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THE INFORMATION CONTENT OF ALTERNATIVE MONETARY AGGREGATES: SIMPLE-SUM VERSUS DIVISIA MONEY IN SELECTED ASIAN COUNTRIES

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The use of Divisia monetary aggregate has been proposed in the economic literature to take into account the different degrees of liquidity of the interest-bearing financial assets included in defining 'money'. Despite the theoretical implication of the Divisia approach as an appropriate measurement of monetary services, the investigation has been mostly limited to developed countries. In this paper, the approach is applied to Asian monetary aggregates; the performance of the Divisia monetary aggregates together with its counterpart, the conventional Simple-sum aggregates, were then tested for their information content about national income using Granger-causality technique. Our results suggest that there is a role for Divisia monetary aggregate as intermediate indicator for policy purposes in the 'deregulated' Asian economies.

1. Introduction

The question of the appropriate empirical definition of money is one of the most debatable and unsettled issues in economics. Proponents of the medium of exchange function of money prefer the narrow concept of money which includes currency and demand deposits. On the other hand, the proponents of the store of value of money favor a broader concept of money which includes currency, demand deposits, and other interest-bearing financial assets in the financial system. In fact, monetary authorities all over the world have used alternative measures of money with respect to both approaches to defining money: the medium of exchange and store of value approaches. A recent survey by Kumah (1989) indicates that in general, the measurement of money used by

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monetary authorities for over 150 countries is limited to M1, M2, and M3, depending on the level of development or monetization of the financial system.

Gurley and Shaw (1960) argue that as the financial sector develops, new financial intermediaries emerge, offering varieties of interest-bearing financial assets with various maturity dates, and these financial assets should be added as components of money, giving a broader concept of monetary aggregates. Kumah (1989) observes that this has been the trend for the countries surveyed where broader measures of money are emphasized. However, more recently, the practice of adding the components of financial assets together without appropriately taking into consideration the weight of each asset's component has been criticized by Barnett (1980). According to Barnett, the traditional "simple-sum" monetary aggregates are calculated on the assumption that their components receive equal weights of one and are therefore considered to be perfect substitutes. This would mean that the elasticity of substitution between any pair of components is infinite. This is contrary to the voluminous studies existing in the literature. A survey by Fiege and Pearce (1977) on sixteen econometric studies on the substitutability of money and interest-bearing financial assets revealed that financial assets are less than perfect substitutes. They argued that each monetary asset has a certain degree of 'moneyness' associated with it. An important conclusion from these studies is that in monetary aggregation, it is not which assets are to be included in the measure of money stock which is important, but rather how much of each monetary asset is to be included. This points to the conclusion that each component should be given a different weight when adding the various components of financial assets to arrive at the official monetary aggregates.

Barnett (1980) goes further in pointing out that the simple-sum monetary aggregate is an incorrect measurement of the flow of monetary services. For example, in determining the services of the transportation sector, it is illogical to add the physical units of trains, taxis, buses to come up with an aggregate flow of transportation services. This is inconsistent with economic theory. A meaningful economic measure would be a weighted-sum aggregate, with weights reflecting relevant value-shares. The same principle ought to apply to monetary ag-

gregation. Barnett offers the Divisia monetary aggregate as an alternative to the simple-sum aggregate. The divisia aggregate was derived theoretically from economic aggregation theory and first-order conditions for utility optimization and has been found to be appropriate to measure the flow of monetary services of a country.[1]

The most important contribution of divisia monetary measurement is towards an appropriate indicator for monetary policy purposes. Barnett and his associates have emphasized that the simple-sum measure will badly distort monetary aggregates. Since the conventional monetary aggregates are 'accounting' measures, they are not suitable to measure 'money is what money does,' that is, providing services to the holder. Friedman and Schwartz (1970, pp. 151-152) observe that, "This (simple summation) procedure is a very special case of the more general approach discussed earlier. In brief, the general approach consists of regarding each asset as a joint product having different degrees of 'moneyness,' and defining the quantity of money as the weighted sum of the aggregate value of all assets, the weights for individual assets varying from zero to unity with a weight of unity assigned to that asset or assets regarded as having the largest quantity of 'moneyness' per dollar of aggregate value. The procedure we have followed implies that all weights are either zero or unity. The more general approach has been suggested frequently but experimented with only occasionally. We conjecture that this approach deserves and will get much more attention than it has so far received."

Earlier, Fisher (1922, p. 29) points out that, "...the simple arithmetic average produces one of the very worst of index numbers, and if this book has no effect than to lead to total abandonment of the simple arithmetic type of index number, it will have served a useful purpose." Fisher further strongly advises that this index should not be used under any circumstances because it possessed two undesirable properties—'bias and freakishness.'

Indeed, the early 1980s witnessed a growing interest in the concept of weighted monetary aggregates which was first inspired by an

[1] For a detailed discussion on the theoretical background of Divisia aggregates see Barnett (1980, 1990).

early work by Chetty (1969). Apart from Chetty (1969), other alternative weighted monetary aggregates were proposed by Roper and Turnovsky (1980), Spindt (1985), Rotemberg, et al. (1995), Barnett (1980), and more recently, Feldstein and Stock (1994).[2] However, in most empirical studies, Barnett's (1980) Divisia aggregate has emerged as the most popular approach adopted in the literature. In these studies, the relative performance of the divisia aggregates is compared to the conventional simple-sum aggregates in order to evaluate whether the former are a better monetary indicator than the latter. This is important because if an aggregate is found to have a closer and more predictable link to economic activity, it could be useful for monetary policy purposes.

