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THE EFFECT OF MONEY GROWTH ON INFLATION AND GDP IN THE SELECTED ASIA-PACIFIC MARKETS – WAVELET-BASED BAYESIAN QUANTILE ESTIMATES

Abstract: *This paper tries to determine how money growth effects output and inflation in four Asian-Pacific markets, regarding different time-horizons and different market conditions. We use two innovative methodologies – the wavelet signal decomposing approach and robust Bayesian quantile regression. We find that money growth impacts real GDP growth in Australia by 5% in the long-run, and by 6-7% in midterm in Japan. Money growth positively impacts real output in Korea, and this rate is much higher comparing to Australia and Japan. However, this effect is not found in Indonesia, which has similar real GDP growth rate as Korea, and the probable reason lies in the presence of relatively high inflation rate in this country. Also, Bayesian quantile parameters suggest that money does not have an influence on inflation in Korea and Indonesia, regardless of the observed time-horizons. In Australia, money impacts inflation only in the long-term, and it amounts between 7-10%, while in Japan between 3-6% in the short-term horizon.*

Key words*: money, inflation and GDP, wavelet approach, Bayesian quantile regression, Asia-Pacific countries.*

JEL classification: C63, E31, E32, E51

1. Introduction

Seeking an answer on question how money growth affects inflation and output, represents an enduring area of research in macroeconomics. Su et al. (2016) argued that the nexus between money, inflation and output has attracted a plenty of interest over the years, both empirically and theoretically. This is the case because if monetary

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policy observes money supply as an 'intermediate target', then central bank needs to be aware about the relationship between money and their policy goals (such as income or prices). One of the most important objectives of monetary authorities is to provide the necessary level of money supply, which maintains the desired level of output, employment, and price stability. Generally, the interdependence between money growth, inflation and GDP is associated with the two main theoretical approaches – the traditional quantity theory of money (QTM) and modern QTM. According to Fisher and Brown (1911), the traditional quantity theory of money suggests that money growth only induces inflation in both short and long run, with no impact on GDP. On the other hand, the modern QTM stands in a position that money growth impacts both output and inflation in the short run, but it would be completely translated on inflation in the long run (see Friedman, 1956). Duczynski (2005) claimed that most economists believe that money is neutral in the long run, but non-neutral in the short run. A seminal paper on this topic did Sims (1972), who used post-war US data, and found that there is a Granger causality from money to output. However, the later investigations in this area showed that results are highly dependent on data sample, the choice of money measure and applied econometric models, thus further research is needed in this topic.

According to the aforementioned, this paper tries to add to the literature by investigating how money growth impacts inflation and GDP in four large Asia-Pacific economies – Australia, Japan, South Korea and Indonesia, taking into account different time-horizons. These particular countries have recorded outstanding money growth over the past several decades. We intentionally choose two developed and two emerging markets, because we want to assess whether different GDP growth rates play a role when it comes to the confirmation/rejection of the modern QTM theory. In addition, all these countries pursue prudent anti-inflationary policy, and all of them have adopted inflation targeting (IT) strategy at some point in time. Australia conducts IT policy since June 1993, Japan since January 2013, Korea since April 1998 and Indonesia since July 2005, which raises a question whether the traditional QTM can come to the fore in conditions when central bank is highly dedicated to keep inflation low. Figure 1 reveals a remarkable enlargement of narrow money (M1 aggregate) in these economies in the last 30 years.

According to the OECD statistics, narrow money in Australia, Japan, South Korea and Indonesia has grown 6.8, 4.2, 17.3 and 55.6 times, respectively, in the period from 1990-2020. In the same time-span, real GDP grew about 1.3 times (Australia), 0.3 times (Japan), 2.7 times (South Korea), and 1.9 times (Indonesia), while inflation rose 0.9 times (Australia), 0.1 times (Japan), 1.6 times (South Korea) and 10.6 times (Indonesia). Having in mind all that have been said, it is reasonable to ask whether disproportional money growth affects inflation and real GDP in these countries in

different time-horizons and in different market conditions. In order to find a credible answer, we thoroughly investigate the transmission effect from narrow money to real GDP growth and inflation, using two elaborate methodological approaches in that process. In particular, we combine two innovative methodologies that has been recently developed – the wavelet signal decomposing technique and Bayesian quantile regression. Different time-horizons – short-term, midterm and long-term, are observed by using wavelet signals, while the assessment of these effects in different market conditions is estimated *via* the Bayesian quantile regression.

