PRECAUTIONARY DEMAND FOR MONEY AND ECONOMIC UNCERTAINTY: EVIDENCE FROM THRESHOLD EFFECT OF INSTITUTIONAL DEVELOPMENT

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(Received 20th December 2024; revised 19th February 2025; accepted 27th February 2025)

Abstract. A notable feature of empirical studies on the unknowns about future economic events that lead to precautionary demand for money among economic agents is that very few studies put emphasis on the role of institutional development in mediating the relationship between them. To overcome this shortcoming, this study examines the threshold effect of institutional development on the relationship between precautionary demand for money and economic uncertainty, without neglecting the roles of income, the interest rate and the exchange rate in the money demand function in 28 economies. The empirical results from the panel threshold methods demonstrate significant threshold effect for these determinants, especially for economic uncertainty, which indicate that a better understanding that the relationship between the precautionary demand for money and economic uncertainty may be contingent on institutional development could help policy makers fine-tune the money demand function in a more precise manner to achieve the optimal liquidity provision under economic uncertainty over time.
Keywords: *precautionary, money demand, economic uncertainty, institutional development, panel threshold method*

Introduction

Precautionary demand for money refers to the desire to hold liquid monetary assets as a safeguard against unforeseen economic events. An unforeseen economic event means economic uncertainty (Black et al., 2012). This concept was first introduced by Keynes (1936) in his seminal work, The General Theory of Employment, Interest, and Money. Since then, numerous researchers have explored the propensity of households and firms to hold extra cash as a buffer against economic uncertainty, employing various methodological approaches. However, much of the existing literature has focused predominantly on explaining and forecasting how economic agents adjust their liquidity preferences in response to uncertainty (Friedman and Kuttner, 2010). Despite these efforts, empirical studies have been limited by the lack of evidence on potential moderating or mediating factors in the money demand function. Therefore, the question remains as to whether further research in this area could enhance our understanding of money demand and economic uncertainty, thereby contributing to the refinement of monetary theory. A notable feature of empirical studies on the unknowns about future economic events that lead to precautionary demand for money among economic agents is that very few studies put emphasis on the role of institutional development in mediating the relationship between them; institutional development refers to changes in the overall strength of a country's institutions, including its political governance, legal system, regulatory framework, both formal and informal that could shape individuals' and organizations' behavior (Rodrik, 2006). For example, Ivanovski and Churchill (2019) concludes that economic policy uncertainty affects money demand positively in

the long run while negatively in the short run with money demand in Australia. Gan (2019) concludes that the optimal economic uncertainty index cointegrates with real narrow money demand for a sample of eleven countries. Al Rasasi (2020) presents a long-run positive stable relationship between money demand and stock price uncertainty in Saudi Arabia while the short-run effect is not significant. Khan et al. (2023) find that people in India demand more money facing high monetary and stock market uncertainties. Akinlo (2024) indicate that for Nigeria, the world uncertainty index affects money demand symmetrically in the short run while in the long run, only decreased world uncertainty index significantly contribute to less holding of cash in the long run.

The interest in the possible role of institutional development in money demand gains traction due to two major breakdowns of the conventional money demand function in the 1970s and 1980s for the United States (Goldfeld and Sichel, 1990). The empirical studies on institutional development as a possible determinant in the money demand function date to as early as 1980s but do not last long. For example, Bordo and Jonung (1981) find that the secular pattern of money demand in the US, Canada, the UK, Norway and Sweden from 1880 to 1975 could be explained by institutional development that gives rise to financial sophistication and improved economic stability. Extending the time period to 1986, Bordo and Jonung (1990) confirms the previous finding that institutional development is a significant determinant of the long-run money demand function in the five countries. Through international comparison, Boughton (1992) argues that the institutional factor not only is an important determinant of money demand, but its short-run effect differs across countries. Using cointegration techniques in the same five countries, Bordo et al. (1997) as well as Siklos (1993) respectively confirm that the traditional money demand function consisting of real income and the nominal interest rate needs to be augmented with institutional change proxies to achieve long-run stability. On the other hand, studies in terms of the mediating effect of institutional development mostly focus on the consequences of the behavior by monetary authorities rather than money demand. For example, using data on 82 countries, Blackburn et al. (2008) argue that in countries with low levels of institutional development, there tends to be high inflation due to the creation of seigniorage by central banks under political pressure. Duncan (2014) reports that monetary authorities are expected to conduct procyclical policies in economies with weak institutions that contribute to larger economic fluctuations in 56 economies. Kakar et al. (2020) reveals by estimating non-linear Taylor rule for 51 countries, that central banks in countries with high level of institutional development take more aggressive action against inflation, leading to a very low level of inflation rates. Shabir et al. (2021) demonstrate a significant threshold effect of institutional development on the relationship between economic policy uncertainty and bank stability considering nonlinearity for 1481 banks, revealing that the adverse impact of policy uncertainty on bank stability could be reduced in countries with high levels of institutional quality. Fiador et al. (2022) find that high institutional development helps to enhance the effectiveness the monetary policy transmission channel, causing bank lending rates to fall.

