239 | 0.6106 | 0.6342 | Adj-$R^2$ | 0.5685 | 0.5578 | 0.5729 |

*Notes:* (1) $\sum_{i=0}^{4}\theta_i^m$ is the sum of the money coefficients ($\Delta m_t s$) in the output equation, $\sum_{i=0}^{4}\phi_i^m$ is the sum of the money coefficients ($\Delta m_t s$) in the inflation equation, with their *F*-statistic of Wald test in the parenthesis; (2) Values in other parentheses are *t*-statistics; (3) Values in the significance test are *F*-test statistics for testing whether the coefficients for each subsample are significantly different from each other; (4) ***Significant at 1%, **Significant at 5%, *Significant at 10%.

those estimated by the PLS model. In addition, the previous studies (e.g., Judge et al., 1985) have shown that estimations obtained by using FE model would be more plausible under more general assumptions. Therefore, we only report empirical results estimated by the FE model in the basic analysis.[7]

### 3.1. Baseline results

This sub-section presents the results under the baseline empirical setup. As mentioned in the previous section, we first separate the sample economies by degrees of financial development and then compare the coefficient sizes across the subsamples. More specifically, we divide the 30 sample economies into three equal subgroups according to their average level of overall financial development ($fd_1$) during the sample period (2000Q1–2011Q4): (1) high level of financial development (denoted as "HFD"), which includes the 10 most financially developed economies in our sample; (2) middle level of financial development (denoted as "MFD"), which includes the 11th to 20th most financially developed economies in our sample; (3) low level of financial development (denoted as "LFD"), which includes the 10 least financially developed economies in our sample. Then the regressions are re-estimated separately using the three subsamples. The results are reported in Table 3.

From the results in Table 3 we can see that, in line with the previous literature, both output growth and inflation rate have a considerable degree of persistence, as indicated by the statistically significantly positive AR(1) term in all equations.[8] As for the money coefficients, which is the main focus of the paper, Table 3 shows that the sum of the money coefficients ($\sum_{i=0}^{4}\theta_i^m, \sum_{i=0}^{4}\phi_i^m$) is estimated to be significantly positive in all equations, implying that an increase in money supply is associated with higher output and inflation. Meanwhile, for both the output and inflation regressions, we find consistent results that the sum of the money coefficients ($\sum_{i=0}^{4}\theta_i^m, \sum_{i=0}^{4}\phi_i^m$) is largest in the LFD subsample, lower in the MFD subsample, and lowest in the HFD subsample. This increasingly larger effect of money supply on output and inflation from financially developed economies to financially less developed economies suggest that the effectiveness of monetary policy will decrease in economies with more developed financial systems. This conclusion is further verified by the significance test in Table 3, which shows that the coefficients for HFD, MFD, and LFD countries are significantly different from each other at the 1% level.

As expected, the coefficient of the *crisis* dummy in the output regressions is negative and statistically significant, implying that the 2008 global financial crisis had a dampening effect on output growth. In contrast, the coefficient of the *crisis* dummy in the inflation regressions is estimated to be significantly positive, implying that the global financial crisis was accompanied by high inflation. Although this result may appear puzzling at first glance as it contradicts the standard economic theory that financial crisis is usually associated with low inflation, it is largely consistent with the recent observation that inflation rates did not actually fall during the global financial crisis. For example, Williams (2010) and IMF (2013) have observed that inflation rates over the period 2009–2011 were notably and consistently higher than expected, despite rising levels of unemployment. Friedrich (2014) also documents the evidence of high inflation over the period 2009–2011, where above-target inflation rates occurred at a time when economic growth was at its lowest level in recent history. In our case, the quarterly average inflation rate over the crisis period (2008–2011 for most economies in our sample, according to the definition of Laeven and Valencia (2012)) was 0.97%, which is significantly

[7] Results estimated by other estimation methods such as the RE estimates and the GMM estimate are available upon request.

[8] We only include 1 lag for the autoregressive term of the dependent variable because model evaluation suggests that 1 lag is enough to capture the persistence of the dependent variable (output growth and inflation rate). In addition, robustness analysis shows that including more lags of the dependent variable in the regressions does not alter the main results of the paper. Since the persistence of the dependent variable is not the main focus of the paper, we opt for 1 lag in the regression analysis.

