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Abstract

This paper sets out to build a synthetic quarterly Divisia monetary aggregate for the euro area using area wide data over the sample period from 1980 to 2000. Then, the analysis proceeds in two separate steps. First, the demand for this Divisia monetary aggregate is evaluated using econometric techniques. By means of a cointegrated VECM model, a theoretically plausible and stable demand function may be estimated. Second, the information content of the Divisia monetary aggregate as regards future output and inflation in the euro area is analysed. The outcome of this analysis suggests that the Divisia monetary aggregate has some information content from a forward-looking perspective, of comparable quality as simple sum M1 and M3. More in general, the paper lends further support to the view that money and "liquidity" should be assigned an important role in shaping monetary policy in the euro area.

JEL codes: E41, E52.

Keywords: EMU, Divisia monetary aggregates, money demand, liquidity.

Non-technical summary

Divisia monetary aggregates have received considerable attention in the theoretical literature due to their strong foundations in aggregation theory; under fairly general assumptions they represent the ideal aggregate measure of "liquidity services" available in the economy and are therefore potentially of great interest to monetary policy-makers aiming at maintaining price stability. Yet, Divisia aggregates have traditionally played a rather limited role as indicators or targets for monetary policy mainly due to often insurmountable measurement problems. Nonetheless, central banks and academics have attempted to construct proxies for Divisia-weighted monetary aggregates and to evaluate their econometric properties, often comparing them with those of their simple sum counterparts. Policy-makers have sometimes used such weighted aggregates mainly as a (useful) source of auxiliary information and to cross-check the information derived from simple sum monetary aggregates to which often prominence is given in external communication.

The analysis of the properties of money indicators in the euro area has focused so far on simple sum aggregates (see for example Coenen and Vega, 1999, Brand and Cassola, 2000, Calza, Gerdesmeier and Levy, 2001, and Stracca, 2001), whereas to date no study of the properties of a Divisia-weighted monetary aggregate in the euro area has been carried out. This paper endeavours to fill this gap and aims at constructing a Divisia monetary aggregate based on the short-term financial instruments included in the euro area broad monetary aggregate M3 and at evaluating the properties of this indicator. The study makes use of euro area data, aggregated prior to 1999 on the basis of the irrevocable exchange rates of 31 December 1998.

The analysis of the properties of Divisia money in the euro area leads to three interesting results.

- First, the euro area Divisia-weighted monetary aggregate co-moves with the broad simple sum monetary aggregate M3 in the long run (as cointegration tests indicate), but departs from it in the short run. This signals that the analysis of the Divisia-weighted and of the simple sum M3 aggregates tends to give consistent signals in the long run, but also that the Divisia aggregate may provide some interesting complementary information in the short term.

- Second, the demand for euro area real Divisia money turns out to be well behaved and reasonably stable in the sample period comprised between the first quarter of 1980 and the last quarter of 2000. The Divisia aggregate in real terms is found to co-vary positively with euro area real GDP (with a coefficient somewhat higher than one) and negatively with the log price dual, as predicted by standard theory. Moreover, the transition to Stage Three of EMU does not seem to have affected the demand for this monetary aggregate to a significant extent, although some short-term instability is detected at the beginning of 1999. That the properties of the Divisia monetary aggregate seem to carry though after 1998 is important, because it suggests that the Divisia monetary aggregate should provide useful information also in the new policy environment of Stage Three of EMU.

- Third, investigating the information properties of the Divisia monetary aggregate as regards future output and inflation developments in the euro area suggests that this indicator has some added value. The analysis of the forward-looking information content of the Divisia monetary aggregate is carried out by estimating an unrestricted VAR model (including inflation, the output gap, the real short-term interest rate and changes in real Divisia money). The dynamic interactions in the economy are analyzed on the basis of the impulse response profile of the model. From this analysis, an apparently significant "liquidity effect" of innovations in real Divisia money growth on the output gap stands out, also affecting inflation with a delay of some quarters. This pattern is not peculiar to the Divisia monetary aggregate introduced in this study; indeed, it is found that including euro area simple sum M1 or M3 in the VAR leads to similar results. To give a more structural interpretation to this analysis, also the deviation of real Divisia balances from the equilibrium (a proxy for "excess liquidity" in the economy) is included in the VAR model in place of changes in real Divisia money. Again, a liquidity effect seems to be a feature of the data.

In sum, the results of this study suggest that the Divisia monetary aggregate displays favourable econometric properties and that the monitoring of this indicator could therefore be a useful complement of the analysis of the simple sum broad monetary aggregate M3 under the first pillar of the ECB's monetary policy strategy. More in general, these results lend further support to the view that liquidity and money should be assigned a prominent role in monetary policy-making and that they contain useful information which is not to be found in other indicators such as the output gap and real short-term interest rates.

1 Introduction

Divisia monetary aggregates have received considerable attention in the theoretical literature due to their strong foundations in aggregation theory (Barnett, Fisher and Serletis, 1992); under fairly general assumptions they represent the ideal aggregate measure of "liquidity services" available in the economy and are therefore potentially of great interest to monetary policy-makers aiming at maintaining price stability.[1] Yet, Divisia aggregates have traditionally played a rather limited role as indicators or targets for monetary policy mainly due to often insurmountable measurement problems. Nonetheless, central banks and academics have attempted to construct proxies for Divisia-weighted monetary aggregates and to evaluate their econometric properties, often comparing them with those of their simple sum counterparts. Policy-makers have sometimes used such weighted aggregates mainly as a (useful) source of auxiliary information and to cross-check the information derived from simple sum monetary aggregates to which often prominence is given in external communication.

The analysis of the properties of money indicators in the euro area has focused so far on simple sum aggregates[2], whereas to date no study of the properties of a Divisia-weighted monetary aggregate in the euro area has been carried out.[3] This paper endeavors to fill this gap and aims at constructing a Divisia monetary aggregate based on the short-term financial instruments included in the euro area broad monetary aggregate M3 and at evaluating the properties of this indicator. The present study makes use of euro area data, aggregated prior to 1999 on the basis of the irrevocable exchange rates of 31 December 1998. As the user costs are available only on an area wide basis, the Divisia monetary aggregate constructed in this paper differs from the aggregation of Divisia monetary aggregates in the individual euro area countries. In particular, the difference between the area wide Divisia money and that obtained as the aggregation of country-specific Divisia monetary aggregates hinges on the covariance across countries between the user costs and the rates of growth of the monetary components.

[1]An interesting but so far less popular alternative for Divisia aggregates is represented by the "Currency equivalent" aggregate proposed by Rotemberg, Driscol and Poterba (1995).

[2]See for example Coenen and Vega (1999), Brand and Cassola (2000), Calza, Gerdesmeier and Levy (2001) and Stracca (2001).

[3]Thus far, attempts to compute Divisia monetary aggregates in Europe have generally been restricted to a sub-sample of European countries due to unavailability of data for the euro area as a whole (see, e.g., Fase and Winder, 1996, Drake, Mullineux and Agung, 1997, and Wesche, 1997).

Therefore, the Divisia monetary aggregate analyzed in this paper should be regarded as a "synthetic" indicator, and this feature should be kept in mind in interpreting its properties.

In short, the analysis of the properties of Divisia money in the euro area leads to three interesting results.

First, the euro area Divisia-weighted monetary aggregate co-moves with the broad simple sum monetary aggregate M3 in the long run (as cointegration tests indicate), but departs from it in the short run. This signals that the analysis of the Divisia-weighted and of the simple sum M3 aggregates tends to give consistent signals in the long run, but also that the Divisia aggregate may provide some interesting complementary information in the short term.

Second, the demand for euro area real Divisia money turns out to be well behaved and reasonably stable in the sample period comprised between the first quarter of 1980 and the last quarter of 2000. The Divisia aggregate in real terms is found to co-vary positively with euro area real GDP (with a coefficient somewhat higher than one) and negatively with the log price dual, as predicted by standard theory. Moreover, the transition to Stage Three of EMU does not seem to have affected the demand for this monetary aggregate to a significant extent, although some short-term instability is detected at the beginning of 1999. That the properties of the Divisia monetary aggregate seem to carry though after 1998 is important, because it suggests that the Divisia monetary aggregate should provide useful information also in the new policy environment of Stage Three of EMU.

Third, investigating the information properties of the Divisia monetary aggregate as regards future output and inflation developments in the euro area suggests that this indicator has some added value.[4] The analysis of the forward-looking information content of the Divisia monetary aggregate is carried out by estimating an unrestricted VAR model (including inflation, the output gap, the real short-term interest rate and changes in real Divisia money) in the spirit of, for instance, Christiano, Eichenbaum and Evans (1996). In particular, the dynamic interactions in the economy are analyzed on the basis of the impulse response profile of the model. From this analysis, an apparently significant "liquidity effect" of innovations in real Divisia money growth on the output gap stands out, also affecting inflation with a delay of some quarters. This pattern is not peculiar to the Divisia monetary

[4]Binner, Fielding and Mullineux (1999) recently reported that in the United Kingdom a Divisia M4 monetary measure has a superior performance as a leading indicator of inflation compared to its simple sum counterpart.

aggregate introduced in this study; indeed, it is found that including euro area simple sum M1 or M3 in the VAR leads to similar results. To give a more structural interpretation to this analysis, also the deviation of real Divisia balances from the equilibrium (a proxy for "excess liquidity" in the economy) is included in the VAR model in place of changes in real Divisia money. Again, a liquidity effect seems to be a feature of the data. This evidence is *prima facie* consistent with, although not necessarily explained exclusively by, the idea that agents' adjustment of excess liquidity holdings takes place not only by adjusting money balances, but also by changing aggregate demand (for instance, because of the existence of portfolio adjustment costs), which in turn affects the output gap and inflation. Overall, this evidence suggests that it is not appropriate to discard the information in money and "liquidity" at large in assessing the outlook for output and inflation in the euro area.

In sum, the results of this study suggest that the Divisia monetary aggregate displays favorable econometric properties and that the monitoring of this indicator could therefore be a useful complement of the analysis of the simple sum broad monetary aggregate M3 under the first pillar of the ECB's monetary policy strategy. More in general, these results lend further support to the view that liquidity and money should be assigned a prominent role in monetary policy-making and that they contain useful information which is not to be found in other indicators such as the output gap and real short-term interest rates (on this matter, see also Trecroci and Vega, 2000, and ECB 1999, 2001a,b).

The paper is organized as follows. In Section 2 the theoretical underpinning of Divisia-weighted monetary aggregates are briefly recalled and the practical complications which arise when computing these indicators are also touched upon. Subsequently, in Section 3 a Divisia monetary aggregate for the euro area is constructed and the demand for this aggregate in the sample period between 1980 and 2000 is evaluated empirically. In Section 4, the forward-looking information content of Divisia money with regard to future output and inflation developments in the euro area is analyzed. Finally, some concluding remarks are in Section 5.

2 A quick look at Divisia monetary aggregates in theory and practice

The case for weighted monetary aggregates stems primarily from the observation that instruments included in broad definitions of money may be imperfect substitutes for each other (Serletis and Robb, 1986). It has been shown (Barnett, Fisher and Serletis, 1992) that, from an aggregation theory perspective, under the assumption that agents' utility function is weakly separable between short-term assets and all its other arguments, Divisia monetary aggregates represent an optimal aggregate measure of liquidity services provided by an array of financial instruments with short-term maturity. Being an optimal "summary statistic" for the total transactions services available from a *microeconomic* standpoint, Divisia monetary aggregates may also display a closer correlation with, and be a better leading indicator of, nominal spending and inflation than their simple sum counterparts from a *macroeconomic* perspective.

In formal terms, we may assume the existence of an aggregate measure of liquidity services in the economy, here denoted by L_Ψ:

$$L_\Psi = L(M_1, ..., M_n; \Psi_t), \tag{1}$$

where M_i denote the amount outstanding of short-term financial instruments, $i = 1, ..., n$, and Ψ_t is a (possibly time-varying) set of parameters. A weighted monetary aggregate is generally defined as:

$$M = \sum w_i M_i, \tag{2}$$

where w_i are the weights (in simple sum aggregates, $w_i = 1$, $\forall i$). To determine the aggregate which best measures the amount of liquidity services, the weights w_i have to be chosen so as to minimize the "distance" between L_Ψ and M. As argued above, under the assumption that agents' utility function is weakly separable between short-term assets and all its other arguments and that agents behave in an optimal manner, Divisia-weighted monetary aggregates do minimize the distance with L_Ψ.

