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Does Monetary Policy Regime Determine the Nature of the Money Supply?: Evidence from Seven Countries in the Asia-Pacific Region

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This paper tests empirically the causal relationship between bank loans and the monetary base before and after the adoption of inflation targeting in seven Asia-Pacific countries using Toda-Yamamoto Granger non causality test and the bootstrap test for causality. The most striking finding is that the bank loans Granger cause the monetary base during the inflation targeting period in all the countries, except Japan, which was under the influence of the quantitative easing, whereas the causality appeared diverse before the inflation targeting regime. This result implies the need for the policy makers to take the endogenous nature of the money supply into account in the modern economy.

Keywords: Endogenous Money Supply, Money Multiplier, Monetary Policy Regime, Granger Causality, Bootstrap Test
JEL Classification: E44, E51, E52

I. INTRODUCTION

Money in the modern economy is largely created by commercial banks when they offer loans to the public. The commercial bank creates its own funding in the

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act of lending, and does not need to procure excess reserves before lending. Such a perception is diametrically opposed to the money multiplier model, which suggests that the availability of excess reserves imposes constraints on bank lending and the money supply.

The fact that money is created in the act of lending is acknowledged largely by leading monetary policymakers and practitioners. For example, Mervyn King, former governor of the Bank of England, states that "When banks extend loans to their customer, they create money by crediting their customer's account."[1] Although many policymakers and private sector practitioners understood exactly the nature of the money-supply process, most professional economists seem to have remained undisturbed by the description of the money-supply process based on the money multiplier model. Only a few economists, the majority of whom could be qualified as Post-Keynesians, have been arguing that money is endogenously supplied when commercial banks offer loans to the public[2].

It is curious why the seemingly erroneous conception implied by the money multiplier model prevailed so long among academic economists. One possible explanation could be that the money multiplier model is accepted by many as a kind of parable. The logic behind such a posture might be formulated as follows: Well, it is true that money is created through lending; But newly created deposit money implies the need for more high-powered money, due to increased demand for cash and reserves; It is only the central bank which can supply the high-powered money; The central bank has the ultimate authority to say "yes" or "no" to the money-creating activities of commercial banks; Therefore, it is reasonable to describe the money supply starting from the exogenous change of the monetary base.

We think, however, that the parable needs to be verified by empirical investigation. Our conjecture is that the degree of intention and effectiveness of the control of the monetary base by the central bank depends critically on the monetary policy regime. When the central bank uses a monetary aggregate as an intermediate target, it would not willingly accommodate the demand for the monetary base arising from commercial banks' lending, in order to control the intermediate target within

[1] King (2012), cited by Jakab and Kumhof (2015), p. 6. In that paper, one can find a number of citations showing a similar perspective.

[2] To cite a few of them, see Moore (1988), Lavoie (1992), Goodhart (2000).

the announced range. Once the central bank no longer sets an intermediate monetary target, and aims to achieve its inflation target by using the policy interest rate as an operational target, then it is highly possible that the monetary aggregates and the monetary base would be supplied endogenously by the decision of commercial banks and borrowers.

Let us, however, relativize the schematic correspondence between the money-supply process and the monetary policy regime. First, even when a central bank chooses an intermediate monetary target to achieve its goal, its operational instrument could be the short-term interest rate instead of the monetary base. That was the case for Bundesbank, and subsequently the ECB for a certain lapse of time. In such a case, the central bank would show more accommodating behavior than when it chooses the monetary base as its operational instrument. Second, when a central bank in the monetary targeting regime conducts monetary policy based on control of the monetary base, what it actually does in its operations can be quite different from the official procedure, because a strict control of the monetary base necessarily results in very high fluctuation of short-term interest rates. Third, whether the bank lending is affected by the change of policy interest rate and/or the monetary base depends on whether commercial banks can have access to non-reservable resources, such as CDs, commercial papers, repos, or foreign borrowing, in both inflation targeting regime and other monetary policy regimes. Access to non-reservable resources depends on the development of financial markets, market liquidity, etc. Easy access to non-reservable resources will weaken the effect of the change in the policy interest rate and/or the monetary base on bank lending. Fourth, the nature of the money supply depends not only on the monetary policy regime but also on banking regulations. For example, when the regulator introduces or reinforces the regulation regarding liquidity risk, such as the net stable funding ratio, commercial banks will find it more difficult to expand lending at their will; so the causality running from bank lending to the monetary base may be weakened.

Taking all these considerations into account, we think that the questions as to whether the monetary aggregates and the monetary base are supplied endogenously or not, and whether the change of monetary policy regime results in a significant change in the nature of the money supply are largely empirical issues. The objective of the present study is precisely to investigate empirically those issues.

There are several studies which investigate empirically the endogeneity of the money supply. Badarudin, Ariff, and Khalid (2009) employed a vector error correction

model to verify the money endogeneity for ten emerging economies with monthly data from 1996 to 2007. They found the evidence for the endogenous money supply in China, the Czech Republic, India, Malaysia and Turkey. Money supply was exogenous in Mexico while no causality between money supply and domestic credit was found in Indonesia, Russia and Taiwan. Nayan, Kadir, Abdullah, and Ahmad (2013) reported the evidence consistent with post-Keynesian hypothesis of the endogeneity of money supply using a dynamic panel analysis with annual data of 177 countries from 1970 to 2011. Badarudin, Ariff, and Khalid (2013) showed that the money supply is endogenous for G-7 countries using quarterly data with controls for monetary regime change effects. In a study conducted for Korea, Chai (2017) reported that, although the central bank was able to control bank lending by controlling the monetary base while it targeted a monetary aggregate, it had trouble doing so after the adoption of inflation targeting. Reverse causation, which runs from bank loans to the monetary base, has become predominant during the inflation targeting period.

