CHAPTER 12

Monetary Policy in Taiwan: The Implications of Liquidity

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12.1 INTRODUCTION

With apologies to Mark Twain, reporting practices of modern central banks beg the expression, "Lies, damn lies *and monetary data*." Although demonstrably wrong in their construction, simple-sum measures of the money stock continue to be the official data published by most central banks around the world and are used to guide policy decisions whenever monetary quantity variables are part of that process. Moreover, "whether by tradition or ease of access, academic research also persists in using simple sum monetary quantity aggregates to test hypotheses about the effects of money on economic activity" (Belongia, 2000, Chapter 1, p. 1).

We are confident in our belief that conventional wisdom changes only slowly. As Belongia (2000) states, p. 1, little more that 40 years have passed since Friedman and Schwartz, in *Monetary Statistics of the United States* (1970) ended their discussion of the potential usefulness of weighted monetary aggregates by concluding that, so far there is only the barest of answers [of how to do it properly], p. 152. Papers by Andersson and Jordan (1968) reporting a primary linkage between money and nominal spending (and the ineffectiveness of fiscal actions) marked a mid-point of sweeping change in orthodox economics. By the end of the 1970s, the demand for money appeared to be a stable function of a few key macroeconomic variables, changes in the supply of money appeared to have significant short-run effects on output, and inflation appeared to be closely related to the trend rate of money growth (see, e.g., Belongia, 1996 for more details). Many economists, however, believe that the link between monetary growth and inflation has weakened over the last two decades. This is thought to be due in part to rapid innovations in the financial sector, see Crowder (1998). By the mid 1980s, it had become apparent throughout the developed world that increased competition within the banking sector and the computerization of the financial world was beginning to have substantial effects on the relative user costs (prices) of bank liabilities and the ever-increasing array of substitutes for them. It is now well established that the substantial

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financial innovations of the 1980s introduced instability into estimated demand functions for broad money. It was largely for this reason that the case for monetary targeting was discredited (see, e.g., Friedman, 1996).

Recent empirical work (Belongia and Chrystal, 1991; Drake and Chrystal, 1994, 1997) puts forward the view that the breakdown in the demand for money function during the 1980s outlined above is mainly attributable to the use of conventional simple sum aggregates that assume the assets that comprise the aggregate are perfect substitutes. It is now widely acknowledged that the simple sum procedure traditionally used by central banks to aggregate monetary assets is inappropriate in the absence of perfect substitutability between the component assets (see, e.g., Drake et al., 2000). Simply summing the constituent component assets to form the aggregate creates flawed index numbers because aggregating any set of commodities with equal weights implies that each good is a perfect substitute for every other good in the group.

The simple sum aggregation method will lead to particularly severe mismeasurement of monetary services during periods of significant financial development, since it is during these times that interest rate yields on the various components of broad money are changing most over time. The introduction of new instruments and technological progress in making transactions has almost certainly had diverse effects on the productivity and liquidity of monetary assets; thus, the use of equal weights for the user costs of the constituent component assets is wholly inappropriate during periods of high financial innovation.

Barnett (1980) first applied index number formulation devised by Divisia (1925) to the problem of measuring a monetary price and quantity aggregate. A Divisia quantity index of money measures the flow of monetary services from a stock of money holdings. The underlying assumption is that individuals hold monetary assets both for the liquidity services they provide and the return they yield. Thus, monetary assets that yield return are the joint product of a transaction vehicle and investment asset. Therefore, any proper measurement of the monetary service flow must account for the investment service provided by component assets which cannot in any economic sence be considered money. The Divisia index belongs to a class of superlative indices that provide a third-order approximation of the first difference of any unknown aggregator function (see Diewert, 1976, 1978).

The Divisia index has its roots firmly based in microeconomic aggregation theory and statistical index number theory. Belongia (2000) provide a survey of the relevant literature, while Fisher et al. (1993), and more recently, Hancock (2005) review the construction of Divisia indices and associated problems. An empirically weighted monetary aggregate has been developed for the UK by Drake and Mills (2005) and extensions of Divisia to incorporate the risk of assets have been derived by Barnett and Liu (2000) for the USA and Elger and Binner (2004) for the UK.