This study is motivated by the fact that no policy makers have publicly claimed to have taken into account institutional development in fine-tuning the money demand function in response to the precautionary money holding behavior by economic agents during economic uncertainty. They might be reluctant to make such an announcement, or such consideration may simply not exist. Institutional development components,

namely, the control of corruption, law and order, political stability, and regulatory quality are key contributory factors for underpinning economic stability but developing solid institutions is a gradual and long-term endeavor (Asian Development Bank, 2022). Strong institutional development can buffer the impact of uncertainty while weak institutional development will likely foster bad policies and undercuts the resilience of economies to exogenous shocks, producing high volatility and instability (International Monetary Fund, 2023; 2021). When facing economic uncertainty, firms and households could be especially hit hard in weak institutional environment, which constrains liquidity, thus triggering stronger precautionary demand for money (Asian Development Bank, 2022; World Bank, 2016). Amid calls for the reappraisal and recalibration of policy making, policy support for liquidity in responses to economic uncertainty should be targeted and tailored to country-specific circumstances of institutional development (United Nations, 2023; International Monetary Fund, 2021). The study aims to examine the mediating effect of institutional development on the relationship between the precautionary demand for money and economic uncertainty, without ignoring the roles of the scale variable (real income), the opportunity cost variable (the nominal interest rate) and the currency substitution variable (exchange rate) in the money demand function in 28 economies, such that a better understanding that the relationship between money demand and economic uncertainty may be contingent on institutional development can help policy makers achieve the optimal liquidity support over time. For empirical procedures, this study applies the panel threshold method proposed by Seo and Shin (2016) for the baseline estimation, with the kink model proposed by Seo et al. (2019) and the fixed effect model proposed by Wang (2015) for robustness checks.

Materials and Methods

Theoretical model

The theoretical model of the study is an extension of the augmented money demand function proposed by Gan (2019). The advantage of the augmented money demand function is that it recovers the vanished precautionary motive from the Keynes money demand function by incorporating economic uncertainty as the determining factor for the precautionary motive, without ignoring the transactions motive subsumed by income and the speculative motive subsumed by the interest rate. Keynes (1936) on the other hand, though argues that the precautionary demand for money could be explained by uncertainty, does not present a clear definition of uncertainty or elaborate on the relationship between them (Weatherson, 2002). This study further extends the augmented money demand function by incorporating the exchange rate into the function, first specified by Mundell (1963), to take into account the substitution effect between the domestic and foreign currencies. The theoretical model of this study can be expressed in the following form (Eq. (1):

$$m_t = f(y_t, R_t, EX_t, eu_t) \qquad \text{Eq. (1)}$$

where the money demand (m_t) positively depends on real income (y_t) and negatively depends on the nominal interest rate (R_t). Furthermore, m_t negatively depends on positive economic uncertainty (eu_t) and positively depends on negative eu_t (Gan, 2019). The effect of exchange rate (EX_t) on m_t is determined whether the wealth

effect or the substitution effect prevails. When domestic currency appreciates, more domestic currency translates into more wealth, thus the increasing money demand (wealth effect). On the other hand, households may substitute the local currency with more foreign currency to purchase more foreign assets, thus the decreasing money demand (substitution effect) (Arango and Nadiri, 1981). Based on the above discussion, a general econometric model is expressed as follows (Eq. (2):

$$m_t = \alpha + \beta_1 y_t + \beta_2 R_t + \beta_3 EX_t + \beta_4 eu_t + u_t \qquad \text{Eq. (2)}$$

