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Money Growth and Velocity with Structural Breaks: Evidence from the Philippines

Assad L. Baunto[a], Christian Bordes[b], Samuel Maveyraud *[c], and Philippe Rous[d]
[a]*University of Philippines School of Economics, Diliman, Quezon City 1101, Philippines*
[b]*University of Paris I – Sorbonne, Centre d'économie de la Sorbonne (CES) , France*
[c]*University of Bordeaux 4, GREThA, France*
[d]*Université de Limoges, LAPE, 5 rue Félix Eboué, BP 3127, 87 031 Limoges Cedex, France*

This paper aims to test the Friedmanite proposal on the link between the velocity of money demand and money growth. We base our work on the Philippines as its monetary policy has been subject to sharp swings since the 1980s. We use a method that takes into account possible structural breaks in the velocity of money demand and a GARCH model to evaluate the variability of money growth. We apply Granger causality tests to confirm the Friedmanite hypothesis.

Keywords: Friedman hypothesis, GARCH, structural breaks

1 Introduction

Traditionally, inflation in the Philippines has tended to be consistently higher and more variable than in other Asian countries. Historically this feature has often been linked to shocks or disturbances in various areas of the economy, notably the external (which relates to the balance of payments), real (which relates to output or production), and monetary sectors (sharp swings in monetary policy) (Debelle & Lim, 1998; Bangko Sentral ng Pilipinas (BSP), 2006].

This last aspect -- the origins of shocks in the Philippine monetary sector -- is the main subject of this paper. To analyze this question consistently, we propose to test the Milton Friedman hypothesis relative to velocity of money demand and money supply. The relationship on the origins of monetary disturbances due to the role of money supply shocks has been the subject of a vast econometric literature. We propose an original procedure to conduct an econometric test of its validity implemented for the Philippines. More precisely, we allow breaks in money demand as structural changes (e.g., financial system changes) may imply the breakdown of money holdings (Ferrero, Nobili & Passiglia, 2007). Moreover, as recent studies do (cf., inter alia, Serletis & Shahmoradi, 2006), we use a GARCH model to extract the variability of money supply and Granger causality tests in order to appreciate the Friedmanite hypothesis.

The paper is organized in the following way: The main stylized facts relative to the monetary evolution in the Philippines are presented in Section one. Section two examines the origins of monetary disturbances in the Philippines. The Friedman's hypothesis between money and velocity is discussed in Section three. Section four presents the empirical analysis and Section five concludes.

2 Stylized Facts in the Philippines

The history of the Philippine economy beginning early 1980s is marked by episodes of instability. Over the span of nearly three decades, the economy experienced three recessions – 1984-85, 1991 and the 1998 – which hampered its chances of becoming one of East Asia's miracles.

The 1980s was the most turbulent period of the economy, when annual output growth registered -7.4% in 1984 and -7.2% in 1985, the sharpest contraction ever experienced by the economy since post war. Annual inflation rates recorded double-digit figures over the period 1982-85 and in 1984 it reached an all-time high record of 49.3%.

The conduct of erratic monetary policy can be partly blamed for the large swings in output and inflation. Excessive money creation was a result of central bank's pursuit of multiple objectives including monetary aggregate targeting in conjunction with exchange rate targeting and output-growth targeting (Gochoco-Bautista, 2006).

* Corresponding author; Email: samuel.maveyraud@u-bordeaux4.fr

The collapse of the peso in 1983 exacted large losses to the central bank and, eventually, added constraints to meeting its monetary aggregate targets. Central bank's accommodation of chronic public sector deficits and engagement in development financing strained its balance sheet, which contributed to the distortions of monetary policies and restrained achievement of stable domestic price level. According to Gochoco-Bautista, the liabilities of the central bank were serviced by infusing more money in the economy but, with guidance from IMF's country program, the central bank engaged in open market operations to tame inflationary pressures. Lamberte (2002) assessed that the Central Bank of the Philippines is unique among its counterparts in Asia as it had been incurring losses over the years before it was overhauled in 1993 and replaced by the Bangko Sentral ng Pilipinas. From 1983 to 1990, cumulative losses of the old central bank reached 143.7 billion pesos.

