CAHIER D'ÉTUDES
WORKING PAPER

N° 195

MONETARY AGGREGATES AND INFLATION: A NEW VIEW ON AN OLD RELATIONSHIP

GIANNI AMISANO AND ROBERTA COLAVECCHIO

JANUARY 2025

BANQUE CENTRALE DU LUXEMBOURG
EUROSYSTÈME

Monetary Aggregates and Inflation: A New View on an Old Relationship

Gianni Amisano, Roberta Colavecchio [1]

Abstract

Despite the key role that money plays in the economy, its perceived relevance for monetary policy has changed considerably in the last few decades. According to the quantity theory of money, the long run is characterized by a one-to-one link between money growth and inflation, an assertion that was strongly validated by cross-country empirical evidence from the post-war period. However, this link has displayed signs of instability over time, complicating the use of monetary aggregates to guide policy and as predictors for inflation.

This paper reviews the link between money growth and inflation in the theoretical and the empirical literature to assess whether money growth could have provided an early warning of risks to medium-term price stability for the US and the euro area. Our approach takes a regime-dependent view of the money growth-inflation link and evaluates the information content of monetary variables as warning signals for shifts across inflation regimes. Our results show that money growth can be useful to predict inflation in some episodes, such as the 1970s, the early 1980s and the recent post-pandemic phase. Our results also explain why money growth apparently ceased to provide a useful signal to predict inflation from the 1990s until 2021. We conclude that the money growth-inflation relationship is non-linear, with faster money growth signalling a higher probability of entering a "High" inflation regime, thus providing a sharper assessment of the risks to price stability.

[1] Gianni Amisano: Federal Reserve Board (gianni.amisano@frb.gov); Roberta Colavecchio: Central Bank of Luxembourg (roberta.colavecchio@bcl.lu). The views expressed in this paper are those of the authors and should not be attributed to the Board of Governors of the Federal Reserve System, the Luxembourg Central Bank or the Eurosystem. We acknowledge useful suggestions from Paolo Guarda and Boris Hofmann (without implicating them). This paper was prepared for the forthcoming "Research Handbook of Inflation" (Edward Elgar Publishing), edited by Guido Ascari and Riccardo Trezzi.

Non-Technical Summary

In July 2021, the European Central Bank published a new monetary policy strategy based on an integrated analytical framework bringing together an economic analysis with a monetary and financial analysis. This integrated framework replaced the previous two-pillar framework, discontinuing the cross-check between information from monetary analysis and from economic analysis. While previously the monetary analysis concentrated on detecting risks to price stability over medium to longer-term horizons, the new monetary and financial analysis concentrates on the operation of the monetary policy transmission mechanism, while also evaluating how the build-up of financial vulnerabilities and imbalances may affect tail risks to output and inflation. Thus, the new monetary and financial analysis represents a significant shift in focus that reflects the challenges that arose during and after the global financial crisis.

According to the quantity theory of money, as initially developed by David Hume and others, in the long run there is a one-to-one link between money growth and inflation. Countless empirical studies validated this long-run relationship, which is now widely accepted in the macroeconomic literature. However, since World War II there appeared signs of instability in this link, with monetary aggregates becoming particularly controversial as guides to future inflation. For example, the strength of the relationship between money growth and inflation appeared to vary with changes in monetary regime and their correlation disappeared or weakened substantially during periods of low and stable inflation.

For this reason, by the early 1990s most central banks had abandoned monetary targeting in favour of inflation targeting, with the emergence of New Keynesian models limiting the monetary policy transmission mechanism to the interest rate channel, so that monetary policy was often conducted without reference to the quantity of money.

In 2021, inflation rates rose rapidly above their target levels, first in the US and then in Europe. The extraordinarily rapid growth in money before this inflation surge revived the debate regarding the role of money growth as a predictor for inflation. This paper reviews the link between money growth and inflation in the theoretical and the empirical literature to assess whether money growth could have provided an early warning of risks to medium-term price stability for the US and the euro area.

Our approach takes a regime-dependent view of the money growth-inflation link and evaluates the information content of monetary variables as warning signals for shifts across inflation regimes. In particular, we model inflation as a univariate autoregressive regime-switching process, with the probabilities of moving between inflation regimes depending on the rate of money growth.

Our results show that money growth can be useful to predict inflation in some episodes, such as the 1970s, the early 1980s and the recent post-pandemic phase. Our results also explain why money growth apparently ceased to provide a useful signal to predict inflation from the 1990s until 2021. We conclude that the money growth-inflation relationship is non-linear, with faster money growth signalling a higher probability of entering a “High” inflation regime, thus providing a sharper assessment of the risks to price stability.

Résumé Non Technique

En juillet 2021, la Banque centrale européenne a publié une nouvelle stratégie de politique monétaire basée sur un examen intégré qui repose sur l'analyse économique et l'analyse monétaire et financière. Cet examen intégré a remplacé le précédent cadre à deux piliers, mettant fin à la vérification croisée entre les informations provenant de l'analyse monétaire et celles de l'analyse économique. Alors qu'auparavant l'analyse monétaire se concentrait sur la détection des risques pesant sur la stabilité des prix à moyen et long termes, la nouvelle analyse monétaire et financière se concentre sur le fonctionnement du mécanisme de transmission de la politique monétaire, tout en évaluant également comment l'accumulation des vulnérabilités et des déséquilibres financiers peut affecter les risques extrêmes concernant la production et l'inflation. La nouvelle analyse monétaire et financière représente donc un changement d'orientation significatif qui reflète les nouveaux défis qui sont apparus depuis la crise financière mondiale.

Selon la théorie quantitative de la monnaie, développée initialement par David Hume et d'autres économistes, il existe à long terme un lien univoque entre la croissance de la monnaie et l'inflation. De nombreuses études empiriques ont validé cette relation de long terme, qui est aujourd'hui généralement acceptée dans la littérature macroéconomique. Toutefois, depuis la Seconde Guerre mondiale des signes d'instabilité sont apparus dans cette relation, donnant lieu à plusieurs controverses concernant l'utilisation des agrégats monétaires comme indicateurs de l'inflation future. En particulier, l'intensité de la relation entre la croissance monétaire et l'inflation semble varier en fonction des changements de régime monétaire et leur corrélation s'affaiblit considérablement ou disparaît pendant des périodes d'inflation faible et stable.

C'est pourquoi, au début des années 1990, la plupart des banques centrales ont abandonné le ciblage monétaire au profit du ciblage de l'inflation, avec l'émergence de modèles théoriques de la nouvelle économie keynésienne qui limitent le mécanisme de transmission de la politique monétaire au canal des taux d'intérêt, de sorte que la politique monétaire a souvent été menée sans référence à la quantité de monnaie.

En 2021, les taux d'inflation ont rapidement dépassé leurs niveaux cibles, d'abord aux États-Unis, puis en Europe. La croissance monétaire ayant été extraordinairement rapide avant cette poussée d'inflation, elle a relancé le débat sur le rôle de la croissance monétaire en tant que prédicteur de l'inflation. Ce document examine le lien entre la croissance monétaire et l'inflation dans la littérature théorique et empirique afin d'évaluer si la croissance monétaire aurait pu fournir une alerte précoce des risques pesant sur la stabilité des prix à moyen terme aux États-Unis et dans la zone euro.

Nous adoptons une approche à changement de régime pour examiner le lien entre croissance monétaire et inflation, afin d'évaluer le contenu informatif des variables monétaires en tant que signaux d'alerte pour les changements de régime d'inflation. En particulier, nous modélisons l'inflation comme un processus autorégressif univarié avec changement de régime, dans lequel les probabilités de passer d'un régime d'inflation à l'autre dépendent du taux de croissance de la monnaie.

Nos résultats montrent que la croissance monétaire peut être utile pour prévoir l'inflation pendant certains épisodes, notamment les années 1970, le début des années 1980 et la récente phase post-pandémique. Nos résultats expliquent également pourquoi la croissance monétaire a apparemment cessé de fournir un signal utile de l'inflation à venir entre 1990 et 2021. En conclusion, nous trouvons que la relation entre croissance monétaire et inflation est non-linéaire, de sorte qu'une croissance plus rapide de la masse monétaire signale une probabilité plus importante d'entrer dans un régime d'inflation "élevée", améliorant ainsi l'évaluation des risques pesant sur la stabilité des prix.