In the 1980s, most developed countries abandoned their monetary targeting[3] due to financial innovation which has made the relationship between money (Simple sum) and income unpredictable. However, the unstable relationship between money and income found by previous influential studies has been questioned recently. Studies using Divisia aggregates alter significantly the conclusion of instability between money and income made by previous studies. Studies by Swofford and Whitney (1991), and Chou (1991) on the United States monetary data; Spencer (1994), and Belongia and Chrystal (1991) for the United Kingdom; Ishida (1984) and Suzuki (1987) for Japan; Horne and Martin (1989) for Australia; Yue and Fluri (1991) for Switzerland; Fase (1985) for the Netherlands; McCann and Giles (1989) for New Zealand; and Serletis and King (1993) for Canada, support the alleged superiority of Divisia monetary aggregates to the standard Simple-sum aggregates. As a result of these studies, the earlier conclusions on the unstable relationships between money and income have been questioned. Chrystal and MacDonald (1994, pp. 74-76) pointed out that, "There has been a major measurement error in virtually all of the previous literature on money. Instability in empirical relationships has been primarily due to the fact that Simple sum measures of money are not admissible aggregates on index-theoretic grounds...Hence, this suggests that the problems with tests of money in the economy in recent years may be more due to bad

[2] Barnett (1990) surveys and provides critical comments on these approaches.
[3] Except for Germany where her main monetary target is M3.

measurement theory rather than to an instability in the link between the true money and the economy. Rather than a problem associated with the Lucas Critique, it could instead be a problem stemming from the 'Barnett Critique'."

Despite the theoretical implication of the Divisia approach as an appropriate measurement of monetary services, the investigation has been mostly limited to developed countries. An empirical testing of the performance of Divisia aggregate in developing countries, therefore, can be useful in ascertaining the robustness of the conclusion derived for the developed countries. As yet, there has been no attempt to address this issue, particularly for developing countries that have undergone rapid financial liberalization. This study intends to fill that gap in the literature.

The purpose of this paper is twofold. First, to construct the divisia monetary aggregates for selected Asian developing countries, namely, Indonesia, Malaysia, Nepal, the Philippines, Sri Lanka and Thailand. Second, to assess the potential relevance of the divisia aggregates to these countries by evaluating its informativeness with respect to key macroeconomic variables, particularly to income.

The plan of the paper is as follows. Section 2 discusses the relevance of Divisia aggregate in 'deregulated' Asian countries, and the computation of the Divisia aggregate. Section 3 presents the results of the information content of monetary aggregates analyzed using Granger-causality tests. The last section contains our main conclusions.

2. The Relevance of Divisia Money in Asian Countries

It has been observed that there is a lack of empirical research in determining the role of Divisia monetary aggregates in developing economies.[4] One of the probable reasons is that the Divisia money works well in developed market-oriented financial system economies. Even there, it has been found that the Divisia money aggregate does not perform

[4] Except studies by Huang, et al. (1992) for Taiwan, and Subrahmanyam and Swami (1991) for India.

better than the Simple-sum aggregate in some of the developed countries.[5] Thus, why should this deter research in developing countries? Judd and Scadding (1982) have pointed that the construction of a Divisa monetary aggregate depends critically on the measurement of user costs of the relevant monetary components. They concluded that, "The Divisia approach is perhaps most useful for a world in which interest rates on monetary assets are unregulated so that reliable measures of user costs are easily calculated. Hence it promises to become increasingly important if the current trend towards interest rate deregulation continues," (pp. 1011-1012).

However, since the late 1970s and early 1980s, the Asian economies have witnessed a significant financial deepening and disintermediation in the financial system. With the changes in financial markets of the developing countries including the deregulation of financial institutions and innovations in financial instruments, the new development in the theory and practice of monetary aggregation pioneered by Barnett and his colleagues may have some relevance for developing Asian countries.

There are two important developments in the financial system of Asian countries that provide the rationale for using Divisia monetary aggregates. First, in the 1980s, majority of Asian countries experienced substantial structural changes and rapid growth in the financial system. The financial system has undergone a radical transformation from a relatively simple structure in the early 1960s, comprising the Central Bank and small financial intermediaries, into a more sophisticated financial system characterized by the prevalence of finance companies, merchant banks, commercial banks, discount houses, development finance institutions, capital market institutions, commodity market institutions, and new thrift and trust institutions, among others. Parallel to the sophistication of the financial system, there is evidence that financial innovations and deregulation have become more frequent issues in the Asian financial markets. Among the major innovations was the liberalization of interest rates, relaxation of exchange control, foreign exchange dealings by financial institutions, computerized cheque

[5] For example, see Thornton and Yue (1992) and Issing, et al. (1993).

clearing system, electronic banking, new financial instruments (e.g. negotiable certificate of deposits, bankers acceptance and repurchase agreement arrangement [repos]), etc.[6]

Although the implementation of financial liberalization varied widely across these countries in terms of both the pace and scope of reforms (see Table 1), the liberalization of interest rates was a prominent feature of the financial reforms implemented by Asian countries during the 1980s. As clearly indicated in Table 1, interest rates on deposits were fully deregulated in Indonesia, the Philippines, and Sri Lanka in the early 1980s. As for Malaysia, Nepal, and Thailand, majority of the deposit rates were liberalized in the late 1980s. An important implication of these event is that the liberalization of interest rate will enable the computation of user costs, and this situation will not limit the usefulness of Divisia monetary aggregates for these Asian countries.

Table 1 - Liberalization of Interest Rates in Asian Countries

Countries	Year	Feature of Interest Rate Deregulation
Indonesia	1978	State banks, private and foreign banks were allowed to set their own interest rates on time deposits with maturities not exceeding 3 months.
	1983	Deregulation of state banks' interest rates on most categories of deposits and on all loans except for high priority loans.
Malaysia	1978	Financial institutions were free to quote deposits and lending rates except lending rates for priority sectors.

[6] For further discussions on the various financial innovations and deregulation in Asian countries, see The World Bank (1989, 1993), Tseng and Corker (1991, 1993), Talib (1993), Adhikary (1989a) and Cho and Khatkhate (1989).

Table 1 (cont.)

Countries	Year	Feature of Interest Rate Deregulations
Malaysia (cont.)	1983	All interest rates on loans and advances other than those prescribed by maximum ceiling rates and law, had been tied to base lending rates of the respective largest commercial banks.
	1987	All financial institutions were free to determine their deposit rates.
	1991	All financial institutions were free to set their lending rates based on their own cost of funds.
Nepal	1984	Financial institutions were granted freedom to manage their deposit rates with a narrow range of one to one and a half percentage points after maintaining the minimum rate as prescribed by the Nepal Rastra Bank (NRB, the Central Bank).
	1986	Financial institutions were granted the freedom to offer higher rate than the minimum rate as prescribed by the NRB.
	1989	Interest rates were completely liberalized and financial institutions were allowed to fix their own deposit and lending rates.
Philippines	1981	Lifted the ceilings on interest rates on deposit and loans, except those with maturities of less than two years.
	1983	Complete removal of the remaining interest rate ceilings on deposits and loans.