The basic idea behind the construction of Divisia aggregates is that the spread between the tax-free rate of return on a capital-certain financial asset providing no liquidity services, say R, and the tax-free interest rate on a certain monetary instrument r_i (such spread, i.e. $R - r_i$, if often called "user cost") is a reliable indicator of the price of "moneyness" of this instrument and therefore of its degree of liquidity. Whilst this is clearly a restrictive assumption (monetary instruments possess a range of characteristics not necessarily related to their role as a medium of exchange[5]), it may

[5]For instance, holding monetary instruments normally implies also to become a client of a financial intermediary, and to have access to a number of services (including portfolio management advice; see Bank of England, 1993). Pricing these additional services and

be a reasonable approximation in most circumstances.[6] Moreover, the assumptions under which simple sum monetary aggregates are optimal tend to be *more* restrictive than those for which the Divisia monetary aggregates are. In practice, then, Divisia aggregates may represent the best available option if one wants to measure the total amount of transactions services in the economy (see Belongia, 1991).

More in detail, the (Tornqvist-Theil discrete approximation of the) Divisia monetary aggregate (DIV) is defined in terms of its growth rates as follows:

$$\Delta \ln DIV = \sum \widetilde{w_i} \Delta \ln M_i, \tag{3}$$

where the weights $\widetilde{w_i}$ (also called expenditure weights) are a moving average of the variable w_i:

$$w_i = \frac{u_i M_i}{\sum u_i M_i}, \tag{4}$$

and $u_i = \frac{R - r_i}{1+R}$ (i.e., the user costs defined in relative terms). The (log)level of the Divisia index is determined by choosing a base period and cumulating the growth rates from then onwards. Likewise, the Divisia price dual (henceforth $DUAL$) – i.e., the opportunity cost of holding Divisia money – is obtained by cumulating the log changes as in the following expression:

$$\Delta \ln(DUAL) = \sum \widetilde{w_i} \Delta \ln u_i \tag{5}$$

The log-change in $DUAL$ is a weighted average of the log-changes in the user costs, which in turn represent the standardized opportunity costs of holding the monetary instruments included in the Divisia monetary aggregate. According to the theory of monetary aggregation, the demand for Divisia money should depend positively on total expenditure (transactions) and negatively on the Divisia price dual (the opportunity cost).

Divisia monetary aggregates collapse to the simple sum case only if $r_i = r$ for every i (namely, the monetary instruments are perfect substitute). The

adjust monetary aggregates accordingly (to single out a "pure" measure of the transactions services of money) would require a fully-fledged modelling also of intermediaries' supply policies. This is often considered a too daunting task.

[6]It should be added that user costs are representative of liquidity services only if the financial industry is competitive. If interest differentials are due to lack of competition, user costs can be unrelated to the degree of liquidity of certain instruments and – for what matters – to any of their instrisic features. Thus, Divisia monetary aggregates are a "pure" measure of liquidity services only under the assumption that the financial industry is competitive. In some European countries, this may be considered an overly restrictive assumption.

counterpart of the price dual for the simple sum monetary aggregate – say M – is the spread between the rate of return on the "alternative asset" (namely R) and the own rate on the monetary aggregate ($r_M^{own} = \sum r_i \frac{M_i}{M}$).

Notwithstanding their theoretical appeal and their simple algebra, Divisia-weighted monetary aggregates have not gained a prominent role in monetary policy-making in the same way as their simple sum counterparts have. One important reason is that Divisia monetary aggregates are significantly more data-demanding and therefore more difficult to construct than simple sum aggregates.[7] Moreover, Divisia monetary aggregates may be a more difficult concept to grasp for the general public and thus be less effective in central banks' external communication.

Furthermore, it is important to stress that the Divisia index aims only at measuring the transactions services of money, and does *not* deal with other traditional uses of money, namely as a store of value (savings) and as a unit of account. Therefore, the Divisia index should by no means be considered an encompassing indicator of the role of money in the economy (see Cuthbertson, 1997).

Yet, while giving more prominence to simple sum monetary aggregates, most central banks have found it useful to look at Divisia-weighted monetary aggregates to gain auxiliary information.[8] In fact, it is a common result that Divisia-weighted and simple sum monetary aggregates grow together in the long run but may move somewhat differently in the short run. Thus, the weighted monetary aggregates may at times provide information complementary to, and useful to decipher, that contained in simple sum monetary aggregates.

An important practical complication in computing Divisia indexes is the choice of the benchmark rate of return, R. Theoretically, the benchmark asset should be capital-certain (i.e., yielding a non-stochastic payoff) and at the same time provide no liquidity services altogether. Long-term bond yields are often used as benchmark rates, but this approach is somewhat problematic (see for instance Bank of England, 1993). In fact, if agents have a relatively short time horizon in their portfolio allocation, what matters as an opportunity cost is not the long-term yield to maturity of the bond portfolio, but rather its expected short-term rate of return. However, this expected return cannot be observed directly, and must be proxied in some way.

[7] This is particularly true for the euro area, and this partly explains the lack of interest in euro area Divisia money thus far.

[8] For example, see Ayuso and Vega (1992) for Spain, Gaiotti (1994) for Italy, Fisher, Hudson and Pradhan (1993) for the UK and Gaab (1996) for Germany. This is, of course, only a very incomplete list.

3 A Divisia monetary aggregate in the euro area

In this section the construction of a euro area Divisia index is described in detail and the demand for this monetary aggregate is evaluated using econometric techniques. In particular, the first sub-section deals with the database. The details of the actual calculation of the index are spelled out in the subsequent sub-section. In Sub-section 3.3 some descriptive evidence concerning the Divisia monetary aggregate compared with euro area simple sum M1 and M3 is presented. Finally, the demand for Divisia money is evaluated in Sub-section 3.4.

3.1 The data

The analysis in this study is based on quarterly harmonized data from 1980:1 to 2000:4 for the euro-11 – i.e., the euro area excluding Greece.[9]

Four components M_i of the broad monetary aggregate M3 in the euro area are taken into consideration in the calculation of the Divisia monetary aggregate: currency in circulation (CC), overnight deposits (OD), short-term deposits other than overnight deposits (mainly time and savings deposits, OSTD), and marketable instruments (MI, i.e. repurchase agreements, money market fund shares and money market paper and debt securities issued with a maturity of up to two years).[10] The holding sector includes all euro area residents except Monetary and Financial Institutions and central governments. All monetary instruments may be denominated in euro and in foreign currencies. The components of M3 are in levels and seasonally adjusted.[11] As from September 1997, monetary components are also adjusted for statistical reclassifications and for revaluation effects. For the period before the monetary union, the figures for individual countries are aggregated on the basis of the irrevocable exchange rates of 31 December 1998.[12]

[9]Greece is left out of the analysis owing to data limitations. Due to the small weight of Greece in the euro area economy (the weight of its GDP on euro area GDP is less than 2%), this exclusion is unlikely to affect the main results of the paper is a significant manner. In the continuation of this paper, the terms "euro area" and euro-11 will be used interchangeably.

[10]For further details on the components of M3 in the euro area see ECB (1999b). Due to the lack of area wide historical data, we do not consider time and savings deposits separately.

[11]The seasonal adjustment is carried out with the x-12 ARIMA procedure.

As regards other variables, quarterly seasonally adjusted series for real GDP and for the GDP deflator in the euro area are also employed in the study. Real GDP is calculated based on the ESA79 system of national accounts and extended after 1995:1 using ESA95 quarter-on-quarter growth rates. Real GDP and the GDP deflator are also aggregated before 1999 on the basis of the irrevocable fixed conversion rates of 31 December 1998, consistent with the methodology used to aggregate the monetary components. Concerning market interest rates, we consider a weighted average of 3-month money market interest rates and of 10-year government bond yields (or close substitute) as representative of, respectively, short-term and long-term market interest rates in the euro-11.

A key information necessary to derive Divisia monetary aggregate are the own rates of return on the monetary components. To this purpose, it is necessary to estimate three series of rate of return, r_{OD}, r_{OSTD} and r_{MI}, over the sample period 1980:1-2000:4.[13] As regards r_{OD}, this can be drawn from the own rate of return on euro area M1 (r_{M1}^{own}) computed in Stracca (2001) on the basis of the following formula:

$$r_{CC}\frac{CC}{M1} + r_{OD}\frac{OD}{M1} = r_{M1}^{own} \Rightarrow r_{OD} = r_{M1}^{own}\frac{M1}{OD}, \qquad (6)$$

given that $r_{CC} \equiv 0$. Regarding r_{OSTD}, this can be obtained combining the own rate of return of M1 as estimated in Stracca (2001) with the estimate for the own rate of return of M3 estimated in Calza, Gerdesmeier and Levy (2001), by means of a procedure similar to that used to derive r_{OD}. Finally, r_{MI} can be proxied with the short-term market interest rate.[14] Figure 1 below shows the development over time of the own rates of return on the considered monetary components together with the euro-11 10-year bond yield:

[insert Figure 1 here]

[12]This aggregation method corresponds to the figures officially published by the ECB and it is mainly used for this reason. An alternative method of aggregation is based on real GDP weights (see Coenen and Vega, 1999, and Stracca, 2001); in any case, at least for the monetary components applying this latter aggregation method would not lead to significantly different area wide figures.

[13]The rate of return on currency in circulation is, of course, zero.

[14]The only sub-component in MI possibly not remunerated at short-term market rates is repurchase agreements. However, the rate of return on these instruments should be reasonable close to short-term market rates. Moreover, repurchase agreements represent a relatively small part of total marketable instruments in M3.

Prima facie, the estimates for r_{OD} and r_{OSTD} appear to be plausible. In particular, the rate of return on short-term deposits other than overnight deposits tends to follow market developments much more closely than that on overnight deposits. This is due especially to deposits with an agreed maturity up to two years, included in $OSTD$, the rate of return on which is very responsive to changes in market rates.

3.2 The calculation of the Divisia index

When attempting to compute a Divisia monetary aggregate in the euro area, one is confronted with two key issues: first, the aggregation method for the period before the monetary union; second, the choice of the benchmark asset.

Dealing with the aggregation issue first, it is clear that from a theoretical perspective the best way forward would be to construct Divisia aggregates in the individual countries and then aggregate them to obtain an area wide indicator. Let $\Delta \ln DIV_t^j$ be the log change in the Divisia monetary aggregate for country j at time t. Having chosen some aggregation weights ρ^j, the rate of growth of the area wide Divisia money (DIV) would be obtained as:

$$\Delta \ln DIV_t = \sum \rho^j \Delta \ln DIV_t^j = \sum_j \rho^j \sum_i \widetilde{w_i^j} \Delta \ln M_i^j, \qquad (7)$$

where $\widetilde{w_i^j}$ is the expenditure weight for asset i and country j and M_i^j is the monetary component i for country j. A Divisia monetary aggregate thus obtained would express the "average" liquidity services available in the euro area economy, the average being computed on the basis of the aggregation weights ρ^j ($\sum \rho^j = 1$, $\rho^j > 0$). As just argued, this would be the most straightforward aggregation method.

Unfortunately, sufficiently long historical time series for the user costs, necessary to build the expenditure weights $\widetilde{w_i^j}$, are not available for all euro area countries. Thus, deriving the Divisia aggregate as in (7) is not feasible. Hence, in this paper we use the following alternative aggregation method:

$$\Delta \ln DIV_t = \sum_i (\sum_j \rho^j \widetilde{w_i^j})(\sum_j \rho^j \Delta \ln M_i^j) \qquad (8)$$

Intuitively, with this method the "average degree of liquidity of instrument i" for each monetary instrument is multiplied by the "average holdings of the same asset i" to obtain a "synthetic" measure of the liquidity services in the euro area economy. Clearly, the difference between the two methods hinges on the covariance between the expenditure weights (the user costs) and the rates of growth of the monetary components across euro area countries. Due to the aforementioned unavailability of country-specific user costs, it is impossible to evaluate the size of the distortion associated to the synthetic indicator. In any case, this is a caveat that should be borne in mind in assessing the properties of the euro area Divisia monetary aggregate proposed in this study.

Coming to the second issue, namely the choice of the benchmark asset, this should be the rate of return on a capital-certain financial asset providing no monetary services, as discussed above. However, "genuine" examples of such benchmark assets are hardly available in practice. Therefore, in many studies a long-term government bond yield is used as a convenient proxy. This approach, however, may be criticized for a number of reasons.[15] In this paper we follow an alternative route. We assume that the marketable instruments included in M3 provide some limited liquidity service and that they are risk-free. Under these assumptions, the rate of return on a risk-free short-term financial asset providing no transactions services should be given by the short-term market interest rate plus a "liquidity services premium". Of course, the precise amount of this premium is unknown. In this study it is assumed a fixed liquidity services premium of 0.6%, equal to the average spread between the 10–year and the 3-month market interest rates in the euro-11 over the sample period 1980:1-2000:4 (hence, $R_t = r_{MI,t} + 0.6\%$).[16] It should be stressed that similar values of the premium lead to very similar patterns of the Divisia monetary aggregate, suggesting that results are not overly sensitive to the choice of a particular value for the liquidity services premium. In addition, the annual growth rate of the Divisia index computed in this manner ("baseline") is very close to – indeed almost indistinguishable from – that of the Divisia index computed taking the 10-year market interest rate as the benchmark rate ("alternative"), as Figure 2 below shows.