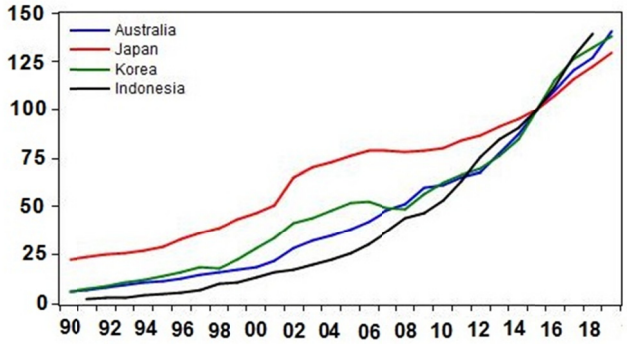

Figure 1. Growth of M1 aggregate index for the selected countries

Caraiani, (2012) contended that wavelet methodology differs considerably from the most conventional mathematical methods which observe only time-domain dimension, and as such cannot identify short-run and long-run relationships between time-series. In addition, Roueff and Sachs (2011) asserted that wavelet analysis has significant advantage over the well-known Fourier analysis, especially when time series are non-stationary or locally stationary. As a powerful signal-processing tool, wavelets are able to decompose the time–frequency relationships between observed variables and help researchers to simultaneously assess whether the relationship varies across frequencies and evolves over time. Specifically, this model-free approach allows researchers to test the dynamic dependence at different time-horizons, whereas it circumvents the problem of sample size reduction at the same time. Number of recent studies utilized wavelet methodology with goal to analyse various economic phenomena at different time-horizons (see e.g. Lee and Lee, 2016; Altar et al., 2017; Živkov et al, 2018).

In order to accurately measure the extent of the spillover effect from narrow money to GDP and inflation, we embed the decomposed wavelet signals into the

Bayesian quantile regression (BQR) framework. This particular methodology uses MCMC (Markov Chain Monte Carlo) algorithm in the estimation process, which leads to exact inference about the quantile parameters, even when data sample is short (as in our case[1]). In addition, comparing to the traditional quantile regression approach, the Bayesian QR methodology decreases the length of credible intervals and increases the accurateness of quantile estimates. Generally, an appealing feature of QR methodology is that it can provide an insight about the transmission effect between the observed variables in different market conditions – downturn (lower quantiles), normality (intermediate quantiles), and upturn (upper quantiles). By utilizing the wavelet-based Bayesian quantiles, we can gain a reliable insight about viability/groundlessness of the traditional and modern QTM principles of the selected countries. Although the money-output and money-inflation relationships are among the most debated topics within the macroeconomic discipline, to the best of our knowledge, none of the academic papers investigated these interdependencies by combining wavelet and QR methodologies.

Besides introduction, this paper is structured as follows. Second section contains literature survey. Third section explains used methodologies – the wavelet decomposing technique and Bayesian quantile regression. Fourth section is reserved for dataset. Fifth section presents the results of wavelet-based Bayesian quantile estimates for money-GDP and money-inflation relations. Sixth section provides complementary analysis of wavelet correlations, while the last section brings concluding remarks.

2. Research methodologies

2.1 Wavelet signal-decomposing methodology

The goal of this research is to assess how/whether money affects GDP and inflation in different time-horizons in the selected Asia-Pacific countries. Therefore, the first step of our two-step procedure considers the transformation of the empirical time-series in the several wavelet time-frequency components. Shuaibu and Kirikkaleli (2020) claimed that wavelet technique can ensure an appropriate trade-off between resolution in the time-frequency domains, which traditional Fourier analysis cannot, since it emphasizes only the frequency domain. On the basis of the wavelet theory, there are two key wavelet functions: father wavelet (ϕ) and mother wavelet (ψ). Father wavelets augment the representation of the smooth or low frequency parts of a signal with an integral equal to 1, whereas the mother wavelets can describe the details of high frequency components with an integral equal to 0. In other words, father wavelet describes the long-term trend over the scale of the time series, while the mother

[1] Each time-series have 123 quarterly observations in 30 years time-span.

