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Andrea Nobili*

Abstract

The prominent role assigned to money by the ECB has been the subject of an intense debate because of the declining predictive power of the monetary aggregate M3 for inflation in recent years. This paper reassesses the information content of monetary analysis for future inflation using dynamic factors extracted from a new and richer cross-section of data including the monetary aggregate M3, its components and counterparts, and a detailed breakdown of deposits and loans at sectoral level. Weighting monetary and credit variables according to their signal to noise ratio allows us to downplay those that in recent times contributed significantly to the deterioration of the information content of the M3. Factor-model based inflation forecasts turn out to be more accurate than those produced by traditional competitor models at the relevant policy horizon of six-quarters ahead. All in all, our results support the view that an analysis based on a large set of monetary and credit variables is a more useful tool for assessing risks to price stability than one that simply focuses on the dynamic of the overall monetary aggregate M3.

JEL Classification: C22, E37, E50.

Keywords: monetary analysis, factor models, forecasting.

Contents

* Bank of Italy, Economic Outlook and Monetary Policy Department.

1.Introduction[1]

The assessment of risks to price stability in the euro area stemming from monetary analysis is an essential ingredient of the ECB's two-pillar strategy, which has been widely discussed in several empirical contributions, including Masuch et al. (2001), ECB (1999, 2004), Nicoletti-Altimari (2001) and Gerlach and Svensson (2003). Recently, Fischer, Lenza, Pill and Reichlin (2006) provided a useful description of the tools and procedures used by the ECB staff in monetary analysis, a source of information that has seldom been presented to the public in the regular publications (ECB, 2005a, 2006a). Besides the estimated money demand equations (Brand and Cassola, 2000; Calza et al., 2001; Bruggeman et al., 2003), euro-area inflation predictions produced by forecasting models involving the current and past values of a monetary indicator played an important role.

This "prominent role" assigned to money has been the subject of an intense debate in the light of the deterioration of money-based models in predicting future inflation (Lippi and Neri, 2007; Hofmann, 2006; Lenza, 2006; OECD, 2007; Berger and Stavrev, 2008; Fischer et al., 2006). Fischer et al. (2006) showed that the use of the broad monetary aggregate M3 in the bivariate regressions tended to produce upward biased inflation forecasts in the period 2002-2006, so that a simple random walk model outperforms them at a six-quarters ahead horizon. In addition, the reliability of inflation forecasts produced by excess liquidity measures have also been widely criticized, because of the signs of instability characterizing the estimated money demand equations for the euro area (Carstensen, 2006; Alves, Robalo Marques and Sousa, 2007; Avouyi-Dovi, Brun, Dreyfus, Drumetz, Oung and Sahuc, 2006).

Some authors pointed out that the diminishing predictability of inflation is a natural feature −common to several forecasting models and not confined to money-based forecasts− mainly reflecting the structural break in the inflation rate process observed in the economies moving to inflation-targeting regimes (Stock and Watson, 2005; D'Agostino et al., 2006;

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D'Agostino and Giannone, 2006). Other authors provided economic interpretations of the breakdown of money and inflation. Ferrero et al. (2007) showed that the leading properties of the M3 growth rate and the excess liquidity measures have been strongly influenced by structural changes in the money-holding sector, namely by the increasing role of non-bank financial intermediaries, whose money holdings are likely to reflect portfolio considerations rather than transaction motives. Similarly, Von Landesberger (2007) estimated sectoral money demand equations and found that those held by non-monetary financial firms and non-financial firms appear to be hardly fitted with the traditional determinants of money demand, thus inducing a break in the trend of money velocity.

Against this background, several lines of research have been put forward in order to improve the leading properties of the M3 for future euro-area inflation. Some authors, such as Gerlach (2003, 2004), Neumann and Greiber (2004), Assenmacher-Wesche and Gerlach (2006), mainly using filtering procedures, highlighted a stronger correlation between money and inflation at very low frequencies; in particular, Lenza and Reichlin (2007) showed that "smoothed money" leads "smoothed inflation" especially at the six-quarter ahead horizon and that this information content of money increases the more the time series are smoothed. However, the computation of a "core" money growth rate crucially depends on the filtering procedure and raises questions regarding its reliability at the end of the sample, which is the relevant timing for monetary policy decisions. Other contributions relied on the use of a large cross-section of data, finding mixed evidence in favor of the marginal predictive content of broad monetary aggregates and excess liquidity measures beyond that contained in other leading indicators (Hofmann, 2006; Lenza, 2006). Finally, the ECB suggested the use of the M3 growth rate corrected for the effects of portfolio shifts (ECB, 2003, 2005b), which aims at correcting the M3 growth rate for temporary drivers linked to financial considerations that have been identified by the ECB as non-inflationary. However, the identification of the direction, timing, and magnitude of the portfolio shifts are based on "ad hoc" corrections, which require a relatively high degree of judgment for their real-time estimation.

In this paper we evaluate the information content of the monetary pillar for euro-area inflation by applying the dynamic factor model approach developed by Forni et al. (2000, 2005) on a new and suitable cross-section of variables comprising the broad monetary aggregate M3, its components and counterparts, notably credit and net external assets, and, most importantly, a detailed sectoral breakdown of deposits and loans. Our dataset is essentially consistent with the ECB "broad" definition of monetary analysis (ECB, 2004) and improves upon the existing literature in several respects.

First, we derive euro-area inflation forecasts by means of a statistical approach that aims at weighting the monetary and credit aggregates according to their signal to noise ratio, namely, down-weighting those with large idiosyncratic variances. More precisely, we exploit the richness of information contained in sectoral money holdings, as well as in the detailed breakdown of money by type of instruments, two features not addressed by previous studies focusing on a large cross-section of data. In this respect, our approach should downplay those monetary instruments that in recent times significantly contributed to the deterioration of the information content of the broad monetary aggregate M3, such as currency in circulation and marketable instruments whose developments are affected by financial innovation as well as portfolio considerations. In addition, it should also weight money holdings at sectoral level, as money held by different sectors may have different leading properties for future inflation (e.g. Ferrero et al., 2007 and Von Landesberger, 2007). Second, we investigate whether adding the counterparts side of money (credit variables at aggregate and sectoral level) improves upon the use of solely monetary aggregates, a feature implicit in the broad definition of monetary analysis provided by the ECB. Third, unlike the previous studies that used a large cross-section of data (Hofmann, 2006 and Lenza, 2006) our dataset does not include excess liquidity measures (e.g. the change in p-star, the real money gap and the monetary overhang) as the instability of the underlying long-run relationships results in non-stationary indicators that cannot be used in dynamic factor models. Fourth, our approach simply lets the data speak for themselves, without involving any degree of judgment or "ad hoc" corrections.

Our empirical results suggest that factor-model based inflation forecasts are better than those produced by competitor models at a six-quarters ahead horizon. The resulting inflation predictions are unbiased and characterized by relatively low volatility. Gains in forecast accuracy are substantial and mainly depend on the inclusion of sectoral money holdings. From a policy perspective, our results support an approach based on a broad monetary analysis, which provides a more reliable assessment of inflation risks than the overall monetary aggregate M3 growth rate.

In Sections 2 and 3 we describe the dataset used in the analysis and we present the methodology used to derive inflation forecasts from monetary and credit variables. In Section 4 we give a primer regarding the signal-to-noise ratio contained in each considered variable, while in Section 5 we assess the predictive power of the dynamic factor models for six-quarters ahead future inflation in an out-of-sample forecasting exercise. Section 6 offers some concluding remarks and provides suggestions for future empirical works.

2. Data

In this Section we describe the large set of data used for the derivation of inflation forecasts. Following the broad definition of the monetary analysis of the ECB (1999, 2000), besides the HICP year-on-year inflation rate, the dataset comprises the standard monetary aggregates M3, M2, M1, as well as the available breakdown of money by sector and instrument announced in ECB (2006b).