**Table 4**
Financial development and monetary policy effectiveness: alternative empirical setup.

| Dependent variable: real output growth $\Delta y_t$ | | | | Dependent variable: inflation rate $\Delta p_t$ | | | |
|---|---|---|---|---|---|---|---|
| Independent variables | Equation i | Equation ii | Equation iii | Independent variables | Equation i | Equation ii | Equation iii |
| $\Delta y_{t-1}$ | 0.3208$^{***}$ (3.6721) | 0.3669$^{***}$ (3.2158) | 0.2937$^{***}$ (3.4653) | $\Delta p_{t-1}$ | 0.3556$^{***}$ (6.9834) | 0.3948$^{***}$ (7.0356) | 0.3593$^{***}$ (7.1342) |
| $fd_t$ | 0.0211$^{***}$ (2.6056) | 0.0158$^{***}$ (7.5329) | 0.0042$^{***}$ (3.4922) | $fd_t$ | 0.0097$^{***}$ (2.5936) | 0.0060$^{*}$ (1.6927) | 0.0071$^{***}$ (2.8538) |
| $fd_{t-1}$ | 0.0200$^{*}$ (1.6987) | 0.0117$^{***}$ (4.3124) | 0.0025$^{**}$ (2.1368) | $fd_{t-1}$ | 0.0027 (0.3319) | 0.0005 (0.6806) | 0.0001 (0.3924) |
| $fd_{t-2}$ | 0.0011 (1.1328) | 0.0012 (0.6933) | −0.0006 (−0.7924) | $fd_{t-2}$ | −0.0005$^{**}$ (−2.2774) | −0.0001 (−0.1678) | −0.0004$^{**}$ (−2.2306) |
| $fd_{t-3}$ | −0.0004$^{***}$ (−2.9526) | −0.0003$^{*}$ (−1.8012) | −0.0003$^{***}$ (−2.7134) | $fd_{t-3}$ | −0.0006 (−1.1826) | 0.0001 (0.2347) | −0.0005 (−1.1732) |
| $fd_{t-4}$ | 0.0007 (0.5542) | 0.0055$^{***}$ (2.7913) | 0.0009 (0.8968) | $fd_{t-4}$ | 0.0002 (0.5194) | 0.0007 (1.3928) | 0.0002 (0.6855) |
| $\Delta m_t$ | 0.2186$^{***}$ (2.9703) | 0.4465$^{***}$ (5.0803) | 0.1263$^{*}$ (1.8222) | $\Delta m_t$ | −0.0891$^{*}$ (−1.6927) | 0.0105 (0.3323) | −0.1093$^{**}$ (−2.3506) |
| $\Delta m_{t-1}$ | 0.1249 (0.9037) | 0.1512 (1.1748) | 0.1127 (1.2565) | $\Delta m_{t-1}$ | 0.0398 (0.5112) | 0.0675 (0.9932) | 0.0255 (0.5827) |
| $\Delta m_{t-2}$ | 0.0753 (0.6149) | −0.0590 (−0.5625) | 0.0957 (1.1343) | $\Delta m_{t-2}$ | 0.0839$^{**}$ (2.1325) | 0.0251 (0.8908) | 0.0572$^{*}$ (1.8114) |
| $\Delta m_{t-3}$ | 0.1197 (1.1023) | −0.0395 (−0.5648) | 0.1135 (1.4187) | $\Delta m_{t-3}$ | 0.0926$^{**}$ (2.1747) | 0.0383 (1.0196) | 0.0737$^{**}$ (2.1895) |
| $\Delta m_{t-4}$ | 0.1329 (1.5104) | 0.0645 (0.8112) | 0.0995 (1.4937) | $\Delta m_{t-4}$ | 0.1247$^{***}$ (2.8503) | 0.0959$^{***}$ (2.7716) | 0.0756$^{**}$ (2.6022) |
| $fd_t\Delta m_t$ | −0.0652 (−1.1292) | −0.4774$^{***}$ (−2.6937) | 0.0478 (1.1488) | $fd_t\Delta m_t$ | 0.0150 (0.5922) | −0.0732$^{**}$ (−2.1842) | 0.0314$^{*}$ (1.6858) |
| $fd_{t-1}\Delta m_{t-1}$ | −0.0692 (−0.6965) | −0.1372 (−0.6829) | −0.0276 (−0.4167) | $fd_{t-1}\Delta m_{t-1}$ | −0.0075 (−0.2163) | −0.0420 (−0.8216) | 0.0084 (0.3347) |
| $fd_{t-2}\Delta m_{t-2}$ | −0.0648 (−0.6204) | 0.1486 (0.8321) | −0.0745 (−0.6984) | $fd_{t-2}\Delta m_{t-2}$ | −0.0513$^{*}$ (−1.8738) | −0.0036 (−0.1345) | −0.0336 (−1.5725) |
| $fd_{t-3}\Delta m_{t-3}$ | −0.1152 (−1.3716) | 0.1629 (1.4990) | −0.1134 (−0.9713) | $fd_{t-3}\Delta m_{t-3}$ | −0.0362 (−1.3781) | 0.0168 (0.5393) | −0.0235 (−1.2127) |
| $fd_{t-4}\Delta m_{t-4}$ | −0.1172 (−1.5705) | −0.0600 (−0.4563) | −0.0818$^{*}$ (−1.6812) | $fd_{t-4}\Delta m_{t-4}$ | −0.0713$^{**}$ (−2.2516) | −0.0624$^{*}$ (−1.7495) | −0.0392$^{*}$ (−1.8183) |
| $crisis_t$ | −0.0022$^{**}$ (−2.1063) | −0.0037$^{*}$ (−1.8125) | −0.0025$^{*}$ (−1.6933) | $crisis_t$ | 0.0011$^{*}$ (1.7159) | 0.0009$^{*}$ (1.7628) | 0.0010$^{*}$ (1.8045) |
| $\sum_{i=0}^{4}\theta_i^f$ | 0.0425$^{***}$ (12.9685) | 0.0339$^{***}$ (12.0346) | 0.0067$^{***}$ (10.8630) | $\sum_{i=0}^{4}\phi_i^f$ | 0.0115$^{***}$ (11.5965) | 0.0072$^{***}$ (10.8794) | 0.0065$^{**}$ (6.1513) |
| $\sum_{i=0}^{4}\theta_i^m$ | 0.6714$^{***}$ (25.2663) | 0.5637$^{***}$ (21.9838) | 0.5477$^{***}$ (20.6469) | $\sum_{i=0}^{4}\phi_i^m$ | 0.2519$^{***}$ (17.1285) | 0.2373$^{***}$ (12.3104) | 0.1227$^{**}$ (6.2948) |
| $\sum_{i=0}^{4}\theta_i^{fm}$ | −0.4316$^{***}$ (13.7829) | −0.3631$^{***}$ (12.3035) | −0.2495$^{***}$ (8.6217) | $\sum_{i=0}^{4}\phi_i^{fm}$ | −0.1513$^{***}$ (16.7268) | −0.1644$^{***}$ (8.8209) | −0.0565$^{**}$ (6.3656) |
| Number of observations | 984 | 984 | 984 | Number of observations | 984 | 984 | 984 |
| Number of countries | 41 | 41 | 41 | Number of countries | 41 | 41 | 41 |
| *F*-statistic | 36.3429$^{***}$ | 36.4716$^{***}$ | 35.0213$^{***}$ | *F*-statistic | 28.0956$^{***}$ | 26.3824$^{***}$ | 27.9883$^{***}$ |
| D.W. | 2.0528 | 2.0615 | 2.0709 | D.W. | 1.9064 | 1.8605 | 1.8926 |
| Adj-$R^2$ | 0.6599 | 0.6602 | 0.6581 | Adj-$R^2$ | 0.6128 | 0.5894 | 0.6098 |

*Notes:* (1) $fd$ s in Eqs. (i) (ii) (iii) are $fd_1$, $fd_2$ and $fd_3$, respectively; (2) $\sum_{i=0}^{4}\theta_i^f$ and $\sum_{i=0}^{4}\phi_i^f$ is the sum of the coefficients of the financial development ($fd_ts$) in the output and inflation equation respectively, $\sum_{i=0}^{4}\theta_i^m$ and $\sum_{i=0}^{4}\phi_i^m$ is the sum of the money coefficients ($\Delta m_ts$) in the output and inflation equation respectively, $\sum_{i=0}^{4}\theta_i^{fm}$ and $\sum_{i=0}^{4}\phi_i^{fm}$ is the sum of the coefficients of the interaction terms $fd_t\Delta m_ts$ in the output and inflation equation respectively, with their *F*-statistic of Wald test in the parenthesis; (3) Values in other parentheses are *t*-statistics; (4) $^{***}$Significant at 1%, $^{**}$Significant at 5%, $^{*}$Significant at 10%.

higher than the average value of 0.76% during the pre-crisis period (2005–2007). A major reason why inflation rates rise during the crisis is that many economies had implemented expansionary monetary policies such as Quantitative Easing (QE) to counteract the negative effects of the global financial crisis on the economy. In this regard, Faia (2008) also argues that rising inflation in financial crises can be attributed to long term implications of expansionary monetary policies. Other possible explanations for rising inflation in the global financial crisis include stable inflation expectations and a long-term decline in the slope of the Phillips curve (IMF, 2013) as well as the role of fiscal policy stance (Friedrich, 2014).

As for the explanatory power of the models is concerned, adjusted $R^2$ values in Table 3 are found to be between 0.55 and 0.63, which could be regarded as quite satisfactory in panel data regression. In addition, calculated D–W values in Table 3 are all around 2, suggesting that there is no autocorrelation in the estimation. Overall, the estimation results in Table 3 tend to suggest that higher levels of financial development will reduce the effectiveness of monetary policy on output and inflation.