wavelet delineates fluctuations in the trend. The functions of father wavelet $\phi_{J,k}(t)$ and mother wavelet $\psi_{j,k}(t)$ are generated as in equation (1):

$$\phi_{J,k}(t) = 2^{-J/2}\phi\left(\frac{t-2^J k}{2^J}\right), \qquad \psi_{j,k}(t) = 2^{-j/2}\psi\left(\frac{t-2^j k}{2^j}\right) \tag{1}$$

For our research purposes, we apply the maximum overlap discrete wavelet transformation (MODWT) algorithm[2], which is based on a highly redundant non-orthogonal transformation. Therefore, signal-decomposing procedure in MODWT are given in the following way:

$$S_J(t) = \sum_k S_{J,k}\phi_{J,k}(t), \tag{2}$$

$$D_j(t) = \sum_k D_{j,k}\psi_{j,k}(t) \qquad j = 1,2,\dots,J \tag{3}$$

where symbols $S_J(t)$ and $D_j(t)$ stand for the fluctuation and scaling coefficients, respectively, at the j-th level, which reconstruct the signal in terms of a specific frequency (trending and fluctuation components). Accordingly, an empirical time series y(t) can be expressed in terms of those signals as:

$$y(t) = S_J(t) + D_J(t) + D_{J-1}(t) + \cdots + D_1(t). \tag{4}$$

2.2 Bayesian quantile regression

After the transformation of the empirical time-series into the several wavelet signals, we insert those signals in the Bayesian quantile regression framework[3]. QR methodology was originally introduced by Koenker and Bassett (1978), and this technique extends the mean regression model to conditional quantiles of the response variable. This approach provides a more nuanced view of the relationship between response variable and covariates, because it allows researchers to estimate how a set of covariates affect the different parts of the distribution of the dependent variable. In addition, Benoit and van den Poel (2012) asserted that parameter estimates of QR are not biased by a location-scale shift of the conditional distribution of dependent variable. This particular advantage of QR encouraged many researchers from various theoretical disciplines to use QR for their studies (see e.g. Vilerts, 2018).

[2] Wavelet transformation was done via 'waveslim' package in 'R' software.

[3] Bayesian quantile parameters were calculated via 'bayesQR' package in 'R' software.

In order to explain the Bayesian QR methodology, we start with the standard linear model as in equation (5):

$$y_i = \mu(x_i) + \varepsilon_i \tag{5}$$

where y_i and x_i are both continuous variables, whereby, in our context, the dependent variable y_i can be either GDP or inflation, while x_i is a narrow money, i.e. M1 aggregate. According to Benoit and van den Poel (2017), if $\text{Med}(\varepsilon|x) = 0$ is assumed, then $\mu(x_i)$ is a conditional median function, while a linear conditional median model is given by $\text{Med}(y_i|x_i) = x_i^{'}\beta$. The regression coefficient can be found by solving equation (6):

$$\text{argmin} \sum_{i=1}^{n} \left| y_i - x_i^{'}\beta \right|; \quad \beta \in \Re \tag{6}$$

Quantile regression extends the median case to all other quantiles, and these quantile parameters can be estimated by solving the equation (7):

$$\hat{\beta}(\tau) = \text{argmin} \sum_{i=1}^{n} \rho_\tau (y_i - x_i^{'}\beta); \quad \beta \in \Re \tag{7}$$

where $\tau \in (0,1)$ is any quantile of interest, while $\rho_\tau(z) = z(\tau - I(z < 0))$ and $I(\cdot)$ stands for the indicator function. The quantile $\hat{\beta}(\tau)$ is called the τ^{th} regression quantile, while in the case where $\tau = 0.5$, it corresponds to median regression.

3. Dataset

Dataset used for this research consists of quarterly index data of monetary aggregate (M1) and consumer price index (CPI), and real GDP growth rate of four Asia-Pacific markets – Australia, Japan, South Korea and Indonesia. We transform quarterly indices of M1 aggregate and CPI into natural logarithms, according to the expression: $r_{i,t} = 100 \times ln(P_{i,t}/P_{i,t-1})$, in order to correct for dimensional differences between the time-series, that is, all the variables are observed as growth rates. Also, all the time-series are seasonally adjusted. The data are collected from OECD statistics, and the time-span ranges from 1990:Q1 to 2020:Q3.