[insert Figure 2 here]

The construction of the Divisia index is sometimes accompanied in the

[15] For instance, the 10-year maturity is too long and not representative of agents' "normal" investment horizon. At shorter horizons bond yields are, of course, not risk-free. In addition, when the yield curve is downward-sloped the weight of some components may become negative.

[16] All rates of return considered are gross of taxes. This is in contrast with theory. Unfortunately, the information on tax rates at euro area level is not available to the author; therefore, the assumption is maintained that taxes affect all financial instruments included in M3 proportionally, i.e. they represent a neutral factor.

literature by a weak separability test, to ensure that the demand for the financial instruments included in the index can be modelled independent of those excluded from it. Given the limited availability of data for the euro area, no separability test can be carried out here. It is instead assumed that all the components of M3 in the euro area provide, in principle, some monetary services, whilst no monetary service is provided by assets excluded from broad money.[17] These restrictive assumptions should be borne in mind when assessing the properties of the Divisia monetary aggregate for the euro area.

Another, more general limitation of the Divisia indicator is that it is constructed under the implicit assumption that the productivity of each component in terms of transaction services does not vary over time due to non-neutral technological progress (see Ford, Peng and Mullineux, 1992). Therefore, this monetary aggregate is not robust to changes brought about by financial innovation. However, simple sum monetary aggregates are not robust to these changes either.

3.3 The properties of the euro area Divisia index: some descriptive evidence

To have a preliminary look at the properties of the new indicator, the annual growth rates of the baseline Divisia monetary aggregate and of euro area simple sum M1 and M3 are reported in Figure 3 below. It is interesting to notice that up to approximately 1996 there seems to be a much closer correlation between the Divisia index and M1, whereas the correlation is closer with M3 thereafter.[18] In the fourth quarter of 2000 (the latest available observation) the annual growth rate of the Divisia index was 4.9%.

[insert Figure 3 here]

Another important test is whether simple sum M1, simple sum M3 and the Divisia monetary aggregate are cointegrated. A Johansen cointegration test[19] on the levels of log real simple sum M1, log real simple sum M3

[17]The euro area M3 monetary aggregate is very broad and therefore the assumption of weak separability should not be too restrictive. However, in some euro area countries (such as Italy and Spain) Treasury bills (which are not included in euro area M3) may be considered as highly substitutable with other short-term instruments included in M3.

[18]Over the whole sample, the correlation of the annual growth rate is stronger with simple sum M3 (0.85) than with simple sum M1 (0.64). To the extent that the Divisia indicator is an "optimal" indicator of liquidity services, the conclusion may be that simple sum M3 is a better proxy for "liquidity" than simple sum M1.

[19]The cointegration test is based on the assumption of a constant term and no trend in the cointegrating relationship.

and log real Divisia (not reported for brevity) shows that a cointegrating relationship exists at the 5% confidence level among these three variables, i.e. these monetary aggregates share a common trend. Moreover, all these monetary aggregates are individually cointegrated. with the log price level.

The weights of the monetary components in the Divisia monetary aggregate are reported in Figure 4.

[insert Figure 4 here]

As expected, the weight of currency in circulation and of overnight deposits (i.e., of the components of M1) is much larger than that in simple sum M3 (a direct comparison is in Figure 5). In other words, the Divisia monetary aggregate is "more liquid" than simple sum M3 and "less liquid" than simple sum M1.

[insert Figure 5 here]

Another interesting piece of information is the development over time of the Divisia price dual compared to the opportunity cost of holding M1 and M3[20] (this is shown in Figures 6 and 7 respectively). Due to the different scales it is difficult to evaluate the difference in detail, but it can be safely concluded that the price dual tends to co-move with the opportunity cost of both M1 and M3.[21]

[insert Figures 6 and 7 here]

3.4 The demand for euro area Divisia money

As already mentioned above, the demand for the Divisia monetary aggregate should depend *positively* on total expenditure and *negatively* on the Divisia price dual (which represents its opportunity cost). Proxies for total nominal expenditure are normally used in empirical applications. The only available proxy for the euro area as a whole is euro area GDP. Hence, the chart below shows Divisia velocity (V_{DIV}) computed subtracting the log of the Divisia index, div, to the log of nominal GDP, $y + p$ (p is the log of the price level; hence, $V_{DIV} = y - div + p$) together with the log of the price dual, $dual$. A clear co-movement is visible in the chart.

[insert Figure 8 here]

On the basis of theory and of this evidence, the long run demand for log real Divisia ($divr = div - p$; henceforth "real Divisia" for simplicity) is specified as follows:

[20]These are computed as $R - r_{M1}^{own}$ and $R - r_{M3}^{own}$, respectively.

[21]The correlations are, respectively, 0.89 and 0.90. Clearly, these correlations have to be interpreted with caution given that the considered variables are I(1).

$$divr_t = \alpha + \beta y_t + \gamma dual_t + \delta(dual_t)^2 + \varepsilon_t \tag{9}$$

This equation is based on a double log functional form (see Lucas, 2000). A quadratic term is added as a parsimonious and unrestricted way to model the possible dependence of the price dual elasticity on the level of the (log-)price dual itself (see the discussion on this topic in Chadha, Haldane and Janssen, 1998, and Stracca, 2001). A *positive* parameter δ would signal a *positive* correlation between the price dual elasticity and the level of the (log-)price dual, similar to what found in Stracca (2001) for euro area M1.[22] The opposite would hold true with a negative δ. Therefore, the above specification is a convenient way to "let the data speak for themselves" about this crucial aspect of the functional form of money demand.

Augmented Dickey-Fuller and Phillips-Perron tests (not reported here for brevity) indicate that all variables in the long run specification of the demand for Divisia money are integrated of order one. The Johansen cointegration test (run assuming a constant term and no trend in the cointegration vectors) indicates (see Table 1) that there is one cointegrating relationship between these variables at the 5% confidence interval.[23]

[insert Table 1 here]

On the basis of the evidence of the Johansen cointegration test, a VECM model is estimated assuming one cointegrating relationship on the vector of variables x:

$$x = \{divr, y, dual, dual^2\} \tag{10}$$

Precisely, the VECM model takes the form:

$$\Delta x_t = a(L)\Delta x_{t-1} + \xi x_{t-1} + u_t, \tag{11}$$

where $a(L)$ is a vector of polynomials in the lag operator L and ξ is the cointegrating vector; $a(L)$ and ξ are estimated simultaneously.

The outcome of this estimation is reported in Table 2 below:

[22] Specifically, one could write down a two equations model, the first capturing the money demand relationship, the second the behavior of the interest rate elasticity, as follows:

(i) $divr_t = \alpha + \beta y_t + \widetilde{\gamma}_t dual_t + \varepsilon_t$

(ii) $\widetilde{\gamma}_t = \gamma + \delta dual_t$

Hence, putting the two equations together:

(i) $divr_t = \alpha + \beta y_t + (\gamma + \delta dual_t) dual_t + \varepsilon_t$,

and therefore:

(i) $divr_t = \alpha + \beta y_t + \gamma dual_t + \delta(dual_t)^2 + \varepsilon_t$.

If $\delta = 0$, the standard double log functional form is recovered.

[23] According to the information criteria, a lag order of three is appropriate for the estimation of the VAR model on which the Johansen test is based.

[insert Table 2 here]

The analysis of the coefficients associated to the error correction term for each variable Δx suggests that the cointegrating relationship may be interpreted as a money demand function. In fact, the coefficient for $\Delta divr$ is negative and significant, while the coefficients for all other variables are insignificant. When normalized for real Divisia, the cointegration vector takes the following form:

$$divr = k + 1.19y - 1.72dual + .09dual^2, \tag{12}$$

and all coefficients are statistically significant. Hence, the demand for real euro area Divisia depends on euro area GDP, with a coefficient of 1.19, and on the log of the price dual, with a coefficient of -1.72.[24] Moreover, the positive and significant coefficient found for $dual^2$,+.09, suggests a *positive* relation between the price dual elasticity of real Divisia demand and the level of the log-price dual, consistent with the findings in Stracca (2001) for euro area simple sum M1. This kind of nonlinearities might be related to the presence of fixed transaction costs in investing in interest-bearing assets, as argued by Mulligan and Sala-i-Martin (2000).

Diagnostic statistics of the VECM model (e.g., the serial correlation tests) all suggest that the model is well specified. Furthermore, the equation related to the demand for real Divisia appears to be stable over time (see Figure 9). The only really conspicuous unexplained change in recent years may be observed in the first quarter of 1999, which comes at no surprise given the special factors exerting their influence at the start of Stage Three of EMU (see ECB, 2001b). Apart from this special episode, the equation has a very good out-of-sample forecasting performance, as indicated for instance by the out-of-sample Chow forecast test (not reported for brevity). Overall, the transition to Stage Three of EMU does not seem to have changed the properties of the demand for real Divisia in a fundamental manner – although an assessment is clearly still premature at this stage.

As to other features of the equation, a relatively low R-squared (0.45) compared with the values normally found for the demand for simple sum euro area monetary aggregates (see, e.g., the M3 equations of Coenen and Vega, 1999, and Brand and Cassola, 2000) and a quite small coefficient of adjustment to the equilibrium (0.15) stand out. The latter evidence suggests that the cost of being away from the equilibrium is not large, and that it takes more than six quarters for a departure of liquidity balances from

[24] The restriction $\beta = 1$ is rejected by the data.

equilibrium to correct itself. This is broadly consistent with the available evidence on simple sum euro area monetary aggregates.

[insert Figure 9 here]

As already noted by Stracca (2001), a shortcoming of a model attributing more importance to movements in the opportunity cost when this is at comparatively low levels is that the error correction term may display "odd" fluctuations when the opportunity cost is really low. This is evident in Figure 10 below:

[insert Figure 10 here]

However, there is no reason to believe that this shortcoming of the model is of fundamental importance – it only signals that the selected functional form is too "rough" for particular values of the opportunity cost (but it still dominates the double log functional form widely used in the literature, given that the coefficient δ is found to be significantly greater than zero). Moreover, it cannot be excluded that the odd pattern of the error correction term reflects the temporary disturbances at the onset of Stage Three of EMU, which however do not seem to affect the stability of the equation (although it is clearly too early to come to a reliable assessment on that at this stage).

Further insight into the properties of the VECM model may be derived from the analysis of the impulse response profile (Figure 11).[25] Overall, the impulse responses appear to be pretty standard and consistent with theory. In particular, a disturbance to real GDP and to the log-price dual leads to, respectively, a permanent rise and a permanent fall in Divisia demand. The only somewhat controversial evidence is the sizeable effect of an innovation in the real Divisia on real output, suggesting *prima facie* the existence of a non-neutrality of liquidity (liquidity effect). This finding appears to be interesting and will therefore be analyzed further in the next section.

[insert Figure 11 here]

4 Does liquidity matter?

4.1 The information content of Divisia money in an unrestricted VAR model of the euro area economy

The analysis in the previous section has pinned down a stable and theoretically plausible demand for Divisia money in the euro area. This is an

[25] The impulse responses are conditional on the ordering $\{divr, y, dual, dual^2\}$. After a few quarters ahead, however, the ordering should not, and indeed does not, affect the outcome of the analysis.

important result, also because it makes it more likely that the Divisia index really proxies the amount of liquidity services available in the euro area economy. However, this is certainly only part of the story. In fact, another important role of money is as an *information variable*, i.e. it is necessary to ascertain whether our measure of aggregate liquidity contains any marginal information on future realizations of the variables which monetary policymakers care about, notably output and inflation (see ECB, 2001b).

The analysis of the information content of money – of the Divisia monetary aggregate in our case – can be carried out using a variety of approaches. In the remainder of this paper we focus on the estimation of a parsimonious unrestricted VAR model including only four key variables, namely inflation, the output gap, the real short-term interest rate, and (changes in) real Divisia money. The VAR model is thus estimated on the vector of variables z:

$$z = \{\pi, ygap, STR, \Delta divr\}, \tag{13}$$

with π representing the quarter-on-quarter inflation rate[26], $ygap$ is the output gap (measured as deviations of real GDP from trend; see Figure 12), and STR is the real short-term interest rate.[27]

[Insert Figure 12 here]

The analysis of the forward-looking information content of Divisia money is then based on the impulse response profile of the model. This way of analyzing the dynamic interactions in the economy in small scale VAR models is popular in the literature (see, for instance, Christiano and Eichenbaum, 1996, and Mankiw, 2001) and thus represents a suitable benchmark to assess the information content of the Divisia monetary aggregate. Moreover, the variables included in the VAR allow some "structural" relationships to be singled out. In particular, the effect of the short-term real interest rate on the output gap should be related to an IS-type of theoretical relationship. In addition, the interaction between the output gap and inflation may be directly related to a Phillips curve equation. Finally, the reaction of the short-term real interest rate to the output gap and inflation may provide interesting insights concerning the reaction function of monetary policy in

[26] In the sample period 1980:1 to 2000:4 inflation appears to be a borderline case between I(0) and I(1), according to ADF and Phillips-Perron tests. In the analysis of this paper we assume that inflation is an I(0) variable. Further insight on the degree of integration of inflation may be drawn from the impulse response profile of the VAR model, as it will be discussed later on.