We focus on the most detailed breakdown of the official definition of M3 and take aggregates for different money holding sectors (other general government, households, non-financial corporations, insurance corporations and pension funds, other financial intermediaries) as well as for type of monetary instrument (overnight deposits, deposits with agreed maturity up to two years, deposits redeemable at notice up to three months and repurchase agreements). This breakdown is not exhaustive as it represents about 70 per cent of the overall stock of M3. We also consider several non-sectorized components, namely currency in circulation, total overnight deposits, short-term deposits other than overnight deposits (M2-M1) and the so-called marketable instruments (M3-M2), which is the component of M3 comprising repurchase agreements, money market fund shares/units and debt securities with a maturity of less than two years. The full list of monetary variables included in our database is summarized in Table 1a.

Regarding the counterparts of M3, we consider total loans to the private sector and the net external assets of the Monetary and Financial Institution (MFI) sector. For the former we also include a non-exhaustive sectoral breakdown comprising total loans to households (also distinguished between consumer credit, loans for house purchase and loans for other purposes) and total loans to non-financial corporations, which are also divided into short-term loans (with a maturity of up to one year) and long-term loans (with a maturity of over one year). Because of the lack of enough long-time series, we cannot use bank loans provided to other sectors in the estimation, such as other financial intermediaries, insurance corporations and pension funds, and other general government. These data are available only since 2002 and represent about ten per cent of the overall credit to the private sector. The full list of credit variables included in our dataset is summarized in Table 1b.

All monetary and credit variables are expressed in annual growth rates, calculated on the basis of the adjusted index of notional stocks, which correct the outstanding amounts of the variable for the effects of reclassifications, exchange rate changes and other revaluations. All in all, our dataset comprises 47 time series spanning the period 1992q1-2008q4. A complete description of data and sources is provided in Appendix A1.

3. Methodology

The methodology used in this paper relies on Forni et al. (2000, 2005). Given a panel of n variables, we assume that each observation is described by the following equation:

$$x_{it} = \chi_{it} + \xi_{it} = b_i(L)f_t + \xi_{it} = \sum_{j=1}^{q} b_{ij}(L)f_{jt} + \xi_{it} \qquad (1)$$

Equation (1) states that each observation can be expressed as the sum of two mutually orthogonal unobservable components: the common component χ_{it} and the idiosyncratic one ξ_{it}. The former is driven by a vector f_t $(q \times 1)$ of few factors or shocks which are the same for all cross-section units but potentially loaded with different coefficients and lag structures b_{ij}. The impulse response function $b_{ij}(L)f_{jt} = b_{ij0}f_{jt} + b_{ij1}f_{jt-1} + ... + b_{ijs}f_{jt-s}$ $j = 1,...,q$ represents how each given variable reacts to each of the q shocks. In this respect, the different delay with which these shocks are loaded on different variables determines whether some of the variables will be leading, coincident or lagging with respect to inflation. The idiosyncratic component is instead driven by non pervasive shocks and idiosyncratic components of different variables are assumed to be not correlated. The model can be easily reparameterized under mild conditions in its static version:

$$x_{it} = \sum_{k=1}^{r} B_{i,k}F_{t,k} + \xi_{it} \qquad (2)$$

where $r = q(s+1)$ is the number of static factors. In equation (2) s is the finite length of the filter and the vector F is simply the collection of all the stacked factors, with $r=q(s+1)$. First, an estimate of the covariance structure of the common components and the idiosyncratic components is obtained by means of the inverse Fourier transform of the corresponding spectral density matrices; then, the estimated covariance matrix of the common components is used to solve the generalized principal components problem:

$$\begin{aligned} \hat{\Gamma}_0^{\chi} V_r &= \hat{\Gamma}_0^{\xi} V_r D_r \\ s.t.\ V_r' \hat{\Gamma}_0^{\xi} V_r &= I_r \end{aligned} \tag{3}$$

where D is a diagonal matrix having on the main diagonal the first r largest generalized eigenvalues of the pair $(\hat{\Gamma}_0^{\chi}, \hat{\Gamma}_0^{\xi})$ and V is the $(n \times r)$ matrix of the corresponding eigenvectors. The first r generalized principal components (common factors) are defined as:

$$\hat{F}_t = V_r' X_t \tag{4}$$

and can be interpreted as static principal components computed on weighted data, where the weights are inversely proportional to the variance of the idiosyncratic components. Using the estimates of the covariance matrices of the common and the idiosyncratic components, we can compute the forecasts of both components separately as:

$$\chi_{iT+h/T} = \text{proj}(\chi_{iT+h} / F_T) \tag{5}$$

$$\xi_{iT+h/T} = \text{proj}(\xi_{iT+h} / x_{iT}, \dots, x_{iT-p}) . \tag{6}$$

The direct inflation forecast h-periods ahead is simply given by:

$$\pi_{T+h/T}^{(f)} = \hat{\chi}_{iT+h/T} + \hat{\xi}_{iT+h/T} . \tag{7}$$

Our approach differs from the two-step approach used by Stock and Watson (1999, 2002a, 2002b) and in previous studies for the euro-area inflation rate (Nicoletti-Altimari, 2001; Fischer et al., 2006; Hofmann, 2006). In the first step an estimate of the common factors is obtained as sample principal components of the dataset; then, these factors are used as predictive variables in the following forecasting equation:

$$\pi_{T+h/T}^{PC} = \alpha_h + \beta_h F_t + \gamma_h(L)\pi_t + \varepsilon_{t+h} \tag{8}$$

where h is the forecast horizon and the order of the lag polynomial in L is chosen on the basis of standard information criteria. In this approach the idiosyncratic component of inflation is assumed to be weak and captured by lagged values of the dependent variable; as in most of the applications the idiosyncratic component is far from being predictable, lagged inflation values are useless in improving forecasts. In addition, the methodology uses neither the lead-lag structure among the target variable and the predictive variables nor the orthogonality assumption between the common and idiosyncratic components.

Our analysis focuses on inflation forecasts at the six-quarters ahead horizon. We avoid shorter horizons, as monetary analysis is used by the ECB to extract information about the outlook for price developments over the medium to long term (see Fischer et al, 2006). At the same time, the relatively short sample period used in the analysis make longer horizon evaluations (the twelve-quarters ahead horizon) very unstable and therefore unreliable. The forecasting properties of all competitor models are evaluated on the basis of a simulated out-of-sample forecasting exercise over the period 2001q1-2008q4. The choice of the forecasting evaluation period extends the one used in Fischer et al. (2006) and comprises the times when monetary indicators appeared to lose their marginal predictive power for future inflation (Lenza, 2006; Hofmann, 2006).

The out-of-sample forecasting exercise is carried out in a recursive way. This entails fully recursive parameters estimation and model selection. For example, the first simulated six-quarters ahead forecast for the period 2001q1 is obtained by using the panel of variables from 1992q1 through 1999q3. All variables are standardized, the common factors estimated and the six-quarters ahead projection of the inflation common component computed. This steps are repeated whenever a new vintage of data become available. One may argue that some caution is required in interpreting the results for the first part of the sample as the initial estimates, being based on a rather short sample period, might be poorly estimated. However, the results highlighted in the following sections appear to emphasize the apprpiateness of our approach. Overall, for each forecasting model we collect a time series of 32 inflation forecasts. The forecast ability of each model is evaluated on the basis of the collected forecast errors. The main summary statistics we report are the Mean Error (ME), the Mean Absolute Error (MAE) and the Mean Squared Error (MSE), which is also decomposed in the Bias and the Variance of the forecast errors.

4. Descriptive analysis of the dataset used

The forecasting approach we use requires the determination of two key parameters: the number of common shocks of the factor model, q, and the number of the linear combinations to retain as regressors, r. Notwithstanding some formal statistical tests have been proposed in the literature to determine the exact number of common shocks, we look at the percentage of the variance explained by the largest common factors in the whole dataset, as suggested by Forni et al. (2000). In Table 2 we report the percentage of the total variance explained by the first q dynamic factors and the first r static factors derived from static principal components.