1. Introduction

Despite the key role that money plays in the economy, its perceived relevance for monetary policy has changed considerably in the last few decades. According to the quantity theory of money, the long run is characterized by a one-to-one link between money growth and inflation, an assertion that was strongly validated by cross-country empirical evidence from the post-war period[2]. However, this link has displayed signs of instability over time, complicating the use of monetary aggregates to guide policy and as predictors for inflation. For example, the strength of the relationship between money growth and inflation appears to be conditional on changes in monetary regimes and the correlation between the two variables has sometimes disappeared or weakened substantially in environments of low and stable inflation. Therefore, the mid-1980s saw a gradual shift from monetary targeting, whose popularity in the 1970s reflected the ascent of the monetarist paradigm, towards inflation-centered regimes. In the decades leading up to the 2007-2008 Global Financial Crisis, monetary aggregates played an increasingly marginal role in monetary theory and policy. The rise of New-Keynesian models, both in the academic literature and in policy institutions encouraged this tendency, since these models typically assume that monetary policy is implemented by setting the nominal interest rate and that the monetary transmission mechanism is limited to the interest rate channel.

The change in monetary policies that took place in the 1990s, which saw major central banks adopt inflation targeting and commit to a credible low inflation regime, contributed to create 25 years of low and stable inflation in most advanced economies. However, the series of shocks that hit the global economy after 2019 –the coronavirus pandemic, global supply chain disruptions and Russia's war against Ukraine - changed this picture dramatically. In 2021, inflation rates began to exceed their target levels, first in the US and then in Europe, while international institutions, central banks and private forecasters began to consistently under-predict short-term inflation, with their errors increasing considerably.[3] The unprecedented nature and scale of these shocks posed substantial challenges for macroeconomic forecasters that led them to turn to information not typically included in traditional econometric models.[4] Since the surge of inflation in 2021 was preceded by extremely high rates of money growth, this rekindled the debate on the relationship between money growth and inflation and put the quantity theory of money under new scrutiny. In particular, the question of interest is whether recent developments in money growth provide additional useful information to explain the post-pandemic inflation surge.

This paper reviews the relationship between monetary aggregates and inflation in an effort to evaluate whether they could provide advance warning of increasing risks to price stability. The chapter outline is as follows. Section 2 briefly describes the quantity theory of money and its building blocks, drawing from the theoretical literature. Section 3 reviews the empirical evidence on the long-run link between money growth and inflation and highlights its instability over time. Section 4 provides an historical overview of the money growth-inflation nexus, with a focus on the role of monetary aggregates in monetary policy frameworks. Section 5 presents our empirical contribution on the role of money in signaling risks to price stability in a framework that allows for changes in inflation regimes, with particular reference to the most recent surge in inflation. Section 6 concludes.

[2] See references in section 3 below.

[3] See, e.g. Chahad et al. (2024).

[4] Ho (2021) reviews several studies that address the issue of forecasting during the pandemic and examines two broad approaches to dealing with events of unprecedented nature. First, the use of subjective judgment or prior knowledge, typically from economic theory, to adapt forecasting models. Second, the use of new sources of information, typically by incorporating new data into forecasting models.

2. The Quantity Theory of Money: Definitions and early theoretical contributions

The quantity theory of money (QTM) links the nominal quantity of money, the general price level and the level of economic activity. A typical exposition of the QTM[5] starts from the so-called "equation of exchange":

$$MV = PT \qquad (1)$$

where P denotes the price level, T measures the volume of transactions (or real output) per period, M is the nominal stock of money and V is monetary "velocity", that is the velocity of circulation of money. Note that the equation of exchange is merely an identity, so it holds all the time, has no predictive content and is consistent with any monetary theory. The quantity theory of money is more than just the equation of exchange.

In its simplest form, the QTM claims that the money stock (M) is the main determinant of the price level (P), but this requires an additional set of propositions.

First, P must vary in exact proportion to changes in the quantity of M. This rests on the assumption that at the economy's full-capacity level of real output people want to hold constant quantity of real cash balances for transactions purposes. Moreover, the proportionality relationship holds only if the demand for real balances is stable ("strict" version of the QTM).

Second, there is a cause-and-effect relationship between M and P. However, this is an equilibrium condition that follows a dynamic adjustment process, triggered by any change in M. The adjustment process happens through two main channels: the direct expenditure mechanism that relies on the misalignment between actual and desired real cash balance, and the indirect interest rate mechanism by which a monetary change affects spending and prices through its impact on the interest rate.

Third, changes in M are neutral in their long-run effect on real variables and any non-neutral effects are transitory. Ultimately, monetary changes influence only the price level.

Fourth, P is mostly driven by changes in M. Therefore, inflation and deflation are largely due to movements in the money stock rather than to other factors originating in the real side of the economy. The QTM does not rule out that (relative) prices might be affected by non-monetary factors, such as productivity shifts or technological changes, but it argues that such changes in relative prices are often likely to balance out, leaving the average price level, P, unaffected.

Fifth, the QTM requires that changes in nominal money are mostly supply-driven and that the nominal stock of money is exogenously determined by the independent central bank via its control over the monetary base (money supply). This condition is necessary for quantity theorists to claim that money plays an instrumental role in the determination of the price level.

Although the quantity theory originated in the mid-16th century, it was refined and extended in the course of the late 17th and 18th centuries. David Hume (1752) introduced the notion of causation from money to prices, claiming that variations in M cause proportional changes in P. He emphasized the short-run non-neutrality of money and clarified the distinction between long-run stationary equilibrium and short-run adjustments toward it. Richard Cantillon (1755) stated that monetary changes would trigger non-neutral distributional effects that would temporarily alter expenditure paths, the structure of production and ultimately the allocation of resources. However, these effects were expected to fade away in the long run.

In the early 19th century, the QTM was absorbed in the mainstream classical analysis and became the standard framework for the formulation of policy recommendations. While acknowledging that the proportionality between M and P was subject to temporary misalignments during the transition between monetary equilibria, classical quantity theorists focused on the long run, where the economic system had fully adjusted to changes in the money stock.

[5] See, for instance, Mc Callum and Nelson (2011), Section 2.

Anti-quantity theory views emerged in the course of the 19th century, but the QTM remained dominant well until the 1930's. One factor that might have contributed to its success was the neoclassical reformulation of the theory, which included three main contributions. First, neoclassical economists formalized the QTM using two equations: the equation of exchange (Fisher, 1912) and the Cambridge cash-balance equation (Pigou, 1917). The equation of exchange, as described above by equation (1), states that over any period the nominal expenditure in the economy, PT, must equal the money used to settle these transactions, MV. Instead, the Cambridge cash balance equation was:

$$M = kPY \qquad (2)$$

where k is the desired ratio of money to nominal income that individuals wish to hold, and Y is real national income or the national product at constant prices. This equation describes the determinants of the demand for money. Together, the two equations formalized the conditions that must hold for the proportionality postulate to hold: constancy of the velocity of money and of real output.

The second neoclassical contribution consisted in extending the idea that control of the money supply could be achieved by controlling an exogenously determined stock of high-powered money, the monetary base. According to the neoclassical version of the QTM, the total stock of money (coins and notes) and bank deposits are a constant multiple of the monetary base. [6]

Finally, the neoclassical formulation of the quantity theory emphasized the concept of short-run non-neutrality of money and integrated it into the neoclassical analysis of business cycles, showing how changes in M were important determinants of booms and busts (Fisher, 1911) and arguing that monetary regulation of the price level was a prerequisite to stabilize the economy.

The neoclassical version of the QTM enjoyed widespread acceptance up to the 1930s. However, in the course of that decade, it was subject to heavy criticism and largely supplanted by the Keynesian income-expenditure model (Keynes, 1936), in which short-run fluctuations in output and employment are mainly caused by variations in aggregate demand. Keynes's critiques focused on several key aspects of the QTM, such as its underlying assumptions that the economy tends to operate at full capacity, that the equation of exchange is a mere identity, and that V can be considered as constant. Moreover, Keynes emphasized that if a liquidity trap developed or the investment-expenditure schedule became interest-insensitive then a monetary expansion would become an ineffective remedy for unemployment and recession. Finally, Keynes provided a non-monetary explanation of the Great Depression, arguing that the deep protracted trough in aggregate output, along with falling employment and capital utilization, originated from exogenous shocks in the real sector, i.e. a collapse of capital spending intensified by a drop in market confidence. Keynesian macroeconomic analysis interpreted these phenomena as failures of the market system to coordinate demand and supply, which provided an obvious justification for government intervention.