This paper can be differentiated from the previous studies in the following points. First, the monetary regime change effects on the nature of the money supply are investigated by dividing the sample period before and after the introduction of inflation targeting, and then the endogeneity of money supply is investigated within each sub-period with the control for the structural breaks caused by unknown internal and external shocks in seven Asia-Pacific countries (Australia, Indonesia, Japan, Korea, New Zealand, Philippines, and Thailand). We use dummy variables indicating the structural changes in the VAR model following the methodology developed by Quandt (1960) and Andrews (1993). Second, we use the Toda-Yamamoto Granger non causality (GNC) test (1995) to test the causal relationship between bank loans and the monetary base. This test is designed for testing the causal relationship regardless of the magnitude of the integration order, or the cointegration properties of the time series. Third, we implement the bootstrap test for causality suggested by Hacker and Hatemi-J (2006) to overcome the weakness of the modified Wald test for Granger causality.

Understanding the nature of the money supply correctly is important not only for academic interests, but also for practical purposes aiming at evaluating the effects of monetary and regulatory policies. For example, the quantitative easing which increases the monetary base significantly may engender comparatively small changes in bank lending and monetary aggregates. In such a case, the policy should pay more attention to the asset side of the central bank's balance sheet rather than the liability side. On the other hand, bank lending might fluctuate abruptly, engendering

huge macroeconomic consequences, if banks can make loans and create money *ex nihilo*. As the correct understanding of the money-supply process is indispensable for explaining many important facets of recent policy debates, the money-supply issue has been revisited recently by several authors, especially among economists in leading central banks or international organizations, such as the Bank of England, the Federal Reserve Board, or the Bank for International Settlements. Borio and Disyatat (2009) provide an appraisal of unconventional monetary policies based on the endogenous money supply framework. Carpenter and Demiralp (2012) criticize the standard multiplier model and bank lending channel of the transmission of monetary policy. McLeay, Radia, and Thomas (2014) present a simple conceptual framework explaining why the creation of reserves cannot be multiplied into more loans. Jakab and Kumhof (2015) show in a dynamic stochastic general equilibrium model why bank lending might change more frequently and might increase once the insights from the endogenous money supply is accepted.

The remainder of the paper is organized as follows. Section II provides a simple conceptual framework based on T-account analysis explaining the process of money supply. Section III investigates empirically the nature of the money supply for seven countries in the Asia-Pacific region based on the Toda-Yamamoto GNC tests. It will be shown that the money multiplier model no longer suits the modern economy if the central bank adopts inflation targeting and uses short-term interest rates as the operational target. Section IV is a conclusion with some remarks about the policy implications of the empirical study.

II. A SIMPLE CONCEPTUAL FRAMEWORK OF THE MONEY SUPPLY

In the modern economy, bank deposits are by far the most important form of money. They are created by the commercial banks in the act of lending and are eventually destroyed in the act of repayment. The deposits created circulate in the economy as they are used as means of payment. Although, for an individual bank, the deposits flowing out of its own network are not necessarily equal to new deposits coming in, the deposit money flowing out of the banking system taken as a whole and the money entering into it are largely comparable. If an individual bank increases its balance sheet in line with the growth of the banking system as a whole, it will

easily find *ex post* the funding for its lending. Therefore, it is not accurate to describe banks as lending only the pre-existing money.

However, the demand for currency and the need to procure more reserves to back the newly created deposits imply the flight to a form of money that the commercial banks cannot create themselves. It is only the central bank that can supply the monetary base, which explains ultimately why the central bank can make commercial banks listen to it. The commercial banks may rely on borrowing from the central bank or the sale of assets to the central bank to meet the needs for the monetary base. The recourse to non-reservable resources is another way to meet those needs.

The following T-account analysis will show how the money creation affects the balance sheets of different sectors in the economy: central bank, commercial banks, and the rest of the economy, that is, the public. The initial balance sheets are as follows:

Central bank

asset	liability
A B	C R

Commercial banks

asset	liability
L R	D N B

Public

asset	liability
C D N	L A

where

A: financial assets issued by the public and bought by the central bank
B: borrowing of commercial banks from the central bank
C: currency
D: reservable deposits
L: claims of commercial banks on the public
N: non-reservable resources issued by commercial banks, and absorbed by the public
R: reserves

The figures in the initial stage are the equilibrium values, in the sense that the implied ratios, i.e. the currency-to-deposits ratio, the reserves-to-deposits ratio, and the ratio between deposits and non-reservable resources are derived from the optimal decisions of different actors in the economy. The currency-to-deposits ratio is mainly determined by the public, given the institutional development of the settlement system. The reserves-to-deposits ratio is determined by the central bank and commercial banks. The ratio between deposits and non-reservable resources depends on the decisions

of commercial banks and the public, given the development of the money market, the policy stance of the central bank, and the banking regulations. When the commercial banks increase lending and accordingly deposits, then currency, reserves, and non-reservable resources should change to attain the desired ratios. The adjustment towards new equilibrium values to attain the desired ratios after granting new bank lending will take place simultaneously. But, we suppose here, for analytical purposes, that the adjustments to restore the currency-to-deposits ratio and the ratio between deposits and non-reservable resources are made before the adjustment to restore the reserves-to-deposits ratio.

