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Is inflation caused by deteriorating inflation expectations or excessive monetary growth?

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Abstract

The near-universal practice of inflation targeting has strengthened the belief of central banks that all that is needed to control inflation is to anchor expectations with a credible inflation target. The use of Taylor rule augmented DSGE models for policy analysis and forecasting adds credence to the view that, provided inflation expectations remain stable, actual inflation will be driven by expectations. The ultimate drivers of inflation are subsidiary to the central bank operation of acting on inflation expectations for the control of inflation. This article poses the question whether inflation is caused by deteriorating inflation expectations or excessive monetary growth. It takes as its theoretical inspiration Friedman's theory of nominal income determination. We use quarterly data of one-year-ahead inflation expectations produced by the Bank of England, and medium-run inflation expectations backed out of five-year bond yields as measures of long-term inflation expectations. To this we add actual inflation, nominal GDP, and M4 to define a four-variable VAR. The results reveal that M4 Granger causes inflation and inflation expectations, and a variance decomposition of inflation shows that while inflation expectations help to drive inflation, after a period of between five and eight quarters money supply dominates the variance decomposition.

KEYWORDS
expectations, Granger causality, inflation, money supply, UK, VAR, variance decomposition

JEL CLASSIFICATION
E31, E51, E52

1 | INTRODUCTION

The title of this article poses a very clear and direct question. In a Popperian sense, the simpler and the more precise the question, the easier it is to answer. But subsumed in the primary question are two other questions. The first is: which measure of money is relevant to the question? Second, how are inflation expectations measured? The answer to the first question is no longer as controversial as it once was. Since the early theoretical debates on the appropriate measure of money,[1] at least in the United Kingdom a consensus has emerged that M4, the broad measure of money, is the most appropriate indicator.[2] However, measuring inflation expectations is not straightforward. Inflation expectations can be extracted indirectly from market behaviour, as from bond yields, or directly from surveys or forecasts. In this article we adopt two such measures. The Bank of England publishes a short-term inflation survey combined with one-year-ahead forecasts of the National Institute of Economic and Social Research (NIESR) and medium-term inflations expectations from five-year indexed-linked bond yields.

Our approach to this question is unapologetically empirical. We bring to bear the power of statistical tests to extract a chain of causality from M4 to nominal GDP and inflation allowing for interaction with a measure of inflation expectations. It takes as its theoretical inspiration Milton Friedman's 'The Quantity Theory of Money – A Restatement' (1956) and 'A Monetary Theory of Nominal Income' (1971). In his early work Friedman was cautious about the monetary transmission mechanism and argued that the channels of monetary influence were too complex to be formally modelled. He opted instead for a reduced-form approach that showed that monetary impulses determined nominal GDP normally over a period of 18 months but made the qualification that the lags are "both long and variable" (Friedman, 1961, p. 447). Underlying this approach was the view that ultimately money influenced only nominal variables, and the real economy tended to some equilibrium position dictated by real variables.

The embedding of inflation expectations into a theoretical macroeconomic model had the effect of adding dynamics and speed to the transmission mechanism. Different schools of thought added different insights to the modelling and measurement of expectations. At the one end is inelastic (mean-reverting) expectations associated with Keynesian thought. Halfway is the adaptive expectations framework associated with Friedman's theory of nominal income determination. At the other end is the rational expectations school associated with Lucas (1972), which can also include the consistent expectations insights of Walters (1971) and the many models of rational and Bayesian learning. Each model adds to the dynamics and the speed at which the economy reverts to equilibrium in response to an unexpected inflation shock. From an empirical perspective, it is impossible to distinguish the natural dynamics of an economy that arises from inertia, learning by doing, or transactions costs, from the dynamics created by the assumption of the inflation-expectations determination mechanism.

The expectations-determination mechanism and the structure of the model are jointly tested and cannot be separated. For this reason, the literature has taken to the application of vector autoregression (VAR) methods to approach such questions.

In section 2 we lay the theoretical foundations for the reduced form approach adopted here and review the recent findings in the literature on the role of inflation expectations in determining inflation. In section 5 we present the data and the stylised facts. In section 4 the empirical results are presented. Section 5 concludes.

2 | MONEY, INFLATION, AND INFLATION EXPECTATIONS

The way money influences the economy is part of an old debate that goes back to the modelling of the economy by way of a structural model or a reduced form. In the Keynesian versus monetarist debate this took the form of the single-equation reduced-form models of Friedman and Meiselman (1963), and the Federal Reserve Bank of St Louis[3] (Anderson & Jordan, 1968) taking the monetarist side against the large structural models of the USA of Klein and Goldberger (1955). The reasoning of the monetarists was that money affects the economy in so many ways, and at such different times, that it is too difficult to model the many channels of its influence. Hence the simplest approach is to model the ultimate effect of money on nominal GDP as predicted by the quantity theory of money. In the analogy of water rushing into the irrigation field, each time the farmer opens the sluice gate, he cannot predict exactly the many paths water takes to flood the field; but when it stops flowing, it has reached a uniform level everywhere. Thus, it is not the channels of monetary policy that matters but the ultimate effect on the economy. The monetarist approach is one of explaining 'much from little'. If something as big as nominal GDP can be explained by something as little as the money supply, why waste effort on devising policies that affect intermediate variables when a simple money supply rule would work as well?

