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ABSTRACT

This paper falls under the literature on weighted monetary aggregates that seeks to relax the assumption of perfect substitutability of assets implicit in the use of traditional monetary aggregates. Specifically, using the methodology recently proposed by Feldstein and Stock, an estimation is made of those weights which, when applied to the broad aggregate components result in liquidity growth that is a stable leading indicator of nominal expenditure.

The weighted monetary aggregate obtained provides an acceptable measure of liquidity in the Spanish economy. This aggregate does not reflect a long-run tendency in the velocity of circulation, and the implied weights are consistent with the relative liquidity of its components: the M2 weight is higher than the M3-M2 weight, which, in turn, is higher than ALP2-M3. In turn, the weighted aggregate has more explanatory power for the growth in nominal expenditure than the traditional monetary aggregates. This result also extends, albeit more weakly, to the explanatory power of inflation, measured in terms of the growth in the GDP deflator.

1. INTRODUCTION

The process of financial innovation under way in Spain since the beginning of the eighties has resulted in a progressively wider range of instruments being demanded, in differing proportions, as liquidity and as financial wealth. As a response, there has been a gradual widening of the monetary aggregates for measuring the money stock in Spain: M3, ALP, ALP2 (ALP plus commercial paper).

As indicators of nominal expenditure, the advantage of the narrowest simple-sum aggregates is that the assets included offer liquidity services in high and relatively homogeneous proportions. In turn, their disadvantage is that the assets excluded also incorporate such services, albeit in lesser proportions. In principle, the broader simple-sum aggregates obviate this disadvantage taking into account all instruments that may, to some extent, be considered as liquidity. However, the (simple-sum) method of constructing these aggregates entails increasingly less plausible assumptions of perfect substitutability. Thus, to make use of the informative properties provided by the broad monetary aggregate regarding the future course of nominal expenditure, it has been increasingly necessary to complement the information offered by this aggregate with the more detailed analysis of changes in its components and of the extent to which such changes were in accordance with the means-of-payment function.

These problems have not been exclusive to Spain. A whole strand of literature has sought to find better measures of the money stock that do not impose the perfect substitutability assumption, considering the different degrees of liquidity of the assets included[1]. Thus, compared with the simple sum implicit in the conventional (more or less broad) aggregates, the weighted aggregates defined in the literature relax this assumption, weighting the assets included precisely by their degree of liquidity. The latter is normally approximated by the interest-rate

[1] See, for example, Barnett and Spindt (1982), and Rotemberg, Driscoll and Poterba (1995).

differentials vis-à-vis an alternative asset that provides no liquidity service.

However, though the theoretical advantages of the traditional weighted monetary aggregates are clear, substantial problems arise on constructing them in practice, including two most notably. First, it is very difficult to select an asset that may be considered as absolutely illiquid. And second, the interest-rate differentials vis-à-vis this reference asset will only reflect changes in the degree of liquidity when the other characteristics (risk, maturity, tax benefits) are equal. To alleviate as far as possible the foregoing problems, alternative approximations to the empirical construction of these traditional weighted aggregates have generally been considered. The relationship of these to the final variables has then been analysed to assess the validity of the empirical approximation, usually obtaining rather discouraging results[2].

To avoid such problems, in this paper an empirical criterion is directly applied in the construction of a weighted monetary aggregate that approximates liquidity growth. Specifically, using the methodology proposed by Feldstein and Stock (1994), an estimation is made of those weights which, when applied to the broad aggregate components, result in liquidity growth with a stable predicting relationship to nominal expenditure.

The essential advantage of this methodology is that it obviates the need to establish relatively implausible assumptions about asset substitutability or its measurement. It is left for the informative content of the future course of nominal expenditure to determine the liquidity services provided by each asset. Against this, as with any empirical approximation, the methodology does not ensure clearly interpretable results. Therefore, the analysis of the estimated weights proves to be of great interest. Thus, the fact that these weights had no economic interpretation would point to problems in the estimation method or to the absence of a stable relationship between the money stock and nominal expenditure. Conversely, the results may offer useful information,

[2] See Ayuso and Vega (1994).

complementary to that of the simple-sum aggregates, facilitating the interpretation of the trend of such aggregates and improving knowledge about the future course of nominal expenditure.

The work is structured as follows. Section 2 briefly explains the methodology followed to construct the monetary indicator. After giving details of the application of this methodology to the Spanish case, the results obtained are discussed in section 3. The estimated weights are then analysed in section 4. Section 5 assesses the informative content of the monetary aggregate constructed, taking as a reference the simple-sum aggregates. Lastly, conclusions are drawn in the final section.

2. METHODOLOGY

Let M_t^s be a simple-sum aggregate formed by the n mutually exclusive sub-aggregates $Z_{i,t}$:

$$M_t^s \equiv Z_{1,t} + Z_{2,t} + \ldots + Z_{n,t}$$

The growth rate of M_t^s (Δm_t^s) is equal to the weighted average of the growth rates of the $Z_{i,t}$ ($\Delta z_{i,t}$) :

$$\Delta m_t^s = p_{1,t} \Delta z_{1,t} + p_{2,t} \Delta z_{2,t} + \ldots + p_{n,t} \Delta z_{n,t}$$

where the weights ($p_{i,t}$) are the share of each Z_i in the total aggregate in the period t-1. This paper, using the methodology proposed by Feldstein and Stock (1994), does not take these weights as given values; instead, it estimates those weights which, when applied to the growth rates of the sub-aggregates Z_i , result in liquidity growth that maintains a stable relationship to nominal expenditure as a leading indicator of this variable. Specifically, the weights are obtained from the estimation of a leading indicator model for nominal GDP, with certain parameters varying over time:

$$\Delta^2 y_t = \alpha_0 + \delta_t + \alpha(L)\Delta^2 y_{t-1} + \gamma(L)\Delta^2 m^p_{t-1} + \phi(\Delta y_{t-1} - \Delta m^p_{t-1}) + \epsilon_t \tag{1}$$

$$\epsilon_t \text{ iid } N(0, \sigma^2_\epsilon)$$

$$\Delta m^p_t = \sum_{i=1}^{n} \beta_{i,t+1} \Delta z_{i,t} \tag{2}$$

$$\beta_t = \beta_{t-1} + \eta_t, \qquad \eta_t \text{ iid } N(0, \sigma^2_\eta I) \tag{3}$$

$$\text{s.a. } \sum_{i=1}^{n} \beta_{i,t} = 1$$

where y_t is the logarithm of nominal GDP, Δm^p_t the growth rate of the weighted monetary aggregate, approximated by the first difference of the logarithm, $\Delta z_{i,t}$ the first difference of the logarithm of the i^{th} sub-aggregate, α_0 is a constant deterministic term and $\alpha(L)$ and $\gamma(L)$ are polynomials in the lag operator of the form:

$$\alpha(L) = \sum_{i=1}^{k} \alpha_i L^{i-1} \quad \text{and} \quad \gamma(L) = \sum_{i=1}^{j} \gamma_i L^{i-1}$$