Where α is the constant term, and u denotes the occurrence of a monetary demand shock that exceeds the impact caused by y_t, R_t, EX_t and eu_t. The problem of improper assumption of linear relationships between dependent and independent variables commonly occurs in the panel data analysis. This study is therefore set to investigate whether there exists the presence of a non-linear relationship between the precautionary demand for money and economic uncertainty in the context of institutional development by using the panel threshold method proposed by Seo and Shin (2016). Threshold methods become popular with the introduction of the static threshold model by Hansen (1999). However, the Hansen model requires both the regressors and the threshold variables to be strictly exogenous for the estimators to be consistent. Though later Caner and Hansen (2004) relaxes this restriction by allowing endogenous regressors, it still requires a exogenous threshold variable. Seo and Shin (2016), on the other hand, employes first-differenced GMM method that allows both the regressors and threshold variables to be endogenous and permits a dynamic model. This study takes the static form of the Seo and Shin (2016) panel threshold model because the default dynamic form reveals no statistical significance. The following is the formula specifying the money demand function with institutional development as the threshold variable (Eq. (3):

$$\begin{aligned} m_{\text{it}} = {} & (\beta_1 y_{it} + \beta_2 R_{it} + \beta_3 EX_{it} + \beta_4 eu_{it}) 1\{INS_{it} \le \gamma\} + \\ & (\lambda_1 y_{it} + \lambda_2 R_{it} + \lambda_3 EX_{it} + \lambda_4 eu_{it}) 1\{INS_{it} > \gamma\} + \varepsilon_{it} \end{aligned} \qquad \text{Eq. (3)}$$

where m is the real money demand, y is the real income, R is the nominal interest rate, EX is the exchange rate, eu is economic uncertainty. INS is the level of institutional development, which acts as the threshold variable that splits the sample into two regimes. $1\{.\}$ is the indicator function that denotes regimes. γ is the threshold parameter. β and λ are the slope coefficients under the lower and upper regimes respectively. All the variables are in the log form except R and INS. i and t refer to cross sectional units and the time dimension respectively. To identify the existence of the threshold effect of institutional development, the statistical significance is tested on the null hypothesis of $H_0: \beta = \lambda$. If the null hypothesis is not rejected, no conclusion can be drawn with respect to the threshold effect of institutional development in mediating the relationship between money demand and its determinants. By contrast, if the null hypothesis is rejected, in other words, if the alternative hypothesis H_1**:** $\beta \neq \lambda$ is supported, we can confirm the threshold effect of institutional development.

Data and empirical results

The empirical study is based on 28 economies from 1996 to 2023 annually. There are six variables, namely, money demand, real income, the nominal interest rate, the exchange rate, economic uncertainty and institution development. Money demand is proxied by real narrow money and real broad money. The real income is proxied by real GDP. The nominal interest rate is proxied by the money market rate. The exchange rate is proxied by the real effective exchange rate. Economic uncertainty is proxied by the optimal economic uncertainty (Gan, 2014), the economic policy uncertainty (Baker et al., 2016) and the world uncertainty index (Ahir et al., 2022). Due to data unavailability, the optimal economic uncertainty index is available for 14 economies, namely, Australia, Canada, China, Hong Kong, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Thailand, the UK and the US. The economic policy uncertainty and world uncertainty index are available for 24 economies, namely, Australia, Belgium, Brazil, Canada, Chile, China, Denmark, France, Germany, Greece, Hong Kong, India, Ireland, Italy, Japan, Mexico, New Zealand, Russia, Singapore, South Korea, Spain, Sweden, the UK and the US. Institutional development is proxied by institutional quality. All the variables are in the logged form ($lm1$, $lm2$, ly, $lREER$, $loeu$, $lepu$ and $lwui$), except the nominal interest rate (R) and institutional development (INS). The detailed description for each variable is as follows:

Consumer price index (CPI): Data on CPI are obtained from International Financial Statistics (IFS) of the IMF.

Real narrow money ($m1$): Data on nominal narrow money ($M1$) are obtained from IFS. $m1$ is obtained by dividing $M1$ by the CPI.

Real broad money ($m2$): Data on nominal broad money ($M2$) are obtained from IFS. $m2$ is obtained by dividing $M2$ by the CPI.

Real income or real output (y): income or output is proxied by gross domestic product (GDP). Data on Nominal GDP are obtained from the IFS. Real GDP (y) is obtained by dividing nominal GDP by the CPI.

Nominal interest rate (R): the nominal interest rate (R) is proxied by the money market rate (MMR) obtained from the IFS.

Real effective exchange rate ($REER$): Data on $REER$ are obtained from the Bank for International Settlements (IBS). An increase in $REER$ denotes appreciation of the domestic currency and vice versa.