The financial system of an advanced economy provides an array of monetary assets, which vary considerably in their ability to facilitate transactions, term to maturity, and rates of return. In other words, monetary assets differ in terms of the kinds of monetary services they provide, their ability to provide transactions services, and their ability to serve as stores of value. A Divisia index formulation is able to overcome the drawbacks of the simple sum provided the marginal rates of substitution between all asset pairs within the aggregate are independent of quantities consumed of goods not in the aggregate; that is, as above, the asset represents a weakly separable commodity group.

The Bank of Taiwan long ago realized the importance of the theoretical developments in the monetary aggregation literature (Shih, 2000, p. 227). The principles outlined in the monetary aggregation literature have gained widespread acceptance among economists as well as practitioners around the world. Lucas (2000, p. 271), for example, considers US data and states that "I share the widely held opinion that M1 is too narrow an aggregate for this period [the 1990s], and I think that the Divisia approach offers much the best prospects for resolving the difficulty." Seminal work on the performance of UK household sector money was conducted by Drake and Chrystal (1997), who concluded that there "was a stable underlying demand for monetary assets on the part of the UK household sector, when Divisia aggregates are used, for a period stretching from the mid-1970s to the early 1990s—a period of substantial change in the UK financial system." In a later study using a UK MSI (Divisia) aggregate, Drake et al. (2000) concluded that "the behavior of Divisia monetary aggregates be taken seriously by both policy-makers and academic economists who use 'money' in their research." Recent evidence using a Euro Divisia further finds that the Divisia index outperforms the Simple Sum index when evaluated in a nonlinear framework (see Binner et al., 2008 for details).

Our hypothesis developed over a series of studies and summarized in Gazely and Binner (2000) is that measures of money constructed using the Divisia index number formulation are superior indicators of monetary conditions when compared to their simple sum counterparts. This hypothesis is reinforced by a growing body of evidence from empirical studies around the world which demonstrate that weighted index number measures may be able to overcome the drawbacks of the simple sum. Ultimately, such evidence could reinstate money as a meaningful macroeconomic variable, which should not be ignored when setting policy.

We offer an exploratory study of the relevance of the Divisia monetary aggregate for Taiwan over the period 1970 to date. We explore the potential of Divisia monetary aggregates in a small macroeconomic model, using vector autoregressive models. The results of our simple monetary experiment using vector autoregressions to evaluate the link between money growth and inflation are presented in Section 12.4 while Section 12.5 concludes and offers suggestions for future research.

12.2 FINANCIAL INNOVATION AND THE DIVISIA MONETARY AGGREGATE IN TAIWAN

The banking system in Taiwan was heavily regulated by the Central Bank and the Ministry of Finance until September 1989, which saw the introduction of the revised Banking Law. At the beginning of the 1980s, drastic economic, social, and political changes took place creating a long-term macroeconomic imbalance. Rising oil prices caused consumer prices to rise by 16.3% in 1981, followed by a period of near-zero inflation in the mid-1980s, although from the 1990s onwards inflation has fluctuated around 5%. The control of inflation has not been the mainstay of recent economic policy in Taiwan, in contrast to the experience of the western world. Rather, policy has focused more on achieving balanced economic and social development.

Major financial liberalization measures were implemented in Taiwan in the late 1980s. In July 1987, trade-related foreign exchange controls were abolished and capital flow-related foreign exchange controls greatly relaxed. The entry of new securities firms was permitted in January 1988, with the result that the number of securities firms increased from 60 to 150 within the first year (Shih, 2000, p. 227). The limit on daily fluctuations in stock prices was raised from 3% to 5% in 1988 and to 7% the following year. In December 1990, foreign institutional investors were allowed to invest directly in the local stock market. In respect of the banking sector, the revised Banking Law in September 1989 resulted in bank interest rates on deposits and loans being completely liberalized and new private commercial banks were allowed to be established. As of the end of 1993, 16 new private banks had begun operating.

This financial revolution in Taiwan over the last three decades has yielded new types of financial assets and liabilities and new markets have been created, as outlined above. These changes have manifested themselves throughout the global economy in the emergence of competition and merger activity between the traditional commercial banks and previously distinct financial institutions. For example, the banks introduced interest payments on formerly non-interest bearing cheque accounts together with a wide range of new financial products, stimulating product innovation.