The time-varying parameters are the seasonal stochastic component δ_t and the vector of weights β_t. The weights vary over time, in accordance with equation (3)[3]. δ_t is constructed using the trigonometric formula proposed by Harvey and Scott (1994) and subjected to w_t stochastic disturbances with σ^2_w variance. It is important to allow

[3] Feldstein and Stock impose no restriction on the sum of the β_i and use the subsequently normalised coefficients to construct the growth of the aggregate. However, this growth would then not predict the growth rate of nominal expenditure with elasticity γ and, in general, the relationship would not be stable, if the unrestricted sum of the β_i coefficients is not stable.

variability in this component, in that it reflects the weighted aggregate's seasonality, which may change either because the seasonality of the components varies or because of changes in the composition of the aggregate, since the components do not necessarily have the same seasonality. The seasonal component is estimated jointly with the equation's parameters, as proposed by Harvey and Scott. Lastly, ϵ_t , η_t and w_t are assumed to be independently distributed.

The specification of equation (1) draws on the available evidence for the integration orders of the variables considered (see Cabrero et al., 1992, and Ayuso and Vega, 1994). In general, it is not rejected that prices and simple monetary aggregates are integrated processes of order 2[4], while the monetary aggregates in real terms and the real income are I(1). Therefore, the growth rate of nominal GDP would be I(1), and the difference between this rate and the monetary growth would be I(0).

Note that, as in Feldstein and Stock (1994), the weighted aggregate is constructed in terms of growth rates, in accordance with equation (2). In other words, it is an indicator of monetary growth and cannot be used to obtain the level of the series[5]. Moreover, the weights will generally not coincide with those in the simple-sum aggregate growth ($p_{i,t}$) . The comparison of β_i and p_i can help to assess the findings, as discussed in section 4.

The parameters of the system (1) to (3) were estimated by maximum likelihood using the Kalman filter[6]. The transition equation (3)

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[4] Alternatively, I(1) around a trend. However, in the sample considered, this second option would entail a double trend, which is hardly satisfactory. In an earlier work (Alonso, Martinez and Pérez-Jurado, 1995), this alternative specification was considered for the period 1980-1994, with similar results, as is later discussed in some sections of this paper.

[5] However, in principle, this would be possible by estimating weightings in levels. But this would further complicate the model's representation in the state space form, without providing any gains in terms of prediction.

[6] See Harvey (1989), Chapter 3.

is enlarged by defining the state vector ψ_t , such that it includes β_t , the lags of β_t that enter in each case in (1), and the parameters of the seasonal component. The following iterative procedure is then performed:

1. The initial values of the constant parameters that must be estimated are established: $\theta = \{\alpha_0, \alpha(L), \gamma(L), \phi, \sigma_\epsilon^2, \sigma_\eta^2, \sigma_w^2\}$.

2. Using these values, the Kalman filter is applied to estimate the state vector conditional on the information available to moment t-1 $\psi_{t/t-1}$. Note that, for this step, the model must be expressed in state space form, and, therefore, the term in $\Delta^2 m_t^p$ must be rewritten in first differences.

3. Given θ and $\psi_{t/t-1}$, the prediction errors one period forward are obtained, and, with these, the value of the likelihood function for initial parameters.

4. The values of θ are changed applying a numerical maximisation algorithm, and the vectors $\psi_{t/t-1}$ and the new likelihood are recalculated.

5. The process is repeated until reaching values of maximum likelihood, according to certain criterion of convergence. Once the estimation of θ is obtained, the Kalman filter produces the optimum (state) values $\beta_{t/t}$ and $\delta_{t/t}$.

6. The growth rate of the aggregate (Δm_t^p) is constructed with the estimation of the weights conditional on all the available data($\beta_{t/T}$ or smoother values).

Thus, the final result is an aggregate with time-varying weights in growth rates: $\Delta m_{t/T}^p = \sum_{i=1}^{p} \beta_{i,t+1/T} \, \Delta z_{i,t}$.

3. CONSTRUCTION OF THE WEIGHTED AGGREGATE

In constructing a monetary aggregate, the first decision to be made involves choosing the range of assets to be considered. In the case of simple-sum aggregates, the choice of a narrow aggregate has, in principle, the advantage of incorporating relatively homogeneous assets that basically include liquidity services. However, the disadvantage lies in that it leaves out other assets that may also be demanded as "money", albeit to a lesser extent. The broader simple-sum monetary aggregates are, in fact, constructed in orther to take account of these other assets, albeit at the price of incorporating increasingly less plausible assumptions of substitutability.

By contrast, the advantage of the method used in this paper to construct the weighted aggregate is, precisely, that it allows a broad set of assets to be considered, taking account of their different informative content in terms of liquidity. On the basis of this content, the estimation procedure itself will indicate in what proportion, variable over time, the assets should be aggregated. Thus, the set of assets included is the broadest among those considered by the Spanish monetary authority in the period analysed (1970-1995) as related to nominal expenditure, namely, ALP2[7].

The second decision refers to the level of disaggregation. Ideally, the maximum disaggregation possible should be contemplated and it should be ascertained a posteriori whether some assets can be considered jointly due to their high substitutability. Unfortunately, this approach is not practical because of the complexity of the estimation procedure. Thus, it was decided to use the most common disaggregation, i.e. the mutually exclusive sub-aggregates M0, M1-M0, M2-M1, M3-M2 and ALP2-M3.

The data are quarterly, 1970:I-1995:III. Quarterly money quantities are averages of daily data of the Banco de España's statistics. The data for nominal GDP were drawn from the quarterly National Accounts compiled by the National Statistics Office. Note that, due to the quarterly National Accounts methodology, the GDP series is only available seasonally adjusted. However, this is not the case of the monetary

[7] This aggregate also includes the special debt issued in early 1992 that was exchanged for Treasury notes. If not take into consideration, a jump would occur in the time series at that time.

aggregates, thus justifying the inclusion of the seasonal term δ_t in equation (1).