Results show that comovements among variables are strong, as already two dynamic factors capture sixty per cent of the whole panel variance. Adding one more factor leads to a 12 per cent increase in the explained variance. Forni et al. (2005) select the optimal number of dynamic factors so that the marginal contribution from adding one more factor is less than 10 per cent. In our case this would imply three common shocks. However, the results in terms of forecast accuracy suggest that a dynamic factor model with two common shocks performs marginally better.

Given the number of common shocks, we gain some insight into the relative weight of different monetary and credit variables in the estimation of the dynamic factors. To this end, we compute the percentage of variance explained by the common component for each variable included in the panel and rank the variables according to this measure (*commonality criterion*). The results are reported in Table 3.

An analysis by sector suggests a low degree of noise for deposits held by households' money holdings, followed by those held by general government, whose money holdings are likely to be more closely related to transaction motives. Deposits held by non-financial firms are rather volatile and ranked after most of the non-sectorized monetary aggregates. Not surprisingly, the procedure downplays deposits held by non-bank financial intermediaries, which are likely to be held for portfolio considerations. This evidence is consistent with the empirical findings of Von Landesberger (2007), where long-run money demand equations for non-bank financial intermediaries and non-financial firms are poorly fitted by traditional determinants. These sectors made a large contribution to the higher volatility observed in the overall M3 annual growth rate, as well as to the decline in the velocity of money. They may also support the claim by Ferrero et al. (2007) that deposits held by non-bank financial intermediaries are a less useful indicator for the assessment of risks to price stability than monetary instruments held by other sectors. These results essentially reflect the different variances in the historical patterns of deposits held by each considered sector (see Figure 1).

An analysis by instrument reveals the relatively high noise embodied by the overnight deposits. This feature, which is common to all sectors, appears in contrast with the common wisdom that overnight deposits represent by far the best proxy for the liquidity held by the private sector for transaction motives. Our intuition is that overnight deposits, whose yields are less sensitive to developments in short-term interest rates, are mainly held by the private sector as a buffer for very short-term transactions, rather than to finance private expenditures in the medium term. In any event, a visual inspection of the time series reveals that most of the noise stems from the anomalous pattern recorder by overnight deposits over the period 2001-2002 when all money holding sectors were first substituting currency in circulation with overnight deposits in the face of the ongoing cash changeover, while they reversed the shift afterwards. These drawbacks are less evident in the overall monetary aggregates M1, M2 and M3 as they include both currency in circulation and overnight deposits. In those cases, the anomalous pattern of these two components during the period 2001-2002 tend to compensate each other.

Interestingly, the procedure gives most weight to time deposits (deposits with agreed maturity up to two years and redeemable at notice up to three months), whose yields follow closely the pattern of the short-term money market rates. Therefore, they may embody information content for future inflation because they are more sensitive to business cycle conditions. We cannot rule out the possibility that developments in the growth rate of time deposits may also reflect portfolio considerations due to changes in risk aversion by private investors in periods of high volatility in the financial markets. Among the non-sectorized components, the monetary aggregates M1, M2 and M3, even when representing a kind of "average" of the different components, stand in the first half of the distribution. Not surprisingly marketable instruments (M3-M2) embody a larger degree of noise.

Regarding the credit aggregates, we observe a high signal-to-noise ratio for loans to non-financial corporations, especially for those with longer maturity. The economic intuition is that long-term loans embody information content for firms' future private investment spending, while loans granted with shorter maturity may reflect developments in firms' short-term working capital needs. Surprisingly, loans to households for consumer credit appear to have a higher degree of noise than mortgage loans.

5. Assessing the dynamic factor models in predicting future inflation

In this Section we assess the accuracy of the factor-model based inflation forecasts in a simulated out-of-sample forecasting exercise. This allows us to compare alternative forecasting models, such as the random walk, the autoregressive and a bivariate regression including lagged inflation and the current and past values of standard monetary aggregates, which is one of the tools used by the ECB (see Fischer et al., 2006). All these competitor models can be nested in the following equation:

$$\hat{\pi}_{t+6} = a + b(L)\pi_t + c(L)m_t + \varepsilon_{t+6}\,. \tag{9}$$

The random walk model is obtained by setting a=*c(L)*=0 and *b(L)*=1 and implies that inflation six-quarters ahead is best forecasted by the current inflation. It is judgmentally considered a benchmark of non-predictability for inflation. The autoregressive model is obtained by setting *c(L)*=0 and selecting an appropriate lag order for the polynomial *b(L)*. We tried for lag orders between 1 and 4, finding the AR(1) model performing best in all sample periods considered. This outcome essentially reflects the limited degree of persistence of the inflation process observed in most recent years. For the bivariate forecasting model we leave all the coefficients in equation (9) to be freely estimated; the monetary aggregate we consider is the M3 growth rate which is one of the "horse race" models used in the monetary analysis.[2] Interestingly, both the standard information criteria as well as the ex-post validations of the models suggested that only the current value of the monetary aggregates helps in forecasting inflation. Regarding the dynamic factor models, we evaluate forecasts from different specifications of the dynamic rank q and the number of static factors r; for all these models the estimates of the common components are obtained using a triangular window of size equal to the square root of the sample size. The forecast accuracy of these models is summarized in Table 4a.

The bivariate model comprising the M3 growth rate outperforms the AR(1) model but does not beat the random walk, in terms of MSE. Surprisingly, the resulting inflation forecasts appear, on average, to be downward biased over the sample period and therefore in contrast with the upward bias result found in Fischer et al. (2006). To a large extent, this discrepancy reflects the different evaluation sample for the out-of-sample forecasting

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[2] Predictive regressions including the monetary aggregates M1 and M2 did not improve upon the use of the M3. These results are not reported here but are available upon request.

exercise used by Fischer et al. (2007), which covers the period 2002Q1-2006Q2.[3] A visual inspection of our M3-based forecasts in Figure 2 suggests that the model produces large negative forecast errors in the year 2001 and the year 2008, which were excluded by Fischer et al. (2006). The model instead provides the well-documented upward bias in the period 2003Q2-2005Q2, which is the result of the high M3 growth rates recorded in 2001-2003, driven by the portfolio reallocations from risky assets to marketable instruments, as well the increasing role of OFIs in the money-holding sector.

The factor model-based inflation forecasts appear to be more accurate than those of the alternative models. The size of the improvements are substantial for several specifications of dynamic factor models, which are not reported to save space.[4] For the best performing dynamic factor model (with q=2 and r=6), the MSE associated to the produced inflation forecasts is lower by 65 percent than those of the random walk (70 percent if compared with the AR(1) model). Another appealing outcome is that the bias of forecast errors produced by the dynamic factor model is almost zero on average over the sample. Finally, the smaller MSE also reflects a considerable reduction in the volatility of forecast errors. In Figure 3 we compare the pattern of real-time inflation forecasts over time produced by the dynamic factor model, the realized inflation rate and the forecasts of the competitor naïve models. Interestingly, the model neither provides an upward bias in the period 2003Q2-2005Q2 − the standard drawback of bivariate M3-based inflation forecasts − nor tends to under-predict inflation like the naïve models in the first year of the sample. The dynamic factor model tends to produce very smooth inflation forecasts, thus providing an accurate path of the underlying trend of inflation. The first outcome stems from the fact that the dynamic factor model down-weights the components of the M3 that mainly contributed to the deterioration of its forecasting performance model; the second outcome essentially reflects the finding that

[3] Another difference stems from the sample period used for the estimation of the model: Fischer et al. (2006) used a sample starting form 1980Q1, while we begin from 1992Q1. Predictive regressions based on longer sample periods tend to provide larger estimated coefficients for the M3 growth rate in equation (9), reflecting a stronger correlation between money and inflation in previous decades as well as changes in the stochastic properties of the time series.