Now, suppose that the commercial banks make loans equal to ΔL to the public. Exactly the same amount of deposit money is created first and circulates in the economy. Some fraction of the newly created deposits will be transformed into currency (= ΔC) and non-reservable resources (= ΔN). When the adjustments to restore the currency-to-deposits ratio and the ratio between deposits and non-reservable resources are made, the balance sheets will be described as:

Central bank

asset	liability
A B	C + ΔC R - ΔC

Commercial banks

asset	liability
L + ΔL R - ΔC	D + ΔD N + ΔN B

Public

asset	liability
C+ ΔC D+ ΔD N+ ΔN	L + ΔL A

where $\Delta L = \Delta C + \Delta D + \Delta N$, $\Delta C / \Delta D = C/D$, and $\Delta D/\Delta N = D/N$. We supposed here that the desired ratios are the same before and after granting new loans. The balance sheets above are not the end of the story. The reserves-to-deposits ratio has decreased and thus needs to be restored to the previous level. The reserves to be increased to restore the initial ratio are $\Delta C + \Delta R$, where $\Delta R = (R/D)\, \Delta D$. There are two ways to restore the reserves-to-deposits ratio. The first method is to borrow from the central bank. In this case, the balance sheets will appear as:

Central bank

asset	liability
A B +ΔC +ΔR	C + ΔC R + ΔR

Commercial banks

asset	liability
L + ΔL R + ΔR	D + ΔD N + ΔN B +ΔC +ΔR

Public

asset	liability
C+ ΔC D+ ΔD N+ ΔN	L + ΔL A

Another method is to sell assets equivalent to $\Delta C + \Delta R$ to the central bank, which will result in the following balance sheets:

Central bank

asset	liability
A+ΔC +ΔR B	C + ΔC R + ΔR

Commercial banks

asset	liability
L+ΔL-(ΔC+ΔR) R + ΔR	D + ΔD N + ΔN B

Public

asset	liability
C+ ΔC D+ ΔD N+ ΔN	L + ΔL A

Although the two methods have different effects on the size of commercial banks' balance sheet and their net position vis-à-vis the central bank, they have the common aspect that the commercial banks will eventually get the reserves they need only when the central bank supplies them. However, that observation does not necessarily imply that the money-supply process starts with the action of the central bank to supply the monetary base. Why? There are two different perspectives.

The first view, called the accommodationist view, asserts that the central bank is obliged to supply as many reserves as the commercial banks demand, to maintain the stability of the financial system (Moore, 1988). If the central bank refuses to accommodate the demand for the monetary base, the short-term interest rates will fluctuate so much that the stability of the financial system will be seriously hampered. Even though the central bank is required to accommodate the demands of commercial banks, it can affect the proportions of borrowed reserves and non-borrowed reserves by fixing the money-market policy rate and discount rate. That concept is criticized by the structuralist view (Palley, 1996) on the grounds that the central bank would not necessarily fully accommodate the demand for the monetary base. They accept even the traditional view that the central bank can change the money supply by increasing or decreasing the supply of the monetary base. But they differ from the traditional view in that the central bank's ability to control the money supply is quite limited, because the commercial banks can reduce the need to procure reserves by relying on non-reservable resources. As we have seen from the above analysis, the bigger ΔN is, the smaller the demand for the monetary base will be. It is not impossible theoretically that, when the central bank sharply restricts the money supply, the latter can increase ΔN so that ΔD becomes zero and the need to procure additional reserves, i.e.. $\Delta C + \Delta R$, becomes also zero and so bypass the central

bank[3]. Financial innovation will make it easier for commercial banks to issue non-reservable resources and to be more independent from the central bank's policy stance.

In our view, whether the central bank is accommodative or not and whether the commercial banks can have easy access to non-reservable resources or not are both empirical issues. Specifically, the answer to the first question seems to depend largely on the monetary policy regime. We think that the transition to inflation targeting, which aims to achieve the inflation rate goal without setting intermediate targets, implies a significant change in the nature of the money supply.

III. EMPIRICAL TESTING

1. Conceptual Framework

This section reports the results of empirical tests on how the monetary policy regime affects the money-supply process. There are three alternative theories about the money-supply process: the traditional view, the accommodationist view, and the structuralist view. The traditional view maintains that the monetary base determines the money supply, which determines the bank loans. The accommodationist view maintains that the bank loans determine both the money supply and the monetary base. The structuralist view lies between the two previous views. The causality implications between the monetary base, money supply, and bank loans are summarized in Table 1.

Table 1. Summary of Causality Implications of Different Approaches between the Monetary Base, Bank Loans, and Money Supply

Traditional View	Accommodationist View	Structuralist View
MB $\Rightarrow$ BL	BL $\Rightarrow$ MB	BL $\Leftrightarrow$ MB
M $\Rightarrow$ BL	BL $\Rightarrow$ M	BL $\Leftrightarrow$ M

Notes: MB: monetary base; BL: bank loans; M: money supply

[3] This situation implies the decrease of the desired ratio *D/N*, while the desired ratios *C/D* and *R/D* rest the same.