As discussed, in the model used to obtain the growth rates of the weighted monetary aggregate, the second difference of the logarithm of nominal GDP is the dependent variable. The regressors are a constant, a seasonal stochastic term, lags of the dependent variable, lags of the second differences of the logarithms of the mutually exclusive sub-aggregates, and an error correction mechanism (ECM) term consisting of the lagged difference of the logarithmic growth rates of nominal GDP and the weighted aggregate. The initial values (necessary for the estimation process described in the previous section) of the parameters $\theta = \{\alpha_0, \alpha(L), \gamma(L), \phi, \sigma_\epsilon^2, \sigma_\eta^2, \sigma_w^2\}$ result from estimating equation (1) with ALP2 as a regressor plus a unitary signal-noise ratio for the weights and for the seasonal component $(\sigma_\eta^2 = \sigma_\epsilon^2 = \sigma_w^2)$. The initial values of the β_{it} as of which the Kalman filter operates are the weights of the sub-aggregates in ALP2 in the first sample observation[8].

The model was estimated for two levels of ALP2 disaggregation: the KM2 aggregate, which includes ALP2-M3, M3-M2 and M2; and KM0, which incorporates ALP2-M3, M3-M2, M2-M1, M1-M0 and M0. Note that, on the one hand, the disaggregation of M2 entailed in KM0 does not translate into any substantial improvement in the explanatory power of the growth in expenditure, and, on the other, the weights for KM0 cannot always be interpreted in terms of relative liquidity. For this reason, KM2 was chosen to continue the analysis[9].

Starting from a specification that included five lags, of both the dependent variable and the weighted aggregate, the number of lags was gradually reduced, in keeping with their significance and with the absence of correlation in the residuals. Lastly, the estimated equation

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[8] In the estimation process, the results proved robust to changes in the initial conditions.

[9] In Alonso et al. (1995), it was also found that disaggregating M2, into M2-M1 and M1, and even taking it as far as M0, did not enhance the explanatory power of nominal expenditure.

included two lags for each variable. As seen in the first column of Table 1, both the lags of the second difference of the weighted aggregate and the error correction mechanism are significant. This allows us to rewrite the equation in the form of a leading indicator model in first differences, i.e. to express the growth in nominal GDP in terms of its past and of the lags in the growth of the weighted aggregate.

This is used to calculate the dynamic response of the growth rate of nominal GDP to a 1% impulse in the growth rate of the weighted aggregate. As shown in Charts 1a and 1b, the greatest impact occurs at a lag of three and four quarters. This means that 60% of the response occurs in the first year. In addition, in the first three years the long-term response (imposed as unitary) is practically completed.

The constant term was not found to be significant and, therefore, does not appear in the equation. This means that, in the long run, the estimated weighted aggregate grows to the same extent as nominal expenditure. Thus, unlike what occurs in the case of the broadest simple monetary aggregates (see Cabrero et al., 1992), the weighted aggregate's velocity of circulation presents no significant trend. The greater trend growth of the broad simple monetary aggregates vis-à-vis nominal GDP tends to be linked to the wealth effect. In contrast, for KM2 to be interpreted as a liquidity indicator, the absence of this effect is a positive element.

Lastly, it is worth noting that the estimated equation appears to be quite stable. If the results obtained under the complete sample are compared with those under 1970:I-1985:IV, a great similarity is observed between the estimated parameters (see Table 1).

The next section analyses the possible interpretation, in terms of liquidity, of the weights estimated. This analysis, together with the prediction exercises described in section 5, is useful in assessing the results of the procedure used.

4. THE WEIGHTS

The estimated weights for KM2 are given in Chart 2a[10]. To analyse whether these estimates have economic meaning, it is useful to compare them with the weights implicit in the simple-sum aggregate that includes the same assets, i.e. ALP2 (see Chart 2b). As discussed, the growth rate of a simple-sum aggregate can also be expressed as the weighted sum of the growth rates of its components. In this case, the weights are the share of each component in the total aggregate, and they do not take into account the different degree of liquidity of each one. Conversely, in the weighted aggregate, the weights should reflect the changes both in the aforementioned share and in the degree of liquidity of the component in question. The extent to which the weights of KM2 differ from those implicit in ALP2 can thus be interpreted as a sign of deviations from the assumption of assets perfect substitutability.

To facilitate the comparison, the estimated weights were divided by the weights implicit in the simple-sum aggregate (see Chart 2c), with the resulting values interpreted as indicators of relative liquidity. In that these indicators are inferred from their explanatory power of nominal expenditure, we will refer to them indistinguishably as relative explanatory power or as indicators of relative liquidity. Note that, under the procedure used, changes in relative liquidity both over assets and over time can be reflected.

As shown in Chart 2c, the results obtained are consistent with the order that would be expected from the standpoint of liquidity: on average, M2 is more liquid than M3-M2, which, in turn, is more liquid than ALP2-M3. In other words, in the assets included in narrower aggregates, the means-of-payment function is weightier, offering greater informative content as leading indicators of nominal expenditure.

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[10] In Chart 3, the weights estimated for the entire sample are compared with those estimated for the sub-sample 1970:I-1985:IV. The levels are practically the same but, logically, the trends that begin at the end of the sub-sample cannot be identified with this sub-sample.

The changes over time in the components' relative explanatory power are also important. That of ALP2-M3 showed a notably sharp increase in the early eighties. This is explained by the emergence of new assets, whose liquidity properties made them partial substitutes for traditional liquid assets, in addition to their greater attractiveness in terms of profitability, tax opacity, etc[11]. However, as from 1985, despite the continued steady rise in this component's share of overall ALP2 (implicit weight in ALP2), its relative explanatory power for the future course of nominal expenditure declined (see Chart 2c). This decline offset the aforementioned increase, causing ALP2-M3 to disappeared in the last part of the sample as a leading indicator of nominal expenditure or, what is the same, cancelling out its weight (see Chart 2a).

In fact, the weight of ALP2-M3 was negative, though not significant as from 1987, whence the restriction of its null weight imposed since that year[12]. It is worth noting, however, that the exclusion of this component would erode the explanatory power of the weighted aggregate, given its important role in one part of the sample. A further reason for not leaving it out is that it could perfectly regain a relevant role in the future.

M3-M2 steadily gained in relative explanatory power in the second half of the eighties (this could be related to the development of public debt repo markets). Moreover, the relative informative content of M3-M2 appeared to fall in periods of slower real growth. Thus, it was minimal during the recession in the seventies, and its upward tendency was halted in the recession of 1992. One possible interpretation of this phenomenon could be the greater relevance of the savings component,

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[11] In fact, the Banco de España incorporated these assets in its intermediate target variable at that time. See Sanz (1988), and Ayuso and Escrivá (1993).

[12] Ideally, it should be imposed a priori that the weights must always be positive. However, this signifies non-normal weights. The estimation is then based on local linear approximations, whose results, particularly for the range of values where the weight of ALP2-M3 moves, proved unsatisfactory.

versus the liquidity component, in the demand for these assets during periods of deceleration in real GDP.