[4] Inflation forecasts stemming from dynamic factor models estimated with different values of q and r are found to be highly collinear than those obtained with our benchmark model.

factor-model based forecasts, being based only on the projection of the common component (the idiosyncratic component that reflects past values of inflation was hardly predictable), do not depend on past inflation, as opposed to the autoregressive model and the random walk. This also explains the relative smoothness of the resulting forecasts.

Another surprising result is the relatively good forecasting performance of the factor model in the year 2008, when the inflation rate was essentially driven by large and unexpected swings in oil prices, a feature that cannot be captured with our dataset. One possibility is that the dynamic of the inflation rate in 2008 might have also reflected other forces that were more directly linked to the relationship between money and the price level, which have been correctly identified by our model (e.g. the strong dynamics in households' deposits and in loans to non-financial firms).

In order to check whether the dynamic factor model-based inflation forecasts are statistically different from those obtained with competitor models, we perform the test proposed by Diebold and Mariano (2002) for both the MAE and the MSE. The results are reported in Table 4b and suggest that gains in forecast accuracy obtained from the dynamic factor model are statistically significant, in terms of both the MAE and the MSE.

Moreover, to evaluate whether the gains in forecast accuracy are also substantial in the period characterized by a relatively low volatility of the inflation rate, we also report the summary statistics for inflation forecasts obtained by dropping the years 2001 and 2008. The overall picture remains broadly the same as the dynamic factor model still outperforms the competitor models. The gains in forecast accuracy are still large: the resulting MSE is lower by more than 40 percent with respect to the random walk and by about 35 percent if compared with the AR(1) model, even if the Diebold and Mariano test fails to reject the null hypothesis that this gain is different from zero. The bivariate model comprising the M3 growth rate is strongly outperformed by the dynamic factor model. The bias in the inflation forecasts increases somehow but still stands on very low levels. The main message is that when the inflation process becomes less erratic naïve models improve considerably but never beat the dynamic factor model.

5.1 Assessing the disaggregated information of money

Is the sectoral breakdown of money or the M3 breakdown by instrument more helpful in forecasting inflation? What about the contribution stemming from the counterparts of M3?

To answer to these questions, in Table 5 we compare the inflation forecasts of the dynamic factor model based on the whole dataset with those provided by dynamic factor models based on smaller sets of variables.[5] More precisely, we consider a dataset excluding the breakdown of M3 by instruments, one dropping the breakdown by sectors and another excluding the counterparts of M3. The relative MSE in the table is referred to the ratio of the MSE of the indicated model and that of the model with the whole dataset. The list of variables included in each subset is indicated according to the numbering shown in Table 1.

One may argue that these results, even if interesting for their economic implications, are subject to the caveat that they are based on smaller sets of variables, thus raising concerns over their reliability. Theoretically, Forni et al. (2000), Stock and Watson (2002a) and Bai and Ng (2002) showed that consistency of the factor estimation is achieved when the cross-section dimension and the number of observations tend to infinity. In any event, the empirical evidence has not always been consistent with theory. Boivin and Ng (2006) argued that the composition of the dataset, and not only the pure size of the cross-section dimension, may be crucial to producing reliable forecasts with factor models: in real-time experiments they showed that factors extracted from as few as 40 series also provide reliable forecasts.

The MSE associated with the model based on the dataset excluding the M3 breakdown by instruments is about 50 percent higher than that obtained with the whole dataset; the losses in forecast accuracy are all concentrated at the beginning and at the end of the sample. Dropping the years 2001 and 2008 the forecasting performance of the model based on the whole dataset worsens by 20 percent. When the sectoral breakdown of M3 is excluded, the corresponding MSE increases by 36 percent. Interestingly, the forecast errors are larger over the entire evaluation period, thus suggesting that sectoral information always made a significant contribution to the improvement of the inflation forecasts: even dropping the years 2001 and 2008 the model worsens by more than 40 percent. Finally, a model based on a dataset excluding the counterparts of money has a marginal effect on the forecasting performance over the entire sample period (the associated MSE error worsens by a modest 4

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[5] For these models we perform the same preliminary analysis of Section 4 in order to choose the appropriate values for the parameters q and r. We report the results for the best performing models.

percent) and slightly larger if the years 2001 and 2008 are excluded from the evaluation period (around 6 percent).

This analysis suggests that the sectoral breakdown of M3 helps more in tracking the future path of inflation, even if we cannot exclude that the M3 breakdown by instrument and the counterparts block gave a contribution in some periods. All in all, the main message is that monetary analysis based on a large set of monetary and credit variables is a more useful tool for policy makers than simply looking at the overall M3 growth rate.

5.2 Additional robustness checks

We also performed additional robustness checks. First, we evaluated the performance of a dynamic factor model based on monetary variables regarding only the households sector, to verify whether the developments in this sector may be “sufficient” statistic for the entire money holding private sector. Interestingly, the forecasting performance of the factor model worsens remarkably, suggesting that information contained in other money holding sectors and counterparts is very important.

Second, we checked whether our forecasts could be improved by means of a careful choice of a subset of variables based on alternative criteria. From a theoretical point of view the larger the number of variables the more efficient the estimates of the common and the idiosyncratic components will be. When the dispersion of the importance of the common component is relatively high, better estimates may be obtained by selecting the variables whose corresponding common component is large relative to the idiosyncratic one. Therefore, we perform a dataset reduction by selecting only variables with a commonality ratio falling in the 75th percentile of the entire distribution. Results in terms of forecast accuracy are very similar to those obtained with the entire dataset. This outcome is not surprising, since in our panel the mean of the distribution by the commonality ratio is about 60% with a relatively low dispersion (the standard deviation is about 10 percent).

Third, there is no guarantee that our whole panel of variables is the most appropriate in capturing the factors driving the target variable. In order to avoid an “oversampling” situation where many variables that have no predictive power for the variable of interest are included in the dataset, we follow Bai and Ng (2007) and select variables according to a pre-test by using a regression of the type

$$\pi_t = \theta x_{i,t-6} + B(L)\pi_{t-6} + \varepsilon_t \,. \tag{10}$$

The above equation is estimated for each candidate variable and the absolute value of the *t*-test on the corresponding θ coefficient is computed. The variables are then ranked by sorting the resulting *t*-tests in descending order and the forecasting exercise is performed by including in the dataset only the variables whose associated *t*-test exceeds in absolute value an arbitrary critical value. Since the resulting standard errors and *t*-tests (and therefore, the pre-selection of the variables) depend strongly on whether both heteroskedasticity and serial autocorrelation in the estimated residuals of the predictive regressions are taken into account, we perform the analysis by using the Newey-West robust estimator of the covariance matrix of the residuals with an order of serial correlation up to six and ranking the candidate variables according to the simple average of these alternative values for the *t*-test. The results for each individual variable are provided in Appendix A2.

We notice that for around 50 percent of the variables the average *t*-test exceeds the critical value of 1.96, thus suggesting that in the panel there are several monetary and credit variables that lead future inflation. Interestingly, we found that most of the variables with the highest *t*-test also had the highest signal-to-noise ratio measures, such as deposits with agreed maturity up to two years, deposits held by households and other general government sectors and loans to the private sector. One remarkable exception is loans to households, especially those for consumer purposes which seem to have important leading properties for future inflation, even if their percentage of variance explained by the common component is relatively low. Results in terms of inflation forecast accuracy are still very similar to those obtained with the whole dataset.

6. Concluding remarks

It has been argued that money-based inflation forecasts dramatically deteriorated over the last years, thus raising concerns regarding the usefulness of monetary analysis for policy decisions. Against this background, we have shown that policy makers can extract a relevant signal from monetary and credit developments, by relying on a richer cross-section of variables including a detailed breakdown of money and credit.