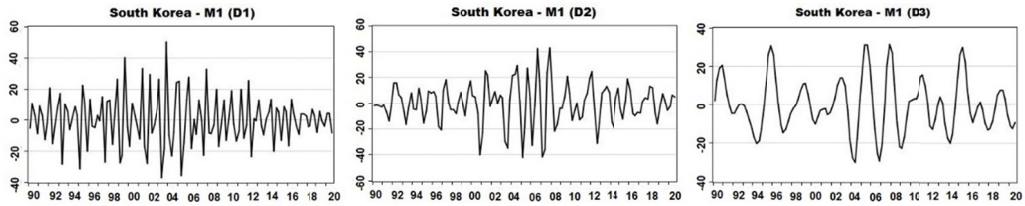

Figure 2. Wavelet details of South Korean M1 aggregate

We perform the wavelet transformation on the empirical time-series, where we observe 3 wavelet scales, which can provide a clue about how money influences GDP and inflation in different time-horizons. These horizons correspond to: scale 1 (2-4 quarters), scale 2 (4-8 quarters) and scale 3 (8-16 quarters). We treat first scale as the short-term horizon, midterm is represented by second scale, while third scale correspond to the long-term dynamics. Due to space parsimony, Figure 2 presents only three scales of the wavelet decomposed series of South Korean M1 aggregate, whereas all other wavelet decomposed series can be retrieved by request. Table 1 contains descriptive statistics of quarterly growth rates of M1 aggregate, inflation and real GDP of all the selected countries.

Table 1. Descriptive statistics of quarterly data for M1, inflation and GDP

	Mean	St. dev.	Skewness	Kurtosis	JB
Australia					
M1 in %	1.905	2.230	-1.430	11.924	424.5
Inflation in %	2.632	1.551	1.273	5.438	60.1
Real GDP in %	0.750	0.592	0.268	5.079	22.3
Japan					
M1 in %	1.529	1.658	3.902	26.709	2959.4
Inflation in %	0.430	1.206	0.864	3.484	15.3
Real GDP in %	0.252	0.926	-1.563	10.117	287.0
South Korea					
M1 in %	2.825	3.320	-1.277	8.688	184.6
Inflation in %	3.554	2.221	0.958	3.482	18.5
Real GDP in %	1.216	1.320	-2.113	16.068	895.9
Indonesia					
M1 in %	3.751	3.384	4.269	34.556	5076.4
Inflation in %	9.639	11.702	4.393	23.613	2384.9
Real GDP in %	1.217	1.601	-2.710	18.174	1233.3

Note: JB stands for Jarque-Bera test of normality.

Table 1 suggests that emerging markets – Indonesia and Korea have the largest money and inflation growth rates, while the developed countries – Australia and Japan follow. Also, it is obvious that these emerging markets have higher real GDP growth rates in comparison with the developed ones. Especially Japan has really low GDP growth rate in the observed period of 30 years. In addition, it is noticeable that inflation rates are higher than M1 growth rates in three out of four cases (only Japan is an exception), which could indicate that traditional QTM might hold in these countries. Empirical time-series of the emerging markets have pronounced erratic dynamics, comparing to the observed time-series of the developed countries, which is indicated by standard deviations. All kurtosis values are higher than benchmark value of 3, while in the case of Indonesia, these values are particularly high for all observed time-series. In the case of Indonesia, very high kurtosis values of all macroeconomic aggregates are present due to exogenous shocks which hit Indonesia particularly severe during Asian financial crisis in 1998. During that time, Indonesian money and inflation skyrocketed, while real GDP growth plummeted. The existence of high kurtosis values justifies the usage of wavelet methodology and quantile regression owing to two reasons. First, the wavelet method successfully tackles extreme movements and numerous outliers in empirical signals (see e.g. Nikkinen et al., 2011; Madaleno and Pinho, 2012). Second, the quantile regression estimators are robust to deviations from normality and it performs very well in extreme value environment. This is the case since QR provides information about the average dependence as well as the extreme tail dependence. Jarque-Bera test suggests nonnormality for majority of the selected time-series. We do not present unit root tests in Table 1, because we operate with the wavelet decomposed series, which are stationary by default.