Table 1 (cont.)

Countries	Year	Feature of Interest Rate Deregulation
Sri Lanka	1977	The National Savings Bank (NSB, government-owned bank) was induced to raise its deposit rates. These reforms in turn led to upward revision on the deposits and lending rates of the commercial banks.
	1984	Financial institutions were given the freedom to fix their own deposit and lending rates.
Thailand	1980	Lending rates of financial institutions were freed from the 15.0 percent per annum limit imposed since 1924.
	1989	Ceiling on commercial banks' time deposit rates of over one year maturity was abolished.
	1990	Ceiling on time deposit rate of less than one year maturity was abolished.
	1992	Ceiling on savings deposit and lending rates was abolished.

Sources: Talib, A. (ed.) (1993), *Monetary Policy in the SEACEN Countries: An Update*. Kuala Lumpur: The South East Asian Central Bank (SEACEN) Research and training Centre; Adhikary, G.P. (1989), *Deregulation in the Financial System of the SEACEN Countries*. Kuala Lumpur: The South East Asian Central Bank (SEACEN) Research and Training Centre.

Second, it has been recognized that deregulation of and innovation in the financial system have widespread implications for the conduct of monetary policy. Although financial deregulation is expected to enhance the effectiveness of monetary policy, it might also distort the relationship between money and other key macroeconomic variables. Tseng and Corker (1993) have pointed out that financial liberalization could lea

to one time shifts or a gradual shift in the level of money holdings, as well as to changes in the measured income and interest elasticity of money demand. Tseng and Corker (1993, pp. 63-64)[7] concluded that, "Financial liberalization brought new chanllenges for the monetary authorities of these countries, many of which remain as reforms continue to be implemented...The liberalization of interest rates and other financial reforms have promoted financial deepening and have contributed to improving resource allocation, the mobilization of financial savings and the efficiency of investment...In particular, financial liberalization has altered the relationships between money, income and interest rates, complicating the interpretation of developments in the monetary aggregates."

Adhikary (1989b) pointed that as a result of financial innovations, most of the countries in the Asian region[8] are emphasizing the use of broader definition of money as intermediate target. For example, M2 has been the major monetary target in Indonesia, Nepal, Sri Lanka and Thailand. In Malaysia and the Philippines, both M2 and M3 have assumed increasing importance for monetary policy actions as they have a more stable and predictable relationship with underlying economic activity. For example, in Malaysia, the Governor of the Central Bank (Bank Negara Malaysia 1985, p. 122) reported that, "Of late, the task of monetary policy has been complicated by structural changes in the demand for money. Traditionally, monetary management by the Central Bank was centered on narrow money or M1, that is, currency holdings and demand deposits of the non-bank private sector. However, the behaviour of M1 in 1984 and 1985 was affected significantly by growing sophistication in the financial system and increasing sensitivity to interest rates, which caused large shifts out of currency holdings and demand deposits into interest-bearing deposits not only with the commercial banks, but also the finance companies, merchant banks, and other financial instituitons. As a result, the broader definitions of money, M2 and M3, have become increasingly important in terms of a more stable and predictable relationship with underlying economic activity."

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[7] Tseng and Corker (1993) estimated money demand functions for nine Asian countries, namely, Indonesia, Korea, Malaysia, Myanmar, Nepal, Philippines, Singapore, Sri Lanka and Thailand.

[8] The Asian countries include Indonesia, Malaysia, Myanmar, Nepal, Philippines, Singapore, South Korea, Sri Lanka, Taiwan and Thailand.

On the other hand, in Thailand, Hataiseree (1991, p. 38) point out the stance made by the Bank of Thailand, "It is suspected that the effect of financial development just described might impair the value of M1 (money as a medium of exchange) as an indicator in the control of money supply, since the traditional distinction between demand deposits and saving deposits can hardly be established...As part of the response to these new developments, the Bank has in recent years placed more emphasis on the broader money (M2) as a monetary policy indicator when periodically reviewing the developments of monetary situations. This is because the broader monetary aggregates like M2 were considered broad enough to internalize the portfolio shifts if any, thus stabilizing the growth rate of M2 relative to M1."

In summary, the rapid transformation of the financial system in the Asian countries in recent years has resulted in depth and sophistication of the banking system. However, the more market-oriented structure along with deregulation and financial innovation have complicated the task of monetary management. The structural changes in the financial system had resulted in volatile movements in the velocity of M1, and consequently resulted to the breakdown in the relationship between M and income. As a result, the broader definition of monetary aggregates M2 and M3, have assumed greater significance in terms of a more stable and predictable relationship with the underlying economic activity. Therefore, increasing emphasis has been placed on M2 and M3 as the intermediate targets for monetary management in those countries.[9]

Therefore, there is an apparent breakdown between the relationship between money and income in the SEACEN countries in a changing financial environment as a result of financial liberalization. Our main questioned is: Is there a role for Divisia monetary aggregates in changing financial environment or 'deregulated' Asian countries as pr

[9] Other financial indicators that could serve such purpose include commodi prices, interest rates, exchange rate, credit aggregates, etc. However, addressing t issue of whether these indicators are better candidate than a monetary aggregate beyond the scope of this study. Federal Reserve Bank of New York (1990) provides collection of empirical studies on alternative intermediate indicators for moneta policy for the United States.

dicted by Judd and Scadding (1982)? Nevertheless, a study by Subrahmanyam and Swami (1991) for India found that although the Indian economy experienced a significant financial deepening and disintermediation, Simple-sum monetary aggregates were more informative than the Divisia aggregates. On the other hand, Huang, et al. (1992), studying the Taiwanese economy, suggest that there are potential roles for Divisia money as a useful aggregate for monetary policy purposes in Taiwan. Therefore, given a new financial environment, the feasibility and usefulness of the Divisia monetary aggregates needs to be examined rigorously in the context of the Asian countries.