In turn, M2 always had a relatively larger weight in the weighted aggregate than in ALP2. This suggests that, as a leading indicator of nominal GDP, greater importance should be given to M2 than is now implied in the monitoring of trends in ALP2. In fact, during the seventies, the weighted aggregate was very similar to M2. In the eighties, with the exception of the importance of ALP2-M3 in the first half of the decade, the aggregate increasingly resembled M3, with a decline in the weight of M2 and an increase in that of M3-M2. Finally, as from 1990, the weights of M3-M2 and M2 stabilised, although the latter still remained higher than its corresponding share of the broader simple-sum aggregates.

In both the level and the behaviour of the weights, these results are very similar to those obtained in Alonso et al. (1995), whose model uses the seasonally adjusted monetary aggregates and incorporates the variables in deviations vis-à-vis a deterministic trend. In other words, it only takes into account the short-term relationship between the growth in spending and monetary growth. Perhaps the most striking difference is the greater weight of M2 that results when using the model which only includes the short-term relationship. But this is not surprising, because, as is later discussed, the long-run relationship between the growth rate of M2 and that of nominal GDP is weaker than the relationship between the latter and the growth rates of the broader simple-sum aggregates. Consequently, even though in the short run M2 by itself has very strong informative content on future trends in nominal expenditure, if an indication of spending trends in the long run is also required, then the aggregate would have to approximate more closely to the broader simple-sum aggregates.

To summarise, the asset aggregation procedure used in this paper to approximate monetary growth seems to reflect acceptably the imperfect substitutability of assets, derived from their different degree of liquidity. It is worth underscoring that this contrasts sharply with the time-pattern observed in the weights of the more traditional weighted monetary aggregates, based on theoretical definitions.

Chart 4 presents the interest-rate differentials vis-à-vis a reference asset considered as illiquid, normalised by said asset. These differentials are used as measures of relative liquidity, providing the basis for constructing weighted averages such as the Currency Equivalent, proposed by Rotemberg, Driscoll and Poterba, and the Divisia Index, advanced by Barnett. Following Ayuso and Vega (1994), who calculated these indices for the Spanish case, the interest rate used as a reference is, at any given time, the maximum between the rate of each of the assets included in the aggregate and the domestic yield of public debt at more than two years held outright by the public. Since the present paper applies a lower level of disaggregation, these differentials are calculated using the interest rates, net of taxes, for M2, M3-M2 and ALP2-M3 compiled by Cuenca (1994)[13].

A comparison of Charts 4 and 2 illustrates the difficulties posed in the empirical application of these theoretical indices[14] and underscores the need to advance in the direction indicated by Feldstein and Stock. Note that, with respect to M3-M2, the weights obtained in this paper indicate that their degree of relative liquidity rose in the eighties (more concretely, as from 1985), as would be expected, while their interest-rate differential trended indistinctly. In the case of ALP2-M3, the differential does not reflect the rise in their degree of liquidity, which appears in the empirically derived weights in the early eighties, and it increases only as from 1986, trending very similarly to that of M3-M2 by 1989, with no clear interpretation in terms of liquidity.

In any event, to assess the results obtained, the relationship between the estimated monetary indicator and nominal GDP should also be examined. This is addressed in the next section, which assesses the

[13] The calculations reproduce those of Ayuso and Vega (1994) by applying to the weights a centred moving average of order 13 to correct the problem of lags and inertias in portfolio adjustments.

[14] These difficulties are discussed in detail in Ayuso and Vega (1994).

explanatory power of GDP growth provided by said indicator, taking the simple-sum aggregates as a reference.

5. INFORMATIVE CONTENT

It seems clear that the weighted aggregate, given its construction procedure, should have high explanatory power with respect to nominal expenditure. This section analyses the extent to which this result is actually obtained, taking as a reference the degree of fit provided by the simple-sum aggregates. Of particular interest is the comparison between the results of KM2 and those of ALP2 (the simple-sum aggregate that includes the same assets as KM2). Nonetheless, the findings for M2 and M3 are also analysed. In addition, evidence is presented on the extent to which the explanatory power of the growth in nominal expenditure translates into explanatory power of inflation, measured in terms of the GDP deflator.

Chart 5 shows the growth rates of nominal GDP, ALP2 and KM2[15]. As can be seen, the growth rates of both aggregates (simple and weighted) evolve, over the long run, in line with the growth in nominal expenditure. However, the weighted aggregate reflects greater variability and adjusts more to the transitory changes in nominal GDP. The main differences occur in periods marked by a slowing in GDP.

Also worth noting are the two relatively long periods observed in which the growth in nominal expenditure differs from the rate of monetary growth, measured by either of the two indicators. Whereas in 1976 and 1977 nominal expenditure reflected systematically higher growth than that of the monetary aggregates, just the opposite occurred in the

[15] To facilitate the chart's interpretation, nominal GDP was forwarded three periods, in line with the lag in its response to movements in the monetary aggregates. The level of the ALP2 time series was displaced when taking account of the existence of a significant constant in the long-run relationship between the growth of this aggregate and that of nominal GDP. The series are presented in year-on-year rates because of the existence of seasonality in KM2 and ALP2.

period 1989-1992. In the latter case, this divergence is possibly attributable to the strong inflow of capital from abroad and the appreciation of the peseta, a process that began shortly before the peseta's entry into the ERM and lasted until the recession of 1992. Nonetheless, Chart 5 appears to indicate that this was a transitory process, after which the relationship between monetary growth and the growth in expenditure was re-established.

However, the observation of Chart 5 should be complemented with a more rigorous analysis to assess the informative content of the weighted aggregate. This analysis is presented below, using the prediction errors, both within- and post-sample, for nominal GDP and the GDP deflator.

5.a Prediction of the growth rate of nominal expenditure

The first criterion taken into account in assessing the informative content of the weighted aggregate is whether the model that includes this aggregate achieves a high degree of within-sample fit of high expenditure. The within-sample fit offered by similar models containing the simple-sum aggregates, especially the simple-sum aggregate with the same assets (but without taking into account their different degree of liquidity) is taken as a reference point. The models specified with the simple-sum aggregates (M2, M3, ALP2) are also estimated by maximum likelihood using the Kalman filter, because they maintain a variable term over time (the term that reflects stochastic seasonality) even though the weights do not appear in them.

The results of the estimates are presented in Table 2, which shows that both the ECM term and the lags of the transformations in the aggregates are, in all cases, significant, although the long-run relationship appears weaker in the case of M2. In general, the greatest impact occurs at a lag of three and four quarters. A unitary relationship in the long run is always imposed. Table 3 gives the standard deviations of the residuals as a measure of the degree of fit.

Here it is important to bear in mind that the within-sample predictions were made in each quarter with θ parameters, estimated with an information set which included that of the quarter in question and β weights --used to construct KM2-- based on said parameters. In view of this, it would be useful to complete this analysis with an examination of the post-sample predictions.