The balance-of-payment problem in the early 1980s, the political assassination of opposition leader Benigno Aquino in 1983 and the authorities' declaration of a moratorium on repayment of its debts starting 1984 helped pave the way for the recession in 1984 and 1985. In response to the economic crisis, government authorities contracted money supply and imposed fiscal austerity that resulted in jacking up the domestic interest rates. The real sector was significantly affected. Restraining liquidity is not entirely a new policy strategy during economic slowdown and, in fact, meeting tight quarterly monetary targets in the 1980s became a common practice every time the economy faced deterioration of balance of payments and high inflation (Lim, 2006). These targets based on monetary base were achieved by influencing required reserve ratio and rediscount rates, and/or resorting to open market operations to buy and sell central bank bills and government securities which often times significantly affected total liquidity and credit in the financial sector.

Meanwhile, the financial scandal in 1981 – when a famous businessman absconded his debts leaving several banks and financial companies on their knees – and the mounting debt crisis alerted the authorities to institute reforms in the financial sector. In 1983, the financial sector was deregulated. Expressed as a ratio of gross domestic product, monetary aggregates (M1, M2 and M3) consistently rose beginning 1986 after they were severely affected by the previous economic turmoil, and became relatively stable after the Asian financial crisis in 1998. Towards the latter part of the 1980s, the volume of M2 and M3 nearly equalized as the central bank gradually abolished deposit substitutes that originally formed part of M3.

Just as the economy saw encouraging signs of economic recovery in the second-half of 1980s with inflation rates albeit at double digits but significantly lower relative to previous levels, a mild recession occurred in 1991. Output contracted by 0.6% as the economy braced for moderate devaluation of the peso and oil price shock brought by the Gulf crisis; inflation rose to 19.3% (average inflation over the 1986-1990 period was 8.7%).

Two important events occurred in early 1990s. In 1992, the economy liberalized its foreign exchange market, which allowed domestic and foreign capital to move freely. Capital inflows rose dramatically reaching 10% of total output in 1996 compared to just 3% by end of the previous decade. It soon dissipated when another crisis blew most economies in East Asia in 1998. In June 1993, Republic Act No. 7653, otherwise known as the "New Central Bank Act", was issued establishing the Bangko Sentral ng Pilipinas (BSP), and transforming the old central bank into the Central Bank Board of Liquidators. Compared to the old central bank, BSP is mandated to maintain its independence to prevent time-inconsistency problem, with price stability as its primary objective.

The economy achieved single-digit inflation rates in the mid-1990s onwards, despite high liquidity and large monetary expansion during the period until the East Asian financial crises when BSP periodically raised policy rates and the liquidity reserve ratios to stave off depreciation of the local currency.

The advent of financial deregulation and liberalization allowed the BSP to rethink the usefulness of its existing monetary framework. Under the monetary targeting framework, BSP uses M3 as its intermediate target for monetary policy and base money as its operating target. Whether the BSP can actually achieve the ultimate target of monetary policy---which are inflation, growth and employment---crucially depends on the predictability and stability governing the relationship between these variables and money, and the ability of the BSP to control broader monetary aggregates.

Recognizing the possible impacts of rapid financial innovations introduced in the economy, the BSP carefully assessed its position and modified its approach to monetary policy in 1995 putting greater emphasis on price stability over rigidly observing targets set for monetary aggregates. With hybrid approach (combination of both monetary targeting and inflation targeting) to conducting monetary policy, the BSP closely monitored movements of a wide range of key variables including interest rates, exchange rates, domestic credit and equity prices and a set of demand and supply and external economic indicators. In January 2000, the BSP approved the principle of inflation targeting and officially adopted inflation targeting as its main monetary framework two years hence.

To operationalize inflation targeting, the BSP underscored the following important elements: 1) setting up inflation range targets, with two-year target horizon, using the rate of change of `headline' consumer price index; 2) making use of sophisticated forward-looking macroeconomic inflation-forecasting model to project future inflation; 3) relying on various monetary policy instruments (e.g., policy rates, to achieve inflation targets); 4) holding periodic meetings – every six weeks – of the Monetary Board, the policy-making body of the BSP to assess macroeconomic conditions and discuss future monetary policy stance; 5) publishing quarterly reports to explain BSP's policy stance and progress in meeting inflation targets; and 6) remaining accountable to the public in case actual inflation deviates from the targets (BSP, 2006).