The Construction of a Divisia Monetary Aggregate

According to Barnett (1980), a Divisia monetary aggregate is constructed in the following manner: Let q_{it} and p_{it} represent the quantities and user costs of each asset to be included in the aggregate at time t. The expenditure share on the services of monetary asset i in period t is:

$$(1) \qquad s_{it} = p_{it}q_{it}/\Sigma_j p_{jt}q_{jt}.$$

The user cost (see Barnett, 1978) of each asset is measured as:

$$(2) \qquad p_{it} = (R_t - r_{i,j})/(1 + R_t)$$

where R_t is the benchmark rate, the maximum $[r_j, r_i; i = 1, 2,...,n). j = 1, 2,..k. i \neq j]$. The growth rate of a Divisia aggregate then can be written as

$$(3) \qquad G(Q_t) = \Sigma_{i=1}^{n} s_{it}^{*} G(q_{it})$$

where $s_{it}^{*} = 0.5(s_{it} + s_{it-1})$ and n is the number of assets in the aggregate. Single period changes, beginning with a base period, can be cumulated to determine the level of the Divisia aggregate in each succeeding period.

The computation of a user cost depends on the choice of the benchmark asset. As Goldfeld (1982) points out, the benchmark asset is not

easily defined or may not even exist. As a result, the value and quality of the Divisia monetary aggregate is influenced by the chosen benchmark asset. According to Barnett and Spindt (1982), the benchmark asset is the one that is held only for accumulating and transferring wealth across time and its rate of return should be the highest in the economy. The benchmark asset is a non-monetary asset and thus, provides no transaction services. Although Barnett and Spindt (1982) suggest that human capital is the 'best' to represent the benchmark asset, its data availability is the major constraint. Nevertheless, the majority of studies of Divisia aggregates utilized the highest available rate of return on a given set of monetary assets. Barnett, et al. (1992, p. 2105) agreed on this point and further noted that, "The role of the benchmark asset is to establish a nonmonetary alternative. It is acceptable for this to be a different asset in each period, since the maximization is repeated each period. In theory, any measurement of R_t could be viewed as a proxy for the unknown rate of return on human capital." In practice, however, the benchmark rate is defined in such a way that the user costs for the monetary assets are positive and this method of selecting the benchmark rate will avoid the problem of negative user cost. Therefore, it is for this reason that the benchmark rate is made to dominate all rate of return of monetary asset components.

In this study, we compute the Divisia monetary aggregates for the SEACEN countries, using the method proposed by Barnett (1980). For computation, we employed the narrow money M1 and broader money M2 for all countries in the Asian region.[10] Details of the monetary components and their respective user costs are presented in Table 2. From Table 2, we can observe that the rate of return on currency is assumed to be zero since it is a perfectly liquid asset. On the other hand, although the explicit rate of return on demand deposits is also zero, Offenbacher (1980) and Barnett, et al. (1981) strongly argued that an implicit rate of return must be imputed to demand deposits, if the substitutability between currency and demand deposits is to be estimable. Barnett

[10] In various Asian countries, the official Simple sum monetary aggregates range from M1, M2 and M3. Apart from Indonesia, Nepal and Sri Lanka, other countries like Malaysia, the Philippines and Thailand use the broadest definition of money supply M3 as one of the monetary indicators. However, published data on most of the components of M3 and their respective rate of returns are not available.

(1982, p. 699) proposes that, "In some cases implicit rates of return must be used in computing the interest rates in the formula p_i, especially when the own rate of return on an asset is subject to govenrmental rate regulation. An implicit imputation is also used in the measurement of R. The Divisia quantity index has been found to be robust to those imputations within the plausible ranges of error in the imputation."

However, the proper implicit rate imputation to demand deposits remains an open issue. Following Offenbacher (1980), the approach taken in this study is to compute an implicit rate using Klein's (1974) methodology. The formula used for constructing the implicit rate on demand deposits (DDr) is given as follows

$$DDr = r_L[1 - (BR/DD)] \tag{4}$$

where r_L is the rate of return on bank's earning assets and BR is bank reserves. For arriving at the rate of return on foreign currency dposits (FCDr), we follow Musi (1989) using the following formula

$$FCDr = Dr.e \tag{5}$$

where Dr is the rate of return on saving or time deposits and e is the expected rate of devaluation.

As for the benchmark asset, as shown in Table 2, it varies between countries. Nonetheless, using the envelope approach, a series of benchmark rates is formed by selecting that benchmark rate which is higher than the rate of return of each monetary components. This will ensure that $p_i \geq 0$ (see Mullineux, 1996). Furthermore, Binner (1990) proposes adding 0.10 points to the benchmark rate to ensure that this rate will be non-zero.

Table 2 - Information used to Construct Divisia Aggregates

Countries	Money	Asset Components	Rate of Return
Indonesia	M1	Currency in circulation	Zero
		Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows: $DDr = r_L$ (1–RRDD), where r_L is commercial bank's lending rate for working capital loans (percent p.a.) and *RRDD* is reserve requirement on demand deposits.
		Foreign currency demand deposits	Implicit rate of return. Using Musi's (1989) method. The basic formula for computing Foreign currency demand deposits rate (FCDDr) is as follows: $FCDDr=DDr*e$, where e is expected rate of de-valuation, is computed as $e = E_{t-1}/E_t$, where E is the actual exchange rate (Rupiah/US$).
	M2	Saving deposits	Saving deposit rate (SDr). Proxied with the SBI (Statistical Bank of Indonesia) 30-day discount rate (percent p.a.).
		Time deposits	Time deposit rate (TDr). $TDr = \max [(r_{ij})]$, where i = state National private and Foreign banks. j = 1, 3, 6, 12 and 24 months maturity (percent p.a.).

Table 2 (cont.)

Countries	Money	Asset Components	Rate of Return
Indonesia (cont.)	M2 (cont.)	Foreign currency time deposits	Foreign currency time deposit rate (FCTDr). $FCTDr$ = max $[(r_{ij})]$, where i = state, National private and Foreign banks. j = 1, 3, 5, 12 and 24 months maturity (percent p.a.).
		Benchmark asset	*Maximum available rate.* Max = $\{[DDr, FCDDr, SDr, TDr, FCTDr, r_i] + 0.1\}$, where i = certificate of deposits, Bank Indonesia certificates and Jakarta interbank call money (weighted average).
Malaysia	M1	Currency in circulation	Zero
		Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows: $DDr = r_L^*$ $(1-RRDD)$, where r_L is commercial bank's base lending rate (percent p.a.), and $RRDD$ is reserve requirement on demand deposits.
	M2	Saving deposits	Savings deposit rate (SDr) in percent p.a.
		Fixed deposits	Fixed deposit rate (FDr). FDr = max $[(r_{ij})]$, where i = 1, 3, 6, 9 and 12 months maturity (percent p.a.).

