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MEASURING MONEY WITH A DIVISIA INDEX: AN APPLICATION TO ITALY

by Eugenio Gaiotti(*)

Abstract

The use of a weighted monetary index has been proposed in the economic literature to take account of the different degrees of liquidity of the short-term instruments included in "money". In this paper, the approach is applied to the Italian monetary aggregates; the performance of the index is then tested using vector autoregressions and cointegration techniques. The evidence shows that a Divisia index is a good monetary indicator. Until the mid-eighties, its behavior is very similar to that of traditional M2; however, the two measures of liquidity increasingly diverge in recent years, as a result of financial innovation on the liability side of banks' balance sheets. In this period, the index provides additional information, relative to M2, on real GDP and prices; it indicates a slower growth of liquidity than M2 does.

Contents

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1. Introduction

Most of the short term instruments included in "money" are very poor substitutes for each other (e.g. currency and banks' Certificates of Deposit). Since the end of the seventies, a growing literature has been proposing the construction of a "weighted" monetary index (the Divisia index)[1] based on the degree of liquidity of each instrument, estimated as an inverse function of its market yield. The Divisia index is based on explicit microfoundations and on aggregation theory, according to which it measures the aggregate "liquidity", provided some conditions hold;[2] these are looser than those needed for a traditional monetary aggregate.

Divisia monetary indexes gained some popularity both in the economic literature and among Central Banks, who adopt them to complete, rather than replace, the information obtained from traditional monetary aggregates.[3] On theoretical grounds the approach is still debated, as some of the underlying assumptions look quite restrictive; it is usually judged on an empirical basis.

In this paper we examine the evidence available for Italy, an interesting case for many reasons. First of all, Italian data have not been used so far to evaluate this approach. Moreover, in Italy a monetary aggregate (namely M2) has been the main intermediate variable for monetary policy since 1984 (together

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1. The index was introduced in 1925 by the economist Divisia, who applied it to price indexes. See Barnett, Fisher and Serletis (1992).
2. The necessary conditions to split the consumer choice into two stages: the overall choice of "liquidity" and the choice of its composition (see section 2.2).
3. On the Federal Reserve, see Thornton and Yue (1992), Lindsey and Spindt (1986); on the Banco de España, Ayuso and Vega (1992); Bank of England (1993). A study was recently conducted by the Bundesbank.

with the exchange rate); it is considered to have significant informational content on income and prices; the study of its properties gained further relevance after September 1992, when the exchange rate ceased to be a nominal anchor. From time to time, the definition of the monetary aggregates was revised, in order to take proper account of institutional and financial innovations; in recent times, the number of short term instruments available to the public increased, blurring the distinction between money and non-monetary assets.

The main conclusion of the paper is that a Divisia index (based on the instruments currently included in the "liquid assets") has desirable properties as a monetary policy indicator, although the difference with traditional M2 is not as big as in other countries. Until the mid-eighties, the pattern of the index is almost identical to M2; in recent years, however, with the introduction of new kinds of banks' liabilities, the two diverge, as the index indicates a slower growth of "liquidity" than M2 does. We conclude that, under these circumstances, the Divisia index provides additional information relative to M2.

The first part of the paper is a brief summary of the main features of Divisia indexes and of the existing empirical literature. In the second part, the indexes are defined and computed (sec. 3.1); they are compared with the traditional, simple-sum aggregates (sec. 3.2); their short- and long-run properties are analyzed through cointegration techniques and vector autoregressions (sec. 3.3, 3.4); the last section comments on the behaviour of the indexes in 1992 and 1993, to check their monetary policy implications (sec. 3.5). The main conclusions are summarized in the third part.

2. Divisia monetary indexes: main features

2.1 The "user cost" and the definition of a monetary index

A Divisia monetary index was first proposed by William Barnett.[4] In the underlying theoretical framework, rather than a demand for "money", there is a demand for "liquidity services", that can be satisfied holding different kinds of short-term instruments. In the Divisia index each of them is weighed with its degree of liquidity; although unobservable, this may be measured by the "user cost": the yield that has to be foregone to hold the short-term instrument rather than a "non-liquid" asset. The user cost is defined as (the present value of) the spread between the yield on the non-liquid asset (R) and on the short-term instrument (r_i):

(1)
$$\pi_i = \frac{R - r_i}{1 + R} \qquad \text{(user cost)}$$

The user cost π_i may be viewed as the "price" of the i-th instrument, and used to compute "weighted" shares of each component on the total. The percent change in the index is then obtained as the sum of the percent changes in each component times their shares.

(2)
$$\sigma_{k,t} = \frac{\pi_{k,t} x_{k,t}}{\sum_{i=1}^{n} \pi_{i,t} x_{i,t}}$$

$$\frac{D_t}{D_{t-1}} = \sum_{i=1}^{n} s_{i,t} \frac{x_{i,t}}{x_{i,t-1}} \qquad \text{where} \quad s_{k,t} = \frac{(\sigma_{k,t} + \sigma_{k,t-1})}{2}$$

4. See the survey in Barnett, Fisher and Serletis (1992).

where D is the index, x_i the i-th component, σ_i the weighted shares, s_i the average share between time t and t-1. By construction, D is defined for a given base period; it measures the change in "liquidity", not its absolute level.[5]

From (2), the high-yield components have a smaller weight in the index. An increase in CDs has a smaller effect on the index than an increase in currency, reflecting the lower liquidity of the former.

2.2 Microfoundations

Aggregation theory shows that, under appropriate conditions, the index (2) is the best measure of the liquidity services obtained from a given set of short-term instruments. This may be shown by means of a simple maximization (abstracting, for the sake of simplicity, from the intertemporal dimension).[6] The consumer has given income y_0 and wealth W; he chooses a consumption bundle, under the constraint that total expenditure in consumption goods is equal to the sum of income and the return on total wealth; he also chooses the optimal allocation of its wealth among short- and long-term financial assets. The short term assets

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5. Rotemberg et al. (1991) argue in favour of the construction of a weighted aggregate whose level is expressed in terms of "currency equivalent" units. However, this requires stronger assumptions; furthermore, it may give rise to empirical problems, since there is a spurious correlation between the sum of the weights and the business cycle. For Italy, such an aggregate was built and analyzed by Grande and Rinaldi (1993).

6. The example is derived from Barnett, Fisher and Serletis (1992). The results do not substantially change if the maximization problem is defined as an intertemporal one (either with finite or infinite horizon; see Barnett, 1987).

produce liquidity services, hence they are included in the utility function;[7] each of them yields r_i, while the remaining wealth yields $R>r_i$.

$$(3) \qquad \max_{\bar{c},\bar{x}} \quad U(\bar{c},\bar{x})$$

$$s. \qquad y_0 + \frac{R}{1+R}(W - \Sigma x_i) + \Sigma \frac{r_i}{1+R} x_i = \Sigma v_i c_i$$

(here c_i is the i-th consumption good, v_i its price, x_i the i-th short term asset).

The main assumption is that the utility function is weakly separable in the short term assets, i.e. there exist a function f(x) such that:[8]

$$(4) \qquad U = U(\bar{c}, f(\bar{x}))$$

In the assumption that f(x) is homothetic,[9] the standard results of aggregation theory may be applied, and problem (3) may be split into two stages (Varian, 1984, p. 149): the "aggregate" demand for liquidity, given its "mean" price; and the choice of the composition of the liquid assets, given total liquidity and

7. The assumption implies no loss of generality; it is formally equivalent to the explicit introduction of either transaction costs or cash-in-advance constraints in the budget constraint (see Feenstra 1986).

8. Here, the intuition is that assets x_i all provide the same utility-generating service to the consumer.

9. A homothetic function is a monotonic transformation of a homogeneous function. See Barnett(1987) to extend the results to a non-homothetic utility function.

the relative price of each component. The sub-utility function f(x) represents the liquidity services produced by the assets x_i, and may be used as an aggregation function.

Defining the "price" $P^* \equiv \frac{\Sigma \pi_i x_i}{f(\bar{x})}$,[10] the aggregate problem is:

$$\text{(5a)} \qquad \max_{\bar{c}, f} \quad U(\bar{c}, f)$$

$$s. \qquad y_0 + \frac{R}{1+R} W = \Sigma v_i c_i + P^* f$$

where the "quantity" f and the "price" P* are equivalent to an elementary good.[11] For given total "expenditure" in monetary assets, defined as $P^* f \equiv m$, the portfolio composition is determined by the second problem:

$$\text{(5b)} \qquad \max_{\bar{x}} \quad f(\bar{x})$$

$$s. \qquad \Sigma \pi_i x_i = m$$

The total differential $df(\bar{x}) = \Sigma \frac{df}{dx_i} dx_i$ shows that the change in total liquidity f(x) can be measured as the sum of the change

10. If f(x) is homothetic, P* just depends on prices π_i, since in this case the indirect utility function is such that $f(\bar{x}) = g(\bar{\pi}) \Sigma \pi_i x_i$; hence $P^* = g(\bar{\pi})$ (Varian, 1984, p.149).