Average inflation from 2002 to 2006 was 5.3%. According to the official report by the BSP, inflation rates for the first-two years after the official adoption of inflation targeting are below their targets while from 2004 onwards, actual inflation rates are slightly above their targets. Supply side factors are blamed for the deviations. Average output growth over the period was 5.2%.

3 Money and Velocity: The Friedmanite Proposal

The past two decades and the current one have witnessed a literal flood of econometric literature dealing with Friedman's proposal on the links between money and velocity. Expressed in broad terms, the literature has dealt with the following overlapping proposal:

"An exceptional volatility of monetary growth increases the degree of perceived uncertainty and thereby increases the demand for money" (Friedman, 1984).

This hypothesis was a subject of much debate across academic and policy circles when a decline in the income velocity of money, derived from the Quantity Theory of Money equation, was observed. Milton Friedman (1983, 1984) argued that the decline in M1 velocity that began in the United States in 1982 was due to an increase of the variability of the growth rate of money supply. An increase in money supply implies a rise of uncertainty, which leads to a rise in money demand for precautionary reasons and hence to a decline in investment (as the increase of money demand implies a decline in the demand for financial assets). Ceteris paribus, income velocity should decrease. Hence, an active monetary policy is not appropriate as its effects on activity are uncertain and may even be harmful[1].

Earlier accounts supporting Friedman's hypothesis include Hall and Noble's (1987) suggestion that money growth volatility in the US, proxied by eight-quarter lagged moving standard deviation of money, causes changes in velocity, in the sense of Granger. Other studies questioned the robustness of the specification of the model used by Hall and Noble; they proposed, instead, that there may be other causal influences on velocity possibly due to structural change in the short-run (Brocato & Smith, 1989) including financial deregulation (Mehra, 1987; 1989), financial innovation (Thornton & Molyneux, 1995) and disinflation. The instability of the relationship implies that there exists a shift in the process generating velocity rather than mere variability in the determinants of income velocity (McMillin, 1991). A more recent assessment of this configuration points to the determinants of velocity driving the instability (Chowdhury & Wheeler, 1999).

[1] From a theoretical point of view, the Friedman’s hypothesis is based on the fact that the income effect is higher than the substitution effect. The substitution effect occurs when an increase of the variability of money growth rate implies a rise of demand for foreign currency, considered as a perfect substitute of money. When substitution effect dominates, income velocity increases.

Attempts that lend support to the hypothesis were found in both developed economies (Chowdhury, 1988; Lynch & Ewing, 1995; McCornac, 1994) and emerging economies (Baliamoune-Lutz & Haughton, 2004). In Malaysia, for instance, the hypothesis is found to be robust for M1 and M2 such that much of the volatility of money growth was attributed to the financial liberalization process (Choong, Law, Poon, & Yusop, 2004). Still, others argue in favor of "little general applicability" of the hypothesis (Bordes, 1990; Thornton, 1995; Payne, 1992) or no causal relationship at all (Arize, 1993), at least for the major industrialized economies. Finally, Friedman's hypothesis appears to be moot for narrower definitions of money, like in UK (Thornton, 1991) and Egypt (Baliamoune-Lutz & Haughton, 2004). In the Philippines, no known work has been done yet on this topic and this serves as a motivation for this paper.

This study employs a traditional Granger-causality test. However, this paper is different from previous literature, with the exception of Serletis and Shahmoradi (2006), as the variability of money growth is computed using a Generalised Autoregressive Conditional Heteroskedasticity (GARCH) set up (Bollerslev, 1986). One particular novelty of the model is that it avoids the ad hoc nature of calculating variability of money growth traditionally used in the literature that is based on moving standard deviation of the series. Instead, the GARCH model generates a stochastic volatility process of money (M1) growth, after controlling for other covariates that have potential influence on the money growth variability, e.g., output growth and interest rate rates (*see also* Serletis & Shahmoradi, 2006). Its great degree of flexibility allowed this paper to structure the conditional variance to accommodate the effect of high money growth translating into high money growth variability (see Figures 1 and 2). Moreover, structural breaks in the income velocity of M1 are taken into account as these shifts can imply non-stationarity of the series. If found stationary, after accounting for the breaks in detrending the series, cointegration techniques are not relevant and a simple Granger causality test can be implemented.