### 3.2. Results under the alternative empirical setup

As mentioned in Section 2, in addition to the baseline empirical setup, we also use an alternative empirical setup where the variable of financial development is explicitly included in the regressions. This is done by estimating the regression Eqs. (5) and (6) based on the panel dataset of 41 economies over the period 2005Q1–2011Q4. Meanwhile, to facilitate quantitative assessment of the importance of financial development in affecting monetary policy

**Table 5**
Robustness to an extended sample period.

| Dependent variable: real output growth $\Delta y_t$ | | | | Dependent variable: inflation rate $\Delta p_t$ | | | |
|---|---|---|---|---|---|---|---|
| Independent variables | Equation i | Equation ii | Equation iii | Independent variables | Equation i | Equation ii | Equation iii |
| *Constant* | 0.0029** (2.2503) | 0.0026** (2.0475) | 0.0031*** (2.7012) | *Constant* | 0.0032*** (3.9792) | 0.0035*** (3.8983) | 0.0038*** (4.0145) |
| $\Delta y_{t-1}$ | 0.4742*** (3.5634) | 0.4591*** (3.9041) | 0.4606*** (3.5837) | $\Delta p_{t-1}$ | 0.3689*** (4.3803) | 0.3635*** (4.4107) | 0.3528*** (4.7060) |
| $\Delta m_t$ | 0.0702*** (3.0811) | 0.1227*** (3.9506) | 0.0212** (2.4188) | $\Delta m_t$ | −0.0283 (−1.0509) | 0.0086 (0.0956) | −0.0391*** (−3.5071) |
| $\Delta m_{t-1}$ | 0.0539* (1.8693) | 0.0525 (1.5045) | 0.0381 (1.1739) | $\Delta m_{t-1}$ | 0.0329 (1.0522) | 0.0304* (1.8610) | 0.0171 (0.8245) |
| $\Delta m_{t-2}$ | 0.0015 (0.0410) | −0.0125 (−0.5011) | 0.0228 (0.3472) | $\Delta m_{t-1}$ | 0.0190 (1.4613) | 0.0068 (0.8141) | 0.0157 (1.3329) |
| $\Delta m_{t-3}$ | 0.0427 (1.1602) | −0.0209 (−0.3318) | 0.0258 (1.5071) | $\Delta m_{t-3}$ | 0.0441* (1.7417) | 0.0224* (1.7532) | 0.0233** (2.0928) |
| $\Delta m_{t-4}$ | 0.0112 (1.1006) | 0.0230 (0.6785) | 0.0253 (0.4525) | $\Delta m_{t-4}$ | 0.0382*** (3.3209) | 0.0391** (2.9107) | 0.0289** (2.3835) |
| $fd_t\Delta m_t$ | −0.0072** (−2.0516) | −0.0215*** (−4.0920) | 0.0021 (0.5743) | $fd_t\Delta m_t$ | −0.0016 (−0.5457) | −0.0091** (−2.2997) | 0.0037 (1.0353) |
| $fd_{t-1}\Delta m_{t-1}$ | −0.0056* (−1.7612) | −0.0067 (−1.0256) | −0.0072* (−1.7392) | $fd_{t-1}\Delta m_{t-1}$ | −0.0009 (−0.9003) | −0.0026 (−1.0064) | 0.0013 (0.1109) |
| $fd_{t-2}\Delta m_{t-2}$ | 0.0018 (0.3043) | 0.0052 (1.1217) | −0.0020 (−0.6130) | $fd_{t-2}\Delta m_{t-2}$ | −0.0022 (−1.5676) | −0.0038 (−0.2681) | −0.0041 (−1.2803) |
| $fd_{t-3}\Delta m_{t-3}$ | −0.0040 (−0.6615) | 0.0024 (0.3926) | −0.0112* (−1.7503) | $fd_{t-3}\Delta m_{t-3}$ | −0.0027 (−0.3349) | 0.0005 (0.2603) | −0.0022 (−0.4329) |
| $fd_{t-4}\Delta m_{t-4}$ | −0.0045 (−0.0702) | −0.0013 (−0.0951) | −0.0041 (−1.0721) | $fd_{t-4}\Delta m_{t-4}$ | −0.0047*** (−2.7903) | −0.0044*** (−2.6825) | −0.0073** (−2.0168) |
| $crisis_t$ | −0.0032** (−2.1953) | −0.0036** (−2.0938) | −0.0033** (−2.0795) | $crisis_t$ | 0.0022** (1.9982) | 0.0024** (2.1576) | 0.0020** (2.2831) |
| $\sum_{i=0}^{4}\theta_i^m$ | 0.1885*** (19.3738) | 0.1649*** (19.6226) | 0.1332*** (13.6605) | $\sum_{i=0}^{4}\phi_i^m$ | 0.1059*** (20.4474) | 0.1072*** (25.3581) | 0.0458*** (11.0605) |
| $\sum_{i=0}^{4}\theta_i^{fm}$ | −0.0196*** (13.1582) | −0.0217*** (12.6040) | −0.0222*** (9.5749) | $\sum_{i=0}^{4}\phi_i^{fm}$ | −0.0121*** (15.8228) | −0.0192*** (19.9423) | −0.0086*** (7.9506) |
| Number of observations | 1320 | 1320 | 1320 | Number of observations | 1320 | 1320 | 1320 |
| Number of countries | 30 | 30 | 30 | Number of countries | 30 | 30 | 30 |
| *F*-statistic | 153.90*** | 132.83*** | 143.11*** | *F*-statistic | 146.06*** | 136.18*** | 135.76*** |
| D.W. | 2.1031 | 2.1060 | 2.0942 | D.W. | 1.8792 | 1.8906 | 1.9802 |
| Adj-$R^2$ | 0.4956 | 0.4899 | 0.5073 | Adj-$R^2$ | 0.5589 | 0.5665 | 0.5581 |

*Notes:* (1) $fd$ s in Eqs. (i) (ii) (iii) are $fd_1$, $fd_2$ and $fd_3$, respectively; (2) $\sum_{i=0}^{4}\theta_i^m$ and $\sum_{i=0}^{4}\phi_i^m$ is the sum of the money coefficients ($\Delta m_t s$) in the output and inflation equation respectively, $\sum_{i=0}^{4}\theta_i^{fm}$ and $\sum_{i=0}^{4}\phi_i^{fm}$ is the sum of the coefficients of the interaction terms $fd_t\Delta m_t s$ in the output and inflation equation respectively, with their F-statistic of Wald test in the parenthesis; (3) Values in other parentheses are *t*-statistics; (4) ***Significant at 1%, **Significant at 5%, *Significant at 10%.

effectiveness (see the discussions below), the regressions are estimated using the "standard normalized" variables.[9] The results are reported in Table 4, where Equations i, ii and iii show the results using $fd_1$, $fd_2$ and $fd_3$ as the proxy variable for financial development, respectively.

From Table 4 we can see that both output and inflation exhibit a considerable degree of persistence, as suggested by the significantly positive AR(1) term in all equations. Similar to the results in Table 3, the coefficient of the *crisis* dummy in the output regressions is significantly negative while that in the inflation regressions is significantly positive, implying that the global financial crisis had a dampening effect on output growth and was accompanied by high inflation. In addition, consistent with the previous studies (e.g., Levine, 1997; Levine et al., 2000; Khan, 2001; Hassan et al., 2011), the sum of the coefficients of the financial development ($\sum_{i=0}^{4}\theta_i^f, \sum_{i=0}^{4}\phi_i^f$) turn out to be significantly positive, indicating that financial development tends to have a positive impact on output growth and inflation rate.