Optimal economic uncertainty (oeu): oeu captures interest rate uncertainty, output uncertainty, inflation uncertainty and exchange rate uncertainty. The positive and negative in value indicate positive (negative) uncertainty movements deviating from its long-term equilibrium respectively. Data on optimal economic uncertainty (oeu) is provided by Gan (2014). To not lose the negative values after logarithm, we employs the Webber (2012) method to obtain $loeu$.

Economic policy uncertainty (epu): Developed by Baker et al. (2016), epu captures a broad range of uncertainty-related keywords by news media. The index demonstrates desirable effectiveness, conforming to stock market volatility and strongly correlating with Fed's Beige Books' references of policy uncertainty. Data on epu are obtained from economic policy uncertainty website. A higher epu indicates greater uncertainty and vice versa.

Word Uncertainty Index (wui): Developed by Ahir et al. (2022), the advantage of wui is that it is highly comparable across countries and time as it relies on a single source, namely, the country reports from the Economist Intelligence Unit to count the frequency of the word "uncertain" (and its variants) and then rescaled, without

compromising its effectiveness. A higher *wui* indicates greater uncertainty and vice versa.

Institutional development (*INS*): *INS* is calculated by taking the average of the six indices under the world governance indicator released by the World Bank. *INS* ranges from -2.5 to 2.5, with the higher value indicating a higher level of institutional development and vice versa. Due to value gaps, we interpolate the *INS* data for 1997, 1999 and 2001 based on the method by Schoenberg (1973).

Results and Discussion

Prior to the panel threshold method, two panel unit root tests, namely, Im et al. (2003) as well as Levin et al. (2002) are employed to identify the level of stationarity of variables. Results from *Table 1* demonstrate that all the variables are stationary to the order of zero.

Table 1. *Panel unit root test results.*

Variables	Tests	Im et al. (2003)	Levin et al. (2002)
$lm1_t$	Level	-3.319(5)***	-4.153(3)***
	First Difference	-13.614(3)***	-13.228(3)***
	Decision	$I(0)$	$I(0)$
$lm2_t$	Level	-1.369(1)*	-4.885(3)***
	First Difference	-11.016(4)***	-9.960(4)***
	Decision	$I(0)$	$I(0)$
ly_t	Level	-1.334(3)*	-4.536(2)***
	First Difference	-17.451(1)***	-17.927(1)***
	Decision	$I(0)$	$I(0)$
R_t	Level	-4.836(3)***	-3.203(3)***
	First Difference	-17.861(1)***	-18.305(1)***
	Decision	$I(0)$	$I(0)$
$lREER_t$	Level	-1.910(1)**	-1.835(1)**
	First Difference	-20.659(5)***	-20.341(5)***
	Decision	$I(0)$	$I(0)$
$loeu_t$	Level	-15.303(4)***	-15.059(4)***
	First Difference	-18.382(5)***	-10.185(5)***
	Decision	$I(0)$	$I(0)$
$lepu_t$	Level	-9.572(2)***	-8.627(2)***
	First Difference	-27.288(3)***	-27.625(2)***
	Decision	$I(0)$	$I(0)$
$lwui_t$	Level	-10.185(5)***	-9.536(5)***
	First Difference	-25.607(5)***	-23.384(5)***
	Decision	$I(0)$	$I(0)$
INS_t	Level	-6.214(4)***	-10.449(4)***
	First Difference	-15.442(4)***	-14.776(4)***
	Decision	$I(0)$	$I(0)$

*Notes: The symbols ***,**,* indicate the rejection of the null hypothesis of the existence of unit roots at 1%, 5% and 10% level respectively. ( ) stands for the lag order. The lag orders are selected based on the Schwarz criterion.*