To investigate the validity of the different causality implications of different approaches, this study uses the Granger non causality (GNC) test, which is based on two axioms. First, the observable cause proceeds temporarily to the observable effect. Second, the cause has significant information that other variables do not have in predicting the effect. In this study, we plan to test the GNC only between the monetary base and bank loans, and not between bank loans and money supply, because money supply and bank loans change at the same time for all the three approaches. According to the accommodationist or structuralist approaches, bank loans and money supply vary simultaneously although the former logically determines the latter. According to the dynamic money-multiplier model, which is the conceptual backbone of the traditional approach, bank loans and money supply vary simultaneously also, although the former is logically determined by the latter. As was mentioned before, the GNC test cannot be used to see the causal relationship between variables that vary simultaneously. To understand this point, let us consider the simple model as follows[4]:

$$x_t = a\,x_{t-1} + b\,y_{t-1} + u_t \tag{1}$$

$$y_t = c\,x_{t-1} + d\,y_{t-1} + v_t \tag{2}$$

According to Granger (1969), *y* does not Granger cause *x* if $b = 0$. Sims (1972) showed that if *y* does not Granger cause *x*, *y* can be expressed as the present and past values of *x*, and the reverse is also true. Now, suppose that the following model represented by equations (3) and (4) is the genuine structural model between *x* and *y*. The error terms are not autocorrelated and not correlated each other.

$$x_t = \alpha_1 y_t + \beta_{11} x_{t-1} + \beta_{12}\,y_{t-1} + \epsilon_{1t} \tag{3}$$

$$y_t = \alpha_2 x_t + \beta_{21} x_{t-1} + \beta_{22}\,y_{t-1} + \epsilon_{2t} \tag{4}$$

[4] We owe to Geweke (1987) the passage which follows.

Simple arithmetic allows us to transform the model composed of equations (3) and (4) into the model composed of equations (1) and (2). Then the coefficients *a*, *b*, *c*, *d* and the error terms u_t, v_t can be represented in terms of the coefficients α_i, β_{ij}, and the error terms e_{it} (i, j = 1, 2). For example,

$$b = \frac{\beta_{12}+\alpha_1\beta_{22}}{1-\alpha_1\alpha_2} \tag{5}$$

It is clear here that $b = 0$ does not imply $\alpha_1 = 0$. In other words, the fact that *y* does not Granger cause *x* does not exclude the possibility that x_t is influenced by the contemporary variable of *y*, i.e., y_t. On the other hand, $\alpha_1 = 0$ does not imply $b = 0$ either: The fact that *x* is predetermined does not imply the causality running from *y* to *x* in the Granger sense of the term. Because of these considerations, we decided not to conduct the GNC test between banks loans and money supply, but to concentrate the test between banks loans and monetary base.

Another important limit to the GNC test using the bivariate VAR system for the MB and BL variables needs to be mentioned. As bank loans and monetary base can respond to current and future economic condition with different speeds, timing-relation or predictability between two variables might not be fully attributed to the structural one[5]. One way to circumvent (albeit imperfect) the problem would be to introduce control variables representing economic conditions in the VAR framework. It is however difficult to determine which control variables to include, and the direction (past or future?) and length of time lag. Inadequate specification might even lead to erroneous test results. That is the reason why we decided here to conduct the test based on a simple model of two variables.

2. Data Sources

The empirical analyses of the GNC test are performed using monthly data for different sample periods. The data for all relevant variables are collected from the

[5] We owe this passage to one of the anonymous reviewers.

central bank of each country and the International Financial Statistics (IFS) of the International Monetary Fund (IMF). The sample periods depend on the availability of the data for the countries: Australia (1990:1–2017:3); Indonesia (2002:1–2017:2); Japan (1998:4–2017:2); Korea (1970:1–2017:3); New Zealand (1990:1–2017:3); Philippines (2001:12–2017:3); and Thailand (2001:12–2017:2)[6].

The time series of the monetary base (MB) and bank loans (BL) are chosen for the empirical analysis. All variables are seasonally adjusted with the X-13 ARIMA method of the US Bureau of the Census and deflated by the consumer price index (CPI)[7]. Finally, they are transformed to logarithmic form.

3. Methodology

To test the endogeneity of money in each country, we perform a GNC test using the bivariate VAR system for the MB and BL variables. If the integration order of both time-series variables is I(0), the Wald test statistic of GNC follows the standard χ^2 distribution.

However, in most cases these variables exhibit the characteristics of nonstationary time series with a maximum integration order of 1. Thus, the distribution of the usual Wald test statistic for the GNC follows a nonstandard asymptotic distribution. Moreover, if structural changes occur because of a financial crisis or policy changes, it becomes more difficult to know the limiting distribution of the Wald test statistic because of their nuisance parameters. In this study, we use the modified Wald test (MW) suggested by Toda and Yamamoto (1995), and Dolado and Lütkepohl (1996), which is designed for testing the causal relationship regardless of the magnitude of the integration order, or the cointegration properties of the time series. Since the distribution of the MW statistic follows the standard χ^2 distribution, this method allows us to take the structural breaks easily into account in the empirical test framework.

[6] For some countries, the data are available only since December 2001 (Philippines and Thailand) or January 2002 (Indonesia) as those countries report the data based on the Standardized Report Forms (SRFs), a unified framework for reporting monetary and financial statistics to the IMF, from those dates on.

[7] The test results are found to be almost the same when the nominal variables are used.

To explain our methodology more formally, consider first a bivariate augmented level VAR (p + m) model consisting of the nonstationary time series as follows:

$$z_t = \nu + \sum_{i=1}^{p} A_i z_{t-i} + \sum_{j=1}^{m} A_{p+j} z_{t-p-j} + \varepsilon_t \quad (6)$$

where, $z_t = (x_t, y_t)'$, ν and ε_t are two-dimensional vectors, A_i is a 2 x 2 matrix of parameters, p is the lag length of true VAR DGP, and m is the highest order of integration for any component of z_t. The disturbance term,ε_t , is a zero-mean independent, identically distributed process with a nonsingular covariance matrix.