11. See Barnett (1987).

in each component, weighted by its marginal utility. The weights df/dx_i are not directly observable, but they may be derived from the first order conditions of problem (5b):[12]

(6) $$\frac{df}{dx_i} = \lambda \pi_i \qquad i = 1, \ldots, n$$

$$\lambda = \frac{\Sigma \frac{df}{dx_i} x_i}{\Sigma \pi_i x_i} = \frac{f(x)}{\Sigma \pi_i x_i}$$

Substituting (6) in the total differential above, we get:

(7) $$d \log f(\bar{x}) = \sum_{i=1}^{n} \sigma_i \, d \log x_i \qquad \sigma_k = \frac{\pi_k x_k}{\sum_{i=1}^{n} \pi_i x_i}$$

Comparison between (7) and (2) shows that the rate of growth of the divisia index represents a discrete approximation of the rate of growth of total liquidity f.

Equation (7) coincides with simple-sum aggregation only when the prices πi (hence the yields r_i) are all equal (in this case $s_i=1/n$). This happens, according to (6), when all the components are perfect substitutes; only in this case "money" is defined by their simple sum.

An implication of the above is that the estimation of a standard demand function would be appropriate for a Divisia index, but not for a simple sum aggregate: the latter does not have a one-to-one relation with its average yield.

12. The expression for λ is derived from the assumption of homotheticity, since $f(x) = \Sigma \frac{df}{dx_i} x_i$.

2.3 Some problems and some results in the literature

According to the simple model in the last section, some conditions on the preferences of the public (the weak separability of the utility function) must be fulfilled in order to aggregate different monetary instruments; moreover, the proper weight assigned to each component depends on its market yield, which in turn measures liquidity.

Many arguments have been brought against the latter conclusion, based on the restrictive assumptions it requires.[13] In the simple model exposed so far a) the only reason to hold a short term instrument is its liquidity services; b) the actual return on the instrument depends only on its contractual interest rate, while other conditions do not matter; c) portfolios instantaneously adjust to changes in relative yields.

Propositions a) and b) may not be true, either in the presence of uncertainty and risk premia,[14] or in the case of non-price competition among banks; the effect of expectations on the term structure introduces a further complication, since the interest differential between assets with different maturities can no longer be uniquely interpreted as a liquidity premium. Proposition c) is unlikely to hold unless transaction costs are negligible; as a consequence, a change in the average level of market rates may bias the index, since it does affect the relative weights (those of the more liquid assets increase with the level

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13. A theoretical and empirical examination of the problems connected to the construction of a Divisia index for the United Kingdom is in Fisher, Hudson and Pradhan (1993).

14. On the effects of uncertainty on Divisia indexes, see Barnett, Hinich and Yue (1991).

of R), and this is initially not matched by the quantity adjustments that will take place in equilibrium.[15] In this case, moving averages of the interest rates must be used to compute the weights.

Financial innovation may also affect the properties of the index. We may distinguish two cases: i) a change in the "cost" of producing a short-term instrument (e.g., induced by changes in taxation or reserve requirements) or the introduction of a new one; ii) a change in the liquidity services yielded by an already existing asset (e.g., the introduction of ATMs, that affects the liquidity of current accounts). While case i) does not violate any of the assumptions in the model above, case ii) implies a change in the functional form of f(x). It has been shown[16] that this introduces a "wedge" between the change in the index and the actual change in liquidity.

Some practical problems also arise in the actual construction of the index, as i) the results are very sensitive to the choice of the interest rate on the "alternative" asset, R; ii) in a monetary restriction, the yield on a short-term instrument may be greater than R, causing the corresponding weight to be negative; iii) the length of the moving average used to compute the weights is *ad hoc*.

All the above does in fact suggest caution in interpreting the index. However, one has to bear in mind that not only a weighted index, but also a simple-sum aggregate is based on quite restrictive assumptions. On the one hand, the procedure used to compute the weights may indeed bias the Divisia index; on the

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15. The direction of the bias can not be determined a priori, since the weights sum to unity. On the contrary, for a "currency equivalent" aggregate (Rotemberg et al., 1991) the sum of the weights turns out to be procyclical, producing a spurious correlation between the index and the business cycle (see Grande and Rinaldi, 1993).

16. See Ford, Peng and Mullineaux (1992).

other hand, an aggregation bias is always present in a simple-sum aggregate, as the perfect substitutabilty assumption is far too restrictive. Both just approximate the "correct" aggregate; each one's usefulness has to be evaluated on empirical grounds, based on their performance as monetary indicators.[17]

Empirical investigation has been conducted both in the academic literature and by Central Banks, following two directions: the proper choice of the components to be included, based on weak separability tests; and the analysis of the properties of the index, taking composition as given.

While on the first issue the available procedures do have weaknesses,[18] on the second issue there is a large body of literature, based on many criteria: comparisons of traditional aggregates and Divisia indexes, stability of the velocity of circulation, information content, Granger-causality tests, demand equations, cointegration analysis. The results are not clear-cut, but they are usually quite satisfactory. For the US, Barnett(1982) concludes that the Divisia index based on "liquidity" (L) performs better than both traditional aggregates and indexes based on narrower aggregates. Thornton e Yue (1992) again show that Divisia indexes are mostly useful when applied to L. According to Orphanides and Porter (1993), the performance of the Divisia index is good, much better than for other "weighted" indexes, but is not superior to some simple-sum monetary aggregate. In

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17. Since the aggregation bias is larger, the less substitutable are the individual components, one is led to believe that the Divisia index performs better when applied to "broad" definitions of money. In most empirical investigations, this turns out to be the case.

18. A non-parametric test for weak separability was introduced by Varian (1983); however, its extension to a stochastic environment is not straightforward. Parametric tests require assumptions on the form of the utility function; the most used are flexible-form functions, like the trans-log (see Serletis, 1987; Serletis and Robb, 1986).

the UK, according to the results of a recent paper by Fisher, Hudson and Pradhan (1993), the index is a leading indicator for nominal income and inflation (see also Bank of England, 1993). For Spain, Ayuso e Vega (1992) reach negative conclusions on the use of weighted indexes, based on cointegration analysis.

3. An application to Italy

In Italy, for more than a decade the monetary aggregates have been a guidance to monetary policy: since 1984, growth ranges for M2 are publicly announced each year. The Bank of Italy also defines a narrower aggregate (M1) and a larger one (M3 until 1990, "liquid assets" (AL) after this date). A number of empirical investigations highlighted the information content of M2 on the behaviour of final targets.[19] Revisions of the definition of these aggregates were carried on from time to time, in order to consider institutional and financial innovations.[20]

3.1 Short-term instruments, user costs, weights

We built a Divisia index corresponding to the composition of each of the above-mentioned aggregates. The first step was the definition of the yield on the alternative, "non-liquid" asset (R).

In the existing empirical applications, R is usually the yield on a medium term, low-risk bond.[21] For Italy, we used the

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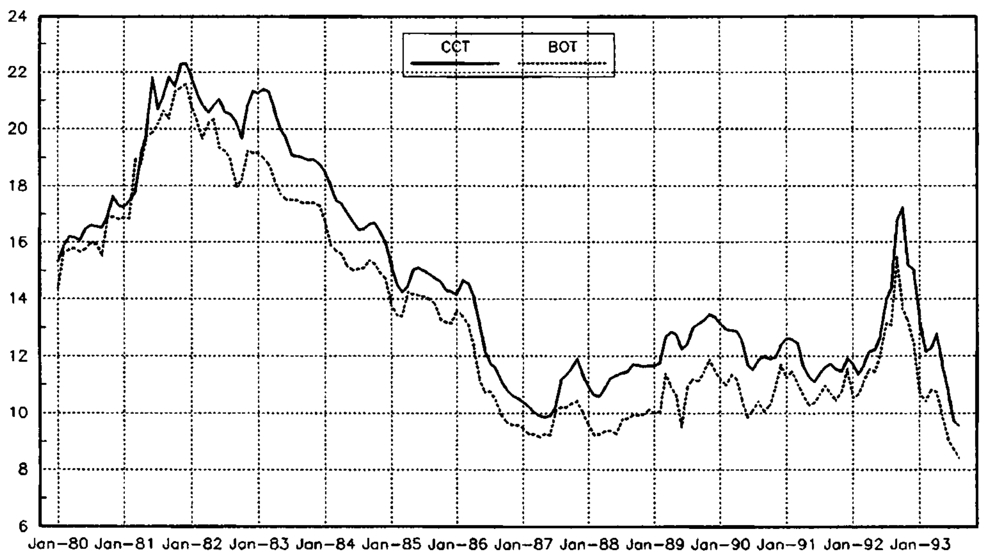
19. See for instance Angeloni and Cividini (1989).