By using a dynamic factor model we have been able to downplay those monetary instruments and sectoral variables that in recent times contributed significantly to the deterioration of the information content of M3, such as currency in circulation after the cash changeover in 2002, short-term deposits held by non-bank financial intermediaries, as well as marketable instruments whose developments are driven by portfolio motives in periods of increased risk aversion and uncertainty in financial markets. We showed that our tool delivers reliable inflation forecasts at a six-quarters ahead horizon. These conclusions are, however, subject to a couple of caveats: first, the longer the time series and the larger the cross-section of variables, the more efficient our methodology will be, two features difficult to improve in the actual circumstances; second, the evaluation period used in the out-of-sample forecasting exercise is characterized by low volatility in the inflation rate, so that our model lacks a strong validation in periods characterized by a more difficult economic environment. Nevertheless, we may simply offer a suitable and reliable tool for monetary analysis, which can be complementary to those actually used by the ECB staff.

On the basis of our analysis, we claim that monetary analysis remains essential in the conduct of monetary policy, to the extent that we do not discard any variable and use a large information set with sound economic interpretation.

Future research could be devoted to combining the large dataset we used for our broad monetary analysis with that used to derive inflation forecasts in the context of the economic analysis. In this respect, assessing whether our proposed dataset contains marginal predictive content for future inflation beyond that contained in the other macroeconomic variables is a natural question. Finally, it would be interesting to assess the usefulness of monetary analysis for financial stability purposes. Historical experience has shown that in many industrialized countries costly asset price booms and financial imbalances have been often led by brisk growth of credit and money (e.g. Borio and Lowe, 2002, 2004; Adalid and Detken, 2007; Detken and Smets, 2004). Nevertheless, the empirical evidence on this topic is far from conclusive.

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Figures and Tables

Figure 1: Historical patterns of sectoral money holdings

(annual growth rates; percentage points)

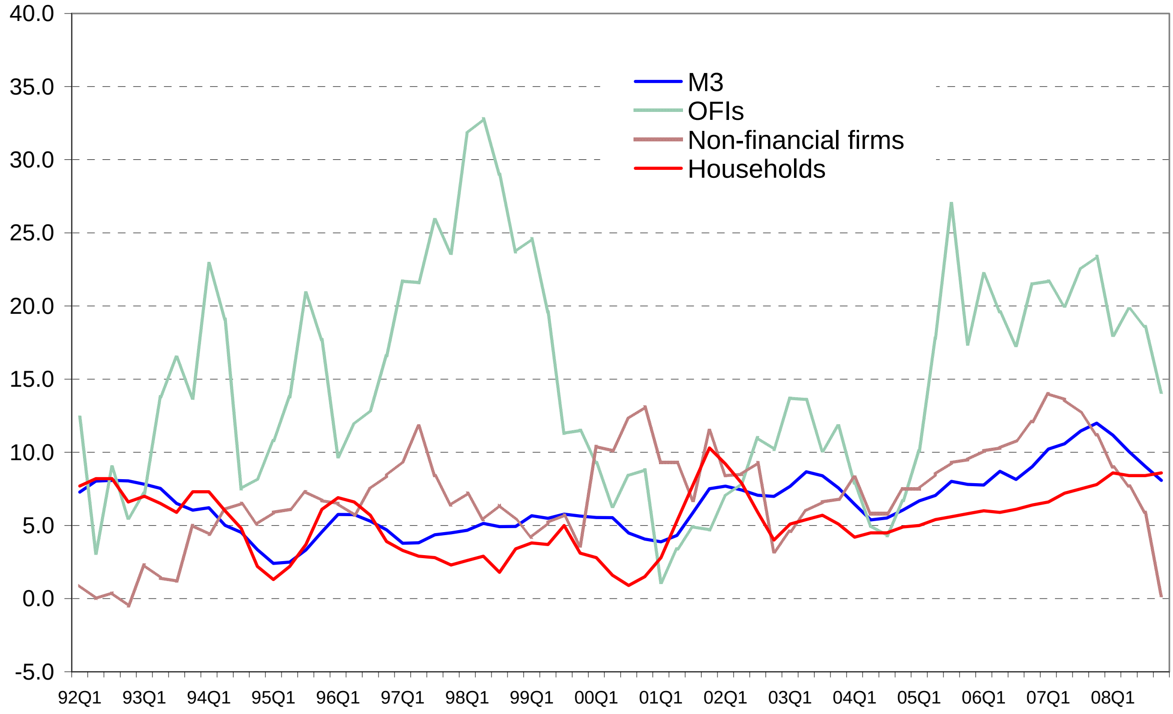

Figure 2: Inflation forecasts produced by a bivariate model including the M3 growth rate and the dynamic factor model

(six-quarters ahead inflation projections in percentage points)

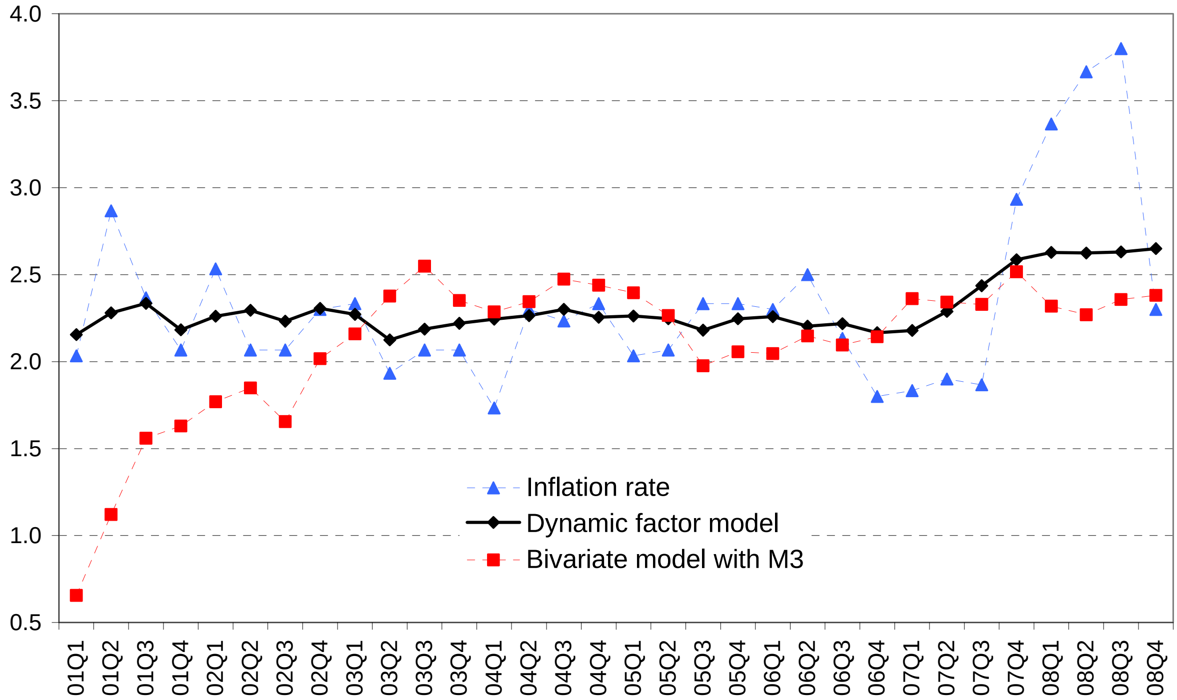

Figure 3: Inflation forecasts produced by naive models and the dynamic factor model

(six-quarters ahead inflation projections in percentage points)