As for the money coefficients $\Delta m_t$ s and the interaction terms $fd_t\Delta m_t$ s, which are the main focus of the paper, Table 4 shows that the sum of the coefficients of the money supply ($\sum_{i=0}^{4}\theta_i^m, \sum_{i=0}^{4}\phi_i^m$) is positive and statistically significant, suggesting that an increase in the money supply is generally associated with a corresponding increase in output and inflation. In addition, even if the signs of estimated coefficients of $fd_t\Delta m_t$ s sometimes do change, the sum of the coefficients of the interaction terms ($\sum_{i=0}^{4}\theta_i^{fm}, \sum_{i=0}^{4}\phi_i^{fm}$) is strictly negative and statistically significant in all equations. This again leads to the conclusion that the effectiveness of monetary policy is negatively correlated with financial development, since higher level of financial development tends to weaken the effects of monetary policy on output and inflation. One thing worth noting is that, by comparing the results of Equation ii with those of Equation iii, we can see that the sum of the coefficients of the interaction terms ($\sum_{i=0}^{4}\theta_i^{fm}, \sum_{i=0}^{4}\phi_i^{fm}$) is statistically more significant in Equation ii (where $fd_2$ is used as the proxy variable for financial development) than those in Equation iii (where $fd_3$ is used as the proxy variable for financial development), implying that the effectiveness of monetary policy may depend more on the development of the financial intermediary than that of the stock market.

[9] As is well known, the values of the conventional metric coefficients would tell us little about whether a variable is most important in determining the value of the dependent variable, since the regression variables are usually measured in different ways (different units). One proposed solution in the standard literature is to estimate the regressions using "standardized" variables which are "metric-free." This is done by computing *Z* scores for each of the dependent and independent variables. That is, $x' = (x - \mu)/s_x$, where $\mu$ and $s_x$ is the mean and tandard deviation of the original variable $x$ respectively, and $x'$ is the "standardized" value of $x$. Using the standardized variables to estimate the model, we can obtain the standardized regression coefficients, which is helpful to determine whether a 1 standard deviation change in the independent variable of interest would produce a notable change in the dependent variable. Note that the constant term is typically not included in the standard normalized regressions because all variables are demeaned in the process of standardization.

**Table 6**
Robustness to long-term average of the proxies (3-year averages).

| Dependent variable: real output growth $\Delta y_t$ | | | | Dependent variable: inflation rate $\Delta p_t$ | | | |
|---|---|---|---|---|---|---|---|
| Independent variables | Equation i | Equation ii | Equation iii | Independent variables | Equation i | Equation ii | Equation iii |
| *Constant* | 0.0106** (5.6251) | 0.0103** (6.1745) | 0.0105*** (4.9602) | *Constant* | 0.0065*** (6.7820) | 0.0068*** (5.6638) | 0.0062*** (6.3215) |
| $\Delta y_{t-1}$ | 0.3024** (2.1235) | 0.2977** (2.1033) | 0.3109** (2.0757) | $\Delta p_{t-1}$ | 0.1821** (2.0315) | 0.1696** (2.0181) | 0.1762** (1.9902) |
| $\Delta m_t$ | 0.1422*** (5.8913) | 0.1307*** (6.0905) | 0.1218** (5.0458) | $\Delta m_t$ | 0.0928*** (5.1529) | 0.0996*** (5.3965) | 0.0382*** (4.9877) |
| $\Delta m_{t-1}$ | 0.0486* (1.8063) | 0.0435 (1.5008) | 0.0311 (1.1294) | $\Delta m_{t-1}$ | 0.0271 (1.1012) | 0.0210* (1.7933) | 0.0203 (0.9547) |
| $fd_t\Delta m_t$ | −0.0202** (−8.9566) | −0.0183*** (−9.0291) | −0.0221*** (−8.7365) | $fd_t\Delta m_t$ | −0.0155*** (−9.7547) | −0.0196*** (−6.5995) | −0.0062*** (−7.5202) |
| $fd_{t-1}\Delta m_{t-1}$ | −0.0033 (−1.4624) | −0.0059 (−1.3229) | −0.0046* (−1.7102) | $fd_{t-1}\Delta m_{t-1}$ | −0.0028 (−1.2023) | −0.0031 (−1.5267) | −0.0024 (−1.0915) |
| $crisis_t$ | −0.0102** (−2.1930) | −0.0101** (−2.4526) | −0.0102** (−2.0974) | $crisis_t$ | 0.0012** (2.0526) | 0.0011** (1.9732) | 0.0010* (1.7816) |
| $\sum_{i=0}^{1}\theta_i^m$ | 0.1908*** (59.6621) | 0.1742*** (57.2106) | 0.1529*** (53.7051) | $\sum_{i=0}^{1}\phi_i^m$ | 0.1199*** (61.2284) | 0.1206*** (67.8521) | 0.0585*** (55.1902) |
| $\sum_{i=0}^{1}\theta_i^{fm}$ | −0.0235*** (113.4223) | −0.0242*** (102.7895) | −0.0267*** (118.0532) | $\sum_{i=0}^{1}\phi_i^{fm}$ | −0.0183*** (106.0742) | −0.0227*** (108.1503) | −0.0086*** (101.2661) |
| Number of observations | 90 | 90 | 90 | Number of observations | 90 | 90 | 90 |
| Number of countries | 30 | 30 | 30 | Number of countries | 30 | 30 | 30 |
| *F*-statistic | 41.206*** | 43.385*** | 39.017*** | *F*-statistic | 43.064*** | 37.280*** | 45.323*** |
| D.W. | 1.9905 | 2.0561 | 2.0384 | D.W. | 2.0112 | 2.0406 | 2.0529 |
| Adj-$R^2$ | 0.8663 | 0.8978 | 0.7521 | Adj-$R^2$ | 0.7859 | 0.7657 | 0.8510 |

*Notes:* (1) *fds* in Eqs. (i) (ii) (iii) are $fd_1$, $fd_2$ and $fd_3$, respectively; (2) $\sum_{i=0}^{1}\theta_i^m$ and $\sum_{i=0}^{1}\phi_i^m$ is the sum of the money coefficients ($\Delta m_t s$) in the output and inflation equation respectively, $\sum_{i=0}^{1}\theta_i^{fm}$ and $\sum_{i=0}^{1}\phi_i^{fm}$ is the sum of the coefficients of the interaction terms $fd_t\Delta m_t s$ in the output and inflation equation respectively, with their F-statistic of Wald test in the parenthesis; (3) Values in other parentheses are *t*-statistics; (4) ***Significant at 1%, **Significant at 5%, *Significant at 10%.

Finally, to have a quantitative assessment of the importance of financial development in affecting monetary policy effectiveness, let us take a closer look at the results. From Equation i in the left section of Table 4, we can see that the sum of the money coefficients ($\sum_{i=0}^{4}\theta_i^m$) is estimated to be 0.671. Keeping in mind that the regressions are estimated using "standard normalized" variables, this would imply that a one standard deviation increase in money growth would lead to a 0.671 standard deviations increase in output growth within four quarters. At the same time, the sum of the coefficients of the interaction terms ($\sum_{i=0}^{4}\theta_i^{fm}$) is estimated to be −0.432, implying that a one standard deviation increase in the level of financial development would lead to a 0.432 standard deviations decrease in the growth effect of money supply, corresponding to a reduction of 64.38% ($0.432/0.671 = 64.38\%$) in the effectiveness of money supply. As for the inflation effect of money supply, from Equation i in the right section of Table 4 we can see that the sum of the money coefficients ($\sum_{i=0}^{4}\phi_i^m$) is estimated to be 0.252 while the sum of the coefficients of the interaction terms ($\sum_{i=0}^{4}\phi_i^{fm}$) is estimated to be −0.151, implying that a one standard deviation increase in the level of financial development would lead to a 0.151 standard deviations decrease in the growth effect of money supply, corresponding to a reduction of 59.92% ($0.151/0.252 = 59.92\%$) in the effectiveness of monetary policy. Summarizing these results, it might be interpreted that the impact of financial development on the effectiveness of monetary policy is not only significant but also important.