Table 2 (cont.)

Countries	Money	Asset Components	Rate of Return
Malaysia (cont.)	M2 (cont.)	Negotiable Certificate of Deposits	Rate on NDCs (NDCr). Proxied with the interbank rates, r. $NCDr$ = max $[(r_i)]$, where i = overnight, 7-day, 1-month and 3-month call mo-ney (percent p.a.).
		Repurchase agreement (Repos)	Repo rate (REPOr). Proxied with the call money rate at dis count houses, r. $REPOr$ = max $[(r_i)]$, where i = 3, 6 and 1 months maturity (percen p.a.).
		Benchmark asset	*Maximum available rate.* Ma = $\{[DDr, SDr_i, TDr_i, NCDr$ $REPOr, r_j] + 0.1\}$, where i rates at commercial banks an Finance companies; j = Trea sury bill rates (3, 6 and 1 months) and yield on go vernment securities (5 and 2 years).
Nepal	M1	Currency in circulation	Zero

Table 2 (cont.)

Countries	Money	Asset Components	Rate of Return
Nepal (cont.)	M1 (cont.)	Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows: $DDr = r_L^*$ (1–*RRDD*), where r_L is commercial bank's lending rate on Industry loans (percent p.a.), and *RRDD* is reserve requirement on demand deposits.
	M2	Saving deposits	Saving deposit rate (SDr) in percent p.a.
		Fixed deposits	Fixed deposit rate (FDr). $FDr = \max [(r_i)]$, where $i = 3, 6, 12, 24$ months maturity (percent p.a.).
		Margin deposits	Margin deposit rate (MDr). Proxied with $-MDr$ = Export bill rate less saving deposit rate.
		Benchmark asset	*Maximum available rate.* Max = {[*DDr*, *SDr*, *FDr*, *MDr*, r_i] +0.1}, where i = Treasury bills, National savings certificate, Development bonds and Nepal Rastra Bank Bonds.
Philippines	M1	Currency in circulation	Zero

Table 2 (cont.)

Countries	Money	Asset Components	Rate of Return
Philippines (cont.)	M1 (con.t)	Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows: $DDr = r_L^*$ (1–*RRDD*), where r_L is commercial bank's secured loans (over 2 years) rate (percent p.a.) and *RRDD* is reserve requirement on demand deposits.
	M2	Saving deposits	Saving deposit rate (SDr) in percent p.a.
		Time deposits	Time deposit rate (TDr). *TD* = max $[(r_i)]$, where i = 1, 2, 3 6, 12 and 24 months maturity (percent p.a.).
		Benchmark asset	*Maximum available rate.* Ma = {[*DDr*, *SDr*, *TDr*, r_i] + 0.1} where i = interbank call, Treasury bills, Promissory notes Repurchase agreement (private), Certificate of assignment, Repurchase agreemen (government) and Commercial paper (non-financial).
Sri Lanka	M1	Currency in circulation	Zero

Table 2 (cont.)

Countries	Money	Asset Components	Rate of Return
Sri Lanka (cont.)	M1 (cont.)	Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows: $DDr = r_L^*$ $(1-RRDD)$, where r_L is commercial bank's lending rate on loans and overdrafts (percent p.a.), and RRDD is reserve requirement on demand deposits.
	M2	Saving deposits	Saving deposit rate (SDr) in percent p.a.
		Fixed deposits	Fixed deposit rate (FDr). $FDr = \max [(r_i)]$, where $i = 3$, 6 and 24 months maturity (percent p.a.).
		Benchmark asset	*Maximum available rate.* Max = {[DDr, SDr, FDr, r_i] + 0.1}, where i = interbank rates, Government securities, Treasury bills and Fixed deposit rates (6, 12, 18 and 24 months) at National Savings bank.
Thailand	M1	Currency in circulation	Zero

Table 2 (cont.)

Countries	Money	Asset Components	Rate of Return
Thailand (cont.)	M1 (cont.)	Demand deposits	Implicit rate of return. Using Klein's (1974) method. The basic formula for computing Demand deposit rate of return (DDr) is as follows: DDr = r_L* (1–*RRDD*), where r_L is commercial bank's lending rate on loans and overdrafts (percent p.a.), and *RRDD* is reserve requirement on demand deposits.
	M2	Saving deposits	Saving deposit rate (SDr) in percent p.a.
		Time deposits	Time deposit rate (TDr). *TDr* = max [(r_i)], where i = 3, 6, 12 and 24 months maturity (percent p.a.).
		Benchmark asset	*Maximum available rate.* Max = {[*DDr*, *SDr*, *TDr*, r_i] + 0.1} where i = Government bonds Treasury bills (30, 60, 120 and 183 days) and interbank rates

3. Information Content of Monetary Aggregates

Monetary aggregates are widely used as indicators of unobservable economic activity. This is because monetary aggregates, in some way, convey information about the current state of the economy. Thus, one potentially useful characteristic of a monetary aggregate is that it contains information relevant to certain key macroeconomic variables, say for example, current nominal income. Most information content studies adopt a methodology which originated in information theory introduced by Shannon (1948) and later developed by Theil (1967), but it was Tinsley, et al. (1980) who applied this method in monetary aggregation literature. In its simplest form, the approach tries to measure the contemporaneous information in money M, with respect to income Y, defined as

$$I(Y|M) = -1/2\ ln\ (1 - R^2) \tag{6}$$

where R^2 is the coefficient of determination from the following linear regression

$$Y_t = \alpha + \beta M_t + \varepsilon_t. \tag{7}$$

This procedure measures the value of using contemporaneous information only. The measure of information is based on the behavior of ε_t. Equation (7) assumed that ε_t has constant variance, zero serial correlation and zero non-contemporaneous correlation between Y and M. As for time series data, these assumptions are rather restricted. To avoid these strong assumptions and to be more consistent with economic theory, equation (7) can be generalized into a dynamic framework in defining information content of M relative to Y as follows

$$I(Y|M) = -1/2\ ln\ (SSR_2/SSR_1) \tag{8}$$

where SSR_1 and SSR_2 are sum of squared residuals from the following equations, respectively,

$$Y_t = \alpha + \sum_{i=1}^{K} \beta_i Y_{t-i} + \varepsilon_{1t} \tag{9}$$

$$(10) \qquad Y_t = \alpha + \sum_{i=1}^{K} \beta_i Y_{t-i} + \sum_{i=1}^{N} \theta_i M_{t-i} + \varepsilon_{2t}.$$

Equation (8) measures whether M is informative about Y in addition to what Y is to itself. In other words, in the regression framework this is to test whether equation (10) gives a better fit compared to equation (9). This will involve testing the statistical significance of the θ's in equation (10).