Along with the process of price and entry deregulation, local financial markets expanded rapidly and financial price variables (such as interest rates, exchange rates, and stock prices) became flexible and increasingly sensitive to market conditions. The resultant volatility in these financial prices in the second half of the 1980s which was unparalleled in Taiwanese post-Second World War history, deeply affected the portfolio behavior of households and firms. Consequently, the narrowly defined monetary aggregate, M1B, which is vulnerable to deposit-shift behavior, fluctuated significantly, Shih (2000, p. 227).

Faced with the increasing instability of money demand for M1B, in 1990 the central bank replaced M1B with the broadly defined monetary aggregate M2 as the intermediate target variable of monetary policy. Since differing degrees of monetary services are provided by the component assets under the definition of the broad aggregate, M2, this shift to M2 as a policy target has aroused concern as to whether the traditional M2, which sums the balances of component assets with equal weights, can serve as an appropriate measure of monetary service flows in society. One solution to this is to apply a Divisia weighting strategy to the component assets to create admissible monetary aggregates.

We explore the econometric performance of Divisia indices in Taiwan, extending the work of Shih (2000) and Binner et al. (2002). Our objective is to provide an updated picture of the policy relevance of Divisia monetary aggregates and to offer insights into how liquidity measurement and management can be enhanced in the future across different asset risk classes and different risk regimes as a comparative approach to obtain valuable feedback for policy implementation in Taiwan.

12.3 DATA AND METHODOLOGY

12.3.1 Divisia Aggregation

Following Anderson and Jones (2011) and Barnett (1980), we construct Divisia money using the Törnqvist-Theil discrete time approximation of the Divisia service flow index number (see Törnqvist, 1936; Theil, 1967),

$$M_t = M_{t-1} \prod_{n=1}^{N} \left(\frac{m_{n,t}}{m_{n,t-1}} \right)^{\frac{\omega_{n,t}+\omega_{n,t-1}}{2}}, \tag{12.1}$$

where $m_{n,t}$ is the quantity of monetary asset n held in period t, and

$$\omega_{n,t} = \frac{\psi_{n,t} m_{n,t}}{\sum_{i=1}^{N} \psi_{i,t} m_{i,t}} \tag{12.2}$$

is the total expenditure share on monetary asset n held in period t. The Törnqvist-Theil index is simply Simpson's rule applied to the Divisia index number.

Key to the construction of this aggregate is $\psi_{n,t}$, the user cost of monetary asset n held in period t,

$$\psi_{n,t} = \frac{R_t - r_{n,t}}{1 + R_t}, \tag{12.3}$$

which was formally derived by Barnett (1978). The user cost of a monetary asset is a function of $r_{n,t}$, which is the own rate of return on of monetary asset n held in period t, and R_t, which is the rate of return of a pure investment asset, i.e., a "benchmark asset" that provides no liquidity service. While the own rate of return on such a benchmark asset is not available as an observable series, we proxy the benchmark rate by adding a liquidity premium of 100 basis points to the maximum own rate of return of the monetary assets included in the aggregate (see, e.g., El-Shagi and Kelly (2013) for more on the construction of the benchmark rate).

12.3.2 Divisia Money and the Official Aggregates

Kelly (2009) and Kelly et al. (2011) showed that the simple sum monetary stock can be decomposed into the following two stocks

$$SSUM_t = CSM_t + ISM_t, \tag{12.4}$$

where CSM_t is the current stock of money, i.e., the present value of the contemporaneous and future monetary service flows, and ISM_t is the investment stock of money, i.e., the present value of the contemporaneous and future investment returns. Thus, simple sum aggregates conflate monetary and investment stocks.

Kelly (2009) further showed that the conflation of the monetary and investment stocks of money causes simple sum aggregates to obfuscate the dynamics of the money-interest rate relationship. To see this, Kelly examined the first derivative of each stock with respect to the return yielded by each monetary asset. Those derivatives are repeated here:

$$\frac{\partial}{\partial r_{nt}} CSM = -\frac{m_{nt}}{R_t} \quad \forall n = 1 \ldots N, \tag{12.5}$$

$$\frac{\partial}{\partial r_{nt}} ISM = \frac{m_{nt}}{R_t} \quad \forall n = 1 \ldots N. \tag{12.6}$$