20. See Banca d'Italia (1985, 1991).

21. A Baa bond was chosen for the US and Switzerland (Thornton and Yue, 1992; Yue and Fluri, 1992), a two year public bond for Spain (Ayuso e Vega, 1992); in Bank of England (1993), instead, a shorter-term rate is used (the three-month local authority deposit rate).

secondary market yield of variable-rate, medium term Treasury bonds (CCT). The choice of CCTs as the alternative asset is consistent with the large weight that they have in the medium and long-term portfolio of the non-state sector:[22] in 1985, they represented 60 percent of total financial assets excluding liquid assets; at end-1992, this ratio was lower, but still high (44 percent). An advantage of this choice is to minimize the bias that may be introduced by changes in the slope of the yield curve (since the yield is indexed) and to avoid that a negative weight may be assigned to some component[23] (the CCT rate was never lower than the BOT rate, in turn the higher among financial assets; Fig. 1).

AFTER-TAX INTEREST RATES Fig. 1



22. The definition of "non-state sector" is the one used for monetary aggregates; it includes firms, households, insurance companies, local authorities, social security institutions.

23. This occurrence is not infrequent in the applied literature; in this case, the corresponding user cost is set to zero.

The instruments that we considered (i.e., those included in M1, M2, AL) are shown in Table 1, together with the own interest rate.[24] The user costs were computed according to (2) above; six-term moving averages of the yields were used.[25]

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24. The stock of each instrument is computed as the monthly average held by the non-state sector; the average is computed on daily data or, when these are not available, as the mean of end-of-month values. For the sake of simplicity, we did not distinguish among different categories of saving deposits - "liberi" (withdrawal on request) and "vincolati" (time deposits). Although the yield on the latter is slightly higher than the yield on the first, the results are not sensitive to this assumption.

25. For each instrument, the marginal yield (that on new issues) should be used. In some instances, the average yield is used, due to data availability constraints; the effect is likely to be minor, since moving averages are used to "smooth" each interest rate. Data on the interest rate applied to "repo" operations are available since 1988, and they are in line with those on T-bills; before 1988, the latter were used as a proxy. Yields on CDs are available since 1985 (on a quarterly basis for longer term CDs); before 1985, they have been estimated using the interest rate on deposits plus a constant spread. The assumption does not influence the results, since the stock of CDs was almost zero in this period. Postal office saving certificates carry a premium on the nominal interest rate, that increases with the increase in the holding period; we used ex post returns, based on the annual interest flows.

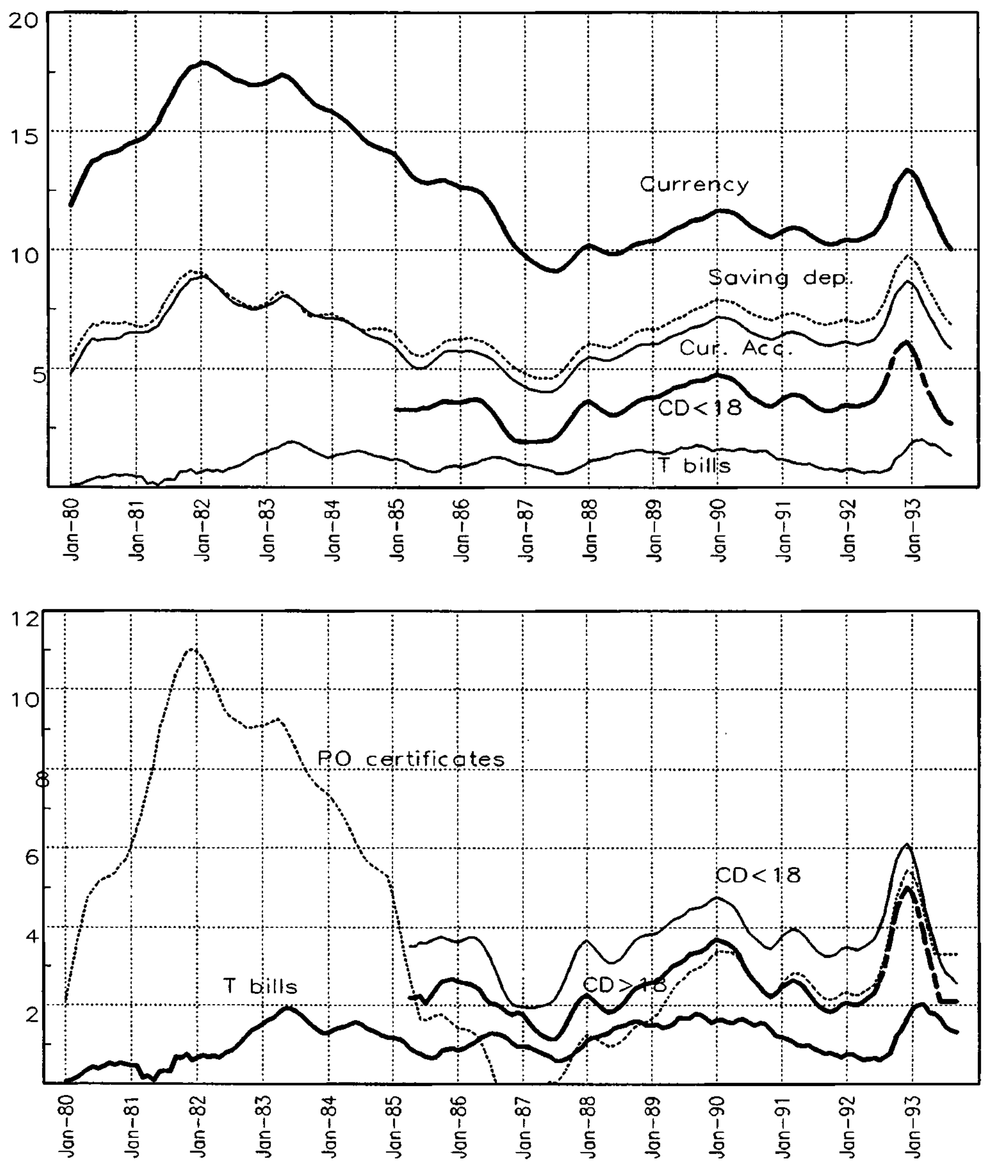
Table 1

MONETARY AGGREGATES AND THEIR COMPONENTS

	Instrument	Yield
	Currency in circulation	zero
	Current accounts with banks	average interest rate on current accounts(1)
	Current accounts with the Post Office	fixed (1.5%)
M1	Bankers' drafts issued by credit institutions and by the Bank of Italy	zero
	Saving deposits with banks	average interest rate on saving deposits(2)
	Saving accounts with the Post Office	fixed (8%)
	CDs issued by banks, with less than 18 months maturity	yield on 6-month CDs issued in the month(3)
M2	CDs issued by banks, with maturity equal or greater than 18 months	average yield on CDs with maturity equal or greater than 18 months(4)
	Post Office saving certificates	ex-post yield (total interest over average stock in the year)
	CDs issued by Special Credit Istitutions	proxied with the interest rate on CDs issued by banks(3)
	Banks' securities repurchase agreements with customers	repo rate until 1988(5); proxied with BOT interest rate before that date
AL	Treasury bills in lire and in ECUs	average yield at BOT auctions in the month
	Alternative asset	secondary market yield, floating-rate CCTs(6)

Sources: (1) ten-day banking statistics (since 1985), Centrale dei Rischi (before 1985); (2) ten-day banking statistics (since 1985), estimates (before 1985); (3) ten-day banking statistics; (4) Centrale dei Rischi; (5) Caboto; (6) Banca d'Italia, based on Stock Exchange figures.

USER COSTS OF THE SHORT-TERM INSTRUMENTS Fig. 2a
(percentage points)



The main user costs are shown in Figures 2a and 2b. In the whole period, they moved together (the only exception is Post Office saving certificates): the relative yields were in fact quite stable. This marks a noticeable difference with the results obtained for the US,[26] were financial innovation caused wide fluctuations in the relative rates of return. This highlights the fact that the degree of substitutability among different instruments was rather stable in Italy, and favours the use of traditional aggregates.

The current definition of M2 is consistent with the ordering of the user costs in the figures: all components of M2 (currency, saving deposits, current accounts, short and long term CDs) are in fact associated with a higher user cost. However, in absolute terms, the user cost of CDs (included in M2) and those of T-bills, repo agreements[27] and Post Office certificates (excluded) are not much different from one another; from this stand-point, the distinction currently drawn between M2 and other short term instruments may be too sharp (Fig. 2b). At the beginning of 1992, the user cost was 3.5 percent for short-term CDs, 2 percent for longer-term CDs, 2.4 for Post Office certificates, 1 percent for T-bills. The monetary role of Post Office certificates reduced sharply in the past decade; the level of the user costs points to the fact that, in 1981, they were close substitutes for current accounts, while in 1993 they were more akin to CDs; this looks consistent with the decision to exclude them from M2, in 1991.