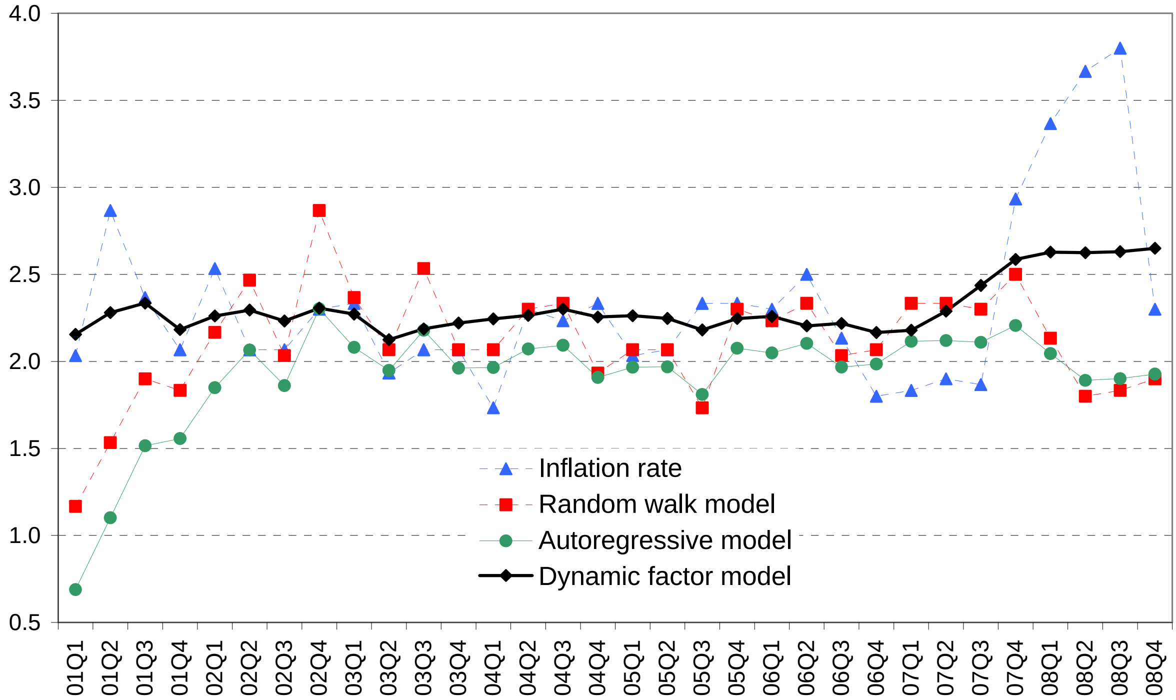

Table 1a. Monetary aggregates used in factor models

	Monetary instruments						
	M3(1)						
	M2(2)						
	M1(3)						
			M2-M1(4)		M3-M2(5)		
Money-holding sector	Currency in circulation (6)	Overnight deposits (7)	Deposits with agreed maturity up to two years	Deposits redeemable at notice up to three months	Repurchase agreements	Money market fund shares	Debt securities up to two years
Other general government (8)		Overnight deposits (9)	Deposits with agreed maturity up to two years (10)	Deposits redeemable at notice up to three months (11)	Repurchase agreements (12)		
Households (13)		Overnight deposits (14)	Deposits with agreed maturity up to two years (15)	Deposits redeemable at notice up to three months (16)	Repurchase agreements (17)		
Non-financial corporations (18)		Overnight deposits (19)	Deposits with agreed maturity up to two years (20)	Deposits redeemable at notice up to three months (21)	Repurchase agreements (22)		
Insurance corporations and pension funds (23)		Overnight deposits (24)	Deposits with agreed maturity up to two years (25)	Deposits redeemable at notice up to three months (26)	Repurchase agreements (27)		
Other financial intermediaires (28)		Overnight deposits (29)	Deposits with agreed maturity up to two years (30)	Deposits redeemable at notice up to three months (31)	Repurchase agreements (32)		
All sectors (33)		Overnight deposits (34)	Deposits with agreed maturity up to two years (35)	Deposits redeemable at notice up to three months (36)	Repurchase agreements (37)		

Table 1b. Counterparts of M3 used in factor models

	Loans to the private sector (38)				
Households (39)	Consumer credit (40)	Credit for house purchases (41)	Credit for other purposes (42)		
Non-financial firms (43)				Loans with maturity up to one year (44)	Loans with maturity over one year (45)
Net external assets (46)					

Table 2. Percentage of the panel variance explained by static (dynamic) factors
(cumulated percentages)

	number of factors					
	1	2	3	4	5	6
principal components	31.8	50.6	61.6	68.3	73.6	78.7
dynamic factors	40.2	59.7	72.0	80.0	86.0	90.3

Table 3. Ranking of variables according to the commonality criterion

Rank	Variable	q=1	Variable	q=2	Variable	q=3
1	DEP2Y_TOT	83.5	DEP2Y_TOT	92.2	DEP2Y_TOT	95.3
2	DEP2Y_HH	81.8	DEP2Y_HH	90.8	DEP2Y_HH	94.4
3	DEP3M_TOT	75.7	LOANS_NFC	83.4	OVERNIGHT	91.3
4	LOANS_NFC	74.5	M2_M1	81.4	OVERN_TOT	91.0
5	DEP3M_HH	73.7	LOANS_NFC_OVER1Y	80.8	LOANS_NFC	89.4
6	DEP3M_GOV	67.4	LOANS	80.4	LOANS	89.3
7	LOANS_NFC_OVER1Y	66.2	OVERNIGHT	79.5	M1	89.0
8	DEP2Y_NFC	64.5	DEP3M_TOT	78.9	M2_M1	88.0
9	M2_M1	59.9	M1	77.6	M3	86.8
10	LOANS_NFC_UP1Y	57.6	DEP3M_HH	77.0	REPO_HH	84.3
11	LOANS	56.5	REPO_HH	76.1	LOANS_NFC_OVER1Y	84.3
12	DEP3M_NFC	56.2	OVERN_TOT	75.3	M2	84.2
13	REPO_HH	55.7	DEP2Y_GOV	74.9	DEP3M_TOT	83.2
14	OVERNIGHT	52.4	DEP2Y_NFC	73.1	DEP2Y_GOV	82.2
15	OVERN_TOT	51.3	DEP3M_GOV	71.4	DEPTOT_TOT	82.0
16	M1	51.1	DEPTOT_GOV	69.9	OVERN_HH	81.8
17	DEP2Y_GOV	50.6	DEPTOT_TOT	69.2	DEP3M_HH	80.6
18	DEP2Y_OFI	50.5	M3	68.2	LOANS_NFC_UP1Y	80.3
19	OVERN_HH	47.0	LOANS_HH	67.5	DEPTOT_GOV	79.4
20	HOUSE_HH	46.8	HOUSE_HH	66.5	DEP3M_GOV	78.4
21	M3	45.6	M2	65.2	DEP2Y_NFC	78.2
22	DEPTOT_TOT	42.9	LOANS_NFC_UP1Y	63.3	DEPTOT_HH	77.1
23	LOANS_HH	41.5	OVERN_OFI	62.0	DEP3M_NFC	74.9
24	M3_M2	39.1	DEP3M_NFC	61.3	REPO_TOT	74.3
25	DEPTOT_GOV	37.1	REPO_TOT	61.0	LOANS_HH	74.1
26	OVERN_NFC	36.0	INFLATION	60.6	OVERN_OFI	73.7
27	DEPTOT_HH	36.0	DEP2Y_OFI	59.7	HOUSE_HH	71.6
28	M2	33.6	OVERN_HH	58.3	INFLATION	69.1
29	DEP3M_INS	32.7	DEPTOT_HH	58.0	NET_EXT_ASSET	66.6
30	INFLATION	32.3	OVERN_NFC	55.6	DEP2Y_OFI	66.5
31	OVERN_OFI	30.4	DEP2Y_INS	55.1	OVERN_NFC	65.7
32	DEP2Y_INS	28.4	M3_M2	54.7	DEP2Y_INS	64.8
33	REPO_TOT	27.6	DEPTOT_INS	53.8	DEPTOT_INS	63.6
34	DEPTOT_NFC	22.6	REPO_NFC	50.4	REPO_NFC	62.6
35	CONSUMER_HH	21.1	OVERN_INS	44.9	REPO_GOV	61.8
36	REPO_INS	20.7	REPO_GOV	44.3	OVERN_INS	61.7
37	OVERN_GOV	20.4	OVERN_GOV	44.0	M3_M2	61.3
38	REPO_GOV	19.0	REPO_INS	43.3	REPO_INS	57.1
39	REPO_OFI	18.9	CONSUMER_HH	42.9	OVERN_GOV	56.7
40	DEPTOT_INS	15.9	DEP3M_INS	40.1	DEP3M_OFI	56.5
41	REPO_NFC	15.4	NET_EXT_ASSET	38.7	DEP3M_INS	52.6
42	DEP3M_OFI	12.0	REPO_OFI	37.9	CURRENCY	52.6
43	OVERN_INS	11.5	DEPTOT_NFC	37.8	CONSUMER_HH	52.4
44	OTHER_HH	7.5	DEPTOT_OFI	33.7	REPO_OFI	50.3
45	NET_EXT_ASSET	6.9	DEP3M_OFI	17.6	DEPTOT_OFI	44.8
46	DEPTOT_OFI	6.5	OTHER_HH	15.0	DEPTOT_NFC	41.9
47	CURRENCY	4.4	CURRENCY	10.3	OTHER_HH	34.2
	WHOLE DATASET	40.2	WHOLE DATASET	59.7	WHOLE DATASET	72.0