Note that (12.5) and (12.6) are identical, except that they have opposite signs. Figure 12.1 demonstrates how the simple sum money stock obscures the dynamics of the monetary stock. Both the Divisia money stock (CSM), i.e., the money stock implied by the Divisia

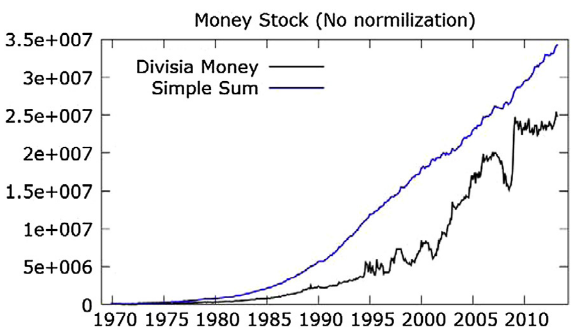

Figure 12.1 Simple sum and Divisia money stock (CSM).

service flow, and the simple sum stocks are plotted. As can be shown, simple sum is smoother and overstates the true money stock, both results are as expected given (12.4).

12.3.3 Data

In order to construct Divisia monetary aggregates for Taiwan, component assets based on the definition of M2 have been classified into the following categories provided in Table 12.1. According to the historical definitions of money in Taiwan, M2 comprises all

Table 12.1 List of Component Assets and Associated Rates of Return for Central Bank of Taiwan Monetary Aggregates

Taiwanese Central Bank Grouping	Quantity Description	Description of Interest Rate or Interest Rate Proxy
Deposit money	Currency held by the public	Interest rate is zero
	Checking accounts[a]	Interest rate is zero
	Passbook deposits	Interest rate on passbook deposits of 1st Commercial Bank
	Passbook savings deposits	Interest rate on passbook saving deposits of 1st Commercial Bank
Quasi-money	Postal savings deposits[b]	Interest rate on passbook saving deposits of Chunghwa Post Co.
	1 month to 3 year N.T. Dollar deposits by non-residents[c]	3 month interest rate on time saving deposits of Chunghwa Post Co.
	Time & savings deposits	3 month interest rate on time saving deposits of Chunghwa Post Co.
	Money market mutual funds[d]	Commercial paper rate in the primary market (31–90 days to maturity)
	Repurchase agreements[e]	Commercial paper rate in the primary market (31–90 days to maturity)
	Foreign currency deposits	3 month interest rate on US dollar deposits of 1st Commercial Bank

[a]Checking Accounts include cashier's checks, certified and traveler's checks. [b]Postal savings deposits include giro accounts, passbook savings deposits, and time savings deposits of Chunghwa Post Co. [c]Non-residents N.T. dollar deposits include demand and time deposits held by foreign non-financial institutions. [d]Money market mutual funds represents net present value of money market mutual funds, issued since October 2004, held by enterprises, individuals, and non-residents. [e]Data on represents repurchase agreements sold to enterprises and individuals by monetary institutions and Chunghwa Post Co. prior to January 1994 is not available.

assets, that is, deposit money plus Quasi-money listed here in each of the ten categories. All data are monthly and seasonally adjusted and are available from DataStream and the Central Bank of the Republic of China (Taiwan) online database, please see http://www.cbc.gov.tw/ct.asp?xItem=1869&ctNode=511&mp=2.

Unlike the earlier work of Shih (2000) we have adjusted the interest rate on foreign currency deposits as follows; before the 1990Q1, we assume the assumption of perfect foresight will be held; from the beginning of 1990Q1, we assume the assumption of Uncovered Interest Rate Parity will be held. Detailed descriptions of each component are provided in Shih (2000).

12.4 RESULTS AND DISCUSSIONS

In this section, we will demonstrate the usefulness of this new data set by applying it to a simple VAR framework inspired by the system used by Leeper and Gordon (1992) and Kelly et al. (2011).

12.4.1 Data Selection

We choose variables similar to those used in the system estimated by Leeper and Gordon (1992), Kelly et al. (2011). Variables and transformations used are as follows:

- IP The natural log of the seasonally adjusted industrial production index for Taiwan
- CPI The natural log of the seasonally adjusted consumer price index for Taiwan
- ONR The average interest rate on overnight interbank loans published by the Central Bank of the Republic of China (Taiwan)
- SSUM The natural log of the official simple sum monetary aggregate for Taiwan (seasonally adjusted)
- DIV The natural log of the Divisia liquidity aggregate for Taiwan (seasonally adjusted)

Figure 12.2 plots each of the variables used in this analysis.