### 3.3. Robustness checks

In this sub-section we investigate the robustness of our empirical findings to a number of generalizations of the estimated models, including robustness to an extended period of time, robustness to varying the data frequency, robustness across sub-samples, and robustness to endogeneity (system-GMM estimation).

#### 3.3.1. Robustness to an extended period of time

In the previous analysis, we have used a panel data set of 41 economies over the period 2005Q1–2011Q4. Although the use of a relatively short time frame (due to data availability) in the study of financial development is not rare in the literature (e.g., Zhang et al., 2012), one might still argue that it would be better to include longer time periods to allow for more changes in the financial development of the sample economies. To address this issue, we extend our analysis by bringing the start point of the sample period to an earlier date (2000Q1). However, this comes with the cost that a less number of countries can be included in our sample due to data availability. To be more specific, eleven economies have to be dropped from our sample because data prior to 2005Q1 or an earlier date are not available for these economies.[10] Then we re-estimate the regressions using the new panel data set of 30 economies over the period 2000Q1–2011Q4. The results are reported in Table 5.

From Table 5 we can see that, for both output and inflation regressions, the sum of the money coefficients ($\sum_{i=0}^{4}\theta_i^m, \sum_{i=0}^{4}\phi_i^m$) is significantly positive while that of the interaction terms ($\sum_{i=0}^{4}\theta_i^{fm}, \sum_{i=0}^{4}\phi_i^{fm}$) is significantly negative. This means that, the main conclusion of the paper, i.e., financial development has a negative impact on the effectiveness of monetary policy, is valid and robust to an extended period of time. Meanwhile, the estimation of other coefficients in the regressions, such as the AR(1) term and the *crisis* dummy, are also consistent with the previous analysis, which adds additional credibility to the robustness of our results.

#### 3.3.2. Robustness to long-term average of the proxies

Another issue related to our discussion is whether the results are affected by the potential "noise" generated by quarterly data.

[10] The eleven economies that have to be dropped include Colombia, Czech Republic, Greece, Indonesia, Japan, Latvia, South Africa, Sweden, Thailand, Ukraine, and Vietnam.

**Table 7**
Robustness to sub-samples: output regression results.

| Dependent variable<br>Independent variables | Real output growth $\Delta y_t$<br>Advanced economies | | | Real output growth $\Delta y_t$<br>Developing economies | | |
|---|---|---|---|---|---|---|
| | Equation i | Equation ii | Equation iii | Equation i | Equation ii | Equation iii |
| *Constant* | 0.0024*** | 0.0018** | 0.0014* | 0.0105*** | 0.0097*** | 0.0079*** |
| | (2.6793) | (2.0495) | (1.7032) | (8.9651) | (8.9966) | (6.5747) |
| $\Delta y_{t-1}$ | 0.2850*** | 0.2781*** | 0.3398*** | 0.1875*** | 0.2500*** | 0.2092*** |
| | (7.4435) | (7.2367) | (9.2625) | (3.5074) | (4.8382) | (3.8436) |
| $\Delta m_t$ | 0.0697 | 0.1886** | 0.0289 | 0.0726*** | 0.1244*** | 0.0679*** |
| | (1.2445) | (2.2412) | (0.8660) | (3.8249) | (8.0756) | (4.1274) |
| $\Delta m_{t-1}$ | 0.1025* | −0.018238 | 0.0356 | 0.1278*** | 0.1110*** | 0.0898*** |
| | (1.7229) | (−0.2016) | (0.9888) | (6.7251) | (6.6370) | (5.3782) |
| $\Delta m_{t-2}$ | 0.0108 | 0.0963 | 0.0161 | 0.1054*** | −0.0291*** | 0.0441** |
| | (0.1773) | (1.0506) | (0.4400) | (5.0536) | (−1.6442) | (2.4684) |
| $\Delta m_{t-3}$ | 0.1056* | 0.1851** | 0.0587 | 0.0416** | −0.0058 | 0.0250 |
| | (1.7517) | (2.0374) | (1.6380) | (2.0940) | (−0.3778) | (1.5459) |
| $\Delta m_{t-4}$ | 0.0712 | −0.0216 | 0.0036 | −0.0075 | 0.0122 | 0.0313** |
| | (1.2467) | (−0.2569) | (0.1096) | (−0.3931) | (0.8116) | (2.0072) |
| $fd_t\Delta m_t$ | −0.0025 | −0.0249* | 0.0104 | 0.0049 | −0.0094 | 0.0159** |
| | (−0.4433) | (−1.7259) | (1.8384) | (1.1145) | (−1.5770) | (2.2568) |
| $fd_{t-1}\Delta m_{t-1}$ | −0.0130** | −0.0002 | −0.0128* | −0.0207*** | −0.0276*** | −0.0222*** |
| | (−2.2185) | (−0.0112) | (−1.9711) | (−4.4425) | (−4.1564) | (−3.0059) |
| $fd_{t-2}\Delta m_{t-2}$ | 0.0036 | −0.010138 | 0.0108** | −0.0375*** | −0.0099 | −0.0468*** |
| | (0.6033) | (−0.6471) | (1.5978) | (−7.6726) | (−1.4105) | (−6.0093) |
| $fd_{t-3}\Delta m_{t-3}$ | −0.0058 | −0.0235 | 0.0001 | −0.0181*** | −0.0056 | −0.0199** |
| | (−0.9623) | (−1.5131) | (0.0060) | (−3.4973) | (−0.8427) | (−2.5121) |
| $fd_{t-4}\Delta m_{t-4}$ | −0.0096 | 0.0031 | −0.0028 | 0.0073 | −0.0038 | 0.0046 |
| | (−1.6275) | (0.2092) | (−0.4661) | (1.5335) | (−0.6370) | (0.6417) |
| $crisis_t$ | −0.0077*** | −0.0082*** | −0.0084*** | −0.0013 | −0.0037*** | −0.0001 |
| | (−6.5124) | (−7.0114) | (−7.4542) | (−1.5500) | (−4.0208) | (−0.0271) |
| $\sum_{i=0}^{4}\theta_i^m$ | 0.3597*** | 0.4301*** | 0.1429*** | 0.3399*** | 0.2126*** | 0.2581*** |
| | (4.4993) | (4.5140) | (3.7997) | (9.2391) | (8.4222) | (8.8917) |
| $\sum_{i=0}^{4}\theta_i^{fm}$ | −0.0272*** | −0.0557*** | 0.0056 | −0.0642*** | −0.0563*** | −0.0683*** |
| | (−2.9165) | (−3.0923) | (0.9431) | (−7.3000) | (−5.4930) | (−6.9100) |
| Number of observations | 624 | 624 | 624 | 360 | 360 | 360 |
| Number of countries | 26 | 26 | 26 | 15 | 15 | 15 |
| *F*-statistic | 6.8261*** | 6.8568*** | 19.4076*** | 129.9733*** | 149.8446*** | 141.5866*** |
| D.W. | 2.2192 | 2.2217 | 2.2454 | 2.0093 | 2.0011 | 0.9106 |
| Adj-$R^2$ | 0.2571 | 0.2581 | 0.2618 | 0.9033 | 0.9213 | 1.9911 |