As pointed by Sims (1972), the information content analysis is closely related to the Granger causality test in the voluminous literature on money-income relationship. In the notion of Granger causality testing, money is said to 'Granger cause' (or be informative about) income if the θ's are statistically significant in equation (10). Schwert (1979) notes that Granger causality test of incremental information content has an important bearing on the usefulness of monetary aggregates as indicators.

Granger's (1969) definition of causality is based on the predictability of a time series. Formally, the above proposition can be stated as follows: if $\sigma^2(Y|\, Y, M) < \sigma^2(Y|\, Y)$, then M is said to 'Granger cause' Y. The term $\sigma^2(Y|\, Y.M)$ is the prediction error variance of Y derived from the information set that includes past values of Y and M. The term $\sigma^2(Y|\, Y)$ is the variance of the prediction error of Y based on information contained only in the past values of Y. If, however, $\sigma^2(M|\, M.Y) < \sigma^2(M|\, M$ then Y is said to 'Granger cause' M. Bidirectional causality is said to occur when the above outcomes occur simultaneously. Finally, if $\sigma^2(Y|\, Y) < \sigma^2(Y|\, Y,M)$ and $\sigma^2(M|\, M) < \sigma^2(M|\, M,Y)$, then the two series are temporally unrelated over time and therefore are independent of each other.

The usual F-statistics can be used to test for the joint statistical significance of θ's=0. The test of the null hypothesis that M does not 'Granger cause' Y based on equations (9) and (10) can be carried out with the following F-statistic,

$$(11) \qquad F = [(SSR_1 - SSR_2)/T]/[SSR_2/(T - K - N - 1)].$$

Here SSR_1 and SSR_2 refer to the sum of squared residuals from ordinary least squares regressions on equations (9) and (10), respectively.

T is the number of observations, and K and N are the chosen lag length for Y and M, respectively. Under the null hypothesis, F is distributed as F with (N, T–K–N–1) degrees of freedom. For a suitably large value of F, we reject the hypothesis that M does not 'Granger cause' Y. In other words, in this case, M is not informative about income Y. However, despite using the Granger causality test, the aim is not to establish a causal link between money and income, but simply to describe a statistical relationship between the two to measure informativeness.

In estimating equations (9) and (10), all variables are required to be stationary.[11] To ensure the use of stationary time series data, augmented Dickey-Fuller (Said and Dickey, 1984) test statistics were computed to test for the presence of unit roots against the alternative hypothesis that the series are stationary around a time trend.[12] The results of these tests are reported in Table 3. We have summarized the results of the order of integration in the lower half of Table 3, and the results suggest that all income series need to be differenced only once to achieve stationarity. However, for most money series in most of the Asian countries, it needs twice differencing to render stationarity. Money series that are stationary after first-differencing are suggested for Indonesia, Divisia M2 and both Simple-sum M1 and M2; Philippines, Simple-sum and Divisia M1; and Sri Lanka, Simple-sum M1.

After transforming all the series in their stationary form, we conduct the Granger causality test from money to income. As for the lag length K and N, there are several options that can be used to determine the K and N of the series. Diebold and Nerlove's (1990) 'rule-of-thumb' consists in setting K or $N = int(T^{1/4})$ where int denotes the integer portion of the term in brackets. Other procedure which is often employed is the one proposed by Said and Dickey (1984) with K or $N = int(T^{1/3})$, and Schwert (1987) proposes two range of K or $N = int[4(T/100)^{1/4}]$ or $int[12(T/100)^{1/4}]$. In this study, we used a range of lag length for K and N. Using Schwert's (1987) rule, we computed the lower bound of $K = N = 3$, and the upper bound of $K = N = 10$. Apart from that, we also used 6 lags in

[11] Description and sources of data used in the analysis are presented in Data Appendix.

[12] Results for test of integration were generated using SHAZAM, Version 7.0 (White, 1978).

Table 3 - Augmented Dickey-Fuller Test for Order of Integration

Series	Levels	First-Differenced	Second-Differenced
		Indonesia	
Simple sum M1	−1.12(0)	−3.70(2)**	
Divisia M1	−0.73(1)	−2.42(4)	−4.91(4)**
Simple sum M2	−2.07(0)	−2.92(3)**	
Divisia M2	−1.40(1)	−3.49(2)**	
Income	−2.83(2)	−4.82(3)**	
		Nepal	
Simple sum M1	−1.76(6)	−2.08(7)	−4.75(7)**
Divisia M1	−2.00(6)	−2.17(7)	−4.08(7)**
Simple sum M2	−1.42(4)	−1.86(7)	−3.58(7)**
Divisia M2	−1.37(6)	−1.99(7)	−6.70(4)**
Income	−3.41(3)	−5.14(4)**	
		Sri Lanka	
Simple sum M1	−2.80(4)	−2.97(4)**	
Divisia M1	−2.17(4)	−2.49(4)	−5.18(4)**
Simple sum M2	−1.06(4)	−2.89(4)	−4.38(4)**
Divisia M2	−2.47(4)	−2.07(4)	−4.44(4)**
Income	−1.87(4)	−3.87(4)**	
		Malaysia	
Simple sum M1	−1.73(4)	−1.58(7)	−3.08(7)**
Divisia M1	−1.28(4)	−1.31(4)	−3.11(5)**
Simple sum M2	−0.39(0)	−2.55(3)	−4.35(4)**
Divisia M2	−1.48(0)	−2.78(3)	−4.47(4)**
Income	−1.11(5)	−2.95(5)**	

Table 3 (cont.)