Note: the variables are ranked according to the percentage of variance explained by the common component; *q* is the number of common factors used for the estimation of the common component.

Table 4a. Forecast accuracy of competitor models

(percentages; percentage points)

Model	ME	MAE	MSE	Bias	bias (%MSE)	variance	variance (%MSE)	Relative MSE
Random walk	-0.215	0.446	0.446	0.046	10.3%	0.400	89.7%	1.00
AR(1)	-0.409	0.489	0.525	0.167	31.8%	0.358	68.2%	1.18
Bivariate model with M3	-0.226	0.511	0.446	0.051	11.5%	0.395	88.5%	0.99
Dynamic factor model	**-0.023**	**0.285**	**0.158**	**0.001**	**0.3%**	**0.158**	**99.7%**	**0.35**
	Sample period: 2002Q1-2007Q4							
Random walk	0.063	0.245	0.101	0.004	3.9%	0.097	96.1%	1.00
AR(1)	-0.135	0.243	0.094	0.018	19.4%	0.076	80.6%	0.93
Bivariate model with M3	0.039	0.334	0.139	0.002	1.1%	0.138	98.9%	1.38
Dynamic factor model	**0.093**	**0.207**	**0.063**	**0.009**	**13.0%**	**0.057**	**87.0%**	**0.62**

Note: ME is the Mean Error, MAE is the Mean Absolute Error, MSE is the Mean Squared Error. Relative MSE is the ratio between the MSE of the indicated model and the MSE of the Random walk model.

Table 4b. Diebold and Mariano test for difference in forecast accuracy

	MAE		MSE	
Model	t-stat	p-value	t-stat	p-value
	Sample period: 2001Q1-2008Q4			
Random walk	-2.372	0.009	-1.878	0.030
AR(1)	-2.097	0.018	-1.974	0.024
Bivariate model with M3	-2.904	0.002	-2.093	0.018
	Sample period: 2002Q1-2007Q4			
Random walk	-1.413	0.079	-1.924	0.027
AR(1)	-0.889	0.187	-1.059	0.145
Bivariate model with M3	-4.334	0.000	-3.323	0.000

Note: the Diebold and Mariano test is applied to verify the null hypothesis that forecast accuracy (measured by the indicated summary statistics) of the factor model is the same as that of the indicated model. The alternative hypothesis is that the factor model outperforms the indicated model.

Table 5. Forecast accuracy of dynamic factor models with different datasets
(percentages; percentage points)

	ME	MAE	MSE	bias	bias (%MSE)	variance	variance (%MSE)	Relative MSE
	Sample period: 2001Q1-2008Q4							
Whole dataset	-0.023	0.285	0.158	0.001	0.3%	0.158	99.7%	1.00
No breakdown by instrument	-0.134	0.299	0.237	0.018	7.6%	0.219	92.4%	1.50
No breakdown by sector	-0.029	0.341	0.215	0.001	0.4%	0.214	99.6%	1.36
No counterparts	-0.011	0.304	0.165	0.000	0.1%	0.165	99.9%	1.04
	Sample period: 2002Q1-2007Q4							
Whole dataset	0.093	0.208	0.065	0.009	13.3%	0.057	86.7%	1.00
No breakdown by instrument	0.025	0.193	0.052	0.001	1.2%	0.051	98.9%	0.79
No breakdown by sector	0.119	0.259	0.093	0.014	15.2%	0.079	84.8%	1.42
No counterparts	0.113	0.229	0.069	0.013	18.3%	0.057	81.7%	1.06

Note: the list of variables included in each subset is indicated according to the numbering shown in Table 1. The "whole dataset" refers to variables numbered (1-47); "no breakdown by instrument" refers to variables numbered (1-7)+(8+13+18+23+28+33)+(38-46); "no breakdown by sector" refers to variables numbered (1-7)+(33-37)+38+46; "no counterparts" refers to variables numbered to (1-37).

Appendices

Appendix A1. Description of data used in the analysis

dep2y_gov	Deposits with agreed maturity up to two years held by other general government and MFIs excluding Eurosystem reporting sector
dep2y_tot	Deposits with agreed maturity up to two years held by all sectors and MFIs excluding Eurosystem reporting sector
dep2y_ofi	Deposits with agreed maturity up to two years held by other financial intermediaries and MFIs excluding Eurosystem reporting sector
dep2y_ins	Deposits with agreed maturity up to two years held by insurance corporations and pension funds and MFIs excluding Eurosystem reporting sector
dep2y_nfc	Deposits with agreed maturity up to two years held by non-financial corporations and MFIs excluding Eurosystem reporting sector
dep2y_hh	Deposits with agreed maturity up to two years held by households and MFIs excluding Eurosystem reporting sector
dep3m_gov	Deposits redeemable at notice up to three months held by other general government and MFIs excluding Eurosystem reporting sector
dep3m_tot	Deposits redeemable at notice up to three months held by all sectors and MFIs excluding Eurosystem reporting sector
dep3m_ofi	Deposits redeemable at notice up to three months held by other financial intermediaries and MFIs excluding Eurosystem reporting sector
dep3m_ins	Deposits redeemable at notice up to three months held by insurance corporations and pension funds and MFIs excluding Eurosystem reporting sector
dep3m_nfc	Deposits redeemable at notice up to three months held by non-financial corporations and MFIs excluding Eurosystem reporting sector
dep3m_hh	Deposits redeemable at notice up to three months held by households and MFIs excluding Eurosystem reporting sector
overn_gov	Overnight deposits held by other general government and MFIs excluding Eurosystem reporting sector
overn_tot	Overnight deposits held by all sectors and MFIs excluding Eurosystem reporting sector
overn_ofi	Overnight deposits held by other financial intermediaries and MFIs excluding Eurosystem reporting sector
overn_ins	Overnight deposits held by insurance corporations and pension funds and MFIs excluding Eurosystem reporting sector
overn_nfc	Overnight deposits held by non-financial corporations and MFIs excluding Eurosystem reporting sector
overn_hh	Overnight deposits held by households and MFIs excluding Eurosystem reporting sector