Starting with a sample ending in 1992:III, the aforementioned equations were estimated both for KM2 and the simple-sum aggregates. These estimations were repeated, successively incorporating the information for each additional quarter to 1995:II and predicting in each case, under the different aggregates, the growth rate of nominal GDP in the next quarter and several quarters ahead[16]. Note that, in the case of KM2, 12 estimations of the weighted aggregate were used, each conditional on a different sub-sample, from $m_{t92:III}$ to $m_{t95:II}$. At the end of the process, the predictions were compared with the observed datum, calculating the mean-squared error as a measure of post-sample fit (see Table 3).

The choice of 1992:III for beginning the post-sample forecasts is conditioned by the above-mentioned anomaly observed in the period 1989-1992. This somewhat limits the interpretation of the results, since the findings refer to a relatively short prediction period (12 quarters). Using this period, an atypical prediction could significantly affect the overall result. Thus, it can prove helpful to give also the results of the exercise for the last eight quarters of the sample.

First, it is worth underscoring that, according to the results obtained for ALP2 and KM2, the latter aggregate and the weights it applies to each ALP2 component add useful information for interpreting ALP2's behaviour in terms of the future course of nominal expenditure.

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[16] Predictions several periods in advance require, in turn, predictions for the growth of the monetary aggregates, which were prepared by the Banco de España's Monetary Research Department from univariate models. The lags in the publication of GDP data and monetary aggregates were taken into account.

In other words, it seems relevant to assess the behaviour of ALP2 taking into account the behaviour and the informative content of its components.

Note that the narrower simple-sum aggregates, M2 and M3, also obtain smaller within- and post-sample errors than ALP2, except for the post-sample prediction of the last 12 periods with M2. Nonetheless, even taking these simple-sum aggregates as a reference, the informative content of KM2 for the future growth in nominal expenditure appears to be high. The results with KM2 either resemble those of the aggregate with the lowest prediction error or are even superior in the case of the within-sample fit and the post-sample fit in the last eight quarters of the sample.

The fact that, among the simple-sum aggregates, the within-sample fit is better with M2 is consistent with its largest weight in KM2. In turn, the fact that M3 gives better post-sample predictions for the final years is consistent with the time-pattern of the weights, which imply that KM2 approximates to M3 in these years.

5.b Prediction of the growth rate of the GDP deflator

This section presents evidence on the extent to which the information content of the monetary aggregates for the future course of nominal expenditure translates into informative content for one of its components, i.e. the GDP deflator. This step is particularly relevant because the rate of inflation (albeit measured in terms of the CPI) is, at present, the direct target of monetary policy in Spain.

To this end, models are specified to predict the growth rate of the deflator, taking as a dependent variable the second difference of the logarithm of the deflator and as independent variables the lags of the same, a constant term, a seasonal stochastic term, the lags of the second difference of the logarithm of the related monetary aggregate, and the first lagged difference of the logarithm of the real monetary balances. This is estimated for M2, M3 and ALP2 and also for the weighted aggregate KM2 previously constructed. Once again, the estimation is made under by maximum likelihood using the Kalman filter. Though the relationship in the short run appears weaker than that with nominal GDP, all the aggregates tend to anticipate changes in the inflation rate. This anticipation occurs in this case, with a three quarter lead for KM2 and M2 and with three, and particularly six, quarter lead for M3 and ALP2.

Note, however, that KM2 is constructed with data of nominal GDP --and, by extension, of the deflator-- for the entire sample, causing problems of endogeneity in the model with this aggregate. For this reason, the results related to the within-sample fit should be interpreted with caution, although the model can be used for predictive purposes[17]. Here it should again be recalled that, in the post-sample predictions, as additional quarters are incorporated into the sample, the KM2 aggregate used to estimate the explanatory equation and predict the deflator is not the KM2 estimated for the entire sample, but rather the one estimated with the corresponding sub-sample[18].

Table 4 presents the results of the deflator predictions with M2, M3, ALP2 and KM2. As can be seen, the results on the informative content for nominal GDP are generally extensive to the informative content for inflation, except in the case of the within-sample fit of M2, which is comparatively worse for the deflator.

Once again, the similarity to the results obtained in Alonso et al. (1995) deserves underscoring. Notable, however, is the greater difference of fit between KM2 and the simple-sum aggregates for the within- and post-sample prediction in the deterministic trend model. This

[17] One alternative would be to estimate the weights on the basis of the components' relationship with the growth rate of the deflator. Nonetheless, to define the money stock, nominal expenditure --not prices-- should be used. In any event, several tests showed that the weak short-run relationship between monetary growth and inflation --much weaker than between monetary growth and GDP growth-- impedes a proper distinction between the explanatory powers of the sub-aggregates.

[18] The variations are small, because the weights are quite stable with different sub-samples.

is explained by the fact that the differences between the weighted aggregate and ALP2 basically affect their behaviour in the short run.

Lastly, Chart 6 shows the recent trends in the growth rates of nominal GDP (at t+3), M2, M3 and KM2. The growth rates of these three monetary aggregates during 1995 should contain information on trends in nominal GDP at the close of 1995 and in the early quarters of 1996. The signals sent by the simple-sum aggregates for the first few quarters of 1996 are very different: strong deceleration in GDP according to M2, and mild acceleration in GDP according to M3. Thus, whereas it may appear, on the basis of the results obtained, that the differences in informative content between the aggregates are small, for purposes of monetary analysis the predictions of each simple-sum aggregate must necessarily be subjected to some type of weight. The results presented in this paper seem promising with respect to the possibility of applying this methodology to arrive at a better interpretation of the movements of the aggregates from the standpoint of their implications for the future course of expenditure. The signal offered by KM2 is closer to that of M3 than to the signal sent by M2, thus indicating that nominal expenditure will continue to grow at its present rate.

6. CONCLUSIONS

The results described in this paper suggest that the sub-aggregates which comprise ALP2 have different informative content regarding the future course of nominal expenditure. The methodology applied provides for the construction of a weighted monetary aggregate that approximates the growth in liquidity by weight these sub-aggregates in accordance with their informative content. It seems that the evolution of this content over time can be interpreted according to the corresponding degree of relative liquidity. In turn, the resulting weighted aggregate shows high explanatory power with respect to the growth in nominal expenditure.

Accordingly, it would seem worthwhile to complete the information offered by the broad simple-sum aggregates with that of other narrower aggregates or with the information provided by their components. When the trends in these monetary variables are divergent, the behaviour of the weighted aggregate (and the weights it applies to the components) can help to improve their interpretation from the standpoint of the signals sent regarding the future course of the final variables in the short run.