Series	Levels	First-Differenced	Second-Differenced
		Philippines	
Simple sum M1	−2.23(7)	−3.80(7)**	
Divisia M1	−1.24(7)	−3.09(7)**	
Simple sum M2	−2.46(4)	−1.49(5)	−2.95(5)**
Divisia M2	−3.07(4)	−2.90(4)	−3.12(5)**
Income	−2.49(7)	−3.80(3)**	
		Thailand	
Simple sum M1	−2.22(6)	−2.09(6)	−4.99(6)**
Divisia M1	−1.64(6)	−2.44(6)	−4.60(6)**
Simple sum M2	−2.67(5)	−2.13(4)	−3.47(4)**
Divisia M2	−3.39(4)	−2.87(4)	−4.05(4)**
Income	−2.52(4)	−3.10(4)**	

Summary Order of Integration

	Ind	Mal	Nepal	Phil	Sri L	Thai
Simple sum M1	$I(1)$	$I(2)$	$I(2)$	$I(1)$	$I(1)$	$I(2)$
Divisia M1	$I(2)$	$I(2)$	$I(2)$	$I(1)$	$I(2)$	$I(2)$
Simple sum M2	$I(1)$	$I(2)$	$I(2)$	$I(2)$	$I(2)$	$I(2)$
Divisia M2	$I(1)$	$I(2)$	$I(2)$	$I(2)$	$I(2)$	$I(2)$
Income	$I(1)$	$I(1)$	$I(1)$	$I(1)$	$I(1)$	$I(1)$

Notes: ** denotes statistically significat at 5% level. The above integration test is based on estimating the following augmented Dickey-Fuller (ADF) regression:

$$\Delta X_t = \alpha_0 + \alpha_1 T + \alpha_2 X_{t-1} + \sum_{i=i}^{N} \phi_i \Delta X_{t-i} + \mu_t$$

where Δ is the first-difference operator, T is a linear time trend and μ is the distrubance term. The null hypothesis is that X_t contains a unit root against that it is stationary around a deterministric trend. Figures in parentheses are truncation lag length automatically set by SHAZAM. The critical values at 5% based on 50 observations are −3.49 and −2.92 with trend and without trend, respectively (see MacKinnon, 1991).

the analysis. We also acknowledge that the above approach of selecting the truncation lag length is essentially arbitrary since it has been shown that Granger causality tests are sensitive to the lag structure specified (Hsiao, 1979). To check for the robustness of the arbitrary lag length selection using Schwert's formula, we used Akaike's (1970) Final Prediction Error (FPE) criterion to select the optimal lags for each of the independent variables. The FPE is calculated as the product of $(T+K+N+1)/(T-K-N-1)$ and SRR/T. This procedure balances the fit of the equation with the degrees of freedom and is judged by an F-test (Judge, et al., 1985).

The results of the Granger causality tests are presented in Table 4. The main entries in Table 4 are values of the F-statistics as described above, comparing the sums of squares between the unrestricted and the restricted regressions. Then, in parentheses, are the p-values (probabilities) associated with these F-statistics. The results of FPE, with the lags chosen appearing in square brackets, are given in the fifth column of Table 4, and in the sixth column, the F-statistic associated with these optimal lag length chosen are reported.

Table 4 - Tests of Granger-Causality from Money to Income

Series	3 lags	6 lags	10 lags	FPE lags	
Indonesia					
Simple sum M1	2.163	2.291	2.416	[3, 4]	4.966
	(0.105)*	(0.056)*	(0.037)**		(0.002)*
Divisia M1	1.210	0.922	0.919	[3, 1]	3.111
	(0.317)	(0.490)	(0.533)		(0.085)*
Simple sum M2	0.935	1.932	1.718	[3, 6]	2.791
	(0.431)	(0.102)*	(0.134)		(0.025)*
Divisia M2	0.646	1.076	1.108	[3, 4]	1.855
	(0.589)	(0.394)	(0.395)		(0.139)

Table 4 (cont.)

Series	3 lags	6 lags	10 lags	FPE lags	
Malaysia					
Simple sum M1	1.233	0.243	2.447	[3, 10]	2.602
	(0.312)	(0.958)	(0.036)**		(0.020)**
Divisia M1	4.258	2.022	4.814	[3, 10]	4.110
	(0.010)**	(0.088)*	(0.000)**		(0.001)**
Simple sum M2	2.429	1.354	0.717	[3, 3]	1.709
	(0.077)*	(0.260)	(0.699)		(0.181)
Divisia M2	1.308	0.533	1.273	[3, 1]	3.315
	(0.283)	(0.778)	(0.300)		(0.084)*
Nepal					
Simple sum M1	1.572	1.130	1.027	[7, 3]	1.535
	(0.209)	(0.365)	(0.451)		0.223
Divisia M1	1.432	1.426	0.848	[7, 1]	1.497
	(0.246)	(0.232)	(0.589)		(0.229)
Simple sum M2	1.875	1.086	1.325	[7, 3]	1.720
	(0.147)	(0.389)	(0.275)		(0.181)
Divisia M2	1.700	1.688	1.244	[7, 3]	1.873
	(0.180)	(0.153)	(0.316)		(0.153)
Philippines					
Simple sum M1	1.906	3.496	1.905	[10, 4]	4.506
	(0.412)	(0.007)**	(0.094)*		(0.005)**
Divisia M1	1.780	7.165	2.577	[10, 4]	6.121
	(0.164)	(0.000)**	(0.027)**		(0.001)**
Simple sum M2	6.665	4.515	1.889	[10, 3]	5.540
	(0.000)**	(0.001)**	(0.100)*		(0.003)**
Divisia M2	8.133	6.550	2.051	[10, 3]	6.330
	(0.000)**	(0.000)**	(0.074)*		(0.001)**

Table 4 (cont.)