repo_gov	Repurchase agreements held by other general government and MFIs excluding Eurosystem reporting sector
repo_tot	Repurchase agreements held by all sectors and MFIs excluding Eurosystem reporting sector
repo_ofi	Repurchase agreements held by other financial intermediaries and MFIs excluding Eurosystem reporting sector
repo_ins	Repurchase agreements held by insurance corporations and pension funds and MFIs excluding Eurosystem reporting sector
repo_nfc	Repurchase agreements held by non-financial corporations and MFIs excluding Eurosystem reporting sector
repo_hh	Repurchase agreements held by households and MFIs excluding Eurosystem reporting sector
currency	Currency in circulation, MFIs, central government and post office giro institutions reporting sector
overnight	Currency in circulation, MFIs, central government and post office giro institutions reporting sector
m2_m1	Other short-term deposits (M2-M1), MFIs, central government and post office giro institutions reporting sector
m3_m2	Marketable instruments (M3-M2), MFIs, central government and post office giro institutions reporting sector
m1	Monetary aggregate M1, MFIs, central government and post office giro institutions reporting sector
m2	Monetary aggregate M3, MFIs, central government and post office giro institutions reporting sector
m3	Monetary aggregate M3, MFIs, central government and post office giro institutions reporting sector
deptot_gov	Total short-term deposits held by other general government, MFIs excluding Eurosystem reporting sector
deptot_tot	Total short-term deposits held by all sectors and MFIs excluding Eurosystem reporting sector
deptot_ofi	Total short-term deposits held by other financial intermediaries and MFIs excluding Eurosystem reporting sector
deptot_ins	Total short-term deposits held by insurance corporations and pension funds and MFIs excluding Eurosystem reporting sector
deptot_nfc	Total short-term deposits held by non-financial corporations and MFIs excluding Eurosystem reporting sector
deptot_hh	Total short-term deposits held by households and MFIs excluding Eurosystem reporting sector

loans	Total loans to the private sector and MFIs excluding Eurosystem reporting sector
loans_hh	Total loans to households and MFIs excluding Eurosystem reporting sector
consumer_hh	Loans to households for consumer credit and MFIs excluding Eurosystem reporting sector
house_hh	Loans to households for house purchase and MFIs excluding Eurosystem reporting sector
other_hh	Loans to households for other purposes and MFIs excluding Eurosystem reporting sector
loans_nfc	Total loans to non-financial corporations and MFIs excluding Eurosystem reporting sector
loans_nfc_up1y	Loans to non-financial corporations with maturity less than one year and MFIs excluding Eurosystem reporting sector
loans_nfc_over1y	Loans to non-financial corporations with maturity over one year and MFIs excluding Eurosystem reporting sector
net_ext_asset	External assets (net), MFIs reporting sector and Extra Euro area counterpart
inflation	HICP inflation rate

Appendix A2. Ranking of variables according to their leading properties for inflation

rank	variable	lags=0	lags=1	lags=2	lags=3	lags=4	lags=5	lags=6	average
1	DEP2Y_GOV	6.47	5.47	5.03	4.80	4.65	4.50	4.37	5.04
2	CONSUMER_HH	5.33	4.29	3.80	3.60	3.53	3.49	3.46	3.93
3	DEP2Y_TOT	3.74	3.59	3.64	3.77	3.89	3.89	3.87	3.77
4	DEP2Y_HH	3.49	3.41	3.51	3.64	3.75	3.76	3.75	3.62
5	LOANS_NFC_OVER1Y	4.32	3.54	3.29	3.23	3.26	3.28	3.29	3.46
6	LOANS	4.51	3.55	3.19	3.04	3.01	3.00	2.99	3.33
7	REPO_INS	4.22	3.55	3.22	2.98	2.79	2.65	2.54	3.14
8	DEP2Y_INS	3.95	3.38	3.10	2.90	2.73	2.61	2.50	3.02
9	M3	3.78	3.12	2.86	2.75	2.72	2.72	2.73	2.96
10	LOANS_NFC	4.04	3.19	2.86	2.72	2.66	2.62	2.59	2.96
11	LOANS_HH	3.72	3.15	2.91	2.79	2.73	2.69	2.64	2.95
12	M2_M1	3.23	2.92	2.83	2.85	2.89	2.91	2.92	2.94
13	M2	3.72	2.94	2.65	2.57	2.58	2.63	2.69	2.82
14	DEP3M_GOV	3.53	2.94	2.72	2.62	2.57	2.54	2.51	2.77
15	DEPTOT_GOV	3.68	2.89	2.61	2.48	2.41	2.35	2.32	2.68
16	DEP3M_TOT	3.73	2.93	2.59	2.42	2.33	2.27	2.24	2.65
17	DEP3M_HH	3.72	2.92	2.57	2.40	2.31	2.26	2.22	2.63
18	DEPTOT_INS	3.13	2.73	2.48	2.34	2.28	2.27	2.30	2.50
19	CURRENCY	3.16	2.61	2.36	2.19	2.14	2.12	2.10	2.38
20	REPO_OFI	3.12	2.43	2.16	2.03	1.95	1.92	1.89	2.21
21	REPO_NFC	2.95	2.50	2.21	2.05	1.94	1.84	1.75	2.18
22	REPO_TOT	3.05	2.45	2.18	2.03	1.91	1.81	1.73	2.16
23	LOANS_NFC_UP1Y	3.01	2.32	2.04	1.90	1.83	1.79	1.76	2.09
24	DEP3M_NFC	2.82	2.23	1.98	1.86	1.78	1.73	1.69	2.01
25	HOUSE_HH	2.36	2.00	1.88	1.82	1.77	1.71	1.65	1.88
26	DEP2Y_OFI	2.36	1.89	1.71	1.67	1.68	1.70	1.70	1.82
27	DEP2Y_NFC	2.31	1.89	1.71	1.62	1.57	1.53	1.50	1.73
28	M3_M2	1.74	1.44	1.36	1.34	1.33	1.32	1.31	1.40
29	M1	1.73	1.42	1.32	1.26	1.21	1.16	1.11	1.31
30	DEPTOT_TOT	1.58	1.26	1.14	1.08	1.06	1.06	1.06	1.18
31	DEPTOT_HH	1.48	1.17	1.05	1.00	0.99	0.97	0.96	1.09
32	DEPTOT_OFI	1.32	1.06	0.94	0.89	0.87	0.87	0.88	0.98
33	OVERN_HH	1.34	1.06	0.95	0.90	0.87	0.84	0.83	0.97
34	OVERN_OFI	1.13	1.07	0.98	0.93	0.89	0.85	0.81	0.95
35	DEP3M_INS	1.35	1.03	0.92	0.87	0.84	0.81	0.79	0.95
36	OVERN_INS	1.09	0.94	0.89	0.89	0.91	0.91	0.92	0.94
37	REPO_GOV	0.96	0.79	0.72	0.68	0.68	0.70	0.72	0.75
38	NET_EXT_ASSET	0.85	0.70	0.65	0.62	0.60	0.59	0.58	0.66
39	REPO_HH	0.82	0.64	0.58	0.55	0.53	0.52	0.51	0.59
40	OVERN_TOT	0.51	0.41	0.38	0.36	0.35	0.34	0.33	0.38
41	DEP3M_OFI	0.48	0.39	0.35	0.33	0.31	0.30	0.29	0.35
42	DEPTOT_NFC	0.24	0.19	0.17	0.16	0.15	0.15	0.15	0.17
43	OVERN_GOV	0.21	0.18	0.17	0.16	0.16	0.15	0.15	0.17
44	OVERN_NFC	0.18	0.15	0.15	0.14	0.14	0.15	0.15	0.15
45	OVERNIGHT	0.20	0.16	0.15	0.14	0.13	0.13	0.13	0.15
46	OTHER_HH	0.09	0.07	0.06	0.06	0.06	0.06	0.06	0.07

Note: following Bai and Ng (2007) the variables are ranked in ascending order according to the absolute value of the average of the *t*-test on the coefficient θ associated with the regression $\pi_t = \theta x_{i,t-6} + \beta(L)\pi_{t-6} + \varepsilon_t$. Standard errors are computed allowing for both heteroskedasticity and serial autocorrelation of the estimated residuals with the Newey-West estimator; the label "lags=*k*" denotes a correction for serial correlation up to a moving average of order *k*.

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