From equation (6), the null hypothesis of GNC to find out whether or not y_t Granger causes x_t is given by $H_0: C_{12} = 0$, where $C_{12} = \left[A_{12,1}, A_{12,2}, \cdots, A_{12,p}\right]$ and $A_{12,i}$ is the 1st row and 2nd column entry of matrix A_i.

Let $\hat{\theta}$ be the LS estimator of $\theta = vec\left[A_1, A_2, \cdots, A_p\right]$ and R is a selection matrix such that $R\theta = vec\,[C_{12}]$. Then the Modified Wald statistic of GNC, *MW*, is given as

$$MW = T\hat{\theta}'R'\left(R\,\hat{V}(\hat{\theta})R'\right)^{-1}R\hat{\theta} \quad (7)$$

This statistic is asymptotically distributed as a $\chi^2(k)$ under the null hypothesis no matter what the VAR system's integration or cointegrating relationships are.

The simulation study by Shukur and Mantalos (2000) shows that the Modified Wald test of Toda and Yamamoto (1995) does not possess the correct size for small samples. Furthermore, if we use the methodology of Toda and Yamamoto (1995) when we are sure that the time series are cointegrated or all the variables in VAR system are in fact I(0), we lose some asymptotic efficiency and power with the test.

To overcome this weakness of the modified Wald test for Granger causality, we, in addition, implement the bootstrap test for causality suggested by Hacker and Hatemi-J (2006). They showed that the modified Wald test based on a bootstrap distribution exhibits smaller size-distortions irrespective of sample sizes, integration orders, and cointegrating rank. In our empirical analysis we obtain the bootstrapped critical values using the parametric bootstrap distribution constructed by means of Monte Carlo simulation using 1,000 samples generated from a VAR model.

During the estimation period of this study, it may have included structural changes due to a financial crisis or policy changes in each country. Therefore, we use dummy

variables indicating the structural changes in the VAR model and modify the model (6) as follows:

$$z_t = \nu + \sum_{i=1}^{p} A_i z_{t-i} + \sum_{j=1}^{m} A_{p+j} z_{t-p-j} + \sum_{k=1}^{s} \Pi_k D_k + \varepsilon_t \quad (8)$$

where Π_k is the two-dimensional vector of parameters, D_k is the k-th dummy variable of structural change, and s is the number of dummy variables. We identified the *unknown* break point of structural change in the data series following the methodology developed by Quandt (1960) and Andrews (1993). The effects of these structural change in time series on the causality analysis have been often ignored in previous studies. Badarudin, Ariff, and Khalid (2013) used the Chow break point test for the US, UK, and Canada as a basis for the change in monetary policy. However, in this study, we used Quandt-Andrews test for a structural change with an unknown break point to identify the breaks in the monetary base. The identified structural changes are controlled using dummy variables.

When employing the Toda-Yamamoto testing procedure, the value of p will not be known in advance. The lag length (p) of the VAR model for each country is calculated by Schwartz information criterion (SIC). Since all the time series in our analysis have at most a unit root with or without structural break, we set the maximal order of integration (m) to one.

4. Findings and Discussions

The results from the empirical study are shown in Tables 2, 3, and 4. Table 2 reports unknown breakpoint test results. Table 3 is the causal relationship between the monetary base and bank loans based on Toda-Yamamoto GNC tests before and after the adoption of the inflation targeting (IT) in seven Asia-Pacific countries. To check the robustness, we conducted the same tests using bootstrapped data, the results of which are reported in Table 4. The results in Table 4 are practically the same as those in Table 3.

The most striking finding is that the bank loans Granger cause the monetary base during the IT period in six out of seven countries, except Japan, whereas the causality appeared diverse before the IT regime. Thus, it seems possible to give an affirmative answer to the question, "Does the monetary policy regime determine the nature of

the money-supply process?" However, a closer look at the results is needed before giving a definitive answer in view of the countries' differences.

Based on the tests using the original data before the IT regime, the central banks appear to have command over bank loans through the control of the monetary base in Korea and Indonesia. The Korean case reflects the fact that the monetary policy had been based on "orthodox" monetary targeting. That result is consistent with the previous study (Chai, 2017). As for Indonesia, there exists bidirectional causality between bank loans and the monetary base. Bank Indonesia adopted formal inflation targeting after July 2005. Before that date, Bank Indonesia announced an inflation target, but also relied on the monetary base as the operational target. However, it could not achieve both targets, with the growth rates of CPI and the monetary base far exceeding the targets. That period was neither a strict monetary targeting regime nor an inflation targeting regime.

In Australia, the causation ran from bank loans to the monetary base, not vice versa, even before the IT period. That result seems to have to do with the specificity of the monetary policy procedure in that country before the IT period. The monetary targeting had been abandoned in early 1985, far ahead of the introduction of inflation targeting in 1993. The period between 1985 and 1993 can be qualified as an 'ad hoc' policy regime. The Reserve Bank of Australia used the money-market rate as the operational target to achieve price stability. Since January 1990, monetary policy has been very accommodative to cope with the severe recession.