In the decades following Keynes, the QTM was subject to two very important theoretical developments: the theory of the real balance or wealth effect (Pigou, 1943) and the reformulation of the QTM by Friedman (1956). The theory of the real balance effect aimed to demonstrate the relevance of M even when the interest rate transmission channel is hindered by a liquidity trap or by

[6] Different measures of a nation's money stock are available. These measures, called « monetary aggregates », differ by the degree of liquidity characterizing the monetary assets that they include. In the US, the monetary aggregates are indicated as follows:

- M0 (or Monetary Base): currency in circulation, plus bank reserves held by the central bank;
- M1: M0 plus traveler's checks and checkable deposits;
- M2: M1, plus money market shares and savings deposits;

In 2006, the Federal Reserve stopped publishing the aggregate known as M3, which is M2 plus large time deposits over $100,000 and institutional money market funds, repo agreements, and large liquid assets, but it is still produced by other institutions.

an interest-insensitive investment-expenditure relationship. The theory of real balance rests on two assumptions: first, real balances are a component of wealth and, second, wealth is an important determinant of consumption and investment spending. According to the real balance argument, a decline in prices would raise the purchasing power of wealth held in money form. The price-induced increase in the real value of cash balances would then stimulate expenditure directly until the economy had reached full capacity utilization. Since this wealth effect operates independently of changes in interest rates, closure of the indirect channel could not impede the restoration of the economy's full employment.

Friedman's (1956) contribution was to reinterpret the QTM as a theory of the demand for money, assuming a stable functional relationship between the velocity of money (or its counterpart, the quantity of real balances demanded) and the variables that determine it. Friedman and Schwartz (1963) provided the empirical and historical evidence to argue that inflation was ultimately a monetary phenomenon and, along with Phelps (1968), Friedman (1968) introduced the idea of the "natural rate" of unemployment, as determined by structural forces and largely independent from monetary forces. Their theories rest on the expectations-augmented Phillips curve, which recognizes that the relationship between current inflation and unemployment is unstable because it depends on expected inflation.

In the 1970s, the coexistence of high inflation with high and rising unemployment in the US and many other advanced economies revealed the shortcomings of the dominating Keynesian paradigm, allowing the monetarist approach to gain popularity in the policy debate. The phenomenon of stagflation seemed closely related to supply-side shocks, which only played a minor role in the Keynesian framework, and accommodative monetary policies seemed to be the main origin of the initial flare-up in inflation. According to the monetarist view, monetary policy has a lasting effect on long-run developments in nominal income and is the only effective means to keep inflation in check. Moreover, monetarists claimed that the quantity of money, rather than the level and structure of interest rates, should be the key instrument for the monetary authority. Finally, monetarists firmly maintained that long and variable lags in the transmission of the effects of monetary policy[7] make it difficult to predict the short-run impact of monetary changes. For this reason, monetarists argue that discretionary stabilization policy should be abandoned in favor of a rigid rule that keeps money supply growing at a fixed rate matching long-term growth in real output.

Another strong line of attack on Keynesian macroeconomics was based on its alleged inadequacy to explain the process of adjustment from the short to the long run and its vulnerability to the Lucas critique (1976), which emphasized the inadequacy of policy analysis based on reduced form models. This called for the development of an alternative macroeconomic framework, building on features that are reasonably invariant with respect to changes in economic policy, such as consumers' preferences, firms' technologies, and market structures. In this context, the contributions of Kydland and Prescott represented crucial advances. Kydland and Prescott (1977) provided a new perspective on the phenomenon of stagflation, by showing that a sustained high rate of inflation might reflect an inability of policymakers to commit to monetary policy due to the time inconsistency of optimal plans.

Kydland and Prescott (1982) integrated the analysis of long-run economic growth with that of short-run macroeconomic fluctuations, suggesting that exogenous shifts in technology are the main determinant of business cycle fluctuations. Their real business cycle model relied on standard microeconomic mechanisms by which prices, wages, and interest rates adjust so that markets clear in

[7] Friedman (1960).

all periods.[8] Therefore, temporarily low output growth could result from temporarily slow technological progress in production rather than from market failures. Kydland and Prescott (1982) was the first study to characterize the general equilibrium of a full-fledged dynamic and stochastic macroeconomic model based on microeconomic foundations. This model had a strong methodological influence on the New Keynesian paradigm, which synthesized earlier Keynesian analysis with the real business cycle analysis.

The New Keynesian approach uses[9] dynamic stochastic general equilibrium models where representative agents optimize their behavior subject to resource, technological and institutional constraints. This framework can describe the adjustment process from the short to the long run, which both Keynesian theory and the QTM neglected. Following the Keynesian tradition, the New Keynesian paradigm views price stickiness as the most important market friction creating a role for monetary policy. In particular, the existence of multi-period contracts in imperfectly competitive markets prevents firms and workers from adjusting their prices and wages in every period and implies that monetary policy can affect aggregate demand and, ultimately, real output in the short run, controlling inflation via the expectations-augmented Phillips curve. In the long run, as in the QTM, monetary policy cannot affect output but fully determines the average inflation rate.[10]

A key feature of the basic New Keynesian model is the passive role played by money stock in policy-making. In this framework, the monetary transmission mechanism is fully captured by the short-term interest rate and monetary policy is assumed to follow an interest rate rule. As a result, money supply adjusts endogenously to achieve equilibrium in the money market. Under certain conditions, Woodford (2003) shows that if such an interest rate rule satisfies the Taylor principle (increasing the real interest rate in response to upward inflationary pressures), then a unique equilibrium emerges where inflation is on target and output is at its potential (the latter being solely determined by real factors).

3. Long-run link between money growth and inflation: empirical evidence and sources of instability

One key proposition of the QTM is that, in the long run, there is a one-to-one link between money growth and inflation. The empirical literature provides strong support in favor of this relationship.

Evidence from large cross-sections of individual country data[11] shows that the correlation between average money growth and average inflation is high and close to one when the sample includes a sufficiently large number of countries, including those featuring high inflation rates, and covers a sufficiently long time span, including episodes of high inflation. This evidence appears to hold for the period since the Second World War[12]. Some cross-country studies analyze the link between money growth and real economic growth.[13] Empirically, the two variables appear to be virtually uncorrelated, which is consistent with the prediction of long-run neutrality of money, as implied by the QTM. McCandless and Weber (1995), Lucas (1996) and Papademos and Stark (2010) use scatter plots to

[8] Consumers and firms make decisions based on current and expected future paths of prices and policy variables, and the equilibrium price sequences are such that private-sector decisions are consistent with clearing markets at all points in time and all states of the world.

[9] See, e.g., Woodford (2003).

[10] Models with a richer structure and dynamics include Smets and Wouters (2003) and Christiano et al. (2003 and 2008).

[11] See e.g. Vogel (1974), Lothian (1985), Dwyer and Hafer (1988, 1999), McCandless and Weber (1995), Rolnick and Weber (1997), De Grauwe and Polan (2005), Frain (2004), Lothian and McCarthy (2009) and Dwyer and Fisher (2009).

[12] Studies with longer periods are discussed below.

[13] See e.g. Lothian (1985) and McCandless and Weber (1995).

depict the link between the average growth rate of money against the average increase in the general price level and the average increase in real income, and provide clear evidence in support of the long-run implications of the QTM.[14] A recent addition to this strand of literature, Borio et al. (2024), analyses the relationship between inflation and excess money growth[15] in a sample of 32 countries, including advanced and emerging market economies for the period 1951–2021. Their analysis confirms that a one-to-one link between money growth and inflation emerges clearly when the observations from all countries are pooled, but casts doubts on the persistence of the link once inflation declines.

Evidence in support of the presence of a long-run one-to-one relationship between money growth and inflation comes also from the empirical studies that use very long runs of time-series data for individual countries. The seminal paper in this strand of literature, Lucas (1980), employs frequency-domain analysis and scatter plots to show that there is a one-to-one link between the low-frequency (i.e. persistent or "long-run") component of money growth and inflation in the US over 1955-75. The 2003 evaluation of the European Central Bank's (ECB) monetary policy strategy and the monetary analysis "pillar" it devoted to the assessment of medium- to long-term inflation developments brought about a revival of the academic debate on the nature of the long-term money growth-inflation relationship. Empirical studies based on so-called extended Phillips curve specifications[16], spectral analysis[17] and cointegration analysis[18], confirmed the presence of a one to one long-run link between money growth and inflation in the euro area. The same was found for other countries like Japan, Switzerland, the US and the UK.[19] A recent addition to this strand of literature, Benati (2021), presents evidence from low-frequency regressions for 27 countries over samples starting in the 19th century. This author finds that the long-run trend of broad money growth moves closely with the long-run trend of inflation, despite the wide range of countries and the heterogeneity of monetary regimes observed over the sample. Jung (2024) re-assesses the validity of QTM in a sample of 18 industrial countries for the period 1870-2020. The analysis shows that the long-run relationship between excess money growth and inflation holds, but the average speed of adjustment from excess money growth to inflation is heterogeneous across time and countries. Moreover, this author claims that over recent decades, structural change has contributed to a "collapse of QTM".