4 Empirical Analysis

Data series used in the foregoing analysis come from the CEIC database. The money measure employed is M1, consisting of domestic currency in circulation and domestic money banks demand deposits, which is a good proxy for money as medium of exchange. The choice of M1 as our reference of analysis is driven by our curiosity whether there is really cogent evidence in favor of the collapse of Friedman's volatility hypothesis for narrow definitions of money as some previous studies claim. Our full-sample consists of quarterly series from 1982:Q2 to 2006:Q4. Data for M1, nominal and real GDP, and income velocity are adjusted for seasonality using multiplicative moving average.

Figure 1. M1 Growth Rate and Income Velocity

We conduct a series of stationarity test for our data. The model rests upon the stationarity of the series. Where a series is not stationary, the relationships derived in the estimation procedures are spurious (Granger & Newbold, 1974). Two criteria to test for non-stationarity are employed: KPSS and DF-GLS. KPSS (Kwiatkowski, Phillips, Schmidt, & Shin, 1992) tests for the null hypothesis of stationary series against the alternative of non-stationarity while the Dickey-Fuller with GLS de-trending (Elliott, Rothenberg & Stock, 1996) tests for the null hypothesis of non-stationarity against the alternative of stationarity. Careful inspection of our data series suggests that, in order to correctly specify our tests, only the drift term should be included in the null and alternative hypotheses for growth rate of M1. On the other hand, both the drift and time trend should be included for the income velocity (log) series. Table 1 displays the results. M1 growth rate is a stationary series using KPSS and DF-GLS criteria. Income velocity is non-stationary using KPSS and DF-GLS.

Table 1. KPSS and DF-GLS Unit Root Tests

Variables	KPSS	DF-GL
Income velocity of M1 (log)		
With drift and time trend	0.149**	-2.502
With drift but no time trend	1.237***	-0.638
M1 growth rate		
With drift and time trend	0.056	-7.929***
With drift but no time trend	0.087	-1.700*
Interest rate differentials		
With drift and time trend	0.035	-6.710***
With drift but no time trend	0.047	-6.623***
Output growth		
With drift and time trend	0.117	-2.606
With drift but no time trend	0.412*	-0.819
Income velocity of M1 (log)		
With drift and time trend	0.149**	-2.502
With drift but no time trend		

*Note: ***, **, * respectively indicates rejection of the null at 1%, 5% and 10% significance levels.*

The non-stationarity of log of income velocity of M1 implies that innovations have persistent effects. However, it is also possible that the trend is not correctly specified. In particular, the persistence of a time series is influenced by infrequent permanent shocks due to rare economic events. Ignoring these shifts in the M1 income velocity generating mechanism may at best distort conventional unit-root tests. It may be fitting then to isolate these rare occurrences, or structural breaks, that significantly altered the behavior of the time series permanently (Perron, 1989).

Bordes, Clerc and Marimoutou (2007) show that the velocity of money in the Euro area is affected by structural breaks both in the intercept and trend. For example, structural change in the financial system seems to explain the breakdown of money holdings in industrial countries (Ferrero, Nobili & Passiglia, 2007).

Table 2. Bai-Perron Results for M1 Velocity Structural Change Model (1982Q2-2006Q4)

	Number of breaks	Suggested breaks	Sup*FT* test	UDmax/WDmax tests
Velocity of M1	BIC: 3 LWZ: 2	1985Q1 1988Q2 1999Q2	Sup*FT* (1) = 0.00 Sup*FT* (2) = 46622** Sup*FT* (3) =668177**	UDmax= 4761499** WDmax= 7810403**

*Note: Break dates are based on minimized sum of squares. ** (*) indicates significance at 1% (resp. 5%) level.*
The following is the interpretation for M1 income velocity with constant and trend, where q stands for the number of regressors which can change overtime:
The supF test for 0 versus 1.0000 breaks (scaled by q) is: 0.0000
The supF test for 0 versus 2.0000 breaks (scaled by q) is: 46622.4172
The supF test for 0 versus 3.0000 breaks (scaled by q) is: 668177.2922

A recent technique that endogenously determines multiple structural breaks and corresponding estimates of the break dates was developed by Bai and Peron (1998, 2003). The BP technique considers a partial structural change model such that not all parameters of the model are subject to shifts and, hence, avoids the penalty of losing the number of degrees of freedom, a conventional pitfall of pure structural change model especially when more than one break exist. It is implemented using a sequential algorithm for estimating models with unknown number of structural breaks and yields consistent estimates of the breakpoints. We consider five as the maximum number of break points. We then determine the location of the breaks by computing the global minimum of the sum-of-squared residuals. We identify the optimal number of breaks both through the Akaike Information and Schwarz (BIC) criteria. The amount of trimming is specified in Table 2.