In order to check the validity of the estimated Bayesian QR parameter, we use a visual inspection of the MCMC chains' convergence, which shows the evolution of the MCMC draws over the iterations. For our computational purposes, we use 2000 iterations, while 200 iterations are burned. Figure 3 displays the trace-plots of the MCMC chain of the median quantiles, $\hat{\beta}(\tau) = 0.5$, for three wavelet scales, regarding the spillover effect from M1 to inflation in South Korean. It can be seen that all trace-plots show a good performance, suggesting that the effect of the initial values of the MCMC chains wears off very fast, while the MCMC sampler quickly moves to the stationary distribution. These findings speak in favour that the estimated median Bayesian quantile parameters are not biased. Due to space brevity and the fact that the trace-plots of all other variables across all quantiles are very similar, we present in Figure 3 only trace-plots for Korean M1 aggregate in three wavelet scales, whereas all other trace-plots can be obtained by request.

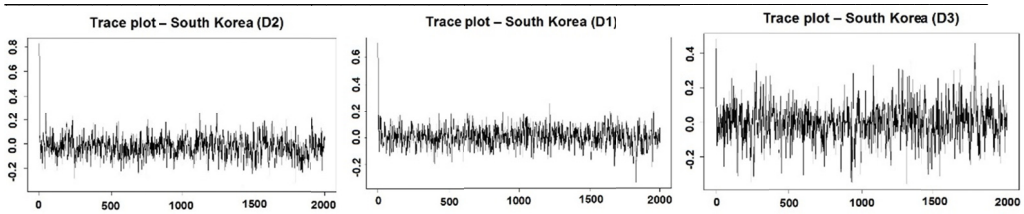

Figure 3. Trace plots for the median quantile of Korean M1 aggregate in three wavelet scales

Note: The horizontal axis represents the number of MCMC iterations.

4. Empirical results

5.1. *Transmission effect from money to real GDP*

This subsection presents the results of the estimated Bayesian quantile parameters for transmission effect from M1 to real GDP. Table 2 presents the five quantile estimates across three wavelet scales of the four selected Asia-Pacific countries, while Figure 4 contains graphical plots of these estimates for Australia. This particular subsection tests the modern QTM theory, since it suggests that money growth impacts both output and inflation. It can be seen that Table 2 contains both positive and negative quantile estimates. Positive quantile estimates confirm modern QTM principle, while negative QR parameters refute this tenet.

In the case of Australia, we find four negative and one very small positive Bayesian QR parameters in the first wavelet scales. In the second wavelet scale, the situation is similar. These results strongly stand against the modern QTM theory, which means that money growth does not positively influence real GDP growth in the short-term and midterm. On the other hand, we find positive QR parameters in the third wavelet scale, which is the time-period of about two years, and these parameters are somewhat higher across all the quantiles. It is interesting to note that money has greater effect on the Australian real GDP in periods when economy records lower GDP growth rates, and in these occasions the transmission effect is around 5%, while in the periods of GDP expansion, this effect is around 3%. Therefore, our results are only partially in line with the findings of Fanta (2013), who asserted that no cointegration relation exists between money and real GDP in the period between 1976-2008 in Australia. However, it should be said that Fanta (2013) based his conclusions on the Johansen cointegration procedure, which can offer relatively modest information about the nexus, comparing to the Bayesian quantile regression approach.

Table 2. Bayesian quantile estimates of the transmission effect from M1 to GDP

	Quantile estimates									
	0.05-th	0.25-th	0.5-th	0.75-th	0.95-th	0.05-th	0.25-th	0.5-th	0.75-th	0.95-th
	Panel A: Australia					**Panel B: Japan**				
D1	0.006	-0.001	-0.017	-0.036	-0.035	-0.019	-0.029	-0.018	-0.018	-0.042
D2	0.004	0.010	0.004	-0.005	-0.001	0.038	0.058	0.069	0.066	0.044
D3	0.050	0.050	0.050	0.046	0.029	-0.057	-0.036	-0.028	-0.015	-0.033
	Panel C: South Korea					**Panel D: Indonesia**				
D1	0.078	0.027	0.040	0.033	-0.034	-0.122	-0.087	-0.053	-0.088	-0.078
D2	0.176	0.091	0.082	0.100	0.129	-0.275	-0.170	-0.127	-0.187	-0.258
D3	0.235	0.237	0.261	0.281	0.246	-0.330	-0.070	-0.039	-0.094	-0.263