[27] More precisely, $STR = \sum_{i=0}^{-3} \frac{ST_{t-i}}{4} - (p_t - p_{-4})$, where ST is the short-term (3-month) market interest rate. This is the same measure of the real rate used by Rudebusch and Svensson (2000).

the euro area over the considered sample period.[28] In order to increase the structural interpretability of the outcome of the impulse response exercise, also a VAR model is estimated including deviations of the real Divisia money holdings from the equilibrium (obtained as the error correction term of the demand equation identified in the previous section). In this case the z vector is the following:

$$z = \{\pi, ygap, STR, EC\}, \tag{14}$$

with $EC = divr - k - 1.19y + 1.72dual - .09dual^2$.

Furthermore, the analysis of the impulse response of the VAR is also replicated with alternative monetary aggregates (euro area simple sum M1 and M3) in order to appraise the relative performance of these aggregates compared with the Divisia money from a forward-looking information content perspective. To anticipate, this analysis shows that the three considered monetary aggregates have a similar performance, with however simple sum M3 performing slightly better than the Divisia money and somewhat better than simple sum M1.

It should be stressed that the approach followed here is by no means the only possible and does not represent a bullet-proof assessment of the information content of Divisia money or any other monetary aggregate.[29] It should nonetheless give some indications on whether the Divisia monetary aggregate constructed in this paper has indeed some value added from a forward-looking perspective.

4.2 The estimation results

The VAR model on the vector $z = \{\pi, ygap, STR, \Delta divr\}$ is estimated on the full sample period from 1980:1 to 2000:4. The analysis of the Akaike and Schwarz information criteria – with the requirement of no serial correlation in the residuals of the four equations – suggests a lag order of three. The results of the estimate of this VAR model are reported in Table 3.

[insert Table 3 here]

The diagnostic statistics – not reported here in full for the sake of brevity – suggest that the model in Table 3 is well specified and stable. Of particular interest is the inflation equation, given that price stability is the primary

[28] The same VAR model is also estimated including a long-term interest rate (not reported for brevity). This inclusion does not change the key features of the estimates, in particular as regards the impulse response profile. Moreover, a linear trend variable is found to be insignificant in all four equations, and it is therefore dropped from the model.

[29] For instance, another interesting approach, not followed here, is the one used by Nicoletti Altimari (2001).

objective of monetary policy in the euro area. The inflation equation has an adjusted R-squared of 0.80 (which is high for such a small scale model) and it is stable over the sample period, as the analysis of the recursive residuals (Figure 13) suggests.

[insert Figure 13 here]

The impulse response profile of the VAR model is reported in Figure 14. It is interesting to look first at the response of inflation to innovations in the variables included in the VAR. First, innovations to inflation tend to die out after some quarters, suggesting that inflation is indeed I(0) in the sample period. Moreover, inflation is positively affected with a lag of some quarters by the output gap, a standard result in the literature.[30] What is striking in this impulse response pattern (although not uncommon in the literature; see, for instance, Christiano, Eichenbaum and Evans, 1996, for a similar result with U.S. data) is a significant "liquidity effect" stemming from Divisia money growth.[31] Indeed, innovations in Divisia money growth positively affect the output gap and hence inflation with a delay of several quarters. The second row of the impulse responses in Figure 14 identifies a euro area IS curve, with the output gap reacting positively to lags of itself (persistence), negatively to the short-term real rate (the classical Keynesian channel) and positively to liquidity innovations (liquidity effect, as mentioned above). The third row of Figure 14 may single out some key traits of a monetary policy reaction function during the considered sample period. Monetary authorities in the euro area have tended to raise the short-term real interest rate in response to higher inflation (although with some lag, as the negative "mechanical" effect of rising inflation on the real rate dominates for the first quarters after a shock to inflation) and a positive output gap. The well known tendency of monetary authorities to smooth interest rates is also evident (*ceteris paribus*, a shock to the real rate needs some time to be absorbed, up to approximately eight quarters). Overall, this impulse response pattern suggests that the Divisia monetary aggregate may provide

[30] The apparently positive reaction of inflation to a shock in the real interest rate (see Figure 14) is not uncommon in the literature, and it may be related to the omission of a variable affecting inflation and at the same time prompting a monetary policy reaction (e.g., oil prices).

[31] In the literature a liquidity effect is also often associated with a lower nominal interest rate following a positive money shock (and vice versa). However, as Christiano and Eichenbaum (1995) point out, such liquidity effect should be a feature of very narrow monetary aggregates such as reserves, i.e. of "outside" money. In our case, the Divisia monetary aggregate should be interpreted mainly as an "inside" money indicator. Hence, the effect of liquidity on the nominal interest rate is essentially a non-issue in the context of our VAR model.

some interesting insights on the dynamic interactions in the economy and hence have some information content from a forward-looking perspective.

[Insert Figure 14 here]

To check whether the above impulse response profile, and in particular the existence of a liquidity effect, is a peculiar characteristic of the Divisia money indicator or it carries through to other monetary aggregates, the VAR model is also estimated including log changes of euro area simple sum M1 and M3 in place of the Divisia monetary aggregate. The vectors of variables are thus respectively $z_{M1} = \{\pi, ygap, STR, \Delta LM1R\}$ and $z_{M3} = \{\pi, ygap, STR, \Delta LM3R\}$, where $\Delta LM1R$ and $\Delta LM3R$ are the log changes of real simple sum M1 and M3. The impulse response patterns of these models (Figures 15 and 16) suggest the same existence of a liquidity effect, with money growth affecting the output gap and inflation with a delay of some quarters.

[Insert Figures 15 and 16 here]

Furthermore, to gain some additional "structural" insight on the results, a VAR model including the error correction term of the demand for Divisia money identified in the previous section is included in place of the money growth indicators (the vector of variables is now $z_{EC} = \{\pi, ygap, STR, EC\}$). The idea behind this econometric exercise is to appraise the reaction of inflation and output to an innovation in "excess liquidity", i.e. to situations when agents' portfolio is more or less liquid than desired. The same result of a significant liquidity effect stands out also in this case (see Figure 17), suggesting *prima facie* that deviations of liquidity holdings from the equilibrium do affect, or at least help to predict, aggregate demand and inflation in the euro area.[32] Although the a-theoretical econometric analysis carried out here does not allow to draw structural conclusions, it should be nevertheless noted that this evidence would be consistent with the idea that, due to portfolio adjustment costs coupled with the existence of cash-in-advance constraints, agents may adjust their liquidity to the desired level not only by changing their money holdings, but also their demand for goods and services.[33]

[Insert Figure 17 here]

One further interesting question which might arise in the context of this econometric exercise is which monetary aggregate among those considered

[32]See Christiano and Eichenbaum (1995) for a thorough theoretical analysis of the liquidity effect.

[33]This behaviour is consistent with, and may be explained by, limited participation models (see, for instance, Christiano, Eichenbaum and Evans, 1997, and Hendry and Zhang, 2001).

(simple sum M1, simple sum M3, Divisia money) has the best performance from a forward-looking perspective. In order to assess the relative performances of these monetary aggregates, in Table 4 some key statistics of the inflation equation in the VAR (chosen because price stability is the main objective of monetary policy in the euro area) are reported. These statistics include the adjusted R-square (a measure of goodness of fit), the standard error of the equation (a measure of the one-step ahead forecasting error of the model), and the Akaike and Schwartz criteria (especially useful to assess the out-of-sample forecasting performance). It is evident from the results in the table that the three considered monetary aggregates have a similar performance, with however simple sum M3 performing slightly better than the other two. Interestingly, including no monetary aggregate turns out to worsen, albeit marginally, three out of four of the considered indicators (only the Schwartz criterion, which penalizes the loss of degrees of freedom very heavily, turns out to get better[34]). Overall, these results suggest that simple sum M3 has – at the margin – the largest information content from a forward-looking perspective and that, more in general, monetary aggregates in the euro area may be a source of valuable information on future inflation.[35]

[Insert Table 4 here]

5 Conclusions

Divisia monetary aggregates are firmly grounded in economic theory and should be of interest to monetary policy-makers aiming at price stability. The main objective of this paper has been to construct and evaluate a Divisia monetary aggregate in the euro area. Such indicator might usefully complement the analysis of simple sum M3 within the first pillar of the ECB's monetary policy strategy (see ECB, 1999a).

Two interesting results emerge from this analysis.

First, applying a VECM methodology it is possible to find a theoretically plausible and stable demand for the Divisia monetary aggregate in the euro area. The Divisia index – in real and seasonally adjusted terms – depends positively on euro area real GDP (with a coefficient somewhat higher than

[34] This is mainly due to the fact that the autoregressive part is dominant in the inflation equation. It is interesting to notice that on the basis of the Schwartz information criterion both the output gap and the real short-term interest rate would be better candidates for exclusion from the inflation equation than the considered monetary aggregates.

[35] A very similar conclusion is also due for the output gap, on the basis of evidence not reported for brevity.

one) and negatively on the price dual, in line with theoretical *a priori*. Moreover, the demand for this definition of money does not appear to have been significantly influenced by the change in policy regime related to the transition to Stage Three of EMU.

Second, the Divisia index is found to possess interesting properties from a forward-looking perspective. Estimating an unrestricted VAR model including inflation, the output gap, the real short-term interest rate and changes in real Divisia money, an interesting impulse response pattern is identified. One important feature of the model, in particular, is the existence of a liquidity effect whereby innovations in liquidity holdings affect the output gap and inflation with a delay of some quarters. While the precise mechanism driving these results cannot be identified in the context of an a-theoretical econometric exercise, this evidence would be consistent with the idea that, due to existence of portfolio adjustment costs and of cash-in-advance constraints, deviations of liquidity holdings from the desired level are adjusted by agents at least in part by changing aggregate spending. Thus, money might play an "active" role in shaping the business cycle in the euro area. At the same time, however, it should be stressed that more theoretical and empirical research is needed before this stylized fact may be pinned down in a rigorous manner. Hence, the results of this paper should be interpreted only as a first step.

All in all, the results in this paper lend further support to the first pillar of the ECB's monetary policy strategy and add to a growing evidence[36] that monetary variables do contain useful information from a euro area policy-making perspective.

[36]See in particular Brand and Cassola (2000), Trecroci and Vega (2000) and Nicoletti Altimari (2001).