26. See for instance Barnett, Fisher and Serletis (1992).

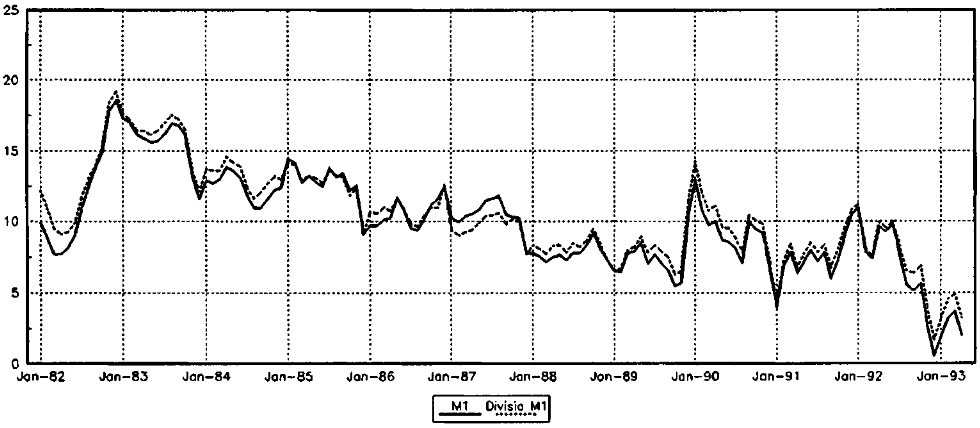
27. The user cost of "repos" is omitted from the figure, since it is very similar to the one of T-bills.

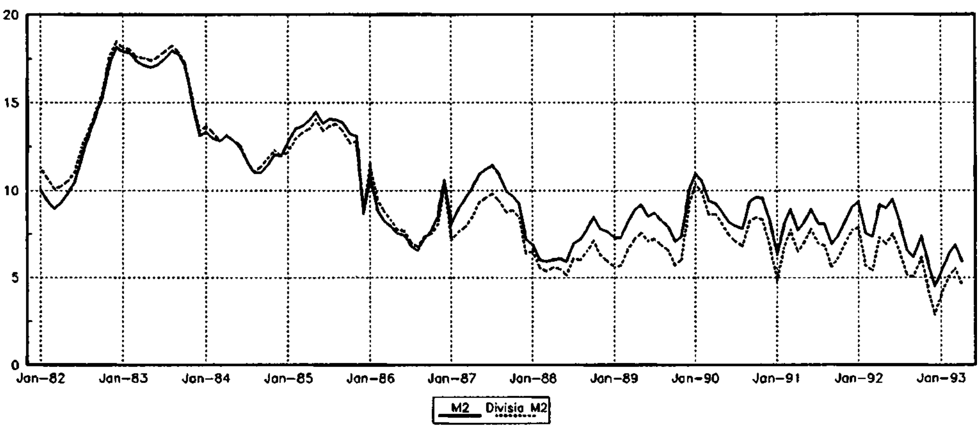
3.2 Simple-sum aggregates and Divisia indexes: a comparison

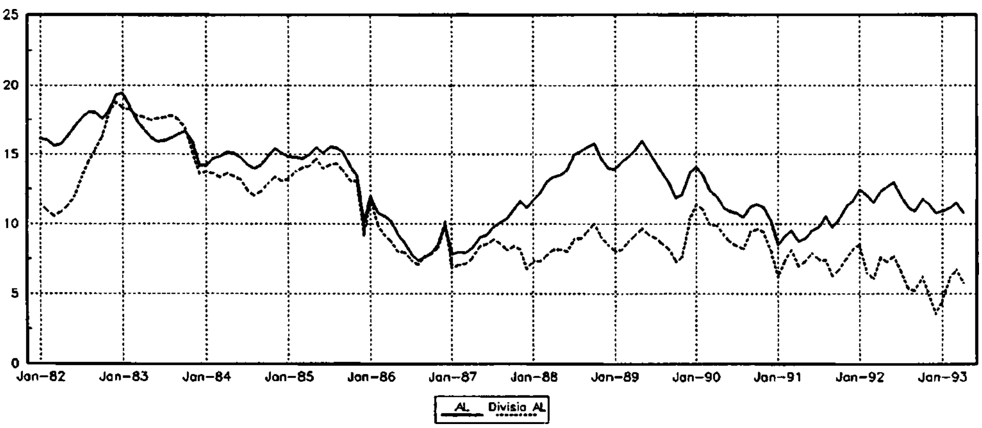
Divisia indexes were computed for M1, M2, AL.[28] In Figure 3, the twelve-month growth rates of simple-sum aggregates and those of the corresponding indexes are shown; Table 2 sums up the differences.

28. The time profile of the index is not very sensitive to the length of the moving average applied to market interest rates; we tried different lenghts, between a maximum of 24 and a minimum of 1 month. On the contrary, different choices for the bench-mark rate of return (R) are not neutral, although the qualitative results are not affected: in recent years, if either the T-bill or the BTP interest rate (both lower than the CCT rate) are chosen, the twelve-month rate of growth of the Divisia index is lower, between 0.5 and 1 percentage point on average (no relevant difference was observed before 1988). A lower level of the bench-mark interest rate further reduces the weight of high-yielding instruments, like CDs, that were the fastest growing in this period.

TWELVE MONTH GROWTH RATES Fig. 3







Until 1986, the Divisia indexes follow the same pattern as the corresponding simple-sum aggregates. It is only after 1987 that they begin to differ: M1 only slightly, M2 and AL in a more marked way (Fig. 2). Over the whole period, the difference between the twelve month rates of growth of M1 and Divisia-M1 (Table 2) is not large, although statistically significant (the Divisia index grows half a percentage point more than the simple sum aggregate); it is larger and more variable for M2 (the index grows 0.8 percentage points less than the aggregate); much bigger for AL (the index grows 2.7 percentage points less than the aggregate; moreover, discrepancies between the two rates of growth are quite variable, as the standard deviation reported in Table 2 shows).

Table 2

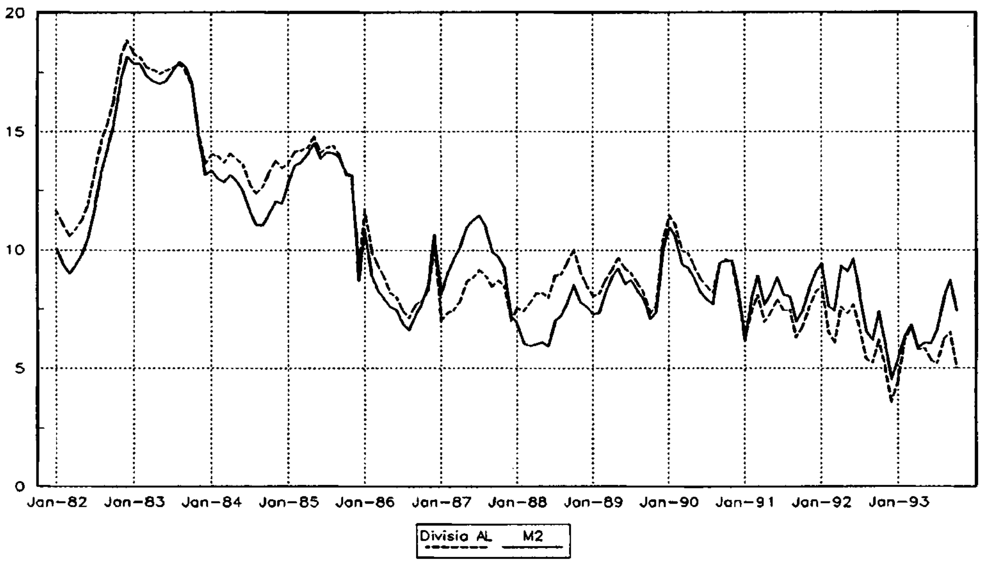
DIFFERENCES AMONG THE TWELVE-MONTH GROWTH RATES OF SIMPLE-SUM AGGREGATES AND DIVISIA INDEXES
(1982,1-1993,8)

Variable	mean	stand. dev.	t(1)
DM1-M1	0.51	0.61	9.9**
DM2-M2	-0.81	1.09	8.7**
DAL-AL	-2.67	2.23	14.1**
DAL-M2	0.17	1.05	1.8

(1) Test that the mean is different from zero.

Both the last row in Table 2 and Figure 4 compare Divisia-AL (the index that takes account of the high substitutability among CDs, T-bills and "repos") and M2 (the officially targeted aggregate). The growth rates were not systematically different; although small on average, however, the differences were quite variable (the standard deviation is about one percentage point). After 1987, the two patterns do sometimes diverge (Fig. 4).

TWELVE MONTH GROWTH RATES Fig. 4



All in all, until the mid-eighties, Divisia indexes do not seem to give much additional information than their simple-sum counterparts, while they increasingly diverge in recent years. This is a consequence of the way financial innovation spread out in Italy. At the end of the seventies, a major change in the Italian financial system was the diffusion of T-bills, but the effect of innovation on the liability side of banks' balance sheet was quite slow compared to other countries (notably the US). Until the mid-eighties, almost the whole stock of short-term instruments was represented by non-CD bank deposits; as a consequence, the different ways to weigh the components of the monetary aggregates do not affect the overall rate of growth. Financial innovation begun affecting the composition of banks' liabilities after 1987; in this year the share of CDs in total bank deposits started increasing,[29] and it further accelerated in 1989, when longer term CDs were introduced, and in 1992-1993, when they experienced a dramatic growth. "Repo" operations between

29. On financial innovation on the liability side of banks' balance sheets see Focarelli and Tedeschi (1993).

banks and customers started to grow in 1987 and accelerated in 1991. Changes in reserve requirements and in the tax treatment contributed to these developments.