Note that, even though the paper's findings seem promising in that they can facilitate a joint assessment of the information offered by the aggregates, the analysis has certain limitations that may condition the results and which should, therefore, be underscored. First, the post-sample prediction period spans only 12 quarters, given the peculiarity of the period prior to 1989-1992, and, therefore, it is very important to continue assessing the behaviour of the weighted aggregate as new observations become available. Second, non-traditional groups of assets, especially those included in ALP2-M2, could result in sub-aggregates with more homogeneous features in the area of tax opacity, terms, etc.

Lastly, another extension that can be considered is the construction of the weighted aggregate, starting from a bi-equational model of real income and prices that not only takes into account the influence of monetary growth on these two variables (i.e. on nominal expenditure) but also the relationship between them. This extension would be especially useful for improving price predictions, while also allowing the CPI to be used as a measure of the economy's prices.

TABLE 1

MODELS WITH THE WEIGHTED AGGREGATE KM2 Dependent variable: $\Delta^2 y_t$		
Sample period	1970:I-1995:III	1970:I-1985:IV
I7580 (*)	-0,377 (0,057)	-0,379 (0,063)
S86 (*)	0,285 (0,102)	----
$\Delta^2 y_{(t-1)}$	0,625 (0,087)	0,611 (0,106)
$\Delta^2 y_{(t-2)}$	-0,258 (0,088)	-0,227 (0,109)
$\Delta^2 m_{(t-1)}$	-0,078 (0,043)	-0,062 (0,053)
$\Delta^2 m_{(t-2)}$	-0,103 (0,038)	-0,100 (0,045)
$(\Delta y - \Delta m)_{(t-1)}$	-0,172 (0,041)	-0,186 (0,051)
σ_ω (a)(%)	0,016	0,000
σ_ϵ (b)(%)	0,266	0,303
σ_η (c)(%)	0,034	0,017
logL/Nº observations	4,310	4,179
Q(4) p-value	6,048 (0,196)	3,664 (0,453)

y: logarithm of nominal GDP; m: logarithm of the monetary aggregate.
Parameters by maximum likelihood method using the Kalman filter.
(*): deterministic variables:
I7580: impulses on nominal GDP in the quarters 75:I and 80:I.
S86: step on nominal GDP growth that takes value 1 in the quarter 85:IV and value 3 as from quarter 86:I.
(a): standard deviation of the residual of the transition equation of the seasonal components. A zero implies deterministic seasonality.
(b): standard deviation of the residual of the explanatory equation of nominal GDP.
(c): standard deviation of the residual of the transition equation of the weights of each sub-aggregate.
In parenthesis, standard deviation of the estimators of the parameters.
Q(4) is the value of the Ljung-Box test of order 4.

TABLE 2

MODELS WITH SIMPLE-SUM AGGREGATES Dependent variable: $\Delta^2\ y_t$			
Variable	M2	M3	ALP2
constant	----	-0,055 (0,031)	-0,076 (0,034)
I7580 (*)	-0,378 (0,054)	-0,388 (0,060)	-0,395 (0,061)
S86 (*)	0,308 (0,096)	0,241 (0,106)	0,243 (0,104)
S92 (*)	0,239 (0,138)	----	----
$\Delta^2\ y_{(t-1)}$	0,651 (0,088)	0,665 (0,090)	0,671 (0,090)
$\Delta^2\ y_{(t-2)}$	-0,351 (0,084)	-0,209 (0,090)	-0,191 (0,092)
$\Delta^2\ m_{(t-1)}$	----	-0,093 (0,056)	-0,111 (0,055)
$\Delta^2\ m_{(t-2)}$	-0,036 (0,029)	-0,111 (0,051)	-0,125 (0,051)
$\Delta^2\ m_{(t-3)}$	0,068 (0,027)	----	----
$(\Delta\ y-\ \Delta\ m)_{(t-1)}$	-0,079 (0,024)	-0,165 (0,041)	-0,166 (0,042)
σ_ω (a)(%)	0,019	0,019	0,018
σ_ϵ (b) (%)	0,274	0,284	0,287
logL/Nº observations	4,337	4,301	4,298
Q(4) p-value	3,261 (0,515)	3,183 (0,528)	4,593 (0,332)

y: logarithm of nominal GDP; m: logarithm of the monetary aggregate.
Parameters estimated by maximum likelihood using the Kalman filter.
(*): deterministic variables:
I7580: impulses on nominal GDP in the quarters 75:I and 80:I.
S86: step on nominal GDP growth that takes value 1 in the quarter 85:IV and value 3 as from quarter 86:I.
(a): standard deviation of the residual of the transition equation of the seasonal components.
(b): standard deviation of the residual of the explanatory equation of nominal GDP.
In parenthesis, standard deviation of the estimators of the parameters.
Q(4) is the value of the Ljung-Box test of order 4.

TABLE 3

PREDICTION OF NOMINAL GDP				
WITHIN-SAMPLE FIT				
AGGREGATES	M2	M3	ALP2	KM2
σ_ϵ	0,274	0,284	0,287	0,266
POST-SAMPLE FIT (WITH 8 PERIODS)				
AGGREGATES	M2	M3	ALP2	KM2
RMSE (1)	0,269	0,224	0,274	0,205
RMSE (2)	0,398	0,379	0,512	0,305
POST-SAMPLE FIT (WITH 12 PERIODS)				
AGGREGATES	M2	M3	ALP2	KM2
RMSE (1)	0,274	0,222	0,270	0,240
RMSE (2)	0,471	0,363	0,472	0,390
RMSE (3)	0,587	0,383	0,521	0,394
RMSE (4)	0,665	0,443	0,599	0,474
RMSE (5)	0,793	0,530	0,659	0,583
RMSE (6)	0,936	0,625	0,629	0,715

All data for growth rates in %.
RMSE (n): Root of mean-squared error in the prediction at n-quarters ahead.
For more than 2 periods, predictions of the simple-sum aggregates obtained from univariate models are used.
As the prediction horizon increases, the number of observations for the calculation of the RMSE gradually decreases.

TABLE 4

PREDICTION OF GDP DEFLATOR				
WITHIN-SAMPLE FIT				
AGGREGATES	M2	M3	ALP2	KM2
σ_{ϵ}	0,294	0,286	0,285	0,281
POST-SAMPLE FIT (WITH 8 PERIODS)				
AGGREGATES	M2	M3	ALP2	KM2
RMSE (1)	0,105	0,158	0,183	0,092
RMSE (2)	0,283	0,309	0,387	0,180
POST-SAMPLE FIT (WITH 12 PERIODS)				
AGGREGATES	M2	M3	ALP2	KM2
RMSE (1)	0,102	0,157	0,178	0,141
RMSE (2)	0,264	0,277	0,322	0,292
RMSE (3)	0,276	0,326	0,397	0,345
RMSE (4)	0,290	0,386	0,476	0,297
RMSE (5)	0,328	0,442	0,503	0,280
RMSE (6)	0,414	0,492	0,554	0,350

All data for growth rates in %.
RMSE (n): Root of mean-squared error in the prediction at n-quarters ahead.
For more than 2 periods, predictions of the simple-sum aggregates obtained from univariate models are used.
As the prediction horizon increases, the number of observations for the calculation of the RMSE gradually decreases.