*Notes:* (1) *fds* in Eqs. (i) (ii) (iii) are $fd_1$, $fd_2$ and $fd_3$, respectively; (2) $\sum_{i=0}^{4}\theta_i^m$ is the sum of the money coefficients ($\Delta m_t s$), $\sum_{i=0}^{4}\theta_i^{fm}$ is the sum of the coefficients of the interaction terms $fd_t\Delta m_t s$, with their *F*-statistic of Wald test in the parenthesis; (3) Values in other parentheses are *t*-statistics; (4) ***Significant at 1%, **Significant at 5%, *Significant at 10%.

This issue can be addressed by using long-term averages of the variables in the regressions to smooth out the short-term effects associated with the quarterly data. To this end, following the standard approach in the literature (e.g., Beck and Levine, 2004; Bekaert et al., 2011; Creel et al., 2015), we split the sample into four non-overlapping three-year periods (2000Q1–2002Q4, 2003Q1–2005Q4, 2006Q1–2008Q4, 2009Q1–2011Q4) and re-estimate the regressions using the three-year non-overlapping panel based on average variables. Note that because one observation now corresponds to a 3-year period length, which is sufficient to allow for the possible transmission lag of monetary policy, we include only one lag in the regressions.[11] The results are presented in Table 6.

From Table 6 we can see that both the sum of the money coefficients ($\sum_{i=0}^{1}\theta_i^m, \sum_{i=0}^{1}\phi_i^m$) and the sum of the coefficients of the interaction terms ($\sum_{i=0}^{1}\theta_i^{fm}, \sum_{i=0}^{1}\phi_i^{fm}$) are estimated to be significant at the 1% level with the same sign as before, implying that the use of long-term average of the proxy variables to estimate the regressions would not alter the main results of the paper. Thus, consistent with our earlier findings, the negative relationship between financial development and monetary policy effectiveness remains robust after accounting for the possible long-term effects of the regression variables, which further strengthens the basic conclusion of the paper.

### 3.3.3. Robustness across sub-samples

One question that has been frequently explored in empirical studies is whether the results differ considerably between advanced and developing countries. In order to address this problem, we repeat the estimation by classifying the sample economies into two categories as advanced and developing economies based on IMF's classification.[12] Table 7 and Table 8 show the empirical results for the output and inflation equation, respectively.

From Table 7 we can see that, consistent with the previous analysis, the effect of monetary policy on output is significantly and negatively associated with financial development. However, both the sum of the money coefficients ($\sum_{i=0}^{4}\theta_i^m$) and the sum of the coefficients of the interaction terms ($\sum_{i=0}^{4}\theta_i^{fm}$) turn out to be greater and more significant in the group of developing economies, indicating that the effect of monetary policy on output decreases more in developing economies than the developed ones. As for the effect of

[11] We also conducted model experiments by allowing for more lags in the regressions and found that the coefficients with lag order larger than 1 were statistically insignificant.

[12] According to the IMF's country classification, advanced economies in our sample include Australia, Austria, Belgium, Canada, Czech Republic, Denmark, France, Germany, Greece, Hong Kong, Hungary, Ireland, Italy, Japan, Korea Republic, Latvia, Netherlands, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States, while developing economies in our sample include Argentina, Brazil, Bulgaria, China, Colombia, India, Indonesia, Lithuania, Mexico, Peru, Russia, South Africa, Thailand, Ukraine, and Vietnam.

**Table 8**
Robustness to sub-samples: inflation regression results.

| Dependent variable<br>Independent variables | Inflation rate $\Delta p_t$<br>Advanced economies | | | Inflation rate$\Delta p_t$<br>Developing economies | | |
|---|---|---|---|---|---|---|
| | Equation i | Equation ii | Equation iii | Equation i | Equation ii | Equation iii |
| *Constant* | 0.0025*** | 0.0024*** | 0.0024*** | 0.0062*** | 0.0058*** | 0.0061*** |
| | (6.1991) | (5.9655) | (5.7410) | (5.4216) | (4.1662) | (5.2562) |
| $\Delta p_{t-1}$ | 0.4205*** | 0.4193*** | 0.4300*** | 0.4117*** | 0.3855*** | 0.4268*** |
| | (10.7437) | (10.6048) | (11.0248) | (9.1013) | (8.4842) | (9.5234) |
| $\Delta m_t$ | −0.0198 | −0.0392 | −0.0326** | −0.0446* | 0.0295 | −0.0670*** |
| | (−0.8410) | (−1.0963) | (−2.2301) | (−1.7039) | (1.3986) | (−3.0512) |
| $\Delta m_{t-1}$ | −0.0160 | −0.0007 | −0.0005 | 0.0446* | 0.0252 | 0.0387* |
| | (−0.6360) | (−0.0176) | (−0.0340) | (1.6703) | (1.1275) | (1.7058) |
| $\Delta m_{t-2}$ | 0.0561** | 0.0862** | 0.0323** | 0.0480* | 0.0040 | 0.0497** |
| | (2.1864) | (2.2202) | (2.0692) | (1.8004) | (0.1784) | (2.1898) |
| $\Delta m_{t-3}$ | 0.0158 | 0.0384 | 0.0223 | 0.0231 | −0.0222 | 0.0448** |
| | (0.6188) | (0.9926) | (1.4481) | (0.9022) | (−0.9863) | (2.1657) |
| $\Delta m_{t-4}$ | 0.0842*** | 0.0685* | 0.0399*** | 0.0142 | 0.0294 | 0.0124 |
| | (3.4679) | (1.9110) | (2.6860) | (0.5756) | (1.3637) | (0.6252) |
| $fd_t\Delta m_t$ | −0.0025 | −0.0002 | −0.0024 | 0.0106* | −0.0229* | 0.0263*** |
| | (−1.0712) | (−0.0311) | (−0.8625) | (1.7748) | (−1.8789) | (3.5796) |
| $fd_{t-1}\Delta m_{t-1}$ | 0.0028 | 0.0015 | 0.0035 | −0.0052 | 0.0036 | −0.0069 |
| | (1.1389) | (0.2265) | (1.2284) | (−0.7953) | (0.2627) | (−0.8625) |
| $fd_{t-2}\Delta m_{t-2}$ | −0.0041 | −0.0125* | −0.0034 | −0.0135** | −0.0004 | −0.0255*** |
| | (−1.6166) | (−1.8785) | (−1.1455) | (−2.0631) | (−0.0284) | (−3.0760) |
| $fd_{t-3}\Delta m_{t-3}$ | 0.0011 | −0.0029 | 0.0020 | 0.0006 | 0.0326** | −0.0099 |
| | (0.4470) | (−0.4344) | (0.6796) | (0.0873) | (2.3903) | (−1.2739) |
| $fd_{t-4}\Delta m_{t-4}$ | −0.0084*** | −0.0106* | −0.0083*** | 0.0038 | −0.0007 | 0.0088 |
| | (−3.3841) | (−1.6754) | (−2.8236) | (0.6419) | (−0.0510) | (1.2159) |
| $crisis_t$ | 0.0018*** | 0.0015*** | 0.0018*** | 0.0040*** | 0.0044*** | 0.0040*** |
| | (3.3419) | (2.8332) | (3.1756) | (4.2513) | (5.0389) | (4.0870) |
| $\sum_{i=0}^{4}\phi_i^m$ | 0.1204*** | 0.1533*** | 0.0613*** | 0.0854** | 0.0659** | 0.0786** |
| | (3.6843) | (3.9461) | (2.9755) | (2.3314) | (2.1340) | (2.5282) |
| $\sum_{i=0}^{4}\phi_i^{fm}$ | −0.0111*** | −0.0246*** | −0.0085* | −0.0037 | 0.0122 | −0.0071 |
| | (−2.8545) | (−3.2922) | (−1.6741) | (−0.4272) | (0.6050) | (−0.6722) |
| Number of observations | 624 | 624 | 624 | 360 | 360 | 360 |
| Number of countries | 26 | 26 | 26 | 15 | 15 | 15 |
| *F*-statistic | 13.3579*** | 13.2077*** | 13.0228*** | 20.5561*** | 22.0492*** | 21.6962*** |
| D.W. | 1.9074 | 1.9144 | 1.9104 | 1.7989 | 1.7879 | 1.8144 |
| Adj-$R^2$ | 0.4233 | 0.4203 | 0.4166 | 0.5861 | 0.6039 | 0.5998 |