Baseline regression results

We then examine the presence of a threshold effect of institutional development in mediating the relationship between real narrow money ($lm1_t$), real broad money demand ($lm2_t$) and its determinants, namely, the real income (ly_t), the nominal interest rate (R_t), the real effective exchange rate ($lREER_t$) and economic uncertainty represented by three indicators, i.e., the optimal economic uncertainty ($loeu_t$), the economic policy uncertainty ($lepu_t$) and the world uncertainty index ($lwui_t$), by employing the panel threshold method by Seo and Shin (2016) in 28 economies. *Table 2* reports the results for the effect of economic policy uncertainty ($lepu$), as well as other determinants on the real narrow money demand ($lm1$) at the lower and upper regimes of institutional development. The threshold effect of institutional development (INS) is confirmed by the bootstrap linearity test at the 1% significance level. The threshold value (γ) of institutional development is expected at 1.647. The effect of economic policy uncertainty ($lepu$) on the real money demand ($lm1$) is significant at 1% significance level in both regimes. When the institutional development is in the lower regimes, a 1% increase in the economic policy uncertainty leads to a reduction in the real narrow money demand by -0.113%. By contrast, when the institutional development exceeds the threshold ($\gamma = 1.647$) and reaches the upper regime, it leads to an increase in the real money demand by 0.481%. The difference arises due to two effects of economic uncertainty. Specifically, when economic uncertainty comes with the expectation of high inflation, people will hedge against it by holding more real assets than money. On the other hand, when it comes with high uncertain job prospects, people will instead hold more money (Bahmani-Oskooee and Nayeri, 2018; Bahmani-Oskooee et al., 2015; Choi and Oh, 2003). Central banks in the higher regime keep inflation at a very low level by reacting aggressively while those in the lower regime do not due to huge political pressure to avoid higher unemployment (Kakar et al., 2020). Consequently, economic policy uncertainty negatively affects the real narrow money demand in the lower regime, but positively in the upper regime.

Table 2. *Panel threshold estimations of real narrow money demand with economic policy uncertainty.*

Dependent variable: $lm1_{it}$	Lower regime β	Difference $\delta = \lambda - \beta$	Upper regime λ
ly_{it}	2.655***	-2.513**	0.142**
	(0.116)	(1.159)	
R_{it}	-0.015***	-0.013	-0.028
	(0.002)	(0.032)	
$lREER_{it}$	-0.339*	-3.998**	-4.337**
	(0.193)	(1.939)	
$lepu_{it}$	-0.113***	0.594***	0.481***
	(0.023)	(0.209)	
INS threshold value (γ)	1.647***	-	-
	(0.003)		
Bootstrap p-value for linearity test	0.000***	-	-
N	24	-	-

*Notes: The symbols ***, **, * indicate the rejection of the null hypothesis at 1%, 5% and 10% level respectively.*

With respect to the control variables, real income (ly) is positively significant with real money demand ($lm1$) in both regimes, but the coefficient is larger in the lower

regime (2.655) than in the upper regime (0.142). In other words, the income elasticity in the lower regime (mostly developing economies) is higher than that in the upper regime (mostly developed). This finding is in line with Kumar et al. (2013) as well as Bitrus (2011), who find that compared with high-level institutionalized economies, economic agents in low-level institutionalized economies have restricted access to financial instruments other than money for transactions, due to underdeveloped financial markets. The effect of the nominal interest rate (R) on the real narrow money demand ($lm1$) is significant and properly signed (-0.015) in the lower regime but insignificant in the upper regime. As suggested by Kumar (2014), this finding may be because narrow money is more commonly used in the lower regime of institutional development while broad money is more commonly used in the upper regime. The real effective exchange rate ($lREER$) is negatively significant in both regimes, suggesting that the substitution effect is larger than the wealth effect regardless of the institutional development. However, the magnitude in the upper regime (-4.337) is much larger than in the lower regime (-0.339). This may be explained by the significant role of the exchange rate in the black market in some low institutionalized economies, rather than the official exchange rate in determining money demand, while the money demand in the upper regime is more sensitive to the official exchange rate (Bahmani-Oskooee and Tanku, 2006).

Table 3 reports the results for the effect of economic policy uncertainty ($lepu$) as well as other determinants on the real broad money demand ($lm2$) at the lower and upper regimes of institutional development. The threshold effect of institutional development (INS) is confirmed by the bootstrap linearity test at the 1% significance level and the threshold value (γ) is expected at 1.601. The effect of economic policy uncertainty ($lepu$) on the real broad money demand ($lm2$) is significant at the 1% level in both regimes. However, the effect is negative (-0.067) in the lower regime when $INS \leq 1.601$ but positive (0.385) in the upper regime when $INS > 1.601$, in line with *Table 2*. For control variables, real income (ly) is positively significant with real broad money demand ($lm2$) in both regimes, but the coefficient is larger in the lower regime (1.913) than in the upper regime (1.142), in line with *Table 2*. The effect of the nominal interest rate (R) and the real effective exchange rate ($lREER$) on the real broad money demand ($lm2$) is significant and properly signed (-0.048 and -1.276 respectively) only in the upper regime, not in the lower regime. This could be because narrow money is more commonly used in the lower regime of institutional development while broad money is more commonly used in the upper regime (Kumar, 2014).