The case of Japan is rather peculiar. For the period before as well as after the introduction of inflation targeting, there is no causal relation between the two variables. The Bank of Japan adopted a "zero interest policy" after 1999. In 2001, the Bank changed its operational target from the money-market rate to the current account balances held by banks at the Bank of Japan. The excess reserves held by banks increased significantly with the introduction of quantitative easing in March 2001. The quantitative easing program came to a stop in March 2006. After the global financial crisis, a relatively small quantitative easing program was implemented in October 2010. The Bank of Japan has been implementing a more ambitious quantitative easing in April 2013 till the end of our sample period. The Granger non causality from the monetary base to bank loans seems to show that the quantitative easing did not have significant effect on bank loans. The Granger non causality from bank loans to the monetary base might be explained by the fact that the increase of bank loans is not related with a subsequent increase of the monetary base because there

exits already a large stock of the monetary base available for banks due to the quantitative easing. We believe that the case of Japan is a kind of outlier because the quantitative easing distort the interpretation of the empirical results.

After the introduction of inflation targeting, the causality running from bank loans to the monetary base is observed in six out of seven countries, except Japan. Which characteristics of the inflation targeting are responsible for such causation? According to Mishkin (1999), an inflation-targeting regime involves five elements:

(1) Public announcement of medium-term numerical targets for inflation;
(2) An institutional commitment to price stability as the primary, long-run goal of monetary policy in order to achieve the inflation goal;
(3) An information-inclusive strategy, with a reduced role for intermediate targets such as money growth;
(4) Increased transparency of the monetary policy strategy by communicating with the public and the markets about the plans and objectives of monetary policymakers; and
(5) Increased accountability of the central bank for attaining its inflation objectives.

Of these five elements, the third one is without doubt the most essential reason why money is created endogenously in the inflation targeting regime. Without using a monetary aggregate as an explicit nominal anchor, the central bank willingly supplies reserves responding to the demand for them by banks.

Based on Table 3, the six countries may be divided into two subgroups: accommodationists and structuralists. The accommodationist group includes the countries that show the causality implied by the accommodationist approach; these are Australia, Korea, the Philippines, and Thailand. The structuralist group include the countries that show the causality implied by the structuralist approach, which are Indonesia, and New Zealand. The second group is characterized by bi-directional causation between bank loans and the monetary base. The reason why the monetary base affected bank loans can be diverse. First, it is possible that commercial banks did not have easy access to non-reservable resources such as CDs, commercial papers, or foreign borrowing, perhaps because of underdevelopment of the financial markets or a shortage of market liquidity after the crisis. Second, bank regulations, especially on liquidity risk, could have made the supply of liquidity by the central bank a binding constraint on bank loans. Third, the supply of central bank liquidity could have improved the profitability of bank loans, and thus increased the demand for them.

Our findings can be summarized as follows. First, the monetary policy regime has to do with the nature of the money-supply process. However, such a result does not imply that there is a one-to-one correspondence between the monetary policy regime, with the IT regime on one side and other regimes on other side, and the direction of causation. Rather, the "orthodox" monetary targeting regime should be distinguished from other policy regimes. The monetary base Granger causes bank lending, whereas the reverse is not true, only when the central bank clings to strict monetary targeting. In other cases, bank lending Granger causes the monetary base not only for an inflation targeting regime, but also for other policy regimes except strict monetary targeting. To the best of our knowledge, there is practically no central bank in the modern economy adhering to "orthodox" monetary targeting. Therefore, it is legitimate to assert that the money supply is endogenous in the modern economy. Second, there may be bi-directional causality between bank lending and the monetary base; that is, commercial banks could feel more or less constrained by the central bank's supply of the monetary base even though they can offer loans without preexisting excess reserves. Limited access to non-reservable resources because of underdevelopment of financial markets, a shortage of market liquidity, for example, after the global financial crisis, and/or the reinforcement of bank regulations may be the reason for such causation.

Table 2. Quandt-Andrews Unknown Break Point Test

Countries	Sample Period	IT Adoption Date	Before IT		After IT	
			Break Date	Maximum Wald Statistic	Break Date or Period	Maximum Wald Statistic
Australia	1990:01–2017:03	June 1993	No Break		2013:10	543.72***
Indonesia	2002:01-2017:02	July 2005	2003:11	227.19***	2008:09	124.12***
Japan	1998:04–2017:02	Jan 2013	2006:04	679.82***	2014:11	133.13***
Korea	1970:05 - 2017:03	April 1998	No Break		2008:11	624.46***
New Zealand	1990:01 - 2017:03	Dec 1989	Data Not Available		2006:02	3731.62***
Philippines	2002:01-2017:03	Jan 2002	Data Not Available		2005:12 – 2007:12	516.85***
Thailand	2001:12-2017:02	May 2000	Data Not Available		No Break	

Note: *** indicates statistical significance at the 1% level.

Table 3. Toda-Yamamoto MW Causality Test between Monetary Base and Bank Loans

Countries	Causalities	MW Test Statistic	
		Before IT	After IT
Australia	BL⇒MB	5.63** (0.018, vlag=1)	8.63** (0.013, vlag = 2)
	MB⇒BL	2.09 (0.149, vlag =1)	0.02 (0.992, vlag = 2)
Indonesia	BL⇒MB	17.95*** (0.000, vlag =1)	18.68*** (0.000, vlag = 2)
	MB⇒BL	23.48*** (0.000, vlag =1)	12.03*** (0.000, vlag = 2)
Japan	BL⇒MB	1.57 (0.211, vlag =1)	1.99 (0.158, vlag = 1)
	MB⇒BL	0.83 (0.362, vlag =1)	0.46 (0.499, vlag = 1)
Korea	BL⇒MB	3.00 (0.223, vlag =2)	11.92*** (0.003, vlag = 2)
	MB⇒BL	11.07*** (0.004, vlag = 2)	0.65 (0.722, vlag = 2)
New Zealand	BL⇒MB	Data Not Available	62.27*** (0.000, vlag = 3)
	MB⇒BL	Data Not Available	35.68*** (0.000, vlag = 3)
Philippines	BL⇒MB	Data Not Available	10.26*** (0.001, vlag = 1)
	MB⇒BL	Data Not Available	1.63 (0.202, vlag = 1)
Thailand	BL⇒MB	Data Not Available	6.26** (0.044, vlag = 2)
	MB⇒BL	Data Not Available	0.54 (0.765, vlag = 2)