This brief overview shows that the empirical literature provides some support for a stable long-run relationship between money growth and inflation. However, evidence also seems to suggest that the strength of this link may vary over time. In particular, the relationship between inflation and money growth appears to weaken in a low and stable inflation environment, when the level of interest rates is low, and during changes in monetary policy and financial regimes. For example, De Grauwe and Polan (2005) find that over the post-second World War period the correlation between money growth and inflation is considerably weaker when only low-inflation countries are included in the analysis.[20] Similarly, the analysis in Gertler and Hofmann (2018) confirm that the finding of a one-to-one link depend on the inclusion of high-inflation episodes, such as those during wartime periods in the 1910s

[14] McCallum & Nelson (2011) and Jung (2024) highlight that tests of the QTM based on scatter plots of long-run country averages of inflation and money growth could be flawed because cross-country differences in velocity and GDP are ignored.

[15] Excess money growth is defined as the difference between money growth and real GDP growth.

[16] An extended Phillips curve is a relationship between inflation and the output (or unemployment) gap that is extended to include a money growth indicator. See Gerlach (2003, 2004), Neumann (2003) and Neumann and Greiber (2004).

[17] See Jaeger (2003), Bruggeman et al. (2005) and Assenmacher-Wesche and Gerlach (2006, 2007, 2008a).

[18] See Kaufmann and Kugler (2008) and Carstensen (2007).

[19] See Assenmacher-Wesche and Gerlach (2007, 2008a, b) and Assenmacher-Wesche et al. (2008).

[20] They define low-inflation countries as those with average inflation below 10%.

and the 1940s, or in the aftermath of the oil price shocks in the 1970s. Fratianni et al. (2021) reach a similar conclusion for a sample of 16 developed countries with data spanning 1870 to 2013. Papadia and Cadamuro (2021), looking at US and euro area data, confirm the hypothesis that monetary aggregates are only relevant for inflation in "unsettled" monetary and inflationary conditions and confirm that money does not really help in forecasting inflation if the latter is stable. Benati (2021) also suggests that the strength of the money growth-inflation link may not be invariant with respect to the monetary regime. His results show that the link appears to be weaker for the post-1985 low-inflation regime, when central banks directly targeted inflation.[21] Finally, Borio et al. (2024) confirm that the strength of the link depends on the inflation regime: it is one-to-one when inflation is high and virtually non-existent when inflation is low. During the recent inflation surge in 2021-2022, the authors find that excluding countries with very high inflation causes the money-inflation link to lose significance.

One potential explanation for the instability of the money growth-inflation nexus are changes in velocity of money. For example, a decline in inflation may allow money to grow faster than prices because interest rates and the opportunity cost of money also decline. This induces people to increase money holdings per unit of output, lowering velocity. By the Fisher effect, the decline in interest rates triggers an increase in money balances, but this is a transitory level effect that cannot produce a persistent inflation increase. An analysis that omits the determinants of money demand might produce biased empirical evidence on the relationship between money growth and inflation. Lucas (1988), Reynard (2006) and McCallum and Nelson (2011) are among the studies that claim that analyzing money growth and inflation developments without considering possible changes in equilibrium velocity may erroneously lead to the conclusion that the link between money growth and future inflation has weakened. More recently, Teles et al. (2016)[22] confirm that, when correcting money growth for variation in output growth and the opportunity cost of money, the long-term money growth-inflation relationship implied by the QTM is still valid.

However, even when controlling for such shifts, the evidence of a strong long-run link between money growth and inflation has become more limited, as inflation persistently declined from the mid-1980s onwards. The decline in inflation volatility during the Great Moderation made it harder to detect robust empirical evidence of money growth-inflation link.[23]

An important implication is that changes in monetary policy regimes can significantly influence the relationship between money growth and inflation, especially if central banks move towards targeting inflation directly.[24] The idea is that relatively low variability in the inflation rate across countries in the inflation-targeting period makes it harder to find a low-frequency relationship between money growth and inflation. This evidence can be seen as an empirical application of the "Goodhart's law", which states that "any observed statistical regularity will tend to collapse once pressure is placed upon it for control purposes" (Goodhart, 1975). In other words, the leading properties of a given measure, such as money growth with respect to inflation, tend to vanish once such a measure is used to guide policy (the central bank reacts to it systematically). This is what happened in many countries after formal or

[21] Sargent and Surico (2011) reach similar conclusions. They revisit the analysis of Lucas (1980), using US data for the period 1900-2005, and find that Lucas' result of a proportional relationship between money growth and inflation does hold over the sub-sample on which his original study was based, but fails to hold over the full sample and other sub-samples, in particular over the more recent period.

[22] Teles et al. (2016) focus on low-inflation OECD countries over the period 1970–2005. Other studies found that the source of instability in the relationship between money demand and interest rates is financial innovation. See, for example, Berentsen, A., Huber, S. and Marchesiani, A. (2015).

[23] See, e.g., Estrella and Mishkin (1997).

[24] See, e.g., Sargent and Surico (2011) and Benati (2021) and Berger et al. (2023).

informal adoption of inflation targeting practices, when many measures of money gradually lost their forecasting power for inflation, which is what seems to have happened since the early 1990s.

To sum up, while the long-run relationship between money growth and inflation is widely accepted in the literature and empirically validated, the occasional weakness and instability of this relationship over time have fueled debate on the extent to which money is relevant for the conduct of monetary policy. The next section briefly reviews the role that money played in central banking, starting with the rise of Monetarism in the 1970s

4. The money growth-inflation link over time and the role of monetary aggregates in monetary policy frameworks

In the past, monetary aggregates played a key role in monetary policy frameworks in many countries. Monetarism gained importance in the 1970s, as an attempt to respond to the "stagflation" of that decade, when major economies were hit by several supply shocks, leading to high and rising inflation combined with slow economic growth. Keynesian economic theory, with its focus on the demand side of the economy, was ill equipped to explain these developments and failed to provide an appropriate policy response. Monetarists, on the other hand, argued that the high inflation was due to rapid increases in the money supply and claimed that money supply control would be the most effective monetary policy. The ascent of the monetarist paradigm, which emphasized the implications of the QTM for macroeconomic outcomes, drove many central banks to shift their focus on money and to adopt monetary targeting.

At the end of 1974, the Deutsche Bundesbank and the Swiss National Bank officially engaged in monetary targeting and maintained it for over twenty years. Both experiences were successful, although to a different extent. A common feature of Germany and Switzerland was that their monetary-targeting frameworks were not mechanical rules to maintain money growth on a constant-growth-rate path, but rather a method of communicating a monetary policy strategy that focused on long-run considerations and inflation control.[25] The Bundesbank and the Swiss National Bank demonstrated a strong commitment to the transparent communication of the strategy to the public, a key element for the success of monetary targeting (Mishkin, 2000).

Mounting inflation concerns in the mid-1970s also lead the US, the UK and Canada to introduce monetary targeting, but their experience was not particularly successful[26], mainly for two reasons (Mishkin, 2000). First, the strategy was not pursued rigorously by the central banks, which targeted multiple aggregates, did not clearly announce the targets and remained silent about deviations; second, the instability of the relationship between monetary aggregates and inflation complicated monetary targeting.

Since the mid-1980s, the monetarist approach was gradually abandoned, as central banks moved away from monetary targets and towards more directly inflation-centered regimes. This tendency was underpinned by the rise of a class of New Keynesian models that were more successful at explaining macroeconomic fluctuations despite the QTM having no role in monetary policy-making.[27] In the 1990s, several industrialized countries adopted inflation targeting: New Zealand in 1990, Canada

[25] "Indeed, given that both central banks frequently missed their money-growth targets by significant amounts, their monetary-targeting frameworks are best viewed as a mechanism for transparently communicating how monetary policy was being directed to achieve their inflation goals and as a means for increasing the accountability of the central bank.", Mishkin (2000).

[26] Between 1980 and 1987, the Federal Reserve was successful in reducing the rate of inflation, but its extreme contractionary policy focused on the short-term and contributed to a severe recession at the beginning of the 1980s.

[27] Goodfriend (2007) reviews how, in the light of evidence generated by the Volker disinflation, academic economists forged the building blocks of the New Keynesian model.

followed in February 1991, Israel in December 1991, the United Kingdom in 1992, Sweden and Finland in 1993, Australia in 1994 and Spain in 1994. The Deutsche Bundesbank and the European Central Bank in its early years were notable exceptions.