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Figure 1 – Rates of return on financial instruments in the euro area

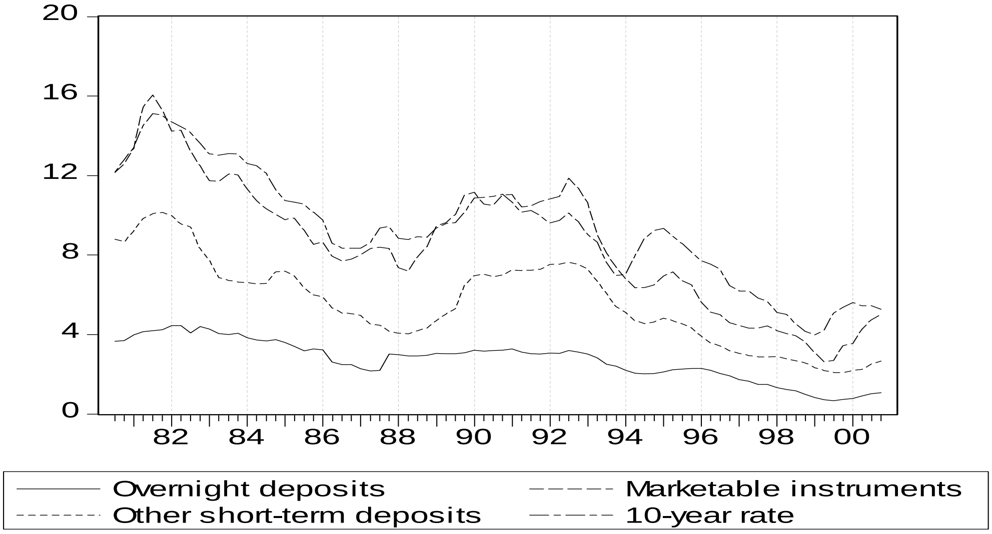


Figure 2 – Annual rate of growth of "baseline" and "alternative" Divisia money

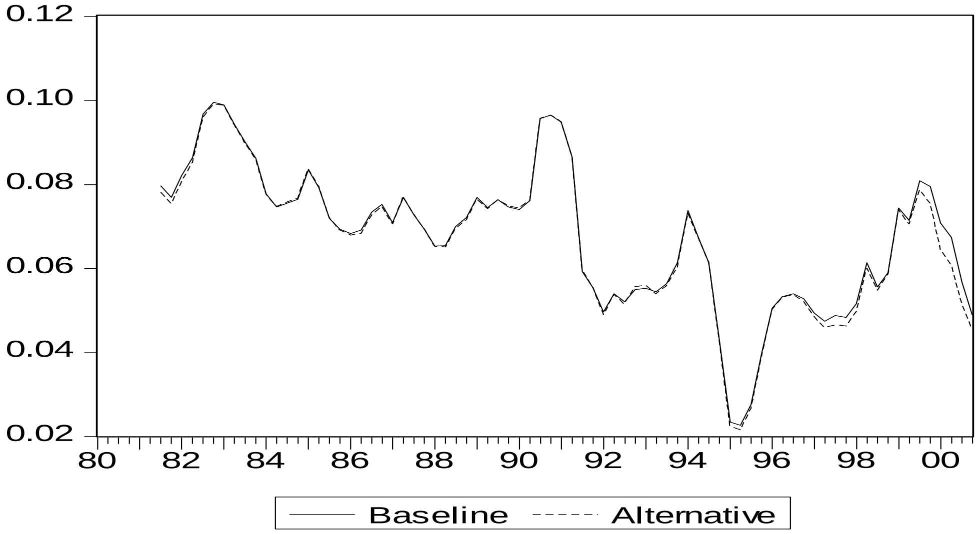


Figure 3 – Annual rates of growth of simple sum M1, simple sum M3 and the Divisia monetary aggregate

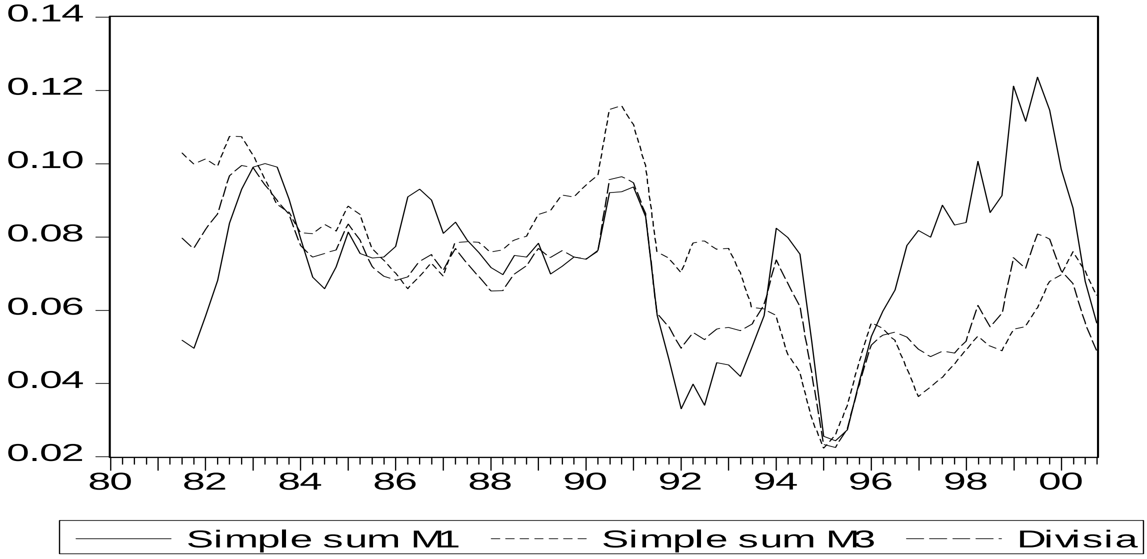


Figure 4 – Expenditure weights

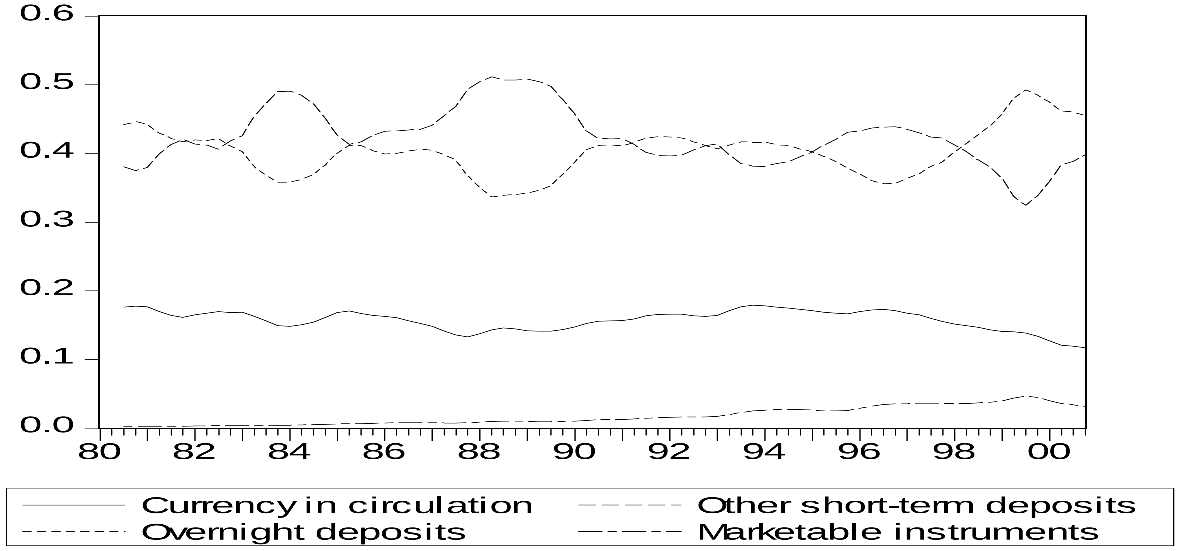


Figure 5 – Weights of the M1 components in the Divisia index and in simple sum M3

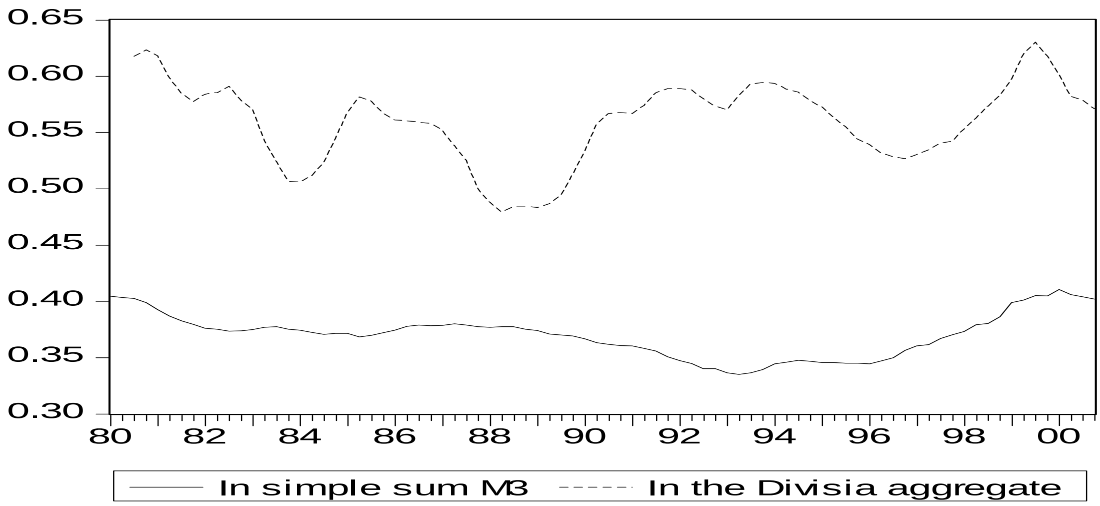


Figure 6 – Opportunity cost of M1 and Divisia price dual

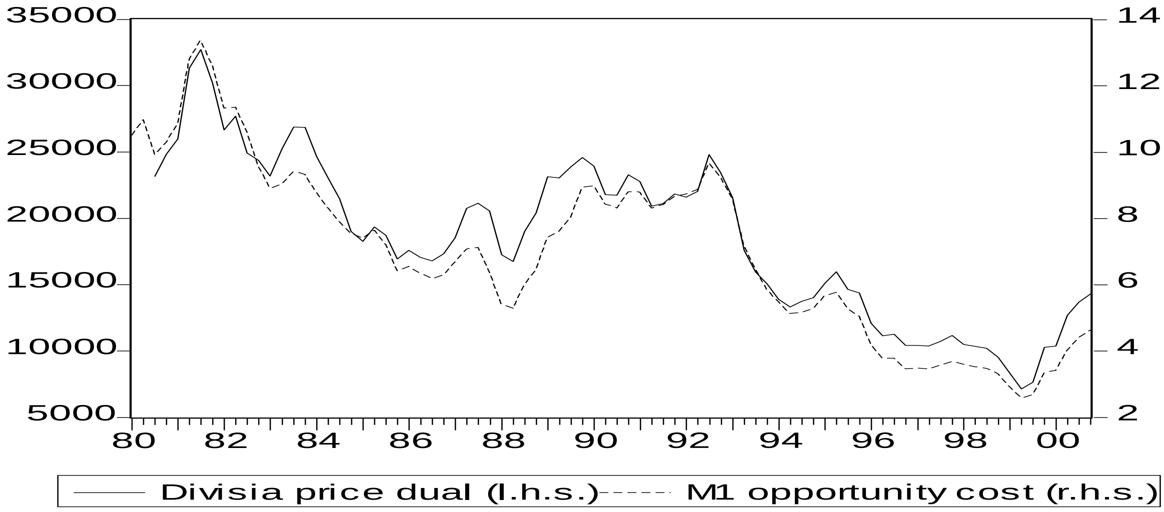


Figure 7 – Opportunity cost of M3 and Divisia price dual

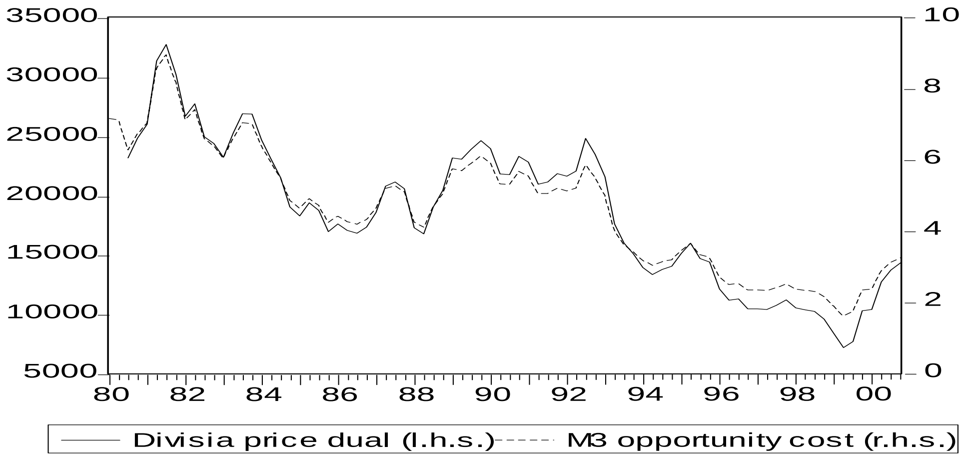


Figure 8 – Divisia velocity and log of price dual

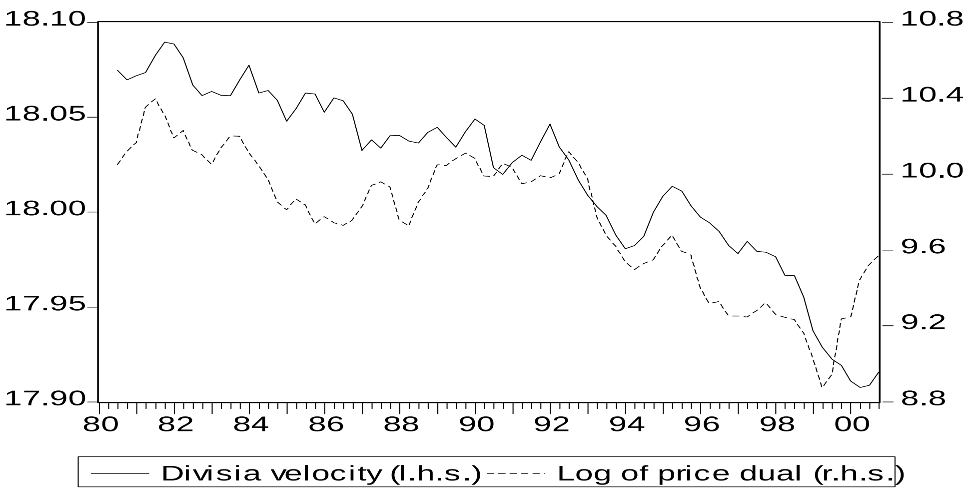


Table 1 – Johansen cointegration test

Sample: 1980:1 to 2000:4 (T=79)