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively. The figures in parenthesis refer to p-values, and vlag means lag length of VAR.
Data Sources: Central Banks of each country

Table 4. Bootstrap MW Causality Test between Monetary Base and Bank Loans

Countries		Bootstrap MW Test Statistic					
		Before IT			After IT		
		10%	5%	1%	10%	5%	1%
Australia	BL⇒MB	2.793	5.63** 3.844	7.693	3.881	8.63** 6.062	19.894
	MB⇒BL	2.845	2.09 4.337	8.402	4.090	0.02 6.295	18.342
Indonesia	BL⇒MB	2.841	17.95*** 4.498	12.382	3.780	18.68*** 6..177	16.749
	MB⇒BL	2.458	23.48*** 4.119	10.641	4.449	12.03** 6.232	14.157
Japan	BL⇒MB	2.637	1.57 3.873	8.238	2.688	1.99 4.134	6.574
	MB⇒BL	2.989	0.83 4.428	7.733	2.785	0.46 3.735	6.740
Korea	BL⇒MB	4.515	3.00 5.703	8.408	4.111	11.92** 6.205	16.121
	MB⇒BL	4.967	11.07*** 6.632	9.176	4.352	0.65 6.276	19.826
New Zealand	BL⇒MB	Data Not Available			0.745	62.27*** 1.689	5.584
	MB⇒BL	Data Not Available.			5.940	35.68*** 8.666	20.336
Philippines	BL⇒MB	Data Not Available			2.574	10.26** 4.095	15.559
	MB⇒BL	Data Not Available			2.282	1.63 4.370	15.477
Thailand	BL⇒MB	Data Not Available			4.889	6.26** 6.247	10.536
	MB⇒BL	Data Not Available			4.795	0.54 6.186	9.597

Note: 10%, 5%, 1% denote corresponding bootstrap critical values of 1,000 iterations, respectively.

IV. CONCLUDING REMARKS

The results from the empirical test show that the causation which run from bank loans to the monetary base has become predominant in the countries adopting inflation targeting. To be sure, a monetary policy regime has to do with the nature of the money-supply process. But it is an exaggeration to say that a monetary policy regime *determines* the nature of the money-supply process. As we have shown from the empirical investigation, the causation which runs from bank loans to the monetary base is not unique to an inflation-targeting regime. Except for a strict monetary targeting regime, such causation is observed elsewhere. Because there is practically no central bank in the modern economy adhering to "orthodox" monetary targeting, it is legitimate to assert that endogeneity of the money supply is a universal phenomenon in the modern economy. This last statement does not necessarily exclude the possibility that the supply of central bank liquidity affects bank lending. Bi-directional causality or the structuralist view can prevail for several reasons.

These results have the following policy implications. First, financial and monetary policy makers should bear in mind that bank lending might grow excessively, eventually engendering serious macroeconomic disaster, as banks can grant loans and create money *ex nihilo*. As was emphasized by Jakab and Kumhof (2015), banks are not intermediaries of preexisting loanable funds. For that reason, monetary policy could not be always effective in controlling excessive development of bank loans. Sometimes, prudential regulations, such as LTV (loan-to-value ratio), DTI (debt-to-income ratio), or NSFR (net stable funding ratio) could be more effective instruments. A policy mix between monetary policy and financial regulation should come up for serious discussion for both academics and policy makers.

Second, a bank lending channel of monetary policy transmission would work in certain circumstances but not in others[8]. The bank lending channel is based on the combination of the following propositions: Monetary policy affects the supply of bank lending, and bank lending is an important source of financing for some

[8] We owe to Bernanke and Blinder (1988), and Bernanke and Blinder (1992) for the early theoretical explanation and empirical study of the bank lending channel. Afterwards, Kashyap and Stein (1994) and Bernanke and Gertler (1995) provide a mitigated version of the theory.

borrowers; so the monetary policy affecting the supply of bank lending can have an important effect on the economy. However, our results suggest that the central bank can hardly increase or decrease the supply of bank lending by controlling the monetary base except when the financial markets are underdeveloped or a shortage of market liquidity prevails because of important financial turbulences. On the other hand, note that the increase of the monetary base can affect bank loans through the demand for them. Such a possibility, however, does not support the bank lending channel, because this latter has to do with the supply side of bank loans. Our analysis did not identify explicitly the demand and supply of banks loans. Data on bank loans reflect the interactions between demand and supply sides. Future research should clarify whether the causation from the monetary base to bank loans in some countries is evidence in favor of the bank lending channel or not.

Third, policy makers applying unconventional monetary policy should pay more attention to the asset side of the central bank's balance sheet rather than to the liability side. For all the countries that used quantitative easing after the global financial crisis, bank loans did not increase significantly compared to the increase in bank reserves. In the UK and Japan before the GFC, the bank loans had even decreased after the introduction of the quantitative easing. In our view, these experiences seem to show the fallacy of the money multiplier model and support the endogeneity of the money supply. Therefore, what the central bank should pay attention to is how the acquisition of assets could affect credit conditions for private economic agents[9]. In other words, more accent should be given to "what kind of", rather than to "how many" assets the central bank is acquiring.