Building on the Bundesbank's policy framework, the founders of the monetary union and the ECB adopted a reference value for broad money growth. While the ECB did not directly commit to reacting to deviations from this reference value, monetary analysis represented the first pillar of the ECB's monetary policy strategy of 1998[28] and money growth held an important role in determining the policy response.[29] In 2003, as part of the ECB's strategy evaluation (ECB, 2003), the ranking of the pillars changed: the economic analysis, which focused on short to medium-term developments, became the first pillar and the monetary analysis, which focused on medium to long-term inflation trends, became the second pillar. This change appeared to be in line with the growing consensus that the link between money growth and inflation had weakened since the 1980s. Since its last strategy review in 2021 (Holm-Hadulla et al., 2021), the ECB has based its policy decisions on an integrated assessment of all relevant factors. This assessment still consists in an economic analysis on the one hand and a monetary and financial analysis on the other, but it implicitly accepts that monetary analysis no longer plays the role intended in 2003, focusing more on the transmission mechanism, the calibration of unconventional monetary policy instruments and financial stability as a precondition for price stability.

Between 1995 and 2020, advanced economies enjoyed a macroeconomic environment characterized by low and stable inflation. It is widely believed that one reason why inflation stayed so low for so long was the change in monetary policies that took place in the 1990s, when central banks adopted inflation targeting in an effort to commit credibly to a policy strategy aiming at low inflation. This stabilized inflation expectations at levels that provided a solid nominal anchor for economic agents to plan their consumption, saving and investment.

Monetary policy was not the only factor behind this phase of broad macroeconomic stability. Several structural changes occurring during this period - globalization, technological progress, labor market developments –helped to dampen price increases. During the latter part of this phase, which became known as the "Great Moderation"[30], central banks, especially the Federal Reserve and the ECB, were particularly concerned about inflation being too low rather than too high. At the same time, policymakers worried that low inflation would permanently move nominal interest rates near their "zero-lower-bound", constraining their interest rate policies in an undesirable way. As a result, monetary policy in all major countries remained highly expansionary throughout the latter part of this phase (near-zero interest rates became common). The broad consensus remained that inflation targeting provided a sound framework for monetary policy and that monetary aggregates only played a peripheral role.

The Global Financial Crisis of 2007–09 prompted major changes in central banks' operating frameworks. Central banks introduced unconventional policy measures, including quantitative easing (QE) and forward guidance, in an effort to circumvent the effective lower bound on the policy rate, to address impairments in various stages of the policy transmission mechanism and to help deliver the intended monetary policy accommodation through the intermediation chain to reach final borrowers, i.e. households and firms. These policies were controversial, with central banks accused of excessively inflating their balance sheets, increasing the money supply and risking a sharp rise in future price levels. However, between 2010 and early 2020, unconventional monetary policy had only moderate effects on broad money growth and did not cause the feared surge in inflation.

[28] See Issing, O. (2000) and ECB (1999a, b).
[29] See, e.g., Masuch et al. (2003) and Rostagno et al. (2019).
[30] See, e.g. Bernanke (2004) and Stock and Watson (2002).

In the wake of the pandemic, central banks' experience with QE was very different. In 2021, inflation rates began to exceed central banks' target levels, first in the US and then in Europe. The post-pandemic surge in inflation, preceded by non-standard monetary policy measures that significantly increased the size of central banks' balance sheets and money supply, revived the debate regarding the role of money growth for inflation[31] and put the actions of central banks under new scrutiny. Schnabel (2023) argued that asset purchases are not necessarily inflationary but that their effects depend on the state of the economy.

Post-pandemic developments also sparked new interest in the question whether the sharp increase in money growth over 2020-2021 could be viewed as an early warning indicator for risks to medium-term price stability. In a recent study, Borio et al. (2023) claim that looking at money growth would have helped to improve post-pandemic inflation forecasts, confirming that money growth provides useful information to policymakers. However, their analysis also shows that the link between money growth and inflation is regime-dependent, i.e. strong when inflation is high and virtually non-existent when inflation is low. The updated results in Borio et al. (2024) cast doubt on the persistence of the link once inflation declines and suggest that the information content of money growth for inflation depends on the level of inflation itself. This makes it difficult to use money growth "reliably as inflation shifts across regimes. Judgment remains of the essence."

To conclude, the long-run relationship between money and prices has been validated by extensive empirical literature. However, how to make this relationship operational is far from uncontroversial. The instability in the relationship since World War II made monetary aggregates less relevant as an intermediate target for central banks, but the dynamics displayed since the pandemic called for a re-examination of the QTM. Our empirical contribution to the debate is summarized in the next section.

5. A regime-dependent nexus between money growth and inflation: some new evidence

Our analysis contributes evidence that money growth can signal risks to price stability. It adopts a regime-dependent view of the money growth-inflation link. Our approach can quantify the information content of monetary variables as warning signals for shifts among inflation regimes. We model inflation as a univariate autoregressive regime-switching process where the probabilities of moving from one inflation regime to another depend on the rate of money growth (Amisano and Fagan, 2013 and Amisano *et al*., 2014). We estimate models for the US and the euro area using Bayesian techniques. The datasets include seasonally adjusted quarterly data for inflation and money growth. Inflation is measured as 100 times the year-on-year log-difference of the consumer price index. As for money growth, we developed an "adjusted" measure to account for changes in trend money velocity and/or in potential growth. This transformation enhances the leading indicator properties of money growth for inflation.[32] The US data range from 1952Q1 to 2024Q1 and the euro area data range from 1970Q1 to 2023Q4.[33]

[31] See, for example, Ambler and Kronick (2023), Congdon (2022), Issing (2021), King (2022), Papadia and Camaduro (2021).

[32] For the details on the construction of the "adjusted" monetary indicator, see Amisano and Fagan (2013).

[33] For the US, we use the Consumer Price Index (CPIAUCSL) and the M2 broad monetary aggregate (M2SL). For the EA, we use the Harmonized index of consumer prices (ICP.M.U2.Y.000000.3.INX) and the M3 broad monetary aggregate (BSI.M.U2.Y.V.M30.X.I.U2.2300.Z01.A), which are both seasonally adjusted by the data providers. The US data comes from the FRED database of the Federal Reserve Bank of Saint Louis and EA data from the Statistical Data Warehouse of the European Central Bank. In brackets are indicated the mnemonics for each series.

In our model, inflation (y_t), is characterized by an autoregressive regime-switching process in which the economy can potentially switch between three regimes (s_t): regime 1, "Extremely Low" inflation[34], regime 2, "Medium" (near target) inflation and regime 3, "High" inflation. Each regime is associated with a regime-specific intercept, c_{s_t}, and shock variance, $\sigma^2_{s_t}$.The persistence term ρ is the same across regimes and across time.

$$y_t = c_{s_t} + \rho y_{t-1} + \sigma_{s_t} e_t \quad (3)$$
$$e_t \sim NID(0,1)$$
$$c_{s_t} = (1-\rho)\mu_{s_t}$$
$$s_t = 1,2,3$$

Transition probabilities (TPs) from one regime to another vary over time as a function of the monetary variable (z_t). We assign them an ordered probit specification as follows: [35]

$$p_{ij,t+1} = pr(s_{t+1} = j | s_t = i, z_t)$$
$$= \Phi(\gamma_{ji} - \beta_0 z_t - \beta_i) - \Phi(\gamma_{j-1,i} - \beta_0 z_t - \beta_i)$$
$$i = 1,2,3; j = 1,2,3 \quad (4)$$

where $\Phi(\cdot)$ is the standardized Gaussian cumulative distribution function. At each point in time $t+1$, TPs indicate the risks associated with regime shifts. TPs are conditional on the event that the model is in a given regime at time *t* as well as on the (lagged) indicator variables.

One distinctive feature of our nonlinear framework is that it exploits the information content of money growth to allocate inflation episodes to different regimes. In other words, the specification of the TPs (equation (4)) allows money to act as **"**warning signal**"** of the risk that inflation may exit the **"**price stability**"** regime. The main purpose of the model is its ability to signal such a risk in a timely fashion. Arguably, this is valuable information for the assessment of price stability, as it provides a real-time, money-based early warning indicator of shifts across inflation regimes. A simple way to assess whether money growth helps to identify the inflation regimes is to compare the one-step-ahead probabilities[36] obtained with the time-varying transition probability model with those provided by a model where transitions between regimes are exogenously determined and independent of money growth. The one-step-ahead regime probabilities, $\xi_{t+1|t}$, are a by-product of the Markov switching framework. For each date *t*, they are defined as follows:

$$\xi_{t+1|t} = \mathbf{P}_{t+1} \xi_{t|t} \quad (5)$$

where $\mathbf{P}_{t+1}$ is the (3x3) transition probability matrix as specified in equation (4) and $\xi_{t|t}$ is the (3x1) vector of conditional probabilities, $pr(s_t = j | y_t, z_t)$, which the model assigns to the *t*-th observation being generated by each of the regimes *j=1…3*. Therefore, for each *t*, the *j*-th element of the (3x1) vector $\xi_{t+1|t}$ contains the probability that the process will be in regime *j* in period $t+1$, conditioned only on information available through date t. Intuitively, this provides a measure of the uncertainty regarding the current regime.