As for the Japanese case, we find negative QR parameters in the first and third wavelet scales, which depicts the short-term and long-term time-horizons. However, our results indicate that positive nexus exists between money and real GDP in the midterm, since we find positive QR parameters across the quantiles. These parameters are somewhat higher comparing to the case of Australia, and also these QR parameters indicate stronger spillover effect in the periods when Japanese economy records modest growth (0.5^{th} and 0.75^{th} quantiles). In particular, money has the highest impact on the Japanese real GDP growth in normal economic conditions in midterm, which is represented by the median quantile, and it amounts 6.9%. Our results coincide with the study of Canova and Menz (2011), who also found statistically and economically important effect of money on the cyclical fluctuations in output in Japan. They explained that Money matters both directly, through its effects on the Euler equation and the Phillips curve, and indirectly, through the Central Bank's determination of the nominal interest rate. However, taking into account both Australian and Japanese results, we can content that the impact of money to real GDP in the developed economies is relatively modest. This conclusion is consistent with the claim of Duczynski (2005), who examined money-output relations in 21 developed countries, and argued that correlations between money and output are relatively low, which imply that money probably matters, but not extremely.

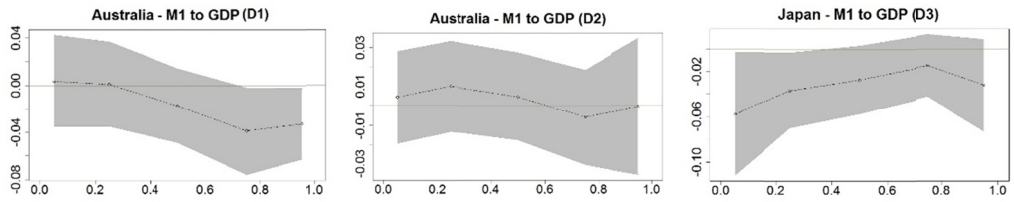

Figure 4. Estimated Bayesian QR parameters – the transmission effect from M1 to GDP for Australia[4]

Note: The shaded area gives the adjusted credible intervals at 70 percent probability.

Regarding the other two countries, Panels C and D in Table 2 contain the Bayesian quantile parameters for emerging South Korea and Indonesia. The results suggest that money growth has the strongest positive effect on the Korean GDP across different time-horizons, while in the case of Indonesia, this effect is constantly negative, regardless of the observed quantiles and wavelet scales. It can be seen that the effect of money on Korean GDP grows with the increase of wavelet scales, and this effect, in the third wavelet scale, reaches the highest magnitudes in left and right tales of the distribution. More specifically, the transmission effect in the periods of economic downturn amounts 23.5%, while in the periods of economic boost, this effect is 24.6%.. South Korea is fast growing emerging market, and its GDP grows 1.62 times faster than Australian GDP and 4.83 times faster than Japanese GDP (see Table 1). Therefore, it is reasonable to believe that demand for money in Korea is higher than in the two developed markets, which consequently spills over on the rise of Korean GDP.

On the other hand, Indonesian average real GDP growth is almost identical as Korean, but Indonesian QR parameters are all negative, which is completely opposite to the Korean findings. These results in the first glance could seem odd and perplexing, but under closer look, a rational explanation could be found. Namely, Duczynski (2005) contended that evidence for the existence of the negative money-output relations could be found in high-inflation countries, whereby Indonesia is the country which fits very well with this assertion. In other words, Table 1 indicates that Indonesia has the highest average inflation of all the examined countries, amounting 9.6%, which is 3.6 times higher comparing to Australian inflation, 24 times in comparison to Japanese inflation and 2.7 times in comparison to Korean inflation. Therefore, it seems that high Indonesian inflation hampers the relationship between money and the Indonesian GDP.

[4] In order to save space, plots for all other countries can be obtained by request.

5.2. *Transmission effect from money to inflation*

This subsection reveals the results of a multiscale transmission effect from narrow money to inflation in the selected Asia-Pacific countries. Table 3 contains the estimated Bayesian quantile parameters, whereas Figure 5 depicts graphically these parameters with the confidence intervals of 70 percent, across three wavelet scales.