12.4.2 VAR Identification

We use a block-recursive identification scheme similar to that first used by Christiano et al. (1999) and later applied to liquidity aggregation by Keating et al. (2013). Let

$$Z_t = \begin{pmatrix} X_{1t} \\ X_{2t} \\ X_{3t} \end{pmatrix} \tag{12.7}$$

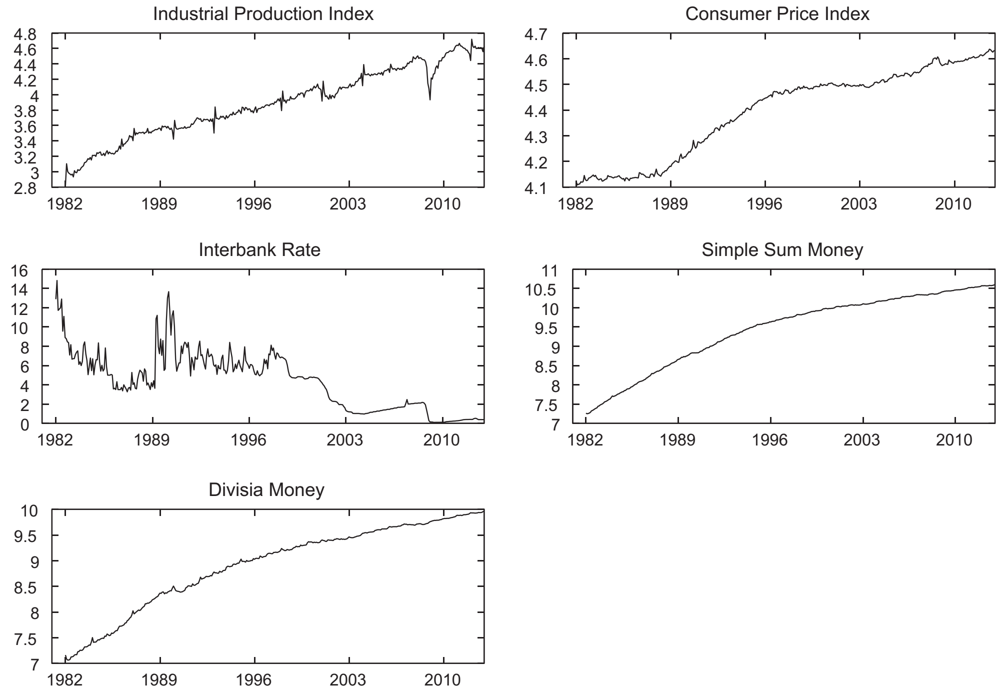

Figure 12.2 Variables included in VAR analysis. All variables except the interbank rate are log levels.

be the vector of variables for which we estimate

$$Z_t = A + B(L)Z_{t-1} + u_t, \quad u_t \sim N(0, \Sigma), \tag{12.8}$$

where we subdivide Z_t into three groups, X_{1t}, X_{2t}, and X_{3t} and follow Christiano et al. (1999) by specifying that X_{2t} contains a single variable designated to be the policy indicator. Then, as was shown by Christiano et al. (1999), the responses to the policy variable, X_{2t}, can be found by applying a Cholesky decomposition to residuals covari–ance matrix, and are invariant to the internal orderings of X_{1t}, and X_{3t}.

We begin our investigation with a standard four variable model, which we will label Model 1, where

$$Z_t = \left(IP_t, CPI_t, ONR_t, SSUM_t\right)' \tag{12.9}$$

and ONR_t is considered to be the policy variable. The impulse responses to a one–standard deviation shock to the policy variable are reported in Figure 12.3. Model 1 clearly exhibits price and output puzzles that are common to many Christiano et al. type models of monetary models.