The Divisia-AL index includes all the "new" instruments, characterized by a lower liquidity and a higher yield. Compared to M2, it assigns a lower weight to CDs, but it includes instruments like T-bills and "repos" (although with a small weight). Portfolio reshufflings among short-term instruments are less likely to be regarded as a change in liquidity.[30]

The patterns of Divisia-AL and simple-sum M2 indicate that, in the past, the latter was a good approximation of "aggregate liquidity", as it would be measured by an aggregation-theory-based index. However, the two profiles do differ in a number of instances in recent times, reflecting the wide portfolio shifts that took place among the "borderline" assets (T-bills, "repos", CDs). The short-run information content of M2 may be affected.

3.3 Some long-run properties

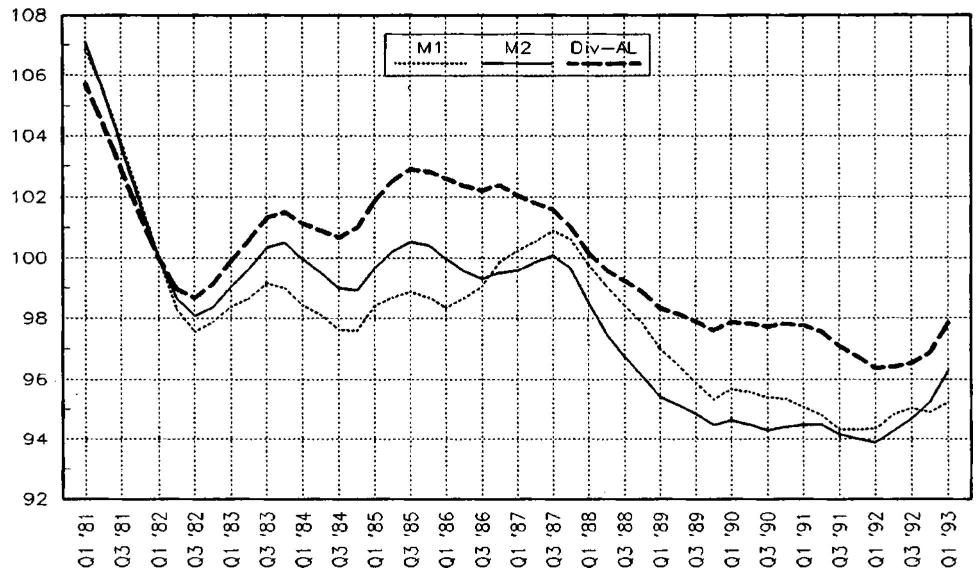
For each aggregate and the corresponding index, Figures 5a and 5b show the ratio to domestic demand;[31] by definition, the ratio is itself an index, and a base date 1982,1=100 was imposed. All ratios are rather stable, with the only exception of simple-sum AL, that follows a strongly increasing trend throughout the whole period; this is not surprising, since the aggregate is not held for transaction purposes. The ratio for Divisia-AL is the most stable; M1, M2 and Divisia-M2 follow.

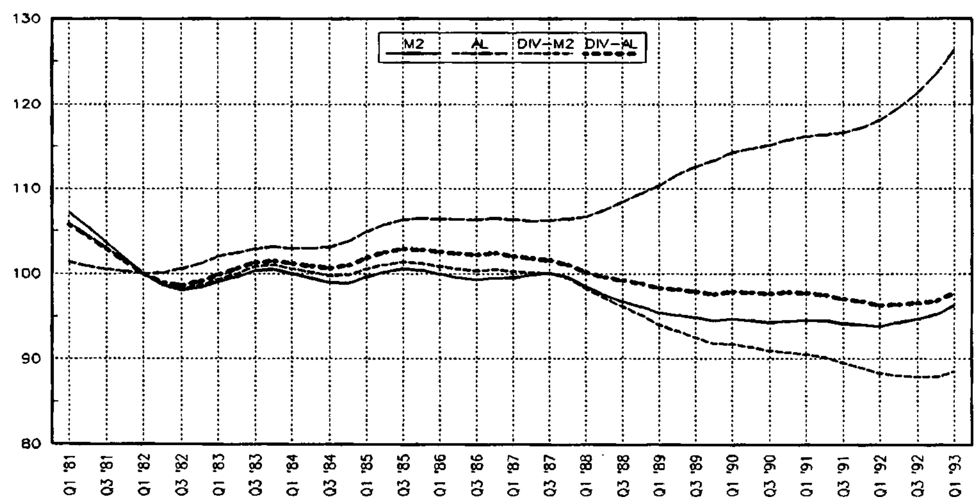
30. As pointed out in section 2.3, when innovation is of this kind, the Divisia index is a correct measure of liquidity.

31. Divisia-M1 is omitted, since it is very similar to simple-sum M1.

RATIOS BETWEEN MONETARY AGGREGATES AND DOMESTIC DEMAND Fig. 5

(1982,1 = 100)



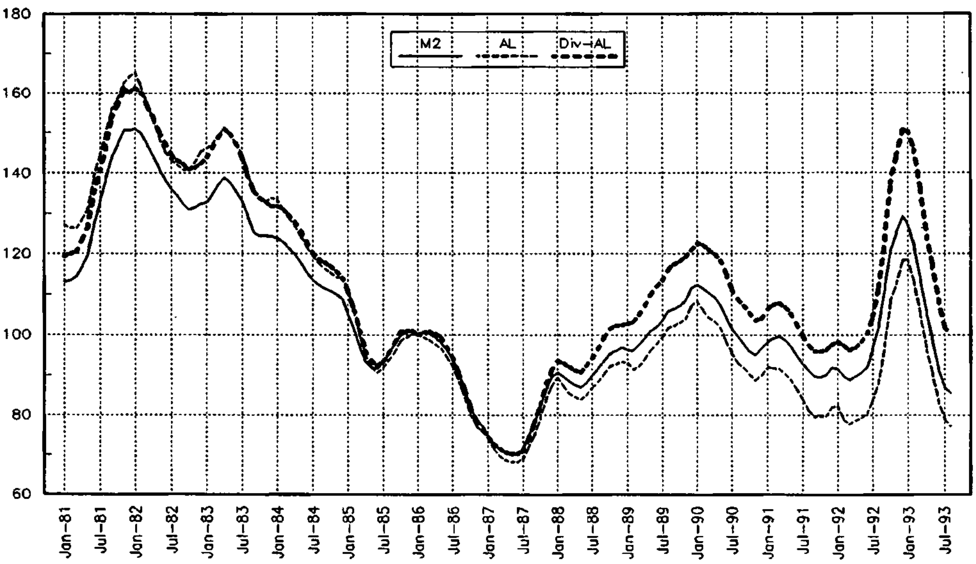


The decrease of the ratio in the years before 1982 and after 1987 is a common feature; in both these periods, the opportunity cost to hold liquidity increased, due to the rise in market interest rates. The opportunity costs since 1982 are shown in Figure 6 (all the patterns are quite similar); for each index, they can be measured, as in equation (5) above, as the ratio between the total interest foregone and the value of the index (as a consequence, it is itself an index):[32]

$$P^* = \frac{\Sigma \pi_i x_i}{D}$$

OPPORTUNITY COST OF LIQUIDITY
(1986,1 = 100)

Fig. 6



Since the series are non stationary, the existence of a long-run relationship among each monetary aggregate (or index), real domestic demand, consumer prices and the opportunity cost has been verified through a cointegration test. Table 3a reports the results of unit-root tests for each monetary index, real domestic demand, consumer prices and the opportunity costs. The hypothesis of a unit root can never be rejected; moreover, the

32. For simple-sum aggregates, this coincides with the traditional way to measure the opportunity cost. Given the definition of π, and imposing $D = \Sigma x_i$, one gets $P^* = \frac{1}{1+R}\left(R - \Sigma \frac{x_i}{\Sigma x_i} r_i\right)$

ADF test does not allow rejection of non-stationarity for first-order differences, suggesting that monetary aggregates may be I(2); the same holds for the other series.[33]

Table 3a

UNIT ROOT TESTS
(1982,Q1-1992,Q4)

variable	ADF(4 lags) (levels)	ADF(4 lags) (1st differences)
M1	-3.3	-1.5
M2	-1.8	-2.5
AL	-0.1	-2.5
D-M1	-3.1	-1.7
D-M2	-2.3	-1.8
D-AL	-1.8	-1.9
real dom. demand	-1.7	-1.9
consumer prices	-0.7	-2.9
opportunity cost:		
M1	-2.0	-0.7
M2	-2.4	-1.0
AL	-2.7	-1.0
D-M1	-2.2	-0.7
D-M2	-1.9	-0.7
D-AL	-1.9	-0.6

The results of Engle-Granger tests[34] are reported in Table 3b. The monetary aggregate, real demand and the price index are in logs. The opportunity cost index is in levels, with base date 1986,1=100.