As for the Australian case, Table 3 indicates that money growth does not have an effect on Australian inflation in short-term and midterm. This is the case because, except left-tail quantile which goes around 3%, all other quantile parameters are very low in D1 wavelet scale, hence they do not have economic significance. In midterm horizon, all quantile parameters bear negative sign, which strongly opposes to the traditional QTM stance. Our findings in first two wavelet scales coincide very well with the results of Makin et al. (2017). He investigated *via* ARDL model the relationship between money and inflation in Australia. His results suggested that excess money growth was the key determinant of Australia's inflation before IT introduction, while after IT was implemented in the early 1990s, Australia was highly successful in keeping inflation low. This is the probable reason why we do not find the spillover effect in the first two wavelet scales. On the other hand, we find positive and economically significant quantile parameters in the long-term horizon, ranging between 5-10%, which stands in line with traditional QTM. In D3 wavelet scale, the highest spillover effect is found in median and in 0.75^{th} quantile, which represents the conditions of moderate and moderately high inflation. This positive nexus also coincides with the findings of some authors, who researched the case of Australian. For instance, Hossain (2019) utilized the Johansen cointegration and reported the presence of a long-term cointegration relationship between Australian money and inflation, and he concluded that money matters when Australian inflation is in the question. Our results support the findings of both authors, although they are diametrically opposite, because wavelet-based quantile approach allow us to assess independently the impact of money on inflation in different time-horizons.

Table 3. Bayesian quantile estimates for the transmission effect from M1 to inflation

	Quantile estimates									
	0.05-th	0.25-th	0.5-th	0.75-th	0.95-th	0.05-th	0.25-th	0.5-th	0.75-th	0.95-th
	Panel A: Australia					**Panel B: Japan**				
D1	0.028	0.009	0.005	0.012	0.009	0.041	0.031	0.027	0.032	0.064
D2	-0.066	-0.080	-0.042	-0.046	-0.017	-0.006	-0.024	-0.039	-0.030	-0.014
D3	0.056	0.067	0.084	0.102	0.081	-0.067	-0.099	-0.085	-0.070	-0.065
	Panel C: South Korea					**Panel D: Indonesia**				
D1	0.018	0.002	-0.014	-0.012	0.002	-0.000	-0.002	0.001	-0.014	-0.137
D2	-0.051	-0.025	-0.026	-0.050	-0.066	-0.432	-0.145	-0.136	-0.324	-0.766
D3	-0.200	-0.164	-0.194	-0.203	-0.149	-0.896	-0.485	-0.484	-0.573	-0.819

In the case of Japan, our results report relatively modest spillover effect from money to inflation only in the short-term horizon, and this effect amounts between 3-6% across the quantiles. On the other hand, in the midterm and long-term horizons, estimated Bayesian quantile parameters have negative sign, which refute any existence of the traditional QTM. It should be said that Japan was facing a decade-long recession in the nineties, and in order to boost economic growth and to raise the inflation rate, Japan launched two separate quantitative easing – the first one in the early 2000s, and the second one at the end of 2012.

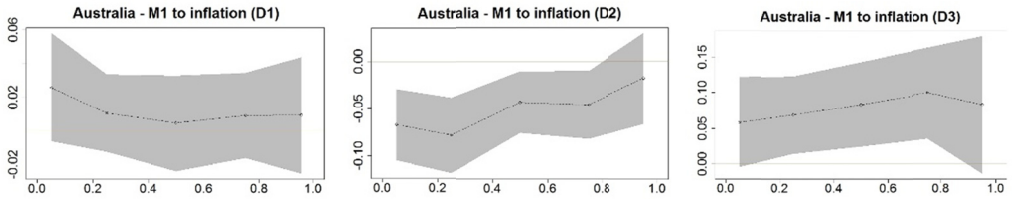

Figure 5. Estimated Bayesian QR parameters – the transmission effect from M1 to inflation for Australia[5]

Note: The shaded area gives the adjusted credible intervals at 70 percent probability.

Ryou, et al. (2019) investigated the cases of Japan and Korea, using time-varying parameter vector autoregression (TVP VAR) model, and they found that Japanese unconventional monetary measures have successfully raised Japanese inflation during the quantitative easing period both in the short and long run. These results coincide with our findings, but only partially, since we found that money affects inflation only in the short-term.