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.228778	53.69949	53.12	60.16	None *
0.191697	33.17693	34.91	41.07	At most 1
0.114599	16.36426	19.96	24.60	At most 2
0.081881	6.748841	9.24	12.97	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Table 2 – Estimation of the VECM model

Sample: 1980:1 to 2000:4 (T=79)

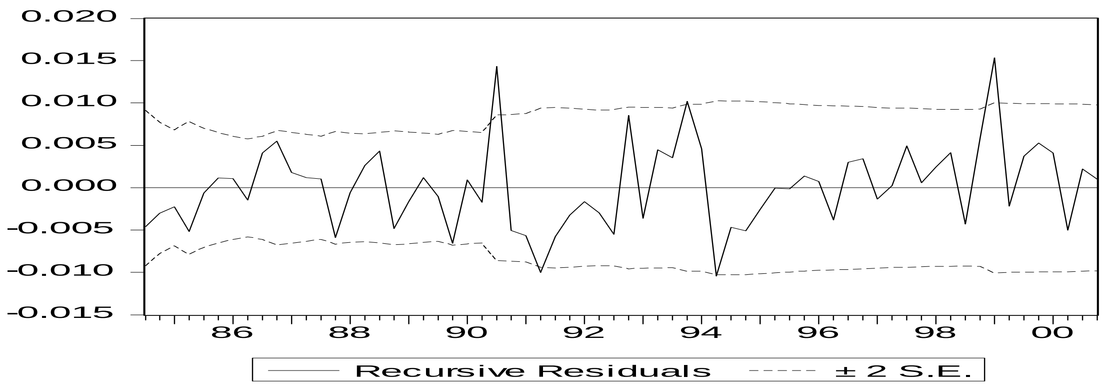
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1			
DIVR(-1)	1.000000			
Y(-1)	-1.193800			
	(0.04100)			
	(-29.1147)			
DUAL(-1)	1.722226			
	(0.61234)			
	(2.81253)			
DUAL2(-1)	-0.085761			
	(0.03161)			
	(-2.71280)			
C	12.35450			
	(2.98570)			
	(4.13789)			
Error Correction:	**D(DIVR)**	**D(Y)**	**D(DUAL)**	**D(DUAL2)**
CointEq1	-0.152780	-0.011959	0.666958	13.19292
	(0.03509)	(0.03675)	(0.61203)	(11.8095)
	(-4.35391)	(-0.32540)	(1.08975)	(1.11714)
D(DIVR(-1))	0.416130	0.094705	0.835581	18.21778
	(0.10564)	(0.11065)	(1.84260)	(35.5541)
	(3.93898)	(0.85589)	(0.45348)	(0.51240)
D(DIVR(-2))	0.199844	0.315066	-0.982824	-20.82839
	(0.10330)	(0.10820)	(1.80172)	(34.7654)
	(1.93459)	(2.91200)	(-0.54549)	(-0.59911)
D(Y(-1))	-0.066401	0.175971	-1.014076	-20.76874

	(0.11649)	(0.12201)	(2.03174)	(39.2038)
	(-0.57002)	(1.44228)	(-0.49912)	(-0.52976)
D(Y(-2))	0.067732	0.133344	3.617008	71.18809
	(0.11263)	(0.11796)	(1.96436)	(37.9036)
	(0.60139)	(1.13040)	(1.84132)	(1.87813)
D(DUAL(-1))	0.406496	-0.025911	-1.379344	-33.63697
	(0.15718)	(0.16462)	(2.74138)	(52.8968)
	(2.58626)	(-0.15739)	(-0.50316)	(-0.63590)
D(DUAL(-2))	0.333740	0.033100	-0.521848	-7.501412
	(0.16783)	(0.17578)	(2.92719)	(56.4821)
	(1.98858)	(0.18830)	(-0.17828)	(-0.13281)
D(DUAL2(-1))	-0.021508	0.001766	0.089392	2.089210
	(0.00810)	(0.00849)	(0.14131)	(2.72676)
	(-2.65461)	(0.20806)	(0.63257)	(0.76619)
D(DUAL2(-2))	-0.017164	-0.002026	0.022283	0.296437
	(0.00866)	(0.00908)	(0.15113)	(2.91614)
	(-1.98086)	(-0.22327)	(0.14744)	(0.10165)
R-squared	0.447130	0.101558	0.169634	0.172802
Adj. R-squared	0.383945	-0.001121	0.074735	0.078265
Sum sq. resids	0.001597	0.001752	0.485901	180.9124
S.E. equation	0.004777	0.005003	0.083315	1.607627
F-statistic	7.076516	0.989084	1.787521	1.827875
Log likelihood	314.8557	311.1980	89.00617	-144.8245
Serial correlation Q(1) [P-value]	0.03 [0.87]	1.39 [0.24]	0.03 [0.86]	0.03 [0.85]
Serial correlation Q(1-4) [P-value]	0.38 [0.98]	4.65 [0.33]	1.80 [0.77]	1.82 [0.77]
Akaike AIC	-7.743181	-7.650581	-2.025473	3.894290
Schwarz SC	-7.473244	-7.380644	-1.755536	4.164227
Mean dependent	0.007575	0.005597	-0.007551	-0.149003
S.D. dependent	0.006086	0.005000	0.086615	1.674488
Determinant Residual Covariance		1.16E-14		
Log Likelihood		818.9839		
Akaike Information Criteria		-19.69580		
Schwarz Criteria		-18.46608		

Figure 9 – Stability of the demand for real Divisia

Recursive residuals:



CUSUM statistic:

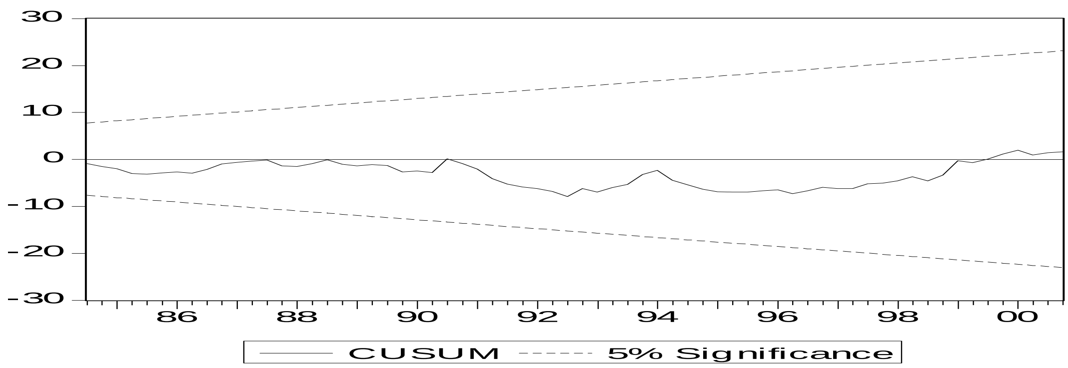


Figure 10 – Demand for real Divisia: error correction term

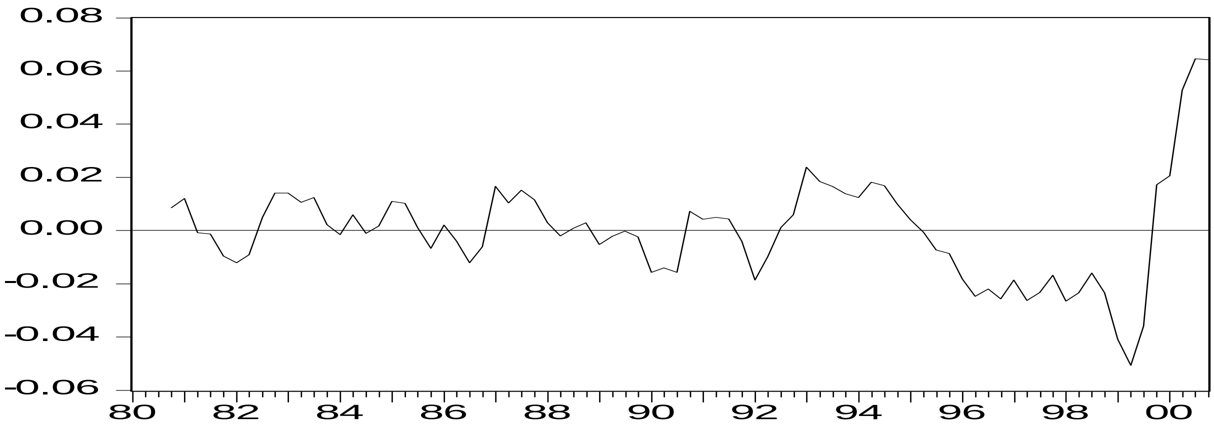


Figure 11 – Impulse responses of the VECM model

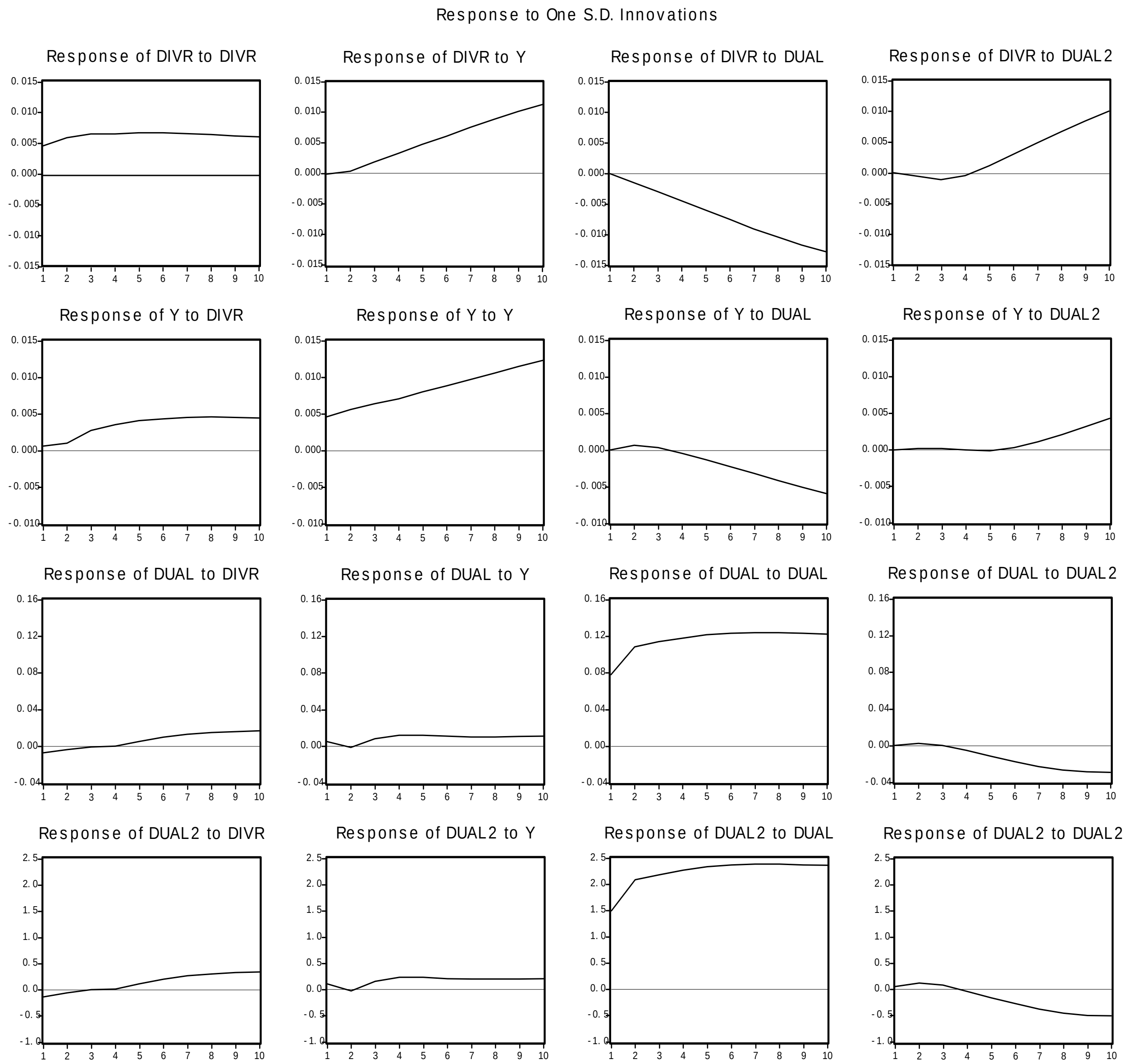


Figure 12 – Detrended output and the output gap derived by applying the Hodrick-Prescott filter