CHART 1a

RESPONSE OF DLGDP
TO AN IMPULSE OF THE WEIGHTED AGGREGATE KM2

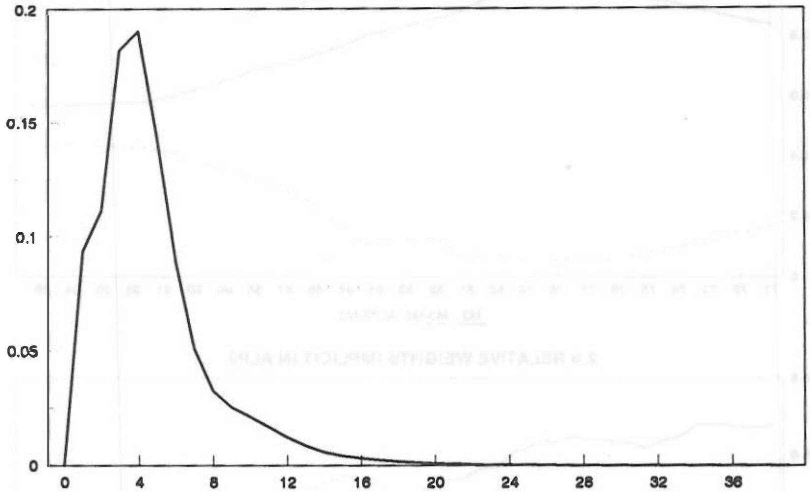
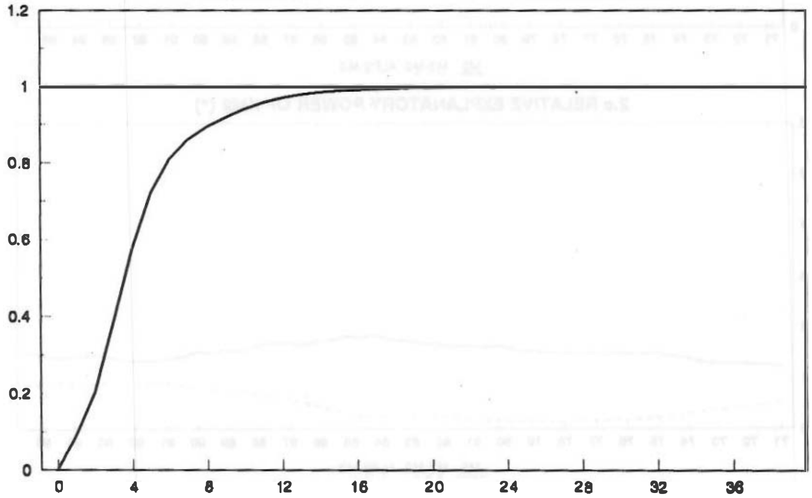


CHART 1b

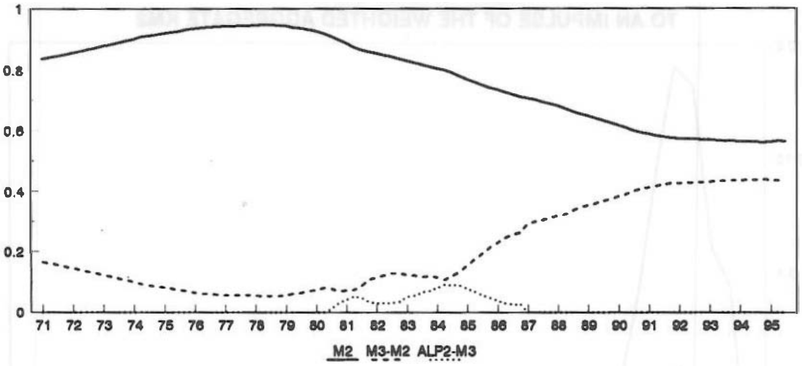
ACCUMULATED RESPONSE OF DLGDP
TO AN IMPULSE OF THE WEIGHTED AGGREGATE KM2



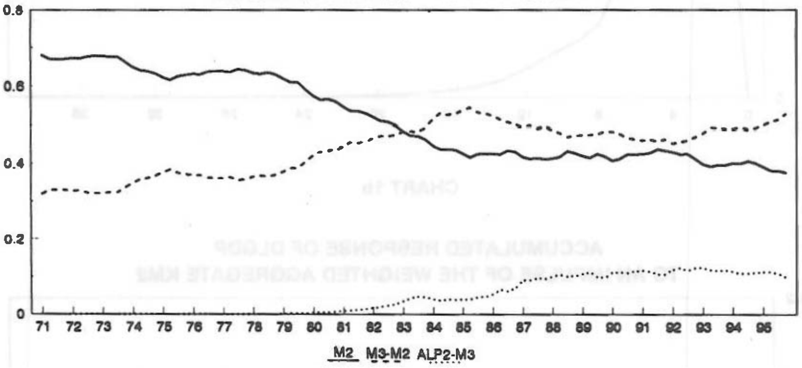
Note: Percentage points in the response of the growth rate of nominal GDP to an increase of 1% in the growth rate of the weighted aggregate.

CHART 2

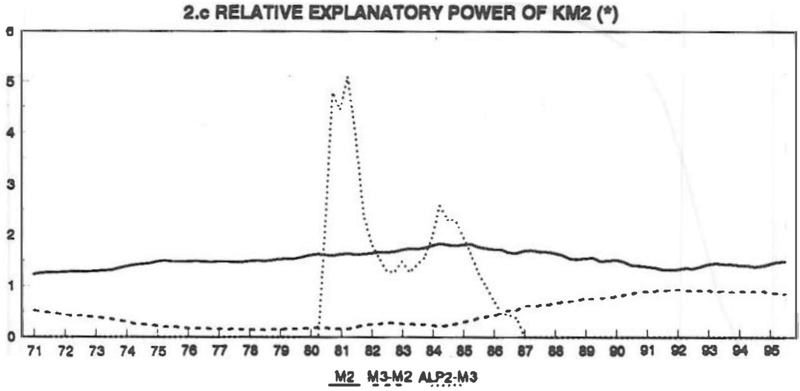
2.a WEIGHTS IN THE WEIGH ED AGGREGATE KM2