*Notes:* (1) *fds* in Eqs. (i) (ii) (iii) are $fd_1$, $fd_2$ and $fd_3$, respectively; (2) $\sum_{i=0}^{4}\phi_i^m$ is the sum of the coefficients on money supply ($\Delta m_t s$) and $\sum_{i=0}^{4}\phi_i^{fm}$ is the sum of the coefficients of the interaction terms ($fd_t\Delta m_t s$), with their *F*-statistic of Wald test in the parenthesis; (3) Values in other parentheses are *t*-statistics; (4) ***Significant at 1%, **Significant at 5%, *Significant at 10%.

monetary policy on inflation, the results in Table 8 show that the sum of the coefficients of the interaction terms ($\sum_{i=0}^{4}\phi_i^{fm}$) is estimated to be significant in the group of advanced economies but insignificant in the group of developing economies, suggesting that the relationship between financial development and the effect of monetary policy on inflation tends to be more pronounced in advanced economies than that in developing economies.

Overall, the above analysis indicates that while the basic conclusion of the paper remains valid, there are also differences in the significance and degree of how financial development may affect the effectiveness of monetary policy. More specifically, as an economy becomes more financially developed, the effect of monetary policy on output decreases more in developing economies while the reverse is true for the effect of monetary policy on inflation.

In addition to the comparative analysis between advanced and developing economies, we also exclude the economies that have the 10% most extreme values for output, inflation and financial development from the regression analysis to see if the results are sensitive to the extreme values. Additionally, to address the problem of endogeneity, we also re-estimate the regressions by using the system Generalized Method of Moments (GMM) estimators developed by Arellano and Bond (1991) and Blundell and Bond (1998). The results show that our main findings are not significantly altered by these robustness checks.[13]

[13] The results for these robustness checks are available upon request.

To sum up, the robustness checks in this section give additional credibility of the basic conclusion of the paper, i.e., the effectiveness of monetary policy tends to decline as the level of financial development becomes higher.

## 4. Concluding remarks

The question of whether financial development influences the effectiveness of monetary policy has captured growing attention among researchers in recent years. However, the number of studies which have explored this question empirically is still relatively limited and the results seem to be mixed. In this context, this paper adds to the literature by providing new evidence on the relationship between financial development and the effectiveness of monetary policy. Using panel data of 41 economies over 2005Q1 to 2011Q4, we find that the effectiveness of monetary policy is negatively correlated with financial development. This finding is shown to be robust across all the different specifications and estimation methods examined.

In addition to this general conclusion for all economies, our results also indicate that the effect of monetary policy on output decreases more with financial development in developing economies while the effect of monetary policy on inflation is strengthened with financial development in advanced economies. Possible reasons that may explain this difference between advanced and developing economies are the fact that advanced economies tend to have deeper and more efficient financial intermediaries and financial markets than developing economies; more stable and less capital flight in advanced economies due to economic and political stability; the availability of more financial instruments to direct money and credit to increase output in advanced economies; and more independent central banks and the adoption of explicit inflation targeting as the dominant monetary policy regime to control inflation in advanced economies.

It is worth noting that, although our empirical results support the argument that the effectiveness of monetary policy will probably decline as the financial system becomes more developed, the theoretical foundations underlying this relationship largely remain absent due to the lack of micro-founded models which can successfully capture the interactions between financial development and the effectiveness of monetary policy. Therefore, how to construct microfoundations for the financial development-monetary policy analysis would be an interesting area of future research. In this regard, a deeper look at the monetary policy transmission mechanism in the context of a micro-founded model that endogenously includes the impact of financial development could give a more solid direction to the next steps to be taken in empirical studies.