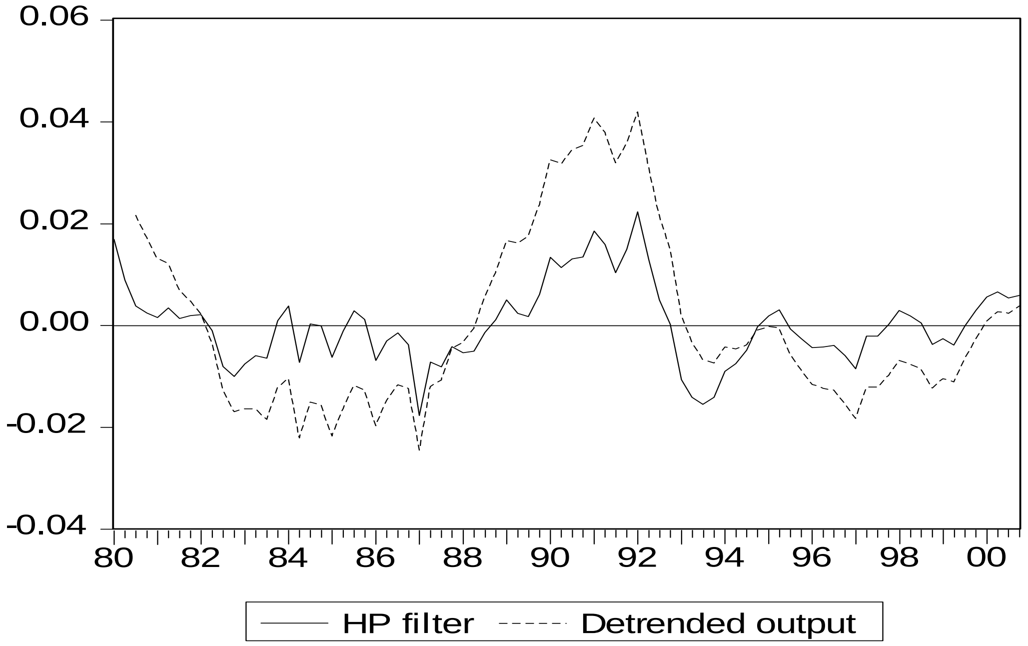


Table 3 – Estimation of the unrestricted VAR model with the Divisia monetary aggregate

Sample period: 1980:1 -- 2000:4 (T=79)

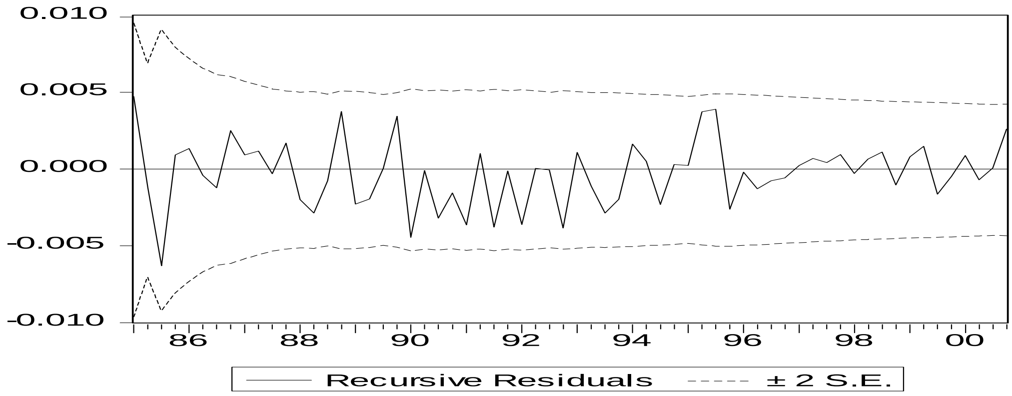
Standard errors & t-statistics in parentheses

	INFL	YGAP	STR	DDIVR
INFL(-1)	0.237464	0.158776	0.311169	-0.268304
	(0.13890)	(0.31692)	(0.19736)	(0.34382)
	(1.70956)	(0.50099)	(1.57662)	(-0.78037)
INFL(-2)	0.446692	0.024245	0.000287	0.244531
	(0.12862)	(0.29347)	(0.18276)	(0.31837)
	(3.47287)	(0.08262)	(0.00157)	(0.76807)
INFL(-3)	0.113746	-0.094819	-0.011850	0.048849
	(0.11965)	(0.27299)	(0.17000)	(0.29616)
	(0.95067)	(-0.34734)	(-0.06971)	(0.16494)
YGAP(-1)	-0.019292	1.000563	0.141953	-0.010452
	(0.05518)	(0.12589)	(0.07840)	(0.13657)
	(-0.34964)	(7.94801)	(1.81069)	(-0.07653)
YGAP(-2)	0.108903	-0.002669	-0.122508	0.158456
	(0.07841)	(0.17890)	(0.11141)	(0.19408)
	(1.38889)	(-0.01492)	(-1.09961)	(0.81643)
YGAP(-3)	-0.105480	-0.023766	0.049893	-0.147871
	(0.05465)	(0.12469)	(0.07765)	(0.13528)
	(-1.93002)	(-0.19059)	(0.64250)	(-1.09310)
STR(-1)	0.040851	-0.195319	1.418337	-0.408598
	(0.09742)	(0.22227)	(0.13842)	(0.24113)
	(0.41935)	(-0.87876)	(10.2469)	(-1.69453)
STR(-2)	0.125494	0.172613	-0.501011	0.675081
	(0.16736)	(0.38184)	(0.23779)	(0.41424)
	(0.74986)	(0.45205)	(-2.10694)	(1.62967)
STR(-3)	-0.117007	-0.007253	-0.050582	-0.351300
	(0.09460)	(0.21585)	(0.13442)	(0.23417)
	(-1.23681)	(-0.03360)	(-0.37630)	(-1.50022)
DDIVR(-1)	-0.096644	0.040202	0.099761	0.425110
	(0.05160)	(0.11772)	(0.07331)	(0.12771)
	(-1.87308)	(0.34150)	(1.36077)	(3.32863)
DDIVR(-2)	0.030947	0.217802	0.011830	0.029642
	(0.05471)	(0.12483)	(0.07774)	(0.13543)
	(0.56562)	(1.74475)	(0.15217)	(0.21888)
DDIVR(-3)	0.103698	0.142384	-0.085095	-0.171192
	(0.05356)	(0.12221)	(0.07611)	(0.13258)
	(1.93596)	(1.16505)	(-1.11808)	(-1.29120)
C	-0.001185	-0.002452	0.003468	0.009472
	(0.00129)	(0.00295)	(0.00184)	(0.00320)

	(-0.91649)	(-0.83163)	(1.88831)	(2.96069)
R-squared	0.830919	0.933703	0.968207	0.309472
Adj. R-squared	0.799217	0.921273	0.962246	0.179998
Sum sq. resids	0.000294	0.001529	0.000593	0.001800
S.E. equation	0.002142	0.004888	0.003044	0.005303
F-statistic	26.20978	75.11319	162.4173	2.390226
Log likelihood	371.0901	307.5743	344.0423	301.3025
Akaike AIC	-9.301042	-7.651281	-8.598501	-7.488376
Schwarz SC	-8.905334	-7.255574	-8.202793	-7.092668
Mean dependent	0.008777	-0.001545	0.048190	0.007844
S.D. dependent	0.004781	0.017421	0.015666	0.005856
Determinant Residual Covariance		8.64E-21		
Log Likelihood		1341.596		
Akaike Information Criteria		-33.49600		
Schwarz Criteria		-31.91317		

Figure 13 – Stability of the inflation equation in the unrestricted VAR model

Recursive residuals:



CUSUM test:

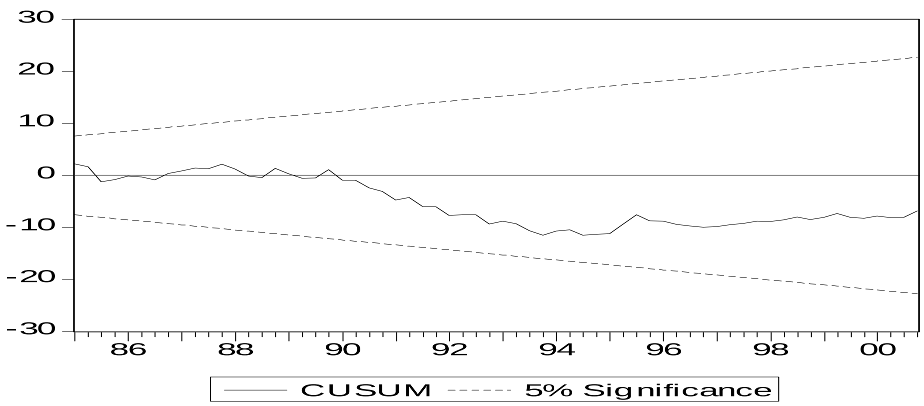


Figure 14 – Impulse responses of the unrestricted VAR model with Divisia money

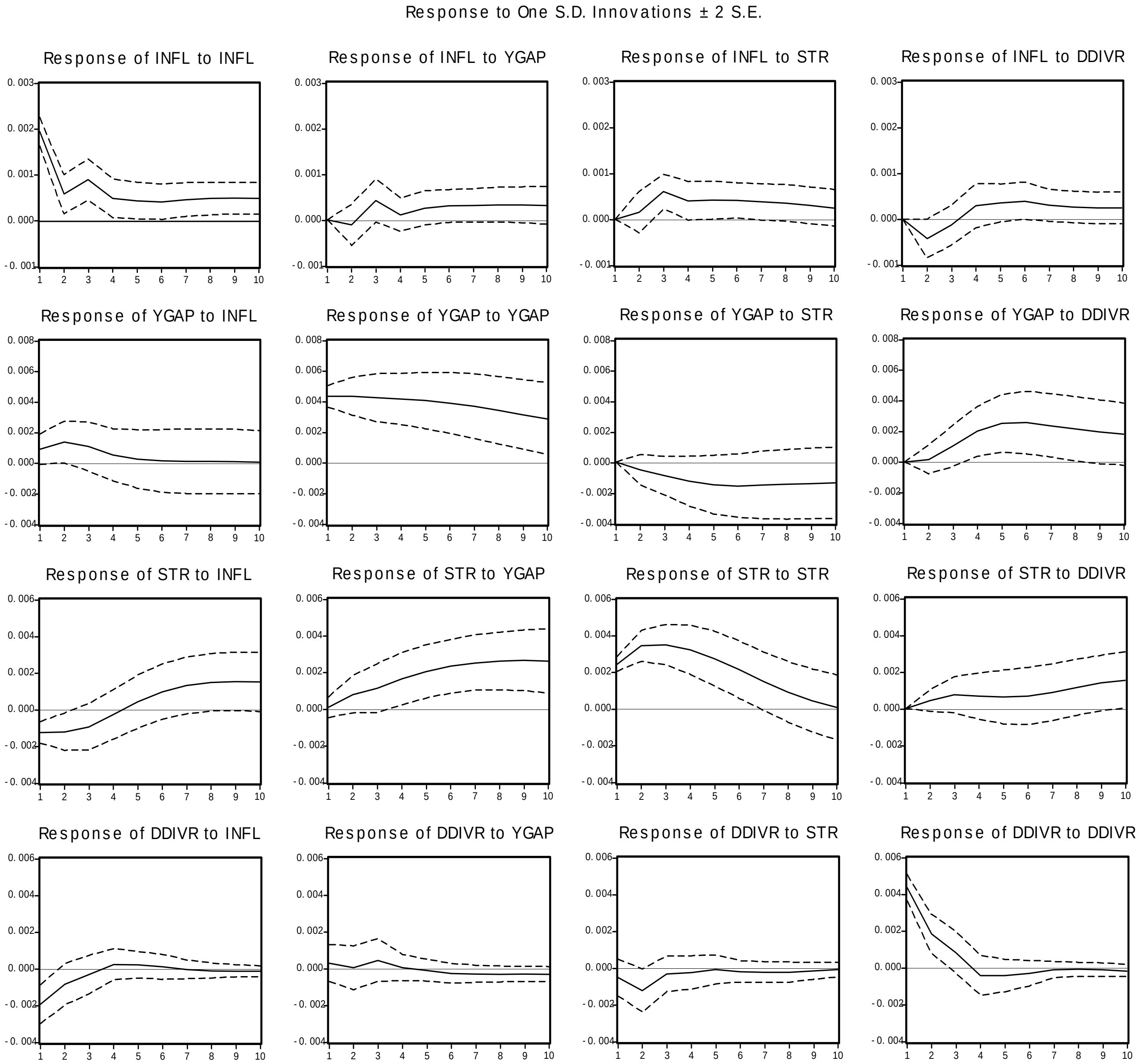


Figure 15 – Impulse responses of the unrestricted VAR model with simple sum M1

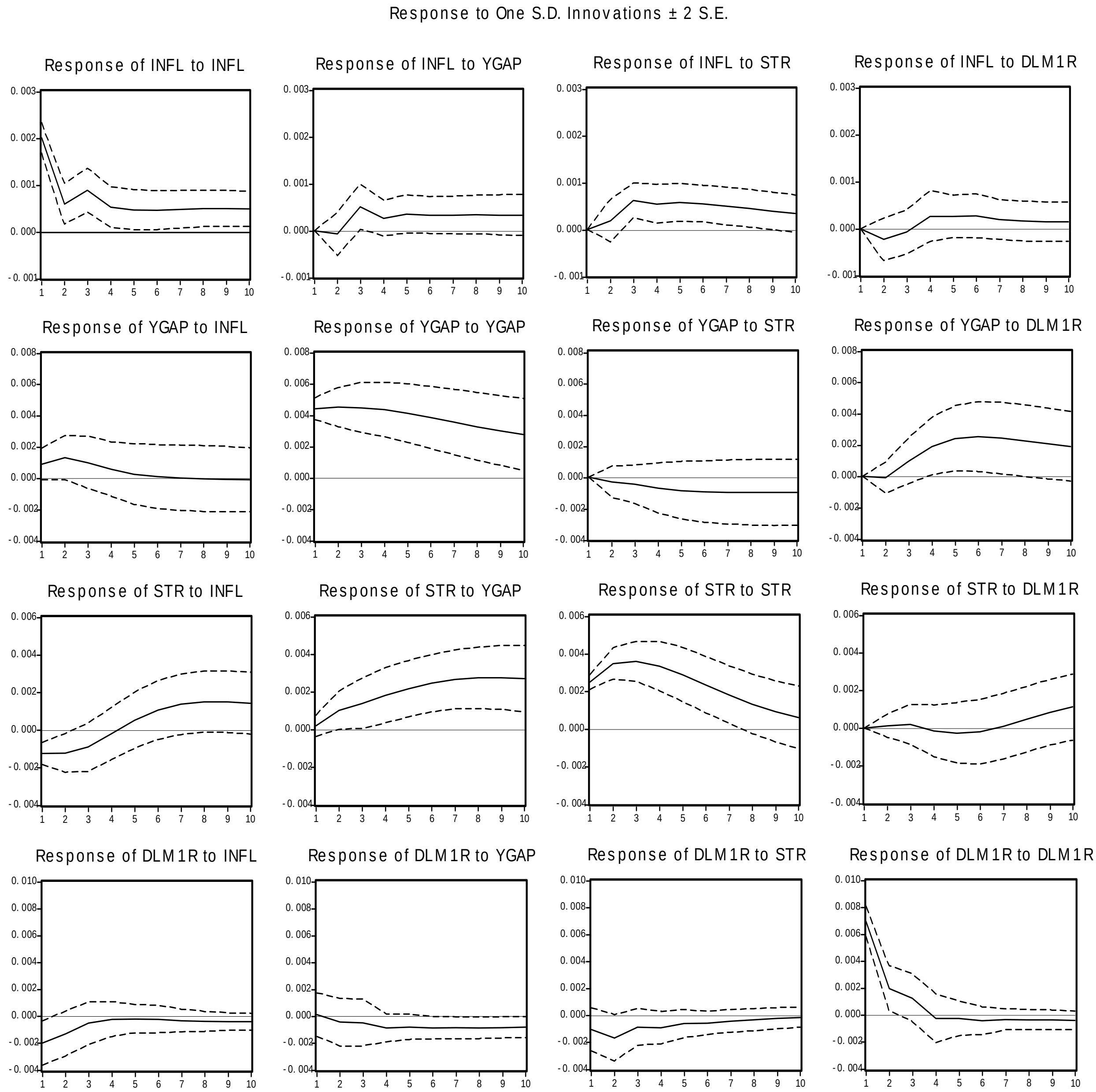


Figure 16 – Impulse responses of the unrestricted VAR model with simple sum M3

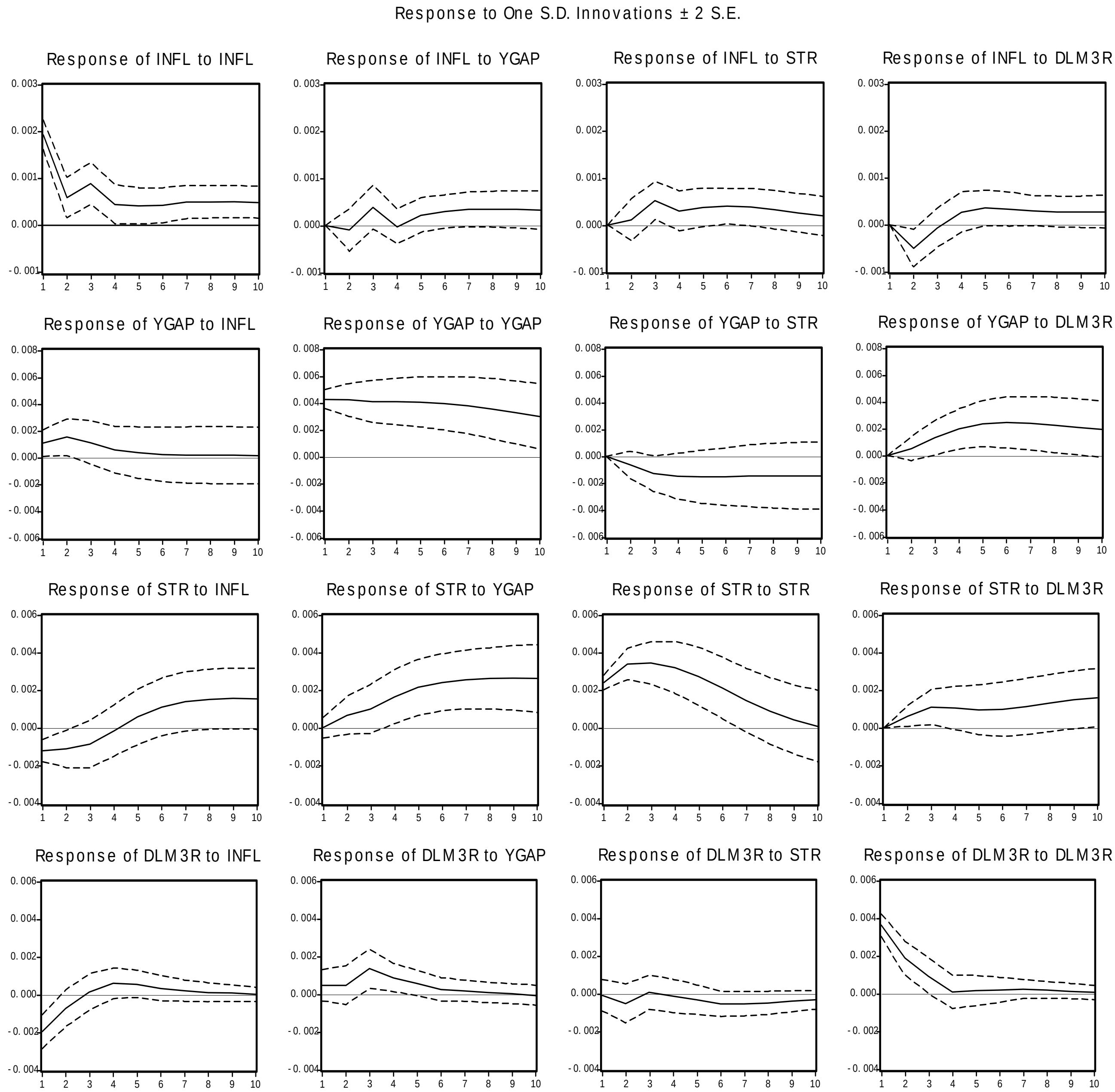


Figure 17 – Impulse responses of the unrestricted VAR model with "excess liquidity"

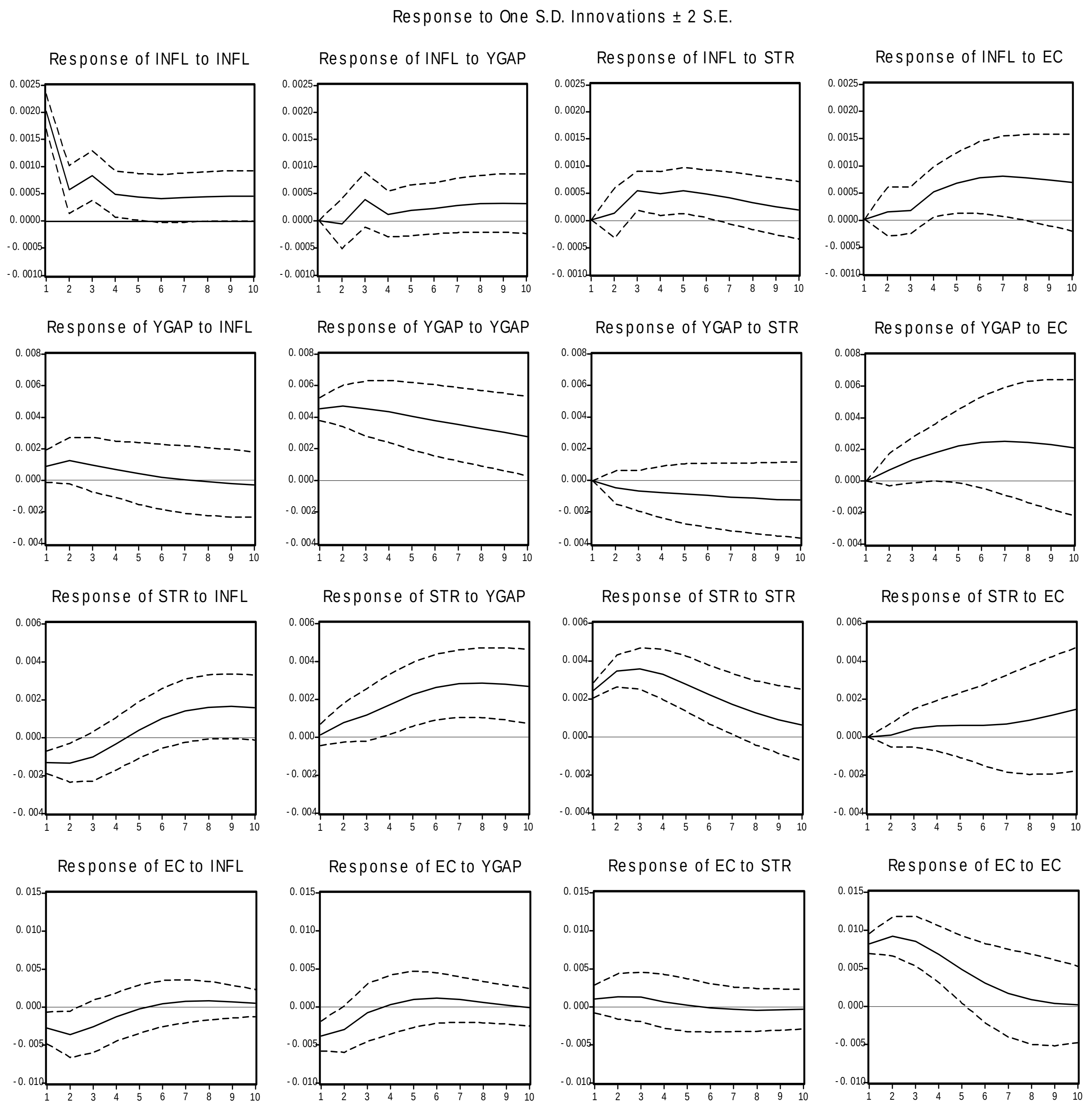


Table 4 – Comparative information value of simple sum M1, simple sum M3 and the Divisia monetary aggregate over future inflation

	Simple sum M1	***Simple sum M3***	***Divisia monetary aggregate***	***No monetary aggregate***
Adjusted R-squared	0.79	0.80	0.80	0.79
Std. Error, in % (a)	46.1	44.5	44.8	46.2
Akaike information criterion	-9.24	-9.31	-9.30	-9.27
Schwartz information criterion	-8.85	-8.92	-8.91	-8.97

(a) As a percentage of the standard deviation of the endogenous variable.

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