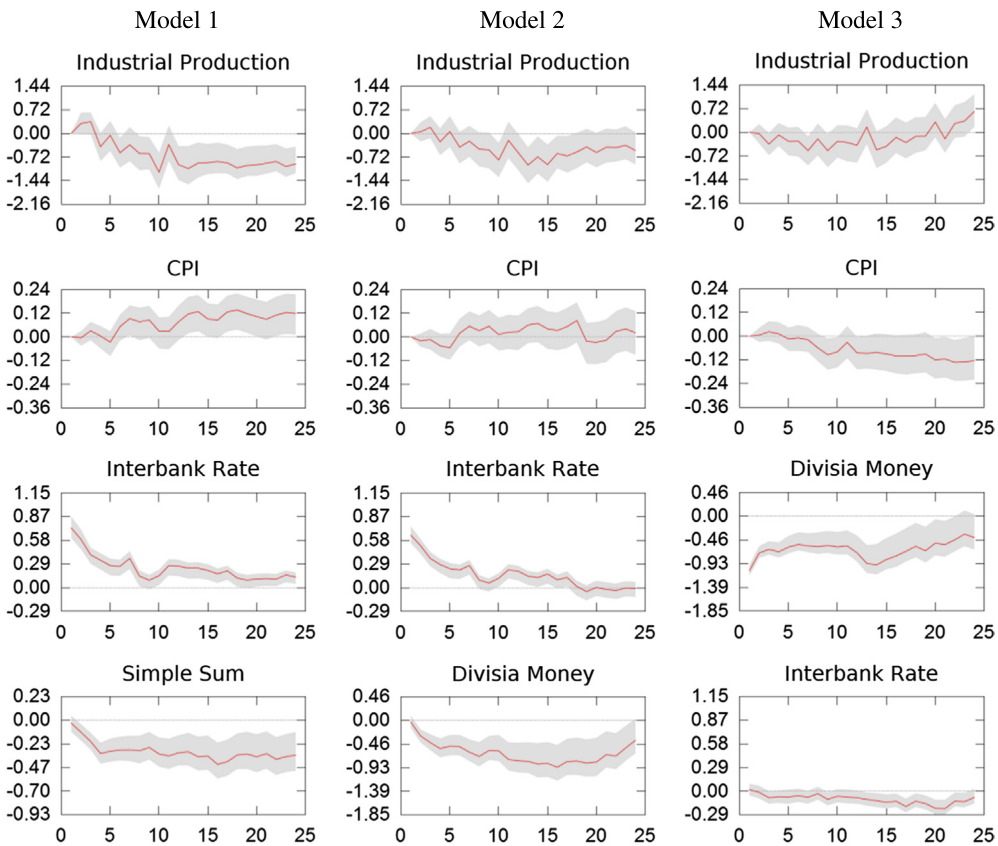

Figure 12.3 Responses to a one-standard deviation shock to the policy variable (1982m1–2013m1).

In Model 2, we replace the theoretically inferior simple sum monetary aggregate with a Divisia Money. Notice that the output puzzle in Model 2 (see Figure 12.3) is all but eliminated and the price puzzle is greatly reduced. In our final model, Model 3, the interbank rate and Divisia money are switched so that Divisia money is designated the policy indicator and the vector, Z_t, becomes

$$Z_t = \left(IP_t, CPI_t, DIV_t, ONR_t\right)'. \tag{12.10}$$

Model 3 exhibits neither a price puzzle nor an output puzzle. Thus, simply by using Divisia money as the policy indicator and removing the flawed simple sum monetary aggregates we are able to correct for two of the most vexing problems in empirical monetary policy analysis. Note, reversing the ordering of Divisia money and the interbank rate in Model 3 negates the influence of the interbank rate. We surmise that in

Table 12.2 Forecast Error Variance Decomposition for Model 3

	12 Months Ahead	24 Months Ahead	60 Months Ahead
Industrial Production	2.35	1.60	1.13
	(0.85, 6.30)	(0.75, 4.86)	(0.63, 4.32)
CPI	2.45	8.39	27.21
	(0.67, 7.23)	(3.15, 16.84)	(16.71, 39.69)
Divisia Money	60.94	47.65	30.63
	(46.82, 74.82)	(33.02, 66.28)	(17.80, 49.78)
Interbank Rate	5.98	6.82	6.90
	(1.37, 15.90)	(1.51, 17.20)	(1.68, 16.85)

Note: Numbers in parentheses are the boundaries of the associated 90% confidence interval.

this case the influence of the interbank rate has already been internalized within the construction of Divisia money.