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## References

Alpanda, S., Aysun, U., 2012. Global banking and the balance sheet channel of monetary transmission. International Journal of Central Banking 8 (3), 141–175.
Arellano, M., Bond, S., 1991. Some tests of specification for panel data: monte carlo evidence and an application to employment equations. Review of Economic Studies 58, 277–297.
Arestis, P., Hadjimatheou, G., Zis, G., 1992. The impact of financial innovations on the demand for money in the UK and Canada. Applied Financial Economics 2, 115–123.
Ashcraft, A., Campello, M., 2007. Firm balance sheets and monetary policy transmission. Journal of Monetary Economics 54, 1515–1528.
Aysun, U., Brady, R., Honig, A., 2013. Financial frictions and the strength of monetary transmission. Journal of International Money and Finance 32, 1097–1119.
Aysun, U., Hepp, R., 2011. Securitization and the balance sheet channel of monetary transmission. Journal of Banking & Finance 35 (8), 2111–2122.
Beck, T., Levine, R., 2004. Stock markets, banks, and growth: panel evidence. Journal of Banking & Finance 28, 423–442.
Beck, T., Lundberg, M., Majnoni, G., 2006. Financial intermediary development and growth volatility: do intermediaries dampen or magnify shocks. Journal of International Money and Finance 25, 1146–1167.
Bekaert, G., Harvey, C., Lundblad, C., 2011. Financial openness and productivity. World Development 39 (1), 1–19.
Bernanke, B., Gertler, M., 1995. Inside the black box: the credit channel of monetary policy transmission. Journal of Economic Perspectives 9, 27–48.
Berument, H., Dogan, B., 2003. Openness and the effectiveness of monetary policy: empirical evidence from Turkey. Applied Economics Letters 10, 217–221.
Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel-data models. Journal of Econometrics 87, 115–143.
Carranza, L., Galdon-Sanchez, J., Gomez-Biscarri, J., 2010. Understanding the relationship between financial development and monetary policy. Review of International Economics 18 (5), 849–864.
Cecchetti, S., 1999. Legal structure, financial structure, and the monetary policy transmission mechanism. Federal Reserve Bank of New York Economic Policy Review 5 (2), 9–28.
Cecchetti, S. and Krause, S., 2001. Financial Structure, Macroeconomic Stability and Monetary Policy. NBER Working Paper No. 8354.
Cetorelli, N., Goldberg, L., 2012. Banking globalization and monetary transmission. Journal of Finance 67 (5), 1811–1843.
Ciccarelli, M., Maddaloni, A., Peydró, J., 2015. Trusting the bankers: a new look at the credit channel of monetary policy. Review of Economic Dynamics 18 (4), 979–1002.
Creel, J., Huberta, P., Labondancea, F., 2015. Financial stability and economic performance. Economic Modelling 48, 25–40.
Demirgüç-Kunt, A., Levine, R., 1996. Stock market development and financial intermediaries: stylized facts. World Bank Economic Review 10, 291–322.
Demirgüç-Kunt, A., Feyen E. and Levine, R., 2011. The Evolving Importance of Banks and Securities Markets. WBPR Working Paper 5805, World Bank Policy Research.
Djankov, S., Hart, O., McLiesh, C., Shleifer, A., 2008. Debt enforcement around the world. Journal of Political Economy 116 (6), 1105–1149.
Djankov, S., McLiesh, C., Shleifer, A., 2007. Private credit in 129 countries. Journal of Financial Economics 84, 299–329.
Elbourne, A. and de Haan, J., 2004. Asymmetric Monetary Transmission in EMU: The Robustness of VAR Conclusions and Cecchetti's Legal Family Theory. CESifo Working Paper Series 1327.
Elbourne, A., de Haan, J., 2006. Financial structure and monetary policy transmission in transition countries. Journal of Comparative Economics 34, 1–23.
Faia, E., 2008. Financial crises and rising inflation: the role of monetary policy. Available at <http://www.economonitor.com/blog/2008/03/financial-crises-and-> rising-inflation-the-role-of-monetary-policy/.
Friedrich, C., 2014. Global Inflation Dynamics in the Post-Crisis Period: What Explains the Twin Puzzle? Bank of Canada Working Paper 2014–36.
Gambacorta, L., Marques-Ibanez, D., 2011. The bank lending channel: lessons from the crisis. Economic Policy 26 (66), 135–182.
Gertler, M., Karadi, P., 2011. A model of unconventional monetary policy. Journal of Monetary Economics 58 (1), 17–34.
Gomez, E., Vasquez, D., and Zea, C., 2005. Derivative Markets' Impact on Colombian Monetary Policy. Banco de la Republica Colombia Working Paper.
Gurley, J., Shaw, E., 1955. Financial aspects of economic development. American Economic Review 45, 515–538.
Gurley, J., Shaw, E., 1967. Financial structure and economic development. Economic Development and Cultural Change 15, 257–268.
Hassan, M., Sanchezb, B., Jung-Suk, Y., 2011. Financial development and economic growth: new evidence from panel data. Quarterly Review of Economics and Finance 51 (1), 88–104.
Hausman, J., 1978. Specification tests in econometrics. Econometrica 46, 1251–1271.
Hendry, D., Ericsson, N., 1991. Modeling the demand for narrow money in the United Kingdom and the United States. European Economic Review 35 (4), 833–881.
IMF, 2013. The Dog That Didn't Bark: Has Inflation Been Muzzled or Was It Just Sleeping. World Economic Outlook, Chapter III, April.
Judge, G., Griffiths, W., Hill, R., Lutkepohl, H., Lee, T., 1985. The Theory and Practice of Econometrics. John Wiley Press, New York.
Karras, G., 1999. Openness and the effects of monetary policy. Journal of International Money and Finance 18, 13–26.
Kashyap, A., Stein, J., 1997. The role of banks in monetary policy: a survey with implications for the European Monetary Union. Federal Bank of Chicago. Economic Perspectives 21, 2–18.
Kashyap, A., Stein, J., 2000. What do a million observations on banks say about the transmission of monetary policy? American Economic Review 90, 407–428.
Khan, A., 2001. Financial development and economic growth. Macroeconomics Dynamics 5, 413–433.
Laeven, L. and Valencia, F., 2010. Resolution of Banking Crises: The Good, the Bad, and the Ugly. IMF Working Papers 10/146, International Monetary Fund.
Laeven, L. and Valencia, F., 2012. Systemic Banking Crises Database: An Update. IMF Working Papers 12/163, International Monetary Fund.
La Porta, R., Lopez-de Silanes, F., Shleifer, A., Vishny, R., 1997. Legal determinants of external finance. Journal of Finance 52, 1131–1150.
La Porta, R., Lopez-de Silanes, F., Shleifer, A., Vishny, R., 1998. Law and finance. Journal of Political Economy 106, 1113–1155.
Levine, R., 1997. Financial development and economic growth: views and agenda. Journal of Economic Literature 35 (2), 688–726.
Levine, R., 1998. The legal environment, banks, and long-run economic growth. Journal of Money, Credit and Banking 30, 596–613.
Levine, R., 2002. Bank-based or market-based financial systems: which is better? Journal of Financial Intermediation 11, 398–428.
Levine, R., 2005. Finance and growth: theory and evidence. In: Aghion, Philippe, Durlauf, Steven N. (Eds.), Handbook of Economic Growth. Elsevier, North Holland, pp. 866–934.
Levine, R., Loayza, N., Beck, T., 2000. Financial intermediation and growth: causality and causes. Journal of Monetary Economics 46, 31–77.
Loutskina, E., Strahan, P., 2009. Securitization and the declining impact of bank finance on loan supply: evidence from mortgage originations. Journal of Finance 64, 861–889.
Mishkin, F., 2009. Is monetary policy effective during financial crises. American Economic Review 99 (2), 573–577.
Mishkin, F., 2012. Monetary Policy Strategy: Lessons from the Crisis. In: Monetary Policy Revisited: Lessons from the Crisis, European Central Bank: Frankfurt, forthcoming.
Mishra, P., Montiel, P. and Spilimbergo, A., 2010. Monetary Transmission in Low Income Countries. IMF Working paper 10/223.
Mullineux, A., 1994. Financial innovation and monetary policy in the UK. Review of Policy Issues 1 (2), 29–44.
Quispe, Z., Rossini, R., 2011. Monetary policy during the global financial crisis of 2007.09: the case of Peru. In: Bank for International Settlements (Ed.), The Global Crisis and Financial Intermediation in Emerging Market Economies, 54. Bank for International Settlements, pp. 299–316.
Taylor, M., 1987. financial innovation, inflation and the stability of the demand for broad money in the United Kingdom. Bulletin of Economic Research 39 (3), 225–233.
Williams, J., 2010. Sailing into Headwinds: The Uncertain Outlook for the U.S. Economy. Presentation to a Joint Meeting of the San Francisco and Salt Lake City Branch Boards of Directors, Salt Lake City, Utah, September 8.
Zhang, J., Wang, L., Wang, S., 2012. Financial development and economic growth: Recent evidence from China. Journal of Comparative Economics 40 (3), 393–412.