2.b RELATIVE WEIGHTS IMPLICIT IN ALP2



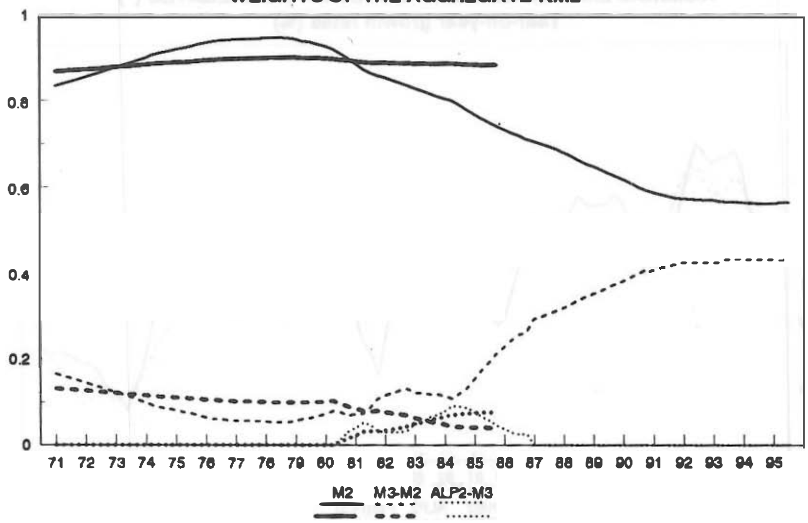
2.c RELATIVE EXPLANATORY POWER OF KM2 (*)



(*) For each sub-aggregate, the coefficient between its weight in KM2 and its share in ALP2.

CHART 3

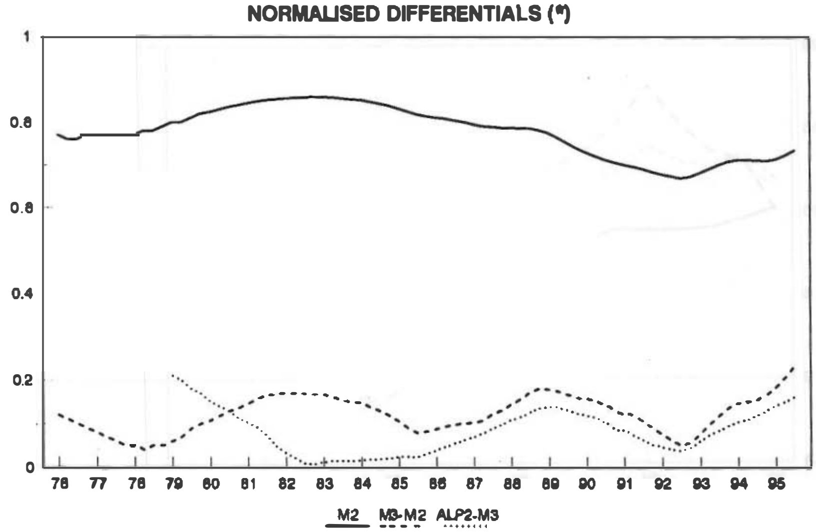
WEIGHTS OF THE AGGREGATE KM2



Note: The fine lines represent the weights estimated with the complete sample, while the thick lines denote the estimation obtained for a sample period ending in 85:IV

CHART 4

NORMALISED DIFFERENTIALS (*)



(*) Constructed as $(r_b - r_i)/r_b$, where r_b is the interest rate net of taxes of the reference asset, and r_i is the interest rate net of taxes of the sub-aggregate.

CHART 5

NOMINAL EXPENDITURE AND MONETARY AGGREGATES (*)
Year-on-year growth rates (%)

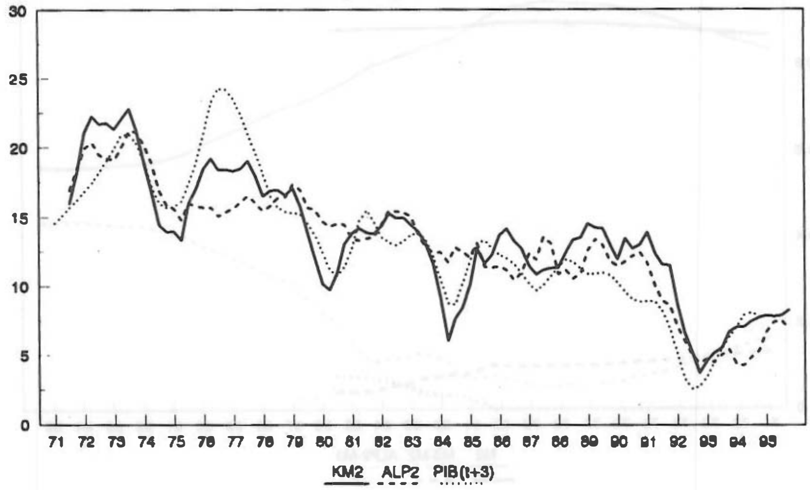
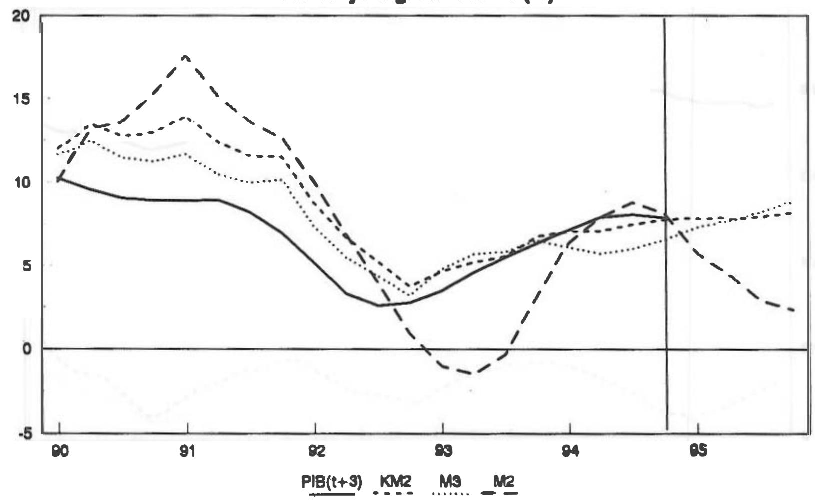


CHART 6

RECENT TRENDS IN NOMI. EXPENDITURE AND AGREGATES (*)
Year-on-year growth rates (%)



(*) To facilitate the chart's interpretatión, nominal GDP is extrapolated three periods forward, because it is primarily effected by the aggregates at a lag of three quarters. Due to the existence of a significant constant in the long-run relationship between the growth rates of nominal GDP and ALP2 this final time serie was displaced to reflect the magnitude of said constant.

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