If monetary aggregates can provide useful information to evaluate the risks to price stability, the one-step ahead probabilities obtained using money growth as an early warning indicator should provide a stronger and possibly more timely signal of departure from the price stability regime than those from a model which excludes money growth. Figures (1) and (2) compare US and euro area results, plotting the one-step ahead probabilities of the "High" inflation regime produced by each model, along with year-on-year inflation.

[34] The level of inflation in the "Extremely Low" inflation regime is calibrated to 0, given that in the estimation sample extremely low values of inflation have been very rare. We consider explicitly this regime because we want the model to be able to capture the risk of deflation.

[35] More details are provided in Amisano *et al.* (2014), and in Amisano and Colavecchio (2024).

[36] Our analysis uses quarterly data and therefore "one-step ahead" refers to the next quarter.

For the US, the model incorporating money growth anticipates the inflationary episodes in the early 1970s, in the late 70s/early 80s and especially in 2022-2023. Just before each of these inflationary episodes, the one-step-ahead probabilities of entering the "High" inflation regime differed across models, with the time-varying TP model signalling a much higher inflationary risk than the model with fixed TP.

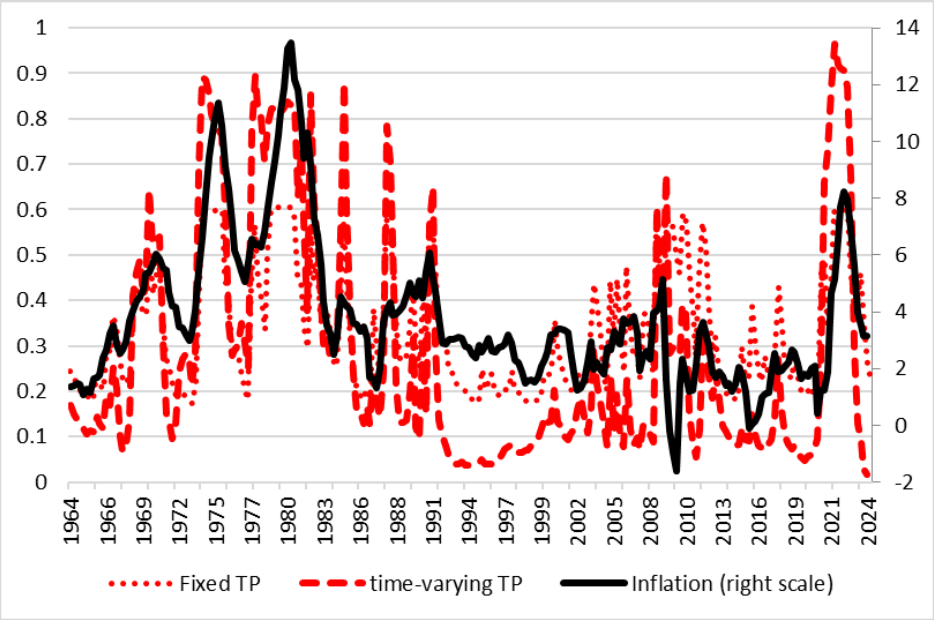

Figure 1: US : One-step-ahead probabilities of "High" inflation regime

Note: One-step ahead probabilities from an information set including money growth (time-varying TP, dashed line) and excluding money growth (fixed TP, dotted line)

Similarly, preceding euro area episodes characterized by volatile and/or high inflation, such as the early 1980s, the Global Financial Crisis and the post-pandemic years (2022-2023)[37], the one-step ahead probability of entering the "High" inflation regime differed substantially across models. In particular, the model including money growth provides a much stronger signal for the risk of entering a "High" inflation regime than the model with fixed TP.

[37] These were periods in which the level and/or the volatility and of inflation were particularly high, as Figure 2 shows. The model assigns these periods to the third regime, labelled "High" inflation regime.

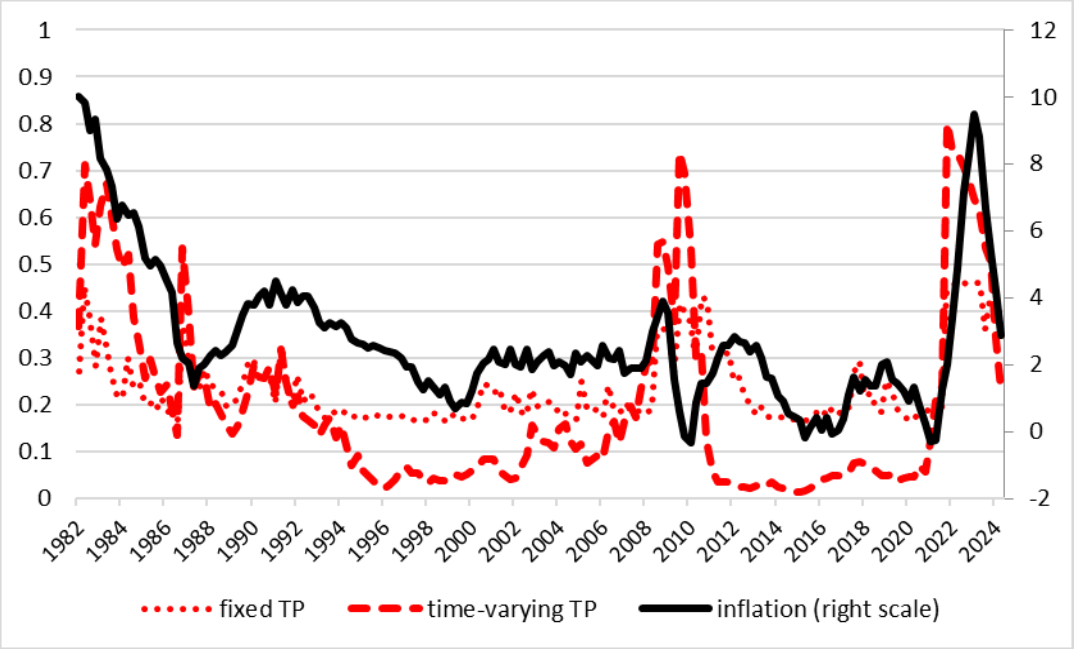

Figure 2: Euro area - One-step ahead probabilities of "High" inflation regime

Note: One-step ahead probabilities from an information set including money growth (time-varying TP, dashed line) and excluding money growth (fixed TP, dotted line).

The main purpose of our money-augmented regime-switching model is to identify increases in the probability of entering the "High" inflation regime, so this must be the criterion to assess its usefulness. Figure 1 and 2 suggest that the model with time-varying TPs has been able to identify the episodes of "High" inflation regime more clearly than the model with fixed TPs. For example, in 2021Q2, shortly before the post-pandemic inflation surge in the euro area, the model with time-varying TP signals an 80% probability of entering the "High" inflation regime, almost twice as high as the probability implied by the model with fixed TP (Figure 2).

Money growth therefore provides a timely signal of inflation risks that can be illustrated by the evolution of one-quarter-ahead conditional forecasts of inflation. As shown in Figure 3 below for the US, the acceleration of money growth that preceded the upsurge of inflation in 2021 produced a massive rightward shift in the one-step-ahead predictive distribution of inflation for 2021:Q2 and 2021:Q3.