Table 12.2 presents the forecast error variance decomposition for a policy shock in Model 3. The confidence intervals reported are calculated by bootstrapping with 10,000 repetitions. From the forecast error variance decomposition, we see that a Divisia money policy shock has a small effect on price level in the short run but much greater effect on price level in the long run. This delayed reaction to monetary policy is a fairly common result (see, e.g., Keating et al., 2013).

12.5 CONCLUSION

Our work has revisited the early questions asked by Shih (2000) and Binner et al. (2002). Because these studies have not been re-examined for over 11 years, we returned to the basic question: Is Taiwan monetary policy still linked closely with variations in money growth? More precisely, we asked whether Divisia aggregates in Taiwan could be employed productively in setting monetary policy in Taiwan.

The theoretical case for weighted monetary aggregates never has been challenged seriously. Their potential for use in practice, however, has been questioned on three fronts. First, criticisms about the choice of a benchmark rate of return and the treatment of risk when measuring monetary user costs (both of which affect index weights) suggest that such an index is subject to unknown, and presumably large, measurement error. Second, if the money stock were measured as the sum of its components, with each weighted by its share of total expenditures on monetary services, it has been alleged (without evidence) that central banks would be unable to influence the behavior of such an index in the pursuit of a monetary policy objective. Most commonly, however, the case against the construction, publication, and use of any superlative index of money has been grounded in empirical evidence showing that an official simple sum measure, in the context of a particular model, time period, or set of tests, performs as well as or better than a weighted index of the same asset collection. In sum, these perceived shortcomings have led most monetary economists and policymakers to conclude that the practical difficulties associated with finding empirical proxies for a weighted index's theoretical components and explaining the behavior of such an index to authorities who monitor central bank actions more than offset the small marginal gains (if any) from use of the index itself (Belongia, 2005).

These are matters that need to be examined in greater detail in further experimentation. Work is also on-going to enhance the construction of Divisia money in line with recent financial innovations, see, for example, Binner (2009), Binner et al. (2004), and Anderson and Jones (2011). Thus the destabilization of the money demand function may be attributed to the financial innovations and deregulations revealing flaws in the construction of monetary aggregates. It has been suggested that it might be appropriate, given the increased financial innovations in the way money is held and utilized, to include risky assets, e.g., equities, bonds, and unit trusts, into the construction of monetary aggregates (see, e.g., Barnett and Zhou, 1995; Elger and Binner, 2004). The latter estimated a demand system over both capital certain and risky assets held by the UK personal sector and showed that risky assets are substitutes for more liquid assets. Money velocity appears to depend on the degree of risk in the returns on monetary assets and the level of risk aversion. With continual innovation in financial markets, the impact on the measurement of monetary aggregates will continue to present problems in empirical studies. More sophisticated Divisia monetary aggregates have the potential to make a valuable contribution to future studies and should ideally focus on finding enhanced methods of capturing the true user cost of money by, e.g., finding enhanced ways of incorporating the risk of holding the asset and more thorough theoretical treatment of the modeling of the opportunity costs for Divisia money, including improvements on measuring the benchmark rate of return in the construction along the lines proposed by Binner et al. (2010). The relationship between monetary policy and long-term interest rates is currently in hot debate, see, e.g., Beckworth et al. (2012), and of great concern to proponents of Divisia money where the role of the Divisia price dual is under—researched and neglected, Belongia (2005); and hence a natural topic for further investigation. Future models should also make full use of the relevant theory, as emphasized by Belongia and Ireland (2012). We echo Carlstrom and Fuerst (2004) who state "…we think the current de-emphasis on the role of money may have gone too far. It is important to think seriously about the role of money and how money affects optimal policy." In a similar vein, the former Governor of the Bank of England King (2002) stated "My own belief is that the absence of money in the standard models which economists use will cause problems in future, and that there will be profitable developments from future research into the way in which money affects risk premia and economic behavior more generally. Money, I conjecture, will regain an important place in the conversation of economists."

In keeping with Barnett and Chauvet (2011), we conclude that the use of simple sum monetary aggregates is indefensible in a modern economy. These are matters that need to be examined in greater detail in further experimentation. Taken together, our results indicate that future research into improved constructions of monetary aggregates is promising and is a worthwhile route to pursue.

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