Table 2 suggests that significant breaks occurred around 1985, 1988 and 1999[2] and this likely supports earlier findings on instability of income velocity of money in the economy that led to Bangko Sentral ng Pilipinas' adoption of inflation targeting in place of monetary targeting in 2002 (Guinigundo, 2005) and a breakdown of equilibrium relationship between logs of M1 and price level as a result of the Asian financial crisis (Gochoco-Bautista, 2006).

The evidence for log of M1 income velocity (v_t) as an integrated process with broken trends shows a strong non-reversible tendency of the series. Therefore, it seems appropriate to remove the deterministic component of the variable prior to investigating its stochastic nature. In detrending the series, the choice of the specification of deterministic trend is crucial since the deterministic component can distort test results for stationarity. Including a single linear trend can impose severe penalty as this assumes a constant growth rate of the series. Hence, we allow the deterministic component of the series to be driven by a simple linear time trend (*trend*). We introduce time dummy variables (D_i) that correspond to the three structural breaks identified earlier using the BP procedure and their possible interaction with the time trend:

$$v_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i D_i + \beta_0 trend + \sum_{i=1}^{q} \beta_i (D_i \times trend) + e_t \qquad (1)$$

$$where\ D_i = \begin{cases} 1 & \text{when } t \in T = \{1985Q1, 1988Q2, 1999Q2\} \\ 0 & \text{otherwise} \end{cases}$$

Estimating Equation 1 using ordinary least squares permits us to generate a detrended series for log of M1 income velocity ($\hat{v}_t$). Further, the detrended series appears to be stationary (test results not presented here) which allows its use as a valid regressor to analyze Friedman's volatility hypothesis later in this section.

Table 3. Coefficient Estimates (Detrending)

Variables	Coefficient
Constant	0.1737***
Dummy1985Q1 (D_1)	0.5799***
Dummy1988Q2 (D_2)	-0.2122**
Dummy1999Q2 (D_3)	-0.7572***
Time trend (*trend*)	0.0134***
D_1 x *trend*	-0.0358***
D_2 x *trend*	0.0123***
D_3 x *trend*	0.0100***

*Note: ***, **, * respectively indicates rejection of the null at 1%, 5% and 10% significance levels.*

Results in Table 3 suggest that the three structural breaks significantly affected both the constant and the velocity trend. Notably, the declining trend velocity that is exhibited by negative effect of the dummy on the slope during the period 1985Q1-1988Q1 reflects growing monetization of the

[2] Following Wang (2006), the BIC criterion is preferred to the AIC criterion.

economy (Gochoco-Bautista, 2006). Towards the latter part of the 1980s, the full impact of financial deepening in the economy on velocity, which introduced financial and technological innovations to enhance transactions including Automated Teller Machines (ATM) and IT, may have been offset by relatively high degree of currency substitution (Yap, 2001) as the economy embraced foreign exchange and capital liberalization in the early 1990s to attract untapped capital from abroad[3]. Interestingly, currency substitution came into force when the Uniform Currency Act, that recognizes the domestic currency or peso as the only legal tender in settling contractual obligations, was abolished in June 1996. It comes as no surprise that structural break in 1988 pulled down only the intercept term and not the slope of trend during the period 1988Q2-1999Q1, probably due to the dominating effect of currency substitution in increasing income velocity of M1. Finally, the effect of the Asian financial crisis in 1998 and the worldwide IT bubble in the early part of 2000s to create temporary supply shocks in the economy may have restrained income velocity to depress the constant by a relatively large amount but not enough to sufficiently reverse the sign of the slope of trend velocity during 1999Q2-2006Q4.