[9] This point is just what Bernanke emphasized when he explained the Federal Reserve's monetary policy after the GFC, with the term "credit easing." See Bernanke (2009).

REFERENCES

Andrews, D. W. K. 1993. "Tests for Parameter Instability and Structural Change with Unknown Change Point," *Econometrica*, vol. 61, no. 4, pp. 821-856.

Badarudin, Z. E., Ariff, M. and A. Khalid. 2009. "Money Supply Behavior in Emerging Economies: A Comparative Analysis," *Journal of the Asia Pacific Economy*, vol. 14, no. 4, pp. 331–350.

_____. 2013. "Post-Keynesian Money Endogeneity Evidence in G-7 Economies," *Journal of International Money and Finance*, vol. 33, pp. 146-162.

Bernanke, B. 2009. The Crisis and the Policy Response. <https://www.federalreserve.gov/newsevents/speech/Bernanke20090113a.htm> (accessed January 5, 2018)

Bernanke, B. and A. Blinder. 1988. "Credit, Money, and Aggregate Demand," *American Economic Review*, vol. 78, no. 2, pp. 435-439.

_____. 1992. "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review*, vol. 82, no. 4, pp. 901-921.

Bernanke, B. and M. Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Transmission," *Journal of Economic Perspectives*, vol. 9, no. 4, pp. 27-48.

Borio, C. and P. Disyatat. 2009. Unconventional Monetary Policies: An Appraisal. BIS Working Papers, no. 292.

Carpenter, S. and S. Demiralp. 2012. "Money, Reserves, and the Transmission of Monetary Policy: Does the Money Multiplier Exist?," *Journal of Macroeconomics*, vol. 34, no. 1, pp. 59-75.

Chai, H.-Y. 2017. "Endogenous Money Supply and Effects of Monetary Policy," *Journal of Money and Finance*, vol. 31, no. 1, pp. 75-108. (in Korean)

Dolado, J. J. and H. Lütkepohl. 1996. "Making Wald Tests Work for Cointegrated VAR Systems," *Econometric Reviews*, vol. 15, no. 4, pp. 369–386.

Geweke, J. 1987. Endogeneity and Exogeneity. In Eatwell, J., Milgate, M. and P. Newman. (eds.) *The New Palgrave: A Dictionary of Economics*. London: Macmillan.

Goodhart, C. 2000. The Endogeneity of Money. In Arestis, P., Desai, M. and S. Dow. (eds.) *Money, Macroeconomics and Keynes: Essays in Honor of Victoria Chick, Vol. 1*. Oxford: Oxford University Press.

Granger, C. W. J. 1969. "Investigating Causal Relations by Econometric Models and Cross-Spectral Special Methods," *Econometrica*, vol. 37, no. 3, pp. 424-438.

Hacker R. S. and A. Hatemi-J. 2006. "Tests for Causality between Integrated Variables Using Asymptotic and Bootstrap Distributions: Theory and Application," *Applied Economics*, vol. 38, no. 13, pp. 1489–1500.

Jakab, Z. and M. Kumhof. 2015. Banks Are Not Intermediaries of Loanable Funds and Why This Matters. Working Paper, no. 529, Bank of England.

Kashyap, A. and J. Stein. 1994. Monetary Policy and Bank Lending. In Mankiw. G. (ed.) *Monetary Policy*. Chicago: Chicago University Press.

King, M. 2012. Speech to the South Wales Chamber of Commerce at the Millennium Centre, Cardiff, October 23.

Lavoie, M. 1992. *Foundations of Post-Keynesian Economic Analysis.* Brookfield VT: Edward Elgar Publishing.
McLeay, M., Radia, A. and R. Thomas. 2014. "Money Creation in the Modern Economy," *Bank of England Quarterly Bulletin*, Q1, vol. 54, no. 1, pp. 4-17.
Mishkin, F. S. 1999. "International Experiences with Different Monetary Policy Regimes," *Journal of Monetary Economics*, vol. 43, no. 3, pp. 579-605.
Moore, B. 1988. *Horizontalists and Verticalists: The Macroeconomics of Credit Money.* Cambridge: Cambridge University Press.
Nayan, S., Kadir, N., Abdullah, M. and M. Ahmad. 2013. "Post Keynesian Endogeneity of Money Supply: Panel Evidence," *Procedia Economics and Finance*, vol. 7, pp. 48-54.
Palley, T. 1996. "Accommodationism versus Structuralism: Time for an Accommodation," *Journal of Post Keynesian Economics*, vol. 18, no. 4, pp. 585-594.
Quandt, R. E. 1960. "Tests of Hypotheses that a Linear System Obeys Two Separate Regimes," *Journal of the American Statistical Association*, vol. 55, no. 290, pp. 324-330.
Shukur, G. and P. Mantalos. 2000. "A Simple Investigation of the Granger-causality Test in Integrated-Cointegrated VAR Systems," *Journal of Applied Statistics*, vol. 27, no. 8, pp. 1021-1031.
Sims, C. A. 1972. "Money, Income and Causality," *American Economic Review*, vol. 62, no. 4, pp. 540-552.
Toda, H. and T. Yamamoto. 1995. "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes," *Journal of Econometrics*, vol. 66, no. 1-2, pp. 225–250.

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