33. The change in the rates of growth of the variables in the second part of the eighties contributes to the result. This is standard for nominal variables (nominal money and prices); less so for real demand and the opportunity cost index.

34. The use of multi-variate cointegration tests à la Joahnssen is not straightforward, since series are I(2).

Table 3b

ENGLE-GRANGER COINTEGRATION TESTS

(1981,Q1-1992,Q4)

Dep. var.	const.	demand	prices	P*	ADF	Test $\beta_{prezzi}=1$
M1	0.56 (8.4)	0.97 (21.6)	0.89 (45.0)	-0.09 (8.0)	-4.5*	t=5.25 (0%)
M1-Div.	0.30 (4.2)	0.95 (20.7)	0.96 (46.2)	-0.07 (5.7)	-3.6*	t=2.1 (4%)
M2	0.38 (4.9)	0.78 (15.9)	0.95 (42.9)	-0.06 (4.5)	-3.4*	t=1.8 (7%)
M2-Div.	0.58 (9.4)	0.50 (11.9)	0.97 (52.1)	-0.11 (9.8)	-4.2*	t=1.6 (12%)
AL	-0.940 (8.0)	1.36 (20.0)	1.14 (35.2)	0.07 (3.8)	-0.5	t=4.5 (0%)
AL-Div.	0.16 (2.6)	0.75 (17.5)	1.02 (55.3)	-0.04 (4.9)	-4.6*	t=0.9 (36%)

Legenda: demand=domestic demand, deflated with consumer prices, logs; Prices=consumer price index, logs; P*=opportunity cost index. Seasonal dummies are included. ADF=augmented Dickey-Fuller test (4 lags).

T-statistics are in brackets below the estimated coefficients; an asterisk near the augmented Dickey-Fuller test indicates that the null hypothesis of no cointegration is rejected; the last column reports the t-statistic for the hypothesis of a unit price elasticity.

A long-run relation with the right-hand-side variables holds for all the monetary variables, except AL (again, this is not surprising, since AL is not held for transaction purposes). Both the sign and the magnitude of the coefficients are broadly consistent with what may be expected to be a "long run" money demand function; however, the restriction of a unit price elasticity is either rejected or accepted at very low confidence levels for all the simple-sum aggregates; it can not be rejected for Divisia-M2 and Divisia-AL (the confidence level is particularly high for the latter). This result is consistent with the view that traditional money demand equations are misspecified due to aggregation bias, although a more detailed econometric analysis would be needed on this point.[35]

Real demand elasticity is about 0.8 per cent for Divisia-AL, comparable to that obtained for M2 (0.6). The opportunity cost has a negative coefficient for all the monetary aggregates (but simple-sum AL); although its absolute value is not of immediate interpretation (it depends on an arbitrary multiplicative factor determined by the base-date chosen for P*) the coefficient for Divisia-AL is about 30 percent lower than the one for simple-sum M2.[36]

A lower interest rate elasticity is consistent with the theoretical properties of the Divisia index: the overall demand for "liquidity" should only be influenced by changes in the average cost of liquidity, while it should be unaffected by changes in the relative yields of the components; unlike simple-sum aggregates, the Divisia index does in fact "internalize pure substitution effects" (Barnett, 1982).

The results stress some desirable features of Divisia-AL as a monetary indicator: a stable velocity, a price elasticity equal to one, an interest elasticity lower than for simple-sum aggregates.

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35. The difficulties in mantaining the unit price elasticity restriction are common to much empirical work on money demand in Italy; it is usually attributed to structural shifts. See Angelini, Hendry and Rinaldi (1994).

36. This ratio is rather stable to the choice of the base-date for P*.

3.4 Short-run dynamics

We examined the short-run dynamics and the information content of the Divisia indexes, by means of both dynamic correlations and vector autoregressions.

The dynamic correlations between each monetary variable and nominal GDP are shown in Figure 7, together with the corresponding confidence interval. Quarterly GDP is reported on a monthly basis using the profile of industrial production; each series is filtered with twelve-month log-differences. The correlations are computed over the more recent period (1986-1992)[37].

The results for M1 and M2 are strikingly different from those for Divisia-AL. For M2, rather surprisingly, no correlation is significantly different from zero; as far as M1 is concerned, only the contemporaneous correlation and the first lag are slightly outside the confidence interval. For Divisia-AL the correlations are instead positive for a large interval of both leads and lags.[38]

The worse performance of simple-sum aggregates may depend on the larger elasticity of their demand to interest rates, shown in the previous section, that reduces the unconditional correlation with GDP. At any rate, inference on causality can not be drawn on the basis of unconditional correlations, although this evidence seems to favour the use of Divisia-AL as a short-run monetary indicator.

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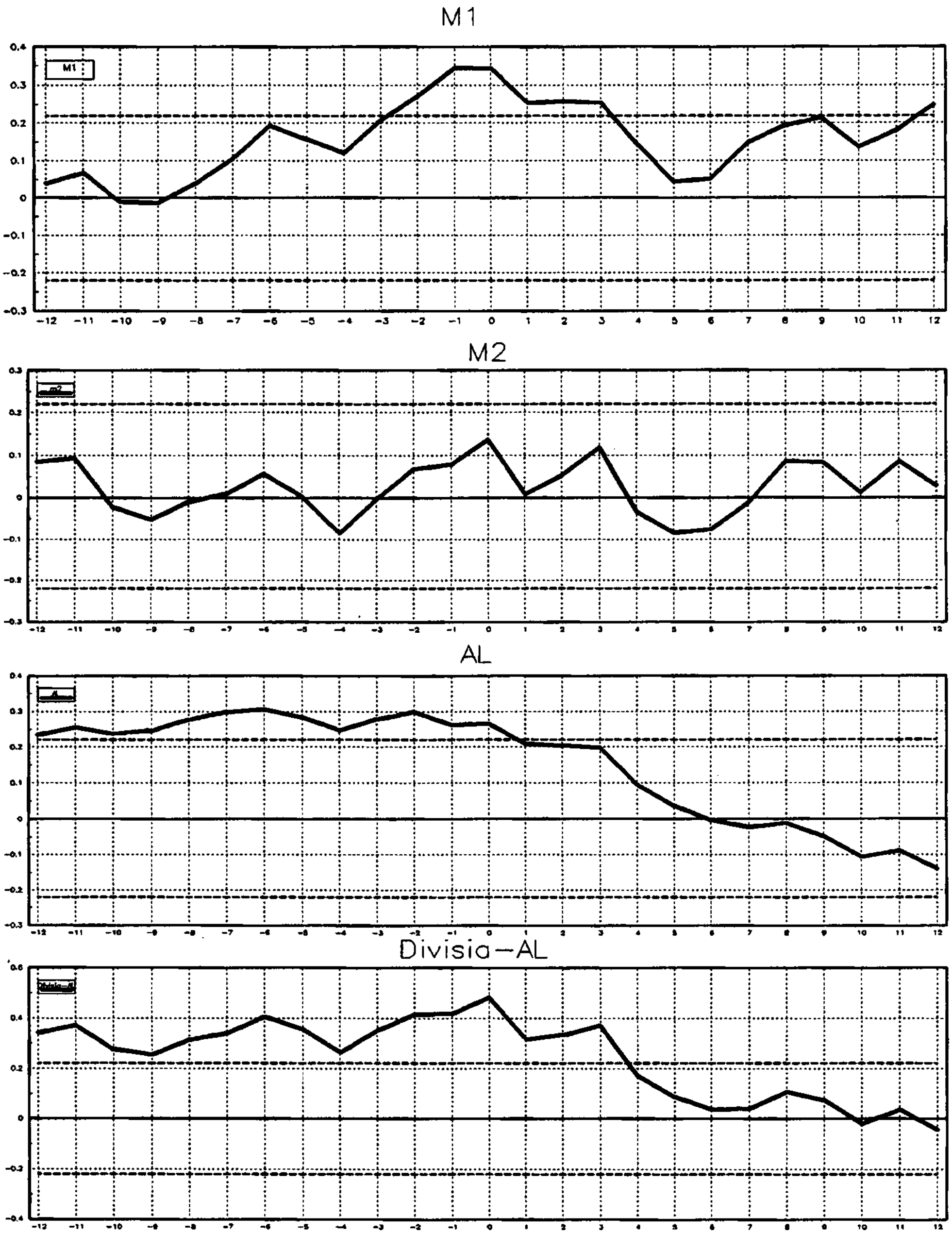
37. In the first part of the eighties the growth rates are themselves not stationary.

38. The correlation are positive for simple-sum AL, too; however, this result is likely to be biased, given the failure to find cointegration in the previous section.

DYNAMIC CORRELATIONS: TWELVE MONTH GROWTH RATES OF A MONETARY AGGREGATE AND NOMINAL GDP Fig. 7



12 month log-differences, 1986,1-1992,12. On the horizontal axis, "-k" stands for the correlation between GDP_t and M_{t-k}. The confidence interval is $\pm 2/\sqrt{N}$.