Series	3 lags	6 lags	10 lags	FPE lags	
Sri Lanka					
Simple sum M1	4.453	2.719	0.436	[10, 3]	1.057
	(0.008)**	(0.027)**	(0.913)		(0.381)
Divisia M1	3.443	5.019	1.420	[10, 6]	2.307
	(0.024)**	(0.000)**	(0.233)		(0.062)*
Simple sum M2	2.710	2.615	0.444	[10, 1]	1.000
	(0.056)*	(0.033)**	(0.908)		(0.324)
Divisia M2	5.515	5.074	1.217	[10, 3]	1.451
	(0.002)**	(0.000)**	(0.331)		(0.247)
Thailand					
Simple sum M1	3.124	2.050	1.266	[9, 1]	7.479
	(0.035)**	(0.084)*	(0.304)		(0.009)*
Divisia M1	1.441	2.114	2.056	[9, 10]	2.208
	(0.243)	(0.076)*	(0.074)*		(0.054)*
Simple sum M2	1.192	3.775	2.330	[9, 4]	3.977
	(0.323)	(0.005)**	(0.045)*		(0.010)*
Divisia M2	0.876	1.869	1.807	[9, 10]	1.819
	(0.460)	(0.114)	(0.116)		(0.111)

Notes: The numbers in parentheses are *p*-values. **, *means statistically significant
5 percent and 10 percent, respectively.

Reading across the table for the truncation lag length 3, 6, and
lags, and the FPE results, they show, first, that only in the case
Nepal that monetary aggregates for both measurement does not Gran
cause income. This result is robust for all arbitrary lag selection a
the lag chosen using the FPE criteria. Second, overwhelmingly, for
Philippines, all monetary aggregates Granger cause income and the
fore, both Simple-sum and Divisia M1 and M2 are informative ab
national income. Monetary aggregates in the Philippines are thus s
as useful information variables during the period under study.

Generally, the null hypothesis that money does not Granger cause income can also be rejected for Indonesia, Malaysia, Sri Lanka, and Thailand. Although the result for Malaysia and Sri Lanka indicate that both Simple-sum and Divisia are informative about national income, in both Indonesia and Thailand, only in the case of Divisia M2 that the null hypothesis that money does not Granger cause income cannot be rejected. This result is robust to the different types of lag selection used. Thus, this implies that Divisia M2 is not a useful information variable in these two countries.

In summary, except in the case of Nepal, we conclude that monetary aggregates can be a useful intermediate indicator for monetary policy purposes in the majority of the Asian countries under study. More interestingly, the Divisia monetary aggregate shows potential roles as intermediate indicators for policy purposes in the Asian countries.

4. Conclusions

In this exploratory study, we attempt to construct and compute Divisia monetary aggregates for selected Asian countries, namely, Indonesia, Malaysia, Nepal, the Philippines, Sri Lanka, and Thailand. All these countries have experienced financial liberalization during the mid-1970s and in the 1980s. As suggested by Judd and Scadding (1982), in countries where financial deregulation, particularly where interest rate liberalization has been the main key financial reform, there is a role for Divisia monetary aggregates, i.e., to act as monetary indicators for policy purposes. Since it has been recognized that Simple sum measurements of money are distorted, there is impetus to find alternative measurements of money that will appropriately measure the monetary services of a country.

In this study, we have computed both narrow Divisia M1 and broad Divisia M2, and together with their counterpart Simple sum M1 and M2, we test for information content of each monetary aggregate about national income using the standard Granger causality analysis. Using arbitrary lag selection and the Akaike's FPE criterion for optimal lag length, the results suggest that monetary aggregates are informative about national income in most of the Asian countries analyzed.

Further, our results suggest that the Divisia monetary aggregates are useful intermediate indicators for monetary policy purpose in Asian countries.

As for future research, it would be interesting to extend the present analysis to test the robustness of Divisia monetary aggregates in these countries by subjecting these aggregates to the standard tests proposed in Barnett et al. (1984), and Chrystal and MacDonald (1994). These test results would be of considerable importance because they will allow us to directly evaluate the usefulness of Divisia aggregates as alternative measure of money which can be used by monetary authorities for policy purposes.

Data Appendix

This study is based on quarterly time series data for the period 1981:1 to 1994:4. Sources of data for each country are as follows.

1. Monetary Asset Components, Bank Reserves, Exchange Rates (Domestic Currency/US$)

   For all countries, The SEACEN Centre, *SEACEN Financial Statistics-Money and Banking.*

2. Rates of Return on Financial Assets, Bank Lending Rate

   Indonesia: Bank of Indonesia, *Indonesian Financial Statistic Weekly Report and Report for the Financial Year.*
   Malaysia: Bank Negara Malaysia, *Monthly Statistical Bulleti and Quarterly Bulletin.*
   Nepal: Nepal Rastra Bank, *Quarterly Economic Bulletin and Ma Economic Indicator-Monthly Report.*
   Philippines: The Central Bank of Philippines, *Philippine Fina cial Statistics, Annual Report and CB Review.*
   Sri Lanka: Central Bank of Ceylon, *Bulletin and Annual Repo*
   Thailand: Bank of Thailand, *Quarterly Bulletin, Monthly Bull tin and Key Economic Indicator.*

1. Gross National Product (GNP)

For Asian countries, nominal GNP is available only in annual form. Following Chow and Lin (1976) and Bahmani-Oskooee (1986) by interpolating quarterly data for GNP from annual observations according to the pattern of quarterly movements in certain macroeconomic variables.[13] In this study we interpolated quarterly GNP from annual observations according to the pattern of quarterly movement in government expenditure and exports.

To compute quarterly GNP, we follow these steps:

Step 1. Regress annual gross national product (GNP_a) on annual government expenditure (G_a) and exports (X_a). For example, the following estimated regression is illustrated,

$$GNP_{at}\hat{} = \alpha + \beta G_{at}\hat{} + \theta X_{at}\hat{} + \varepsilon_t\hat{}$$

The estimated coefficients β and θ are used in step two.

Step 2. Compute quarterly GNP_i (i=1,2,3,4) as follows,

$$GNP_{qit} = GNP_{a}\{[(\beta/(\beta + \theta))(G_i/\Sigma_i G_i)] + [(\theta/(\beta + \theta))(X_i/\Sigma_i X_i)]\}$$

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[13] For a recent application of this technique, see for example Tseng and Corker (1991), Hataiseree (1993) and Huang (1995).

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