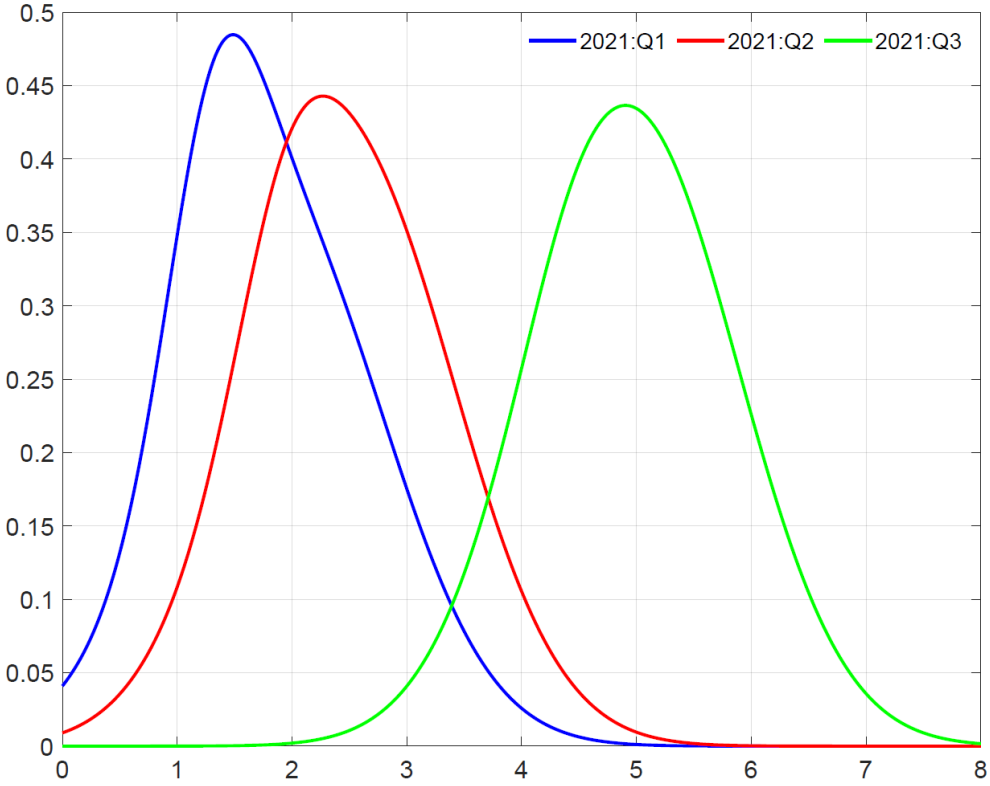

Figure 3: one quarter-ahead real-time predictive distributions for US inflation

To conclude, our analysis shows that money growth provides a signal that is, in some, but not all circumstances, useful to predict inflation. Our model shows, in fact, that the strength of this signal has not been uniform, as would be implied by a simple linear relationship between money growth and inflation, but is relevant in those episodes, such the 1970s, the early 1980s and the recent post-pandemic phase, when the risk of high inflation has been clearly anticipated by rapid money growth. Our results also explain why during the period starting with the 1990s and ending just before the pandemic, money growth had apparently ceased to provide any useful signal to predict inflation.

In other words, the money growth- inflation relationship is non-linear, with faster money growth signaling a higher probability of entering a "High" inflation regime, in this way providing a sharper assessment of the risks to price stability. [38]

6. Conclusion

This chapter reviews the link between money growth and inflation in the theoretical and the empirical literature to shed light on whether monetary aggregates could serve as early warning indicators for risks to price stability. The quantity theory of money predicts a one-to-one relationship between money growth and inflation in the long run (Section 2). This link, originally conceptualized by Hume and validated over time by countless empirical studies, is now widely accepted in the

[38] In Amisano and Fagan (2013) and Amisano *et al.* (2014) it was shown that the model that includes money growth outperforms the version excluding money growth (fixed transition probability model). The TV-TP model's superiority, expressed in terms of higher log predictive score, is not uniform through the sample but particularly evident during periods of accelerating inflation. Same results (not shown) hold for the extended sample used for estimation in this chapter.

macroeconomic literature. However, the money growth-inflation relationship displayed signs of instability in the post-World War II period, making monetary aggregates particularly controversial as guides to policy. For example, the strength of the relationship between money growth and inflation appeared to be conditional on changes in monetary regimes and the correlation between the two variables disappears or weakens substantially in environments of low and stable inflation (Section 3). For this reason, the relevance of monetary aggregates in policymaking varied over time and by the early 1990s most central banks had abandoned monetary targeting in favor of inflation targeting. This shift was theoretically validated by the emergence of New Keynesian models in which the quantity of money had no role in the monetary policy framework. (Section 4)

After the pandemic, inflation rates rose rapidly above their target levels, first in the US and then in Europe. This inflation surge, preceded by extremely high rates of money growth, revived the debate regarding the role of money growth as a predictor for inflation. In particular, the sharp increase in money growth over 2020-2021 could have provided an early warning of risks to medium-term price stability. Our empirical analysis contributes to this debate (Section 5) for the US and the euro area. Our approach takes a regime-dependent view of the money growth-inflation link and exploits the information content of monetary variables as warning signals for shifts across inflation regimes. We conclude that money growth can provide a sharper assessment of risks to price stability, since faster money growth is associated with a higher probability of entering a "high" inflation regime.

References

Ambler, S. and Kronick, J. (2023), "Money Talks: The Old, New Tools for Predicting Inflation", C.D. Howe Institute Commentary No. 623.

Amisano, G. and Colavecchio R. (2013), "Money Growth and Inflation: evidence from a Markov Switching Bayesian VAR", Hamburg University, Department Wirtschaft und Politik Macroeconomics and Finance Series Discussion Paper 4/2013.

Amisano G. and Colavecchio R. (2025), "Multivariate regime-switching models for risk assessment in macro and finance", in preparation.

Amisano G., R. Colavecchio and G. Fagan (2014), "A money-based indicator for deflation risk", Hamburg University, Department Wirtschaft und Politik Macroeconomics and Finance Series Discussion Paper 3/2014.

Amisano, G. and Fagan G. (2013), "Money growth and inflation: A regime switching approach", Journal of International Money and Finance, 33, 118-145.

Assenmacher-Wesche, K. and Gerlach, S. (2006), "Understanding the link between money growth and inflation in the euro area", Discussion Paper Series, No 5683, CEPR.

Assenmacher-Wesche, K. and Gerlach, S. (2007), "Money at low frequencies", Journal of the European Economic Association, 5(2-3), pp. 534-542.

Assenmacher-Wesche, K. and Gerlach, S. (2008a), "Interpreting euro area Inflation at high and low frequencies", European Economic Review, 52(6), pp. 964-986.

Assenmacher-Wesche, K. and Gerlach, S. (2008b), "Money growth, output gaps and inflation at low and high frequency: spectral estimates for Switzerland", Journal of Economic Dynamics and Control, 32(2), pp. 411-435.

Assenmacher-Wesche, K., Gerlach, S. and Sekine, T. (2008), "Monetary factors and inflation in Japan", Journal of the Japanese and International Economies, 22(3), pp. 343-363.

Benati, L. (2021), "Long-Run Evidence on the Quantity Theory of Money", Discussion Papers, No 21-10, University of Bern.

Berentsen, A., Huber, S. and Marchesiani, A. (2015), "Financial Innovations, Money Demand, and the Welfare Cost of Inflation", Journal of Money, Credit and Banking, Vol. 47, pp. 223-261.

Berger, H., Karlsson, S., and Österholm, P. (2023), "A Note of Caution on the Relation Between Money Growth and Inflation", IMF Working Papers, 2023(137).

Bernanke, B. (2004), "The Grat Moderation", remarks at the meetings of the Eastern Economic Association, Washington, DC, 20 February.

Borio, C., Hofmann, B. and Zakrajšek, E. (2023a), "Does Money Growth Help Explain the Recent Inflation Surge?", BIS Bulletin No. 67.

Borio, C., Lombardi, M., Yetman, J, and Zakrajšek, E. (2023b), "The Two-Regime View of Inflation", BIS Papers No. 133.

Borio, C., Hofmann, B. and Zakrajšek, E. (2024), "Money growth and the post-pandemic inflation surge: Updating the evidence".

Bruggeman, A., Camba-Méndez, G., Fischer, B. and Sousa, J. (2005), "Structural filters for monetary analysis: the inflationary movements of money in the euro area", No 470, Working Paper Series, European Central Bank.

Cantillon, R. (1755), "Essai sur la Nature du Commerce en Général".

Carstensen, K. (2007), "Is core money growth a good and stable inflation predictor in the euro area?", Working Paper Series, No 1318, Kiel Institute for the World Economy.

Chahad M., Hofmann-Drahonsky A., Martínez Hernández C. and Page A. (2024), "An update on the accuracy of recent Eurosystem/ECB staff projections for short-term inflation", Economic Bulletin, Issue 2, ECB.

Christiano, L., Motto, R. and Rostagno, M. (2003), "The Great Depression and the Friedman-Schwartz hypothesis", Journal of Money, Credit and Banking, 35(6), pp. 1119-1197.

Christiano, L., Motto, R. and Rostagno, M. (2008), "Shocks, structure or monetary policies? The euro area and US after 2001", Journal of Economic Dynamics and Control, Vol. 32, pp. 2476-2506.

Congdon, T. (2022), "The Case for Restoring the Role of Monetary Aggregates", Central Banking, 8th of August.

De Grauwe, P. and Polan, M. (2005), "Is Inflation Always and Everywhere a Monetary Phenomenon?" The Scandinavian Journal of Economics, Vol. 107, No 2, pp. 239-259.

Dwyer, G.P. and Fisher, M. (2009), "Inflation and monetary regimes", Journal of International Money and Finance, 28(7), pp. 1221-1241.

Dwyer Jr., G.P. and Hafer, R.W. (1999), "Are Money Growth and Inflation Still Related?", Economic Review, Vol. 84, No 2, Federal Reserve Bank of Atlanta, pp. 32-43.