In order to perform causality tests and to allow a better specification of the short-run dynamics, we estimated six vector auto-regressions (one for each aggregate). Each VAR includes four variables: the monetary aggregate, real GDP, the consumer price index, the opportunity cost.[39] All variables are in levels, and the first three are in logs; eleven seasonal dummies are included.[40] The estimation period is 1986-1992, and the lag length is estimated according to a Schwartz criterion (three lags are included).

Table 4a

VECTOR AUTO-REGRESSIONS:
EFFECT OF EACH MONETARY AGGREGATE ON GDP AND PRICES
(Granger-causality tests) (1)
1986,1-1992,12

effect of ->	M1	M2	Divisia-AL
on (dependent variable):			
GDP	F=1.18 (32%)	F=1.28 (29%)	F=2.44 (7,3%)
consumer prices	F=0.43 (72%)	F=0.97 (40%)	F=1.3 (28%)

Each VAR includes three lags of four variables (GDP, prices, opportunity cost and a monetary aggregate) and seasonal dummies.
(1) F-test for the null hypothesis that all coefficients on lagged values of the monetary aggregate are zero. Confidence levels in brackets.

Some of the results are reported in Tables 4a and 4b. They suggest that neither real GDP nor consumer prices are Granger-caused by any of the monetary aggregates: Table 4a reports

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39. A monthly series for GDP, computed using the industrial production, was already available (unlike domestic demand).

40. The existence of a cointegration relation between the variables allows the estimation of a VAR. Cointegration tests on monthly data, using GDP rather than domestic demand, did non give different results from those in the previous section.

the F-tests of the hypothesis that all coefficients on lagged values of each aggregate are zero in the corresponding equations determining GDP and prices, and the hypothesis can never be rejected. On the contrary, as Table 4b shows, lagged values of both GDP and prices do contribute to forecast monetary aggregates (the table also reports the sum of the coefficients on all lagged values of each variable, and the corresponding t-test). This evidence is consistent with the usual view of the Bank of Italy, according to which the monetary aggregates are demand determined.[41]

41. It should be noted that, even if money does not "lead" output in a Granger sense, it may be a useful indicator due to information lags.

Table 4b

VECTOR AUTO-REGRESSIONS
EQUATIONS FOR THE MONETARY AGGREGATE
(Sum of coefficients and Granger-causality tests)
1986,1-1992,12

effect of ->	GDP	prices	opport. cost	lagged dependent	SEE
on (dependent variable):					
M1:					
Σ	0.62	0.51	-0.05	0.45	0.78%
(t)	(3.8)	(4.2)	(2.9)	(3.6)	
F	5.3**	6.9**	5.5**	10.6**	
M2:					
Σ	0.29	0.50	-0.02	0.55	0.61%
(t)	(2.9)	(3.7)	(2.2)	(4.6)	
F	3.5*	7.0**	3.7*	15.0**	
Divisia-AL					
Σ	0.51	0.56	0.0	0.43	0.52%
(t)	(4.5)	(4.5)	(0.1)	(3.7)	
F	7.9**	9.3**	2.2	11.1**	

Each VAR includes three lags of four variables (GDP, prices, opportunity cost and a monetary aggregate) and seasonal dummies.
F-test for the null hypothesis that all coefficients on lagged values of each variable are zero. Rejection at 5 percent is indicated with (*), at 1 percent with (**).

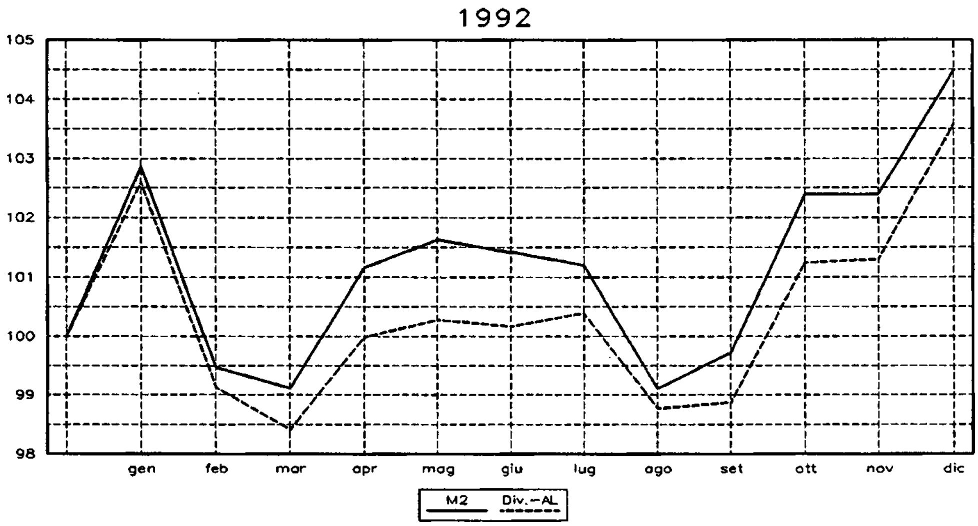
As the F-tests show, the significance of both GDP and prices in explaining "money" is higher for Divisia-AL than for simple-sum M1 and M2. On the contrary, the effect of the opportunity cost is negative on M1 and M2, while it is not statistically different from zero on Divisia-AL.

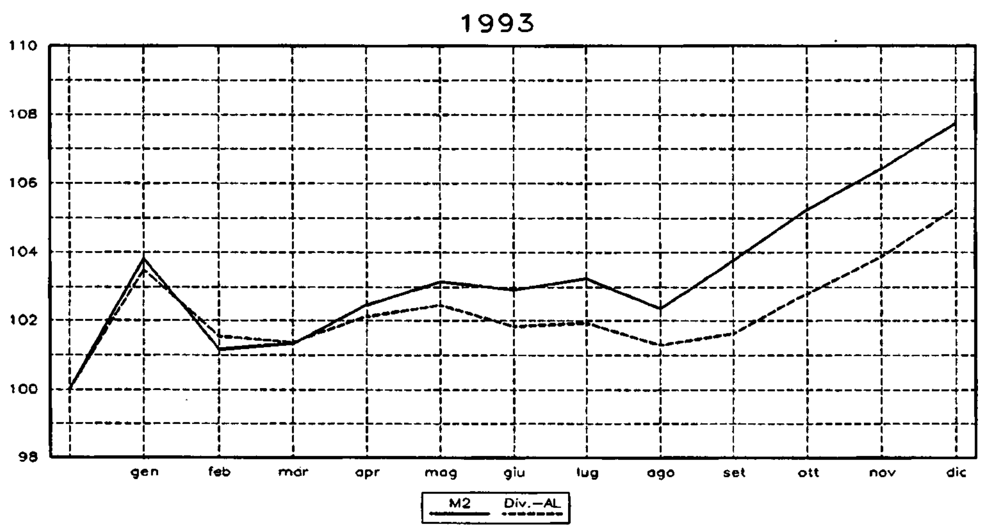
This evidence confirms the previous results. On average, Divisia-AL performs slightly better than M2. The index has a stronger correlation with income and prices; it is less influenced by portfolio shifts in response to interest rate movements. While the appropriateness of the current definition of M2 is not seriously questioned, Divisia-AL may nonetheless give further information on nominal variables. This is especially true in recent years.

3.5 Simple-sum M2 and Divisia-AL in recent years: an interpretation

We compared the behaviour of simple-sum M2 and Divisia-AL in 1992 and in 1993, to check whether they would provide different policy prescriptions. Both years were characterized by unusual, short-run upward instability of the demand for M2.

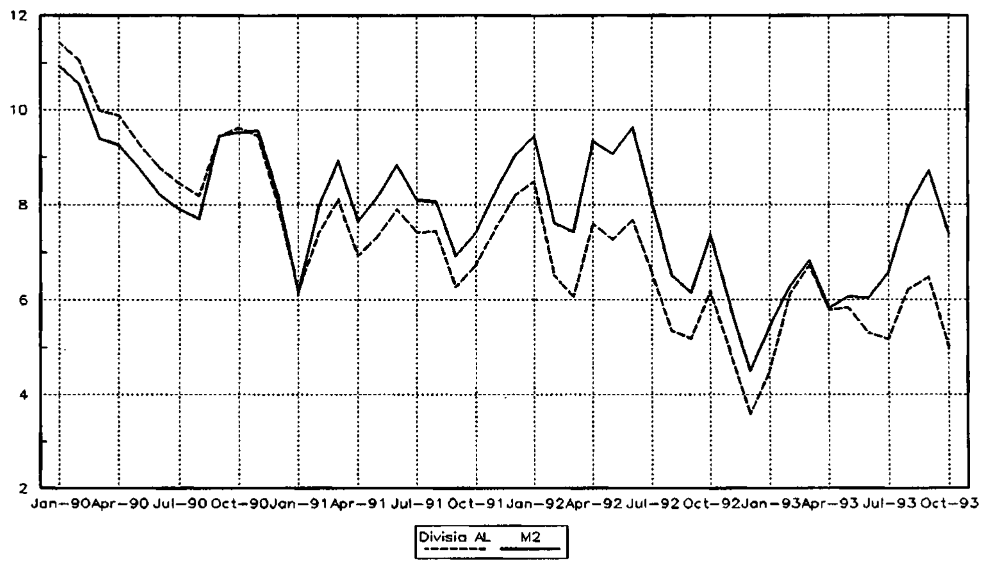
M2 AND DIVISIA-AL IN 1992 AND IN 1993 Fig. 8
(previous December=100)