4.1 Extracting conditional volatility of M1 growth rate

To calculate the variability of money growth, a GARCH (*p*,*q*) model is used. The model assumes that the persistence in the dynamics comes from the conditional second moment of the series. Consider a univariate regression with GARCH (*p*,*q*) effects:

$$\begin{aligned} m_t &= \gamma_0 + \gamma(L)m_t + X\beta + \varepsilon_t \;\; ; \;\; \varepsilon_t \,|\Omega_{t-1} \sim N(0,\sigma_t^2) \\ \sigma_t^2 &= \omega_0 + \alpha(L)\varepsilon_t^2 + \delta(L)\sigma_t^2 + \omega_1 m_t \end{aligned} \tag{2}$$

$$\alpha(L) = \sum_{i=1}^{q} \alpha_i L^i \;\; ; \;\; \delta(L) = \sum_{i=1}^{p} \delta_i L^i \;\; ; \;\; \gamma(L) = \sum_{i=1}^{v} \gamma_i L^i$$

where m_t is money (M1) supply growth; X is a vector of covariates that influence m_t such as short-run nominal interest rate and output growth; ε_t, error term; $\Omega_{t-1,}$ available information set in period t–1; σ_t^2 conditional variance which depends linearly on past squared-error terms and past variances; and $\omega_0 > 0, \alpha_i \geq 0, \delta_i \geq 0;\ \gamma_0, \gamma_i, \beta_i \omega_1 \forall i$ are parameters to be estimated.

Lack of complete data series on T-bill rate (90 days) covering our full sample period confined this research to use weighted average of lending rate of ten Philippine commercial banks as a proxy for short-term nominal interest rate. The use of weighted average of lending rate of ten commercial banks may cast doubts if it really reflects the opportunity cost of holding money. Previous literature points to the existence of undue concentration of banking industry dominated by big players in the market, especially in commercial banking, during the 1970s and 1980s (Tan, 1991; Milo, 2000). Nevertheless, given this limitation in the model, the interest rate variable used in this paper and the T-bill rate exhibit high and positive correlation where data availability permits. Unit-root tests show that interest is a non-stationary process and, hence, the first order difference (which is stationary) is used to control its influence on M1 growth, which is a stationary series. While Table 1 cannot ascertain whether real GDP growth rate is a stationary process, Equation 2 is implemented by including the level of real GDP growth rate.

The optimal number of lags is obtained by using the Schwarz criterion and, in this case, it is one. The mean equation in Equation 2 thus follows an AR(1) process. The conditional variance is determined by a GARCH(1,1) model as a standard model of volatility in the literature and includes contemporaneous M1 growth as one of its regressors, following Thornton (2006).

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[3] Currency substitution may also arise when the economy is plagued by high and variable inflation rate to discourage the use of domestic currency as a medium of exchange. But, according to Yap (2001), given stable macroeconomic conditions in the economy, currency substitution in the Philippines is brought by institutional change, e.g., capital liberalization. Either way, currency substitution is likely to increase income velocity of money.

From Table 4, output growth has the expected positive and significant effect on M1 growth, although only at 10% significance level. The interest rate does have the expected sign and is insignificant. While not all of the parameters in the conditional variance are positive, the GARCH component is nevertheless insignificant. Significance of M1 growth in the conditional variance equation implies positive relationship between money growth rate and money growth volatility. We proceed to calculating M1 growth volatility as the estimated conditional variability defined in equation 2. Unit root test is applied to the estimated conditional variability (results not presented here) and confirms that, indeed, it is stationary using DF-GLS criterion.