As for Korea and Indonesia, it can be seen that majority of parameters bear negative sign across the quantiles and wavelet scales in both countries. It is an indication that money growth has no effect on inflation in these two emerging markets. However, one question seems puzzling regarding these two countries. Namely, both countries perform IT strategy, both countries have relatively high rate of money growth, money does not affect inflation in both countries according to the quantile parameters, but why only Indonesia has relatively high average inflation (see Table 1). The answer for this question could be found in the paper of Taguchi and Kato (2011).

[5] In order to save space, plots for all other countries can be obtained by request.

These authors studied the performance of inflation targeting in four East Asian emerging market economies: Indonesia, Korea, the Philippines and Thailand. They contended that Korea implemented a forward-looking policy under inflation targeting, which was a successful policy from the price stability point of view. On the other hand, Indonesia conducted a backward-looking policy, which had very poor effect in terms of price stabilisation. They offered an explanation why forward-looking and backward-looking policy rules give such different outcomes. They claimed that the difference may arise from the aspect how private sector forms expectations on inflation under forward-looking and backward-looking policies. In other words, they argued that private sector makes inflation expectations much easier when central bank shares reliable inflation-forecasting information with the public. On the other hand, they asserted that the backward-looking rule is frequently accompanied by unreliable inflation forecasting, which makes much harder for private agents to recognize the true intentions of central bank, regarding anti-inflationary measures. Hence, they concluded that differences in policy rules may create differences in policy effects. The explanation of Taguchi and Kato (2011) seems logic, and it fits good with our overall findings.

6. Summary and conclusion

This paper investigates how money affects real GDP and inflation in four major Asia-Pacific markets – Australia, Japan, South Korea and Indonesia in different time-horizons and in different market conditions. The research is conducted by combining two innovative and non-traditional methodologies – wavelet signal decomposing technique and Bayesian quantile regression approach. Wavelet methodology allows us to test the validity of the traditional and modern QTM in different time-horizons, while Bayesian QR is capable of estimating bias-free quantile parameters, which is important for the reliability of the results.

Empirical findings indicate that all the selected countries have very high money growth rates, while the magnitude of the spillover effect from money to real GDP and inflation is heterogeneous across the selected markets. As for the money-real GDP transmission effect, we find that money has an effect on output in developed countries – Australia and Japan, which coincides with the modern QTM stance, but this effect is relatively modest. More specifically, we report that money impacts real GDP growth by 5% in the long-run in Australia, and by 6-7% in midterm in Japan. On the other hand, calculated Bayesian QR parameters suggest that money positively impacts real output in Korea, in much higher rate than in the developed countries. Also, it is found that the effect of money rise with the increase of observed time-horizons in Korea. The rationale for this finding could lie in the fact that Korea grows much faster than

Australia and Japan, which probably spurs demand for money in this country, and consequently spills over to the real output. On the other hand, Indonesia has similar real GDP growth rate as Korea, but the effect of money on the Indonesian real output is not found, whatsoever. The reason why money growth fails to boost real GDP in Indonesia probably lies in the fact that Indonesia has relatively high average inflation rate (almost 10%). Therefore, it could be concluded that positive interdependence between money and GDP does not work in the high-inflation countries, which is in line with some previous studies.

As for the money-inflation relations, it should be said that all countries, except Japan, have an interest to conduct prudent anti-inflationary policy. In that regard, our Bayesian QR findings suggest that money growth does not have influence on the inflation in Korea and Indonesia, regardless of the observed time-horizon. In Australia, money impacts inflation only in the long-term, and it amounts between 7-10% in a range between 0.25^{th} and 0.75^{th} quantiles. Due to stagnation of Japanese economy, which lasts for a very long period of time, Japan initiated a quantitative easing measures in two separate occasions in order to raise inflation rate, in an effort to positively influence Japanese GDP growth. According to our results, these measures affected the growth of Japanese inflation, but very modestly (between 3-6%) in the short-term horizon. In the midterm and long-term horizons, these measures did not have any effect on Japanese inflation.

Results from this paper might be interesting for policymakers of the selected Asia-Pacific countries as well as for wider audience, because it uses combination of two different methodologies, which brings some new answers in the respect of how money growth influences the two crucial macroeconomic aggregates in these economies. Also, this paper provides a new insight about whether and how money impacts real growth and inflation in different time-horizon, and what rational explanations lies behind these findings.

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