For each year, the time paths of both M2 and Divisia AL are shown in Figure 8; twelve-month growth rates are compared in Figure 9. Table 5 reports the annualized growth rates since the beginning of the year, computed on three-month moving averages (as it is usual for monetary targets).[42]

TWELVE-MONTH GROWTH RATES Fig. 9



In the first part of 1992, M2 grew above the upper limit of the target range (5-7 per cent); the growth was partly unexpected, as it resulted in an unusual forecast error of the "traditional" money demand equation. No corresponding behaviour of Divisia-AL can be observed; the two profiles start diverging in March (Fig. 8), and the growth rates of the index are constantly lower than those of M2 and within the target range (Table 5). M2 growth is in fact mostly due to the substitution between longer

42. In Italy, the target growth is based on the average stock of M2 in the last quarter of the year. Divisia-AL was seasonally adjusted with X11-Arima over the period 1986-1992; for M2, official data are used.

term securities (Treasury bonds) and monetary instruments with a low liquidity (CDs with more than 18 month maturity), whose weight in Divisia-AL is low.

From January to April 1993, unlike the previous months, the strong growth of simple-sum M2 is matched by a similar behaviour of Divisia-AL (Fig. 8); for both variables, the growth rates since the beginning of the year are outside the target range (5-7 percent). In these months, the growth is led by the (more liquid) bank current accounts, recovering from the low levels reached at end-1992. In the period from May to December, however, Divisia-AL and M2 start diverging again, as a consequence of the sharp increase of CDs with not-less-than-18-month maturity, that are substituted for T-bills and "repos" (both sharply decreasing). This reshuffling of short-term portfolios does not affect much the index, while it shows up in M2. In December, the annualized rate of growth of the Divisia index since end-1992 is 5.6, against 7.7 for simple-sum M2.

Table 5

GROWTH RATES SINCE THE BEGINNING OF THE YEAR
(quarterly averages, seasonally adjusted data)

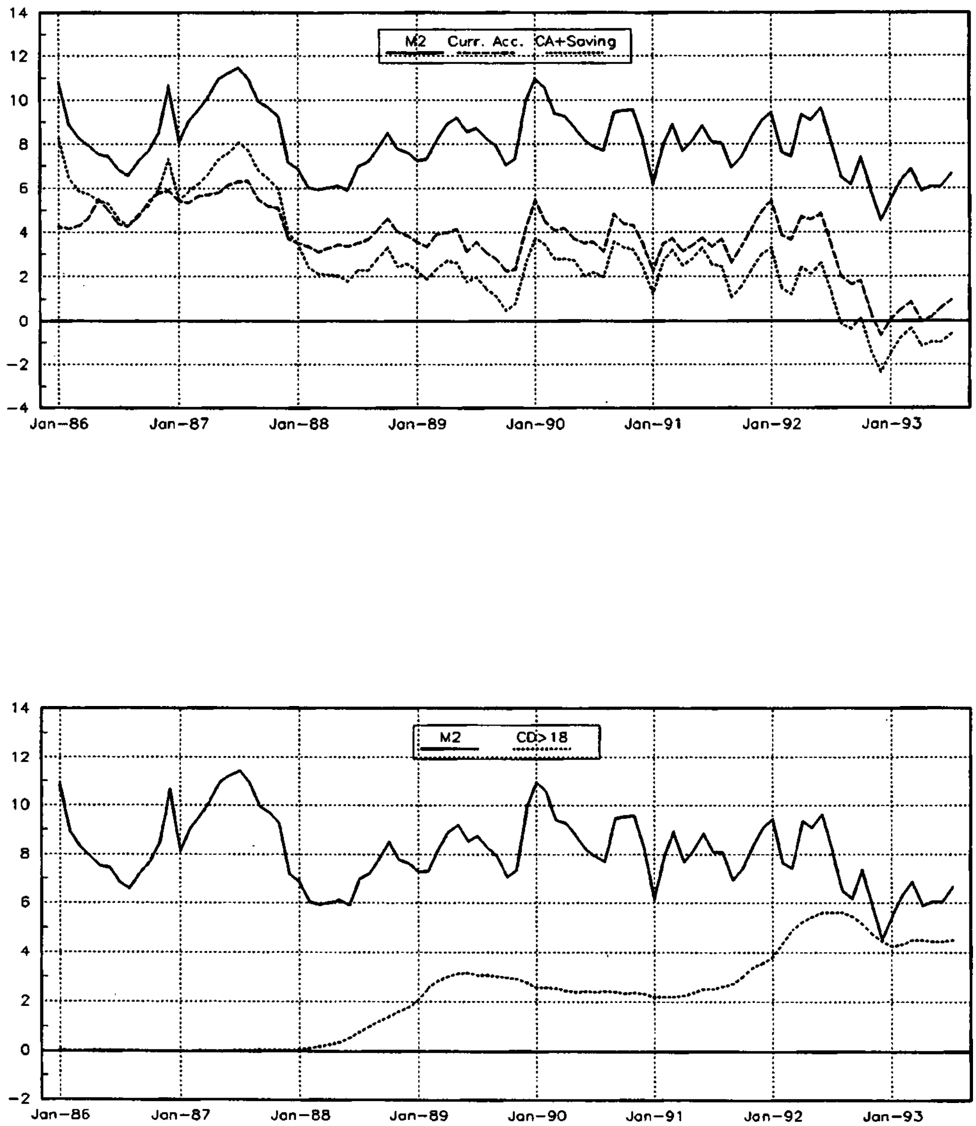
	M2	Divisia AL
1990	9.1	9.0
1991	8.3	7.5
1992 Jan	13.8	8.7
feb	10.2	6.7
mar	8.0	5.3
apr	7.7	5.5
may	8.2	6.1
jun	8.9	6.9
jul	8.0	6.5
ago	6.9	5.7
sep	5.6	4.5
oct	5.6	4.7
nov	5.9	4.8
dec	5.9	4.9
1993 Jan	6.2	3.8
feb	8.0	6.6
mar	8.9	8.1
apr	8.6	8.3
may	8.3	8.0
jun	8.3	7.5
jul	8.1	6.8
ago	8.0	6.4
sep	8.0	6.0
oct	8.0	5.9
nov	8.0	5.9
dec	7.7	5.6

All in all, the Divisia index shows that in recent years some episodes of strong money growth were due to changes in the composition of the short-term portfolio of the non-bank public, with little consequence on its liquidity. The "composition" effect is apparent if one splits the twelve month growth rate of M2 between the contribution of "traditional" bank deposits and that of longer term CDs, as in Figure 10.[43] In the last two years, unlike in the eighties, the growth in longer term CDs accounts for almost all the growth in M2; the contribution of this component was negligible before 1988, while it increased in two instances

43. Contributions to growth are defined as the growth rate of the component, times the (lagged) share of the component on the total.

(1989 and 1991-92), following changes both in regulations and preferences of the public. Some caution must then be used in interpreting the recent growth in M2.

TWELVE MONTH GROWTH RATES OF M2; CONTRIBUTIONS OF TRADITIONAL DEPOSITS AND CDS Fig. 10



Contributions to growth: 12-month change in each component divided by the stock of M2 lagged 12 months. Respectively, current accounts, current accounts plus saving deposits, CDs with maturity not less than 18 months.

4. Conclusions

The main conclusions of this paper may be summed-up as follows:

i) the high correlation among the "user costs" of different instruments indicates that, in Italy, financial innovation had a smaller effect on the substitutability among different kinds of bank liabilities than it did in the US. As a consequence, the composition of M2 does not appear to contrast sharply with the aggregation-theory-based index: the assets included in M2 are the same that have a large weight in the "liquid assets" Divisia index. Nonetheless, the evidence suggests that the separation among "borderline" instruments (those included in M2, as CDs, and those excluded, as T-bills, "repo" operations, Post Office certificates) may be too sharp;

ii) the "liquid assets" Divisia index has good features as a monetary indicator, sometimes better than the simple-sum aggregates. The econometric evidence shows that it has a long-run relation with a "transaction" variable (either real GDP or real demand) and that it has unitary elasticity to consumer prices; in the short run, it is Granger-caused by GDP and prices, while it is rather unaffected by changes in market yields;

iii) overall, M2 has been an appropriate indicator, particularly until the end of the eighties; however, differences between M2 and the Divisia index show up in more recent years, when the use of less liquid bank liabilities spread out. In such a situation, the Divisia index has additional information content;

iv) the index suggests that, recently, the growth of the overall liquidity was smaller than that of M2. The large differences between the index and M2, observed in 1992 and 1993, indicate that the behaviour of the latter was mostly due to changes in the composition of short-term portfolios whose effect on overall liquidity is likely to be minor.

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