ECB (1999a), "The stability-oriented monetary policy strategy of the Eurosystem", Monthly Bulletin, January, pp. 39-50.

ECB (1999b), "Euro area monetary aggregates and their role in the Eurosystem's monetary policy strategy", Monthly Bulletin, February, pp. 29-46.

ECB (2003), "The outcome of the ECB's evaluation of its monetary policy strategy", Monthly Bulletin, June, pp. 79-92.

ECB (2021), "The ECB's monetary policy strategy statement".

Estrella, A. and Mishkin, F.S. (1997), "Is there a role for monetary aggregates in the conduct of monetary policy?", Journal of Monetary Economics, Vol. 40, No 2, pp. 279-304.

Fisher, I. (1911), "The purchasing power of money", Macmillan, New York.

Fisher, I. (1912), "'The Equation of Exchange' for 1911, and Forecast", The American Economic Review, Vol. 2, No 2, pp. 302-319.

Frain, J.C. (2004), "Inflation and money growth: evidence from a multi-country data-set", Economic and Social Review, 35(3), pp. 251-266.

Fratianni, M., Gallegati, M., and Giri, F. (2021),."International Historical Evidence on Money Growth and Inflation: The Role of High Inflation Episodes", The B.E. Journal of Macroeconomics, 21, 541 - 564.

Friedman, M. (1956), “The Quantity Theory of Money: A Restatement”, in Friedman, M. (ed.), Studies in the Quantity Theory of Money, University of Chicago Press, Chicago, pp. 3-21.

Friedman, M. (1960), “A Program for Monetary Stability”, Fordham University Press.

Friedman, M. (1968), “The role of monetary policy”, American Economic Review, 58(1), pp. 1-17.

Friedman, M. and Schwartz, A.J. (1963), A monetary history of the United States, 1867-1960, Princeton University Press, Princeton.

Gerlach, S. (2004), “The two pillars of the ECB”, Economic Policy, 40, pp. 389-439.

Gertler, P. and Hofmann, B. (2018), “Monetary facts revisited”, Journal of International Money and Finance, Vol. 86, pp. 154-170.

Goodfriend, M. (2007) “How the world achieved consensus on monetary policy,” Journal of Economic Perspectives 21(4), pp. 47-68.

Goodhart, C. (1975), “Monetary relationships: a view from Threadneedle Street”, Papers in Monetary Economics, No I, Reserve Bank of Australia.

Ho, P. (2021), “Forecasting in the Absence of Precedent”, FRB Richmond Working Paper No. 21-10.

Holm-Hadulla, F., Musso, A., Vlassopoulos, T. and Rodriguez-Palenzuela, D. (2021), “Evolution of the Ecb's Analytical Framework”, ECB Occasional Paper No. 2021277.

Hume, D. (1752), “Of interest”, in Political Discourses.

Humphrey , T.M. (1974), “The quantity theory of money : its historical evolution and role in policy debates”, Economic Review.

Issing, O. (2000), "The ECB's Monetary Policy: Experience After the First Year", Journal of Policy Modeling, Vol 22, No. 3: 325-43.

Issing, O. (2021), “The Return of Inflation?”, Project Syndicate, 16 July.

Jaeger, A. (2003), “The ECB’s money pillar: an assessment”, Working Paper Series, No 03/82, IMF.

Jung, A. (2024) “The quantity theory of money, 1870-2020,” No 2940, Working Paper Series, European Central Bank.

Kaufmann, S. and Kugler, P. (2008), “Does money matter for inflation in the euro area?”, Contemporary Economic Policy, 26(4), pp. 590-606.

Keynes, J.M. (1936), The general theory of employment, interest and money, MacMillan, London.

King, M. (2022), “Monetary Policy in a World of Radical Uncertainty”, SUERF Policy Note No. 263.

Kydland, F. and E. Prescott (1977), “Rules rather than discretion: The inconsistency of optimal plans”, Journal of Political Economy, 85, 473-490.

Kydland, F.E. and Prescott, E.C. (1982), “Time to build and aggregate fluctuations”, Econometrica, 50(6), pp. 1345-1370.

Lothian, J.R. (1985), “Equilibrium Relationships between Money and Other Economic Variables”, The American Economic Review, Vol. 75, No 4, pp. 828-835.

Lothian, J.R. and McCarthy, R.H. (2009), “The behaviour of money and other economic variables: two natural experiments”, Journal of International Money and Finance, 28(7), pp. 1204-1220.

Lucas, R.E. (1976), “Econometric policy evaluation: a critique”, Carnegie Rochester Series on Public Policy, 1, pp. 19-46.

Lucas Jr., R.E. (1980), “Two Illustrations of the Quantity Theory of Money”, The American Economic Review, Vol. 70, No 5, pp. 1005-1014.

Lucas, R.E. (1988), “Money demand in the United States: a quantitative review”, Carnegie Rochester Series on Public Policy, 29(1), pp. 137-167.

Lucas, Jr., R.E. (1996), “Nobel Lecture: Monetary Neutrality”, The Journal of Political Economy, Vol. 104(4), pp. 661-682.

Masuch, K., Nicoletti-Altimari, S.,Rostagno, M. and Pill, H. (2003), "The role of money in monetary policymaking," BIS Papers chapters, in: Bank for International Settlements (ed.), Monetary policy in a changing environment, volume 19, pages 158-191, Bank for International Settlements.

McCallum, B.T. and Nelson, E. (2011), “Money and Inflation: Some Critical Issues.”, ch. 03, p. 97-153 in Friedman, B. and Woodford, M. (eds.), Handbook of Monetary Economics, Vol.3, Elsevier.

McCandless Jr., G.T. and Weber, W.E. (1995), “Some Monetary Facts”, Quarterly Review, Vol. 19, No 3, Federal Reserve Bank of Minneapolis, pp. 2-11.

Mishkin, F. S. (2001). “From Monetary Targeting to Inflation Targeting: Lessons from the Industrialized Countries”, Policy Research Working Paper No. 2684, World Bank, Washington, DC.

Neumann, M.J.M. (2003), “The European Central Bank’s first pillar reassessed”, Working Paper Series, No 03, IIW, Bonn University.

Neumann, M.J.M. and Greiber, C. (2004), “Inflation and core money growth in the euro area”, Discussion Paper Series, No 36/2004, Deutsche Bundesbank.

Papademos, L., and Stark, J. (Eds.). (2010), “Enhancing monetary analysis”, Frankfurt: European Central Bank.

Papadia, F. and Cadamuro, L. (2021), “Does money growth tell us anything about inflation?” Working Papers, No 11, Bruegel, 4 November.

Phelps, E.S. (1968), “Money-wage dynamics and labour market equilibrium”, Journal of Political Economy, 76(2), pp. 678-711.

Pigou, A.C. (1917), “The value of money”, Quarterly Journal of Economics, 32(1), pp. 38-65.

Pigou, A.C. (1943), “The classical stationary state”, Economic Journal, 53, pp 343–351.

Reynard, S. (2006), “Money and the Great Disinflation”, Working Paper Series, No 2006-7, Swiss National Bank.

Rolnick A.J., and Weber W.E. (1997), "Money, inflation, and output under fiat and commodity standards", Journal of Political Economy, 105 (6) , pp. 1308-1321.

Rostagno, M., Altavilla, C., Carboni, G., Lemke, W., Motto, R., Guilhem, A. S., and Yiangou, J. (2019), "A tale of two decades: the ECB's monetary policy at 20", No 2346, Working Paper Series, European Central Bank.

Sargent, T.J. and Surico, P. (2011), “Two Illustrations of the Quantity Theory of Money: Breakdowns and Revivals”, American Economic Review, Vol. 101, No 1, pp. 109-128.

Schnabel, I. (2023), “Money and Inflation”, SUERF Policy Note Issue No 324, October 2023.

Smets, F., and Wouters, R. (2003), “An estimated stochastic dynamic general equilibrium model of the euro area”, Journal of the European Economic Association, 1(5), pp. 1123-1175.

Stock, J. and Watson, M.(2002), “Has the Business Cycle Changed and Why?”, NBER Macroeconomics Annual, Volume 17.

Teles, P., Uhlig, H. and Valle e Azevedo, J. (2016), “Is quantity theory still alive?”, The Economic Journal, Vol. 126, No 591, pp. 442-464.

Vogel, R.C. (1974), “The Dynamics of Inflation in Latin America, 1950-1969”, The American Economic Review, Vol. 64, No 1, pp. 102-114.

Woodford, M. (2003), Interest and prices, Princeton University Press.

BANQUE CENTRALE DU LUXEMBOURG

EUROSYSTÈME

2, boulevard Royal
L-2983 Luxembourg

Tél.: +352 4774-1
Fax: +352 4774 4910

www.bcl.lu • info@bcl.lu