Table 4. GARCH(1,1) Model of M1 Growth Volatility

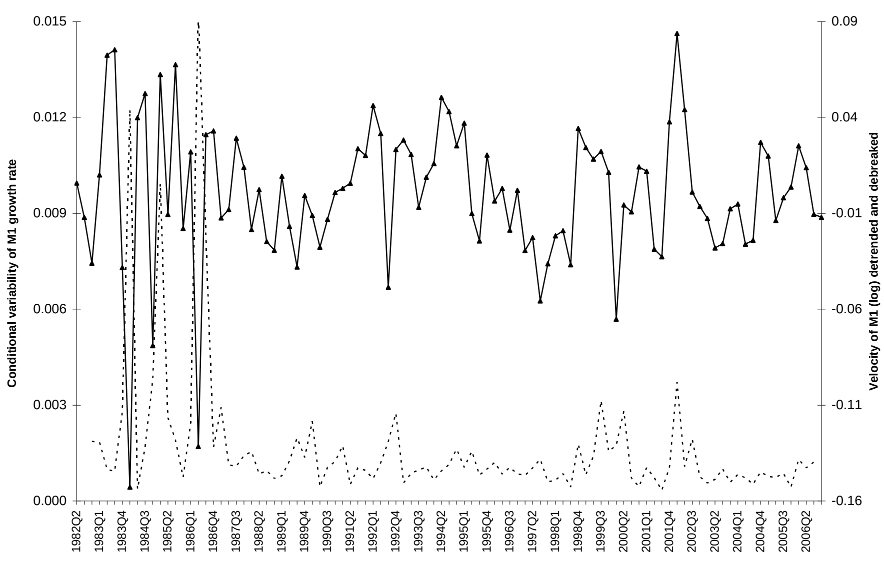
Variables	Coefficient
I. Mean Equation	
Constant	0.0297***
Interest rate (1st difference)	0.0044
Output growth	0.1596*
M1 growth (-1)	0.0471
II. Conditional Variance Equation	
Constant	0.0005**
Residual (-1) or ε^2_{t-1}	0.5317**
GARCH (-1) or σ^2_{t-1}	-0.0530
M1 growth	0.0097***

*Note: ***, **, * respectively indicates rejection of the null at 1%, 5% and 10% significance levels.*

4.2 Testing the Friedman's volatility hypothesis

Using the detrended series of log of M1 income velocity (given by Equation 1) and M1 growth volatility (given by Equation 2) which are each integrated of order zero, I(0), ordinary least square can be performed to test whether the parameter has the expected sign (see Figure 2). Passing the standard diagnostic tests for normality, autocorrelation and heteroskedasticity, result in Table 5 confirms the significantly negative relationship between income velocity and money growth volatility.

Figure 2. Conditional Variability of M1 Growth and Income Velocity (log, detrended)



Finally, before Friedman's hypothesis can be tested in the Philippines, the direction of causality needs to be formally tested. Granger and Sim's tests (Granger, 1969; Sims, 1972) are employed to determine the causality in the Granger sense. If the volatility of M1 growth Granger-causes income velocity, it means that, conditional on information in lagged income velocity, lagged volatility of money growth does help to forecast contemporaneous income velocity. Of course, the opposite direction is also possible in which case the validity of Friedman's volatility hypothesis is questioned. Our Granger causality test is driven by the Schwarz criterion to determine the optimal number of lags as rejection of the null hypothesis is very sensitive to the number of lags included in the process.

Table 5. OLS for M1 Income Velocity (Detrended)

Variables		**Coefficient**
Constant		0.0099**
M1 growth volatility		-5.7842***
Adjusted R^2	0.1122	
F-stat	13.0129***	
Jarque-Bera	4.7287*	
Breusch-Godfrey	0.9546	
White	39.9240***	

*Note: ***, **, * respectively indicates rejection of the null at 1%, 5% and 10% significance levels.*

Table 6. Granger-Causality Test

Variables	**Optimal number of lags**	**Likelihood ratio**	**H0 at a 5% level**
Log velocity (detrended*) does not Granger-cause variability of M1	2	0.13	Cannot reject
Variability of M1 does not Granger-cause log velocity (detrended)	6	29.95	Reject

Note: The optimal number of lags is determined by using the Schwarz (BIC) criterion.
**The Bai-Perron (1998; 2003) procedure is applied to account for multiple trend breaks.*

With the lag of two quarters, the null hypothesis that velocity does not Granger-cause M1 growth volatility is not rejected at 5% significance (see Table 6). On the other hand, with optimal lag of six quarters, the null hypothesis that M1 growth volatility does not Granger-cause income velocity is rejected at 5%. Hence, the Friedman's hypothesis is verified.

5 Conclusion

Using data from the Philippines, this paper provides strong evidence in favor of Friedman's hypothesis on uncertainty in money supply and money demand. Taking into account possible structural breaks in velocity, our study shows that high variability of money growth is linked with a diminution in the income velocity of narrow definitions of money. Moreover, high level of inflation Granger-causes a high variability of inflation, which, to a certain extent, Granger-causes a diminution of the potential output.

Hence, the higher level of inflation that characterized the Philippines relative to other East Asian economies seems to be one of the main explanations of shocks in the 1980's and the 1990's. This further explains the weaker macroeconomic performance of the economy during this period.

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