***Table 3**. Panel threshold estimations of real broad money demand with economic policy uncertainty.*

Dependent variable: $lm1_{it}$	Lower regime β	Difference $\delta = \lambda - \beta$	Upper regime λ
ly_{it}	1.913***	-0.771***	1.142***
	(0.140)	(0.262)	
R_{it}	-0.003	-0.045*	-0.048*
	(0.003)	(0.024)	
$lREER_{it}$	0.075	-1.351***	-1.276***
	(0.131)	(0.490)	
$lepu_{it}$	-0.067***	0.452***	0.385***
	(0.026)	(0.095)	
INS threshold value (γ)	1.601***	-	-

	(0.003)		
Bootstrap p-value for linearity test	0.000***	-	-
N	24	-	-

*Notes: The symbols ***, **, * indicate the rejection of the null hypothesis at 1%, 5% and 10% level respectively.*

Table 4 reports the results for the effect of world uncertainty index ($lwui$) as well as other determinants on the real narrow money demand ($lm1$) at the lower and upper regimes of institutional development. The threshold effect of institutional development (INS) is confirmed by the bootstrap linearity test at the 1% significance level and the threshold value (γ) is expected at 1.309. The effect of world uncertainty index ($lwui$) on the real narrow money demand ($lm1$) is significant at the 1% level in both regimes. The effect is negative (-0.199) in the lower regime when $INS \leq 1.309$ but positive (0.013) in the upper regime when $INS > 1.309$, in line with *Table 2* and *Table 3*. For control variables, real income (ly) is positively significant with real narrow money demand ($lm1$) in both regimes, but the coefficient is larger in the lower regime (2.132) than in the upper regime (1.461), in line with *Table 2* and *Table 3*. The effect of the nominal interest rate (R) on the real narrow money demand ($lm1$) is larger in the lower regime (-0.014) than in the upper regime, in line with *Table 2*. The effect of the real effective exchange rate ($lREER$) on the real narrow money demand ($lm1$) is significant and properly signed (-2.061) only in the upper regime, not in the lower regime, in line with *Table 3*.

***Table 4**. Panel threshold estimations of real narrow money demand with world uncertainty index.*

Dependent variable: $lm1_{it}$	Lower regime β	Difference $\delta = \lambda - \beta$	Upper regime λ
ly_{it}	2.132***	-0.671***	1.461***
	(0.201)	(0.255)	
R_{it}	-0.014***	-0.052***	-0.066***
	(0.003)	(0.019)	
$lREER_{it}$	-0.560	-1.501*	-2.061*
	(0.366)	(0.784)	
$lepu_{it}$	-0.199***	0.212**	0.013**
	(0.052)	(0.088)	
INS threshold value (γ)	1.309***	-	-
	(0.034)		
Bootstrap p-value for linearity test	0.000***	-	-
N	24	-	-

*Notes: The symbols ***, **, * indicate the rejection of the null hypothesis at 1%, 5% and 10% level respectively.*

Table 5 reports the results for the effect of world uncertainty index ($lwui$) as well as other determinants on the real broad money demand ($lm2$) at the lower and upper regimes of institutional development. The threshold effect of institutional development (INS) is confirmed by the bootstrap linearity test at the 1% significance level and the threshold value (γ) is expected at 1.404. The effect of world uncertainty index ($lwui$) on the real narrow money demand ($lm1$) is significant at the 1% level in both regimes. The effect is negative (-0.088) in the lower regime when $INS \leq 1.309$ but positive (0.143) in the upper regime when $INS > 1.404$, in line with *Table 2*, *Table 3* and *Table 4*. For

control variables, real income (ly) is positively significant with real broad money demand ($lm2$) in both regimes, but the coefficient is larger in the lower regime (1.225) than in the upper regime (0.310), in line with *Table 2*, *Table 3* and *Table 4*. The effect of the nominal interest rate (R) and the real effective exchange rate ($lREER$) on the real broad money demand ($lm2$) is significant and properly signed (-0.063 and -1.594 respectively) only in the upper regime, not in the lower regime, in line with *Table 3*.

Table 5. *Panel threshold estimations of real broad money demand with world uncertainty index.*

Dependent variable: $lm1_{it}$	Lower regime β	Difference $\delta = \lambda - \beta$	Upper regime λ
ly_{it}	1.225***	-0.915**	0.310**
	(0.119)	(0.407)	
R_{it}	0.005	-0.068*	-0.063*
	(0.011)	(0.038)	
$lREER_{it}$	0.210	-1.804**	-1.594**
	(0.325)	(0.880)	
$lepu_{it}$	-0.088***	0.231***	0.143***
	(0.031)	(0.048)	
INS threshold value (γ)	1.404***	-	-
	(0.008)		
Bootstrap p-value for linearity test	0.000***	-	-
N	24	-	-

*Notes: The symbols ***, **, * indicate the rejection of the null hypothesis at 1%, 5% and 10% level respectively.*

Robustness check

This study uses an alternative economic uncertainty index, namely, the optimal economic uncertainty (oeu) proposed by Gan (2014) and two alternative threshold models, namely, the kink model by proposed Seo et al. (2019) and the fixed-effect threshold model proposed by Wang (2015) for robustness checks. Unlike the economic policy uncertainty and the world uncertainty index that apply text-searching based technique to calculate the uncertainty index, the optimal economic uncertainty tracks the deviation of key macroeconomic variables from their long-run equilibriums using the grid search algorithm. Due to data unavailability, oeu are available for 14 economies (refer to the section of data and empirical results). For regression techniques, most threshold methods assume discontinuous regression functions (Hansen, 2017). The kink model, however, restrict the regression function to be continuous at the threshold point, i.e., a kink, not a jump (Seo et al., 2019). The specification of the threshold kink model is as follows (Eq. (4):

$$m_{it} = \alpha_i + \beta x_{it} + k(INS_{it} - \gamma)I(INS_{it} > \gamma) + \varepsilon_{it} \qquad \text{Eq. (4)}$$

Where, m refers to money demand, α_i refers to the individual-specific fixed effect for each economy, x_{it} consist of all the independent variables including real income (ly), the nominal interest rate (R), the real effective exchange rate ($lREER$) and the optimal economic uncertainty ($loeu$). $k(\cdot)$ denotes the kink restriction. γ is the threshold parameter. INS_{it} is the threshold variable (institutional quality) and ε_{it} is the error term. *Table 6* reports the results for the effect of the optimal economic uncertainty

($loeu$) as well as other determinants on the real narrow ($lm1$) and real broad money ($lm2$) at the lower and upper regimes of institutional development using the panel threshold kink model. The coefficient of the kink slope is statistically significant (0.493 and 9.405), which confirms the presence of a kink in the threshold model. The threshold effect of institutional development (INS) is confirmed by the bootstrap linearity test at the 1% significance level and the threshold value (γ) is expected at 1.230 and 1.624 for narrow and broad money respectively. The effect of the optimal economic uncertainty ($loeu$) on money demand is significant at the 1% level in both regimes. Specifically, with respect to the real narrow money demand, the coefficient of $loeu$ is -0.025 in the lower regime and 0.468 in the upper regime. With respect to the real broad money demand, the coefficient of $loeu$ is -0.029 in the lower regime and 9.376 in the upper regime. In other words, optimal economic uncertainty affects money demand negatively in the lower regimes while positively in the upper regime, in line with *Table 2*, *Table 3*, *Table 4* and *Table 5*. Additionally, all the control variables, namely, the real income (ly), the nominal interest rate (R), the real effective exchange rate ($lREER$) are all statistically significant and properly signed.

***Table 6**. Panel threshold kink model estimations of money demand with optimal economic uncertainty.*

Dependent variable	$lm1_{it}$	$lm2_{it}$
$loeu_{it}$	-0.025*	-0.029***
	(0.015)	(0.007)
ly_{it}	2.039***	1.716***
	(0.215)	(0.112)
R_{it}	-0.025***	-0.019***
	(0.006)	(0.005)
$lREER_{it}$	-0.553*	-1.216***
	(0.287)	(0.297)
INS threshold value (γ)	1.230***	1.624***
	(0.108)	(0.005)
Kink Slope	0.493*	9.405**
	(0.283)	(4.464)
Bootstrap p-value for linearity test	0.000***	0.000***
N	14	14

*Notes: The symbols ***, **, * indicate the rejection of the null hypothesis at 1%, 5% and 10% level respectively.*

Then, we conduct the fixed-effect threshold model of Wang (2015) based on Hansen (1999) and set the optimal economic uncertainty as the sole variable dependent on institutional development. The formula is as follows (Eq. (5):

$$m_{it} = \alpha + ly_{it} + R_{it} + lREER_{it} + \beta_1 loeu_{it}(INS_{it} < \gamma) + \beta_2 loeu_{it}(INS_{it} \geq \gamma) + u_i + e_{it} \quad \text{Eq. (5)}$$

Where, m refers to money demand, α refers to the constant term, u_i is the individual effect, γ is the threshold parameter. INS_{it} is the threshold variable (institutional quality) and e_{it} is the error term. ly_{it}, R_{it}, $lREER_{it}$ and $loeu_{it}$ share the same meanings as mentioned before. *Table 7* reports the results for the effect of the optimal economic uncertainty ($loeu$) as well as other determinants on the real narrow ($lm1$) and broad

money ($lm2$) at the lower and upper regimes of institutional development using the panel fixed-effect threshold method. The threshold effect of institutional development (INS) is confirmed by the threshold bootstrap test at 5% and 1% for the narrow money and broad money respectively. The threshold value (γ) is expected is at 1.625. The effect of the optimal economic uncertainty ($loeu$) on money demand is significant at the 1% level in both regimes. Specifically, with respect to the real narrow money demand, the coefficient of $loeu$ is -0.035 in the lower regime and 0.244 in the upper regime. With respect to the real broad money demand, the coefficient of $loeu$ is -0.048 in the lower regime and 0.163 in the upper regime. In other words, economic uncertainty affects money demand negatively in the lower regimes while positively in the upper regime, in line with *Table 2*, *Table 3*, *Table 4*, *Table 5* and *Table 6*. Additionally, all the control variables, namely, the real income (ly), the nominal interest rate (R), the real effective exchange rate ($lREER$) are all statistically significant and properly signed.

***Table 7**. Fixed-effect panel threshold model estimations of money demand with optimal economic uncertainty.*

Dependent variable	$lm1_{it}$	$lm2_{it}$
$loeu_{it}$ *(lower regime)*	-0.035***	-0.048***
	(0.013)	(0.011)
$loeu_{it}$ *(upper regime)*	0.244***	0.163***
	(0.058)	(0.045)
ly_{it}	1.902***	1.717***
	(0.065)	(0.057)
R_{it}	-0.032***	-0.014*
	(0.007)	(0.007)
$lREER_{it}$	-0.641***	-0.776***
	(0.184)	(0.269)
INS threshold value (γ)	1.625	1.625
Threshold effect test (bootstrap = 100)	17.47**	16.25***
N	14	14

*Notes: The symbols ***, **, * indicate the rejection of the null hypothesis at 1%, 5% and 10% level respectively.*

In terms of policy implications, the identified threshold effect of institutional development in mediating the relationship between precautionary demand for money and economic uncertainty suggest that in order to achieve the optimal liquidity provision during monetary policy decision making, central banks cannot ignore the factor of institutional quality, featured by components such as the control of corruption, law and order and political stability. Furthermore, as differences in institutional development are large across countries (European Central Bank, 2017), policy support for liquidity in responses to uncertainty should be targeted and tailored to country-specific circumstances of institutional development (International Monetary Fund, 2021), against the backdrop of the currently worldwide situation of heightened uncertainty, which requires flexibility, reappraisal and recalibration of policy making (United Nations, 2023). Additionally, central banks may well also pay attention to the sensitivity of real income, the nominal interest rate, and the exchange rate to institutional change when fine-tuning the money demand function.

Conclusion

This study examines the panel threshold effect of institutional development in mediating the relationship between the precautionary demand for money and economic uncertainty, without ignoring the roles of the scale variable (real income), the opportunity cost variable (the nominal interest rate) and the currency substitution variable (exchange rate) in the money demand function in 28 economies, namely, Australia, Belgium, Brazil, Canada, Chile, China, Denmark, France, Germany, Greece, Hong Kong, India, Indonesia, Ireland, Italy, Japan, Malaysia, Mexico, New Zealand, Philippines, Russia, Singapore, South Korea, Spain, Sweden, Thailand, the United Kingdom and the United States. The estimated results from the panel threshold methods proposed by Seo et al. (2019), Seo and Shin (2016) as well as Wang (2015) respectively demonstrate a significant threshold effect of institutional development on the relationship between the precautionary demand for money and economic uncertainty. Accordingly, policy makers should take into account the institutional development in fine-tuning the money demand function when dealing with economic uncertainty in order to provide the most desirable liquidity support. The current study has some limitations. First, the study employes a sample of 28 economies, while a similar process could be replicated in a broader geographical context. Second, the study applies the world governance indicator as the proxy for institutional development. Future research could apply other proxies or come up with new institutional development indicators. Third, this study is specifically interested in the threshold effect of institutional development. Future research could study other possible threshold variables in mediating the relationship between money demand and economic uncertainty.

Acknowledgement

This research is self-funded.

Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

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