Monetary targets were abandoned in the UK in 1992, when the Bank of England embraced inflation targeting. While operational independence within the boundary of 'constrained discretion' came later (King, 2016, p. 169), we may surmise three reasons for the enthusiastic adoption of inflation targeting. First, controlling the money supply was notoriously difficult in the UK.[4] Second, as Friedman (1961, p. 447) is often quoted, the lags are "long and variable", underscoring the well-recognised instability of the demand for money. Third, the wide acceptance of New Keynesian dynamic stochastic general equilibrium (DSGE)-type models in the academic literature provided central banks with the confidence to operate on the short-term rate of interest within a Taylor-rule framework for the setting of monetary policy. The central banks reasoned that influencing expectations cuts through the monetary channels debate and stabilises inflation by anchoring inflation expectations through a credible inflation targeting policy (King, 2016, p. 305; 2022).

The recent literature on the effect of inflation expectations on inflation paints a mixed picture. In a recent review Rudd (2021) argues that the economic policymaker's belief that inflation expectations drive inflation rests on shaky theoretical foundations. Rudd goes on to question the empirical validity of the use of proxies for expected inflation in the expectations-augmented Phillips curve. His arguments centre on the imposition of the no long-run trade-off and misspecification of the structural function. The empirical studies centre on a standard New Keynesian specification of the Phillips curve of the following type:

$$\pi_t = \alpha\pi_t^e + \beta\pi_{t-1} + \theta(y_t - y_t^*) + \varepsilon_t \tag{1}$$

where π is inflation, π^e is a measure of expected inflation, and $(y - y^*)$ is a measure of the output gap.

However, several papers have examined the functional form of the Phillips curve and the asymmetry of the trade-off when inflation is falling against when it is rising.[5] Fuhrer (2012) finds that surveys of inflation expectations work well as an alternative to the rational expectations approach in determining actual inflation. Specifically, short-run inflation expectations derived from survey data have a significant effect in explaining US inflation within a Phillips-curve framework compared with rational expectations.[6] A study by Friedrich (2014) estimates a global Phillips curve for OECD economies using data on inflation expectations obtained from the surveys of consumers from the University of Michigan for the USA and European households from the OECD. Household inflation expectations are supplemented with professional forecasters' expectations and market expectations backed out of the bond market. The study finds that a combination of both household and professional forecasters' inflation expectations makes a significant contribution to restoring the Phillips curve.[7]

More recent work produces similar results. Moessner (2021) estimates a cross-country dynamic panel model of a New Keynesian Phillips curve for 36 OECD countries using professional predictions of inflation as proxies for inflation expectations. His results confirm that inflation expectations are a significant driver of inflation. Bańbura et al. (2021) go further and conduct out-of-sample forecasts of inflation using the European Central Bank's Survey of Professional Forecasters as measures of inflation expectations. They find modest but statistically significant gains in predicting eurozone inflation. Looking back into history, Lennard et al. (2021) argue that inflation expectations was a key factor in the recovery of the UK economy in the 1930s. Using quoted commodities' futures prices to generate inflation expectations, they use a VAR model of real GDP, actual inflation and expected inflation to show that expected inflation Granger-caused inflation and real GDP in the 1930s.

3 | THE DATA

The brief literature survey above shows that the research is unequivocal: inflation expectations matter in the determination of inflation. But what is unclear is how much it matters. In this section we present the data used in this article that take these matters further. As our starting point we take inspiration from Milton Friedman's key proposition of monetarism:

> Inflation is always and everywhere a monetary phenomenon. (Friedman, 1970, p. 24)

And in 'The Quantity Theory of Money: A Restatement' Friedman (1956) proposed that the income velocity of money is stable and predictable. However, later, in 'A Monetary Theory of Nominal Income' he stated:

> The relation between changes in the nominal quantity of money and changes in nominal income is almost always closer than and more dependable than …. changes in the quantity of money per unit of output and changes in prices. (Friedman, 1971, p. 323)

This sets the scene for the trend in monetary growth and growth in nominal GDP. Taking the lead from Friedman (1959), Figure A1 (in the Appendix) shows the six-quarter moving average of annual nominal GDP growth and annual M4 growth. The moving average exercise smooths the movement of the two series to show the clear trend. The correlation between the two series is 0.6346. More smoothing produces even higher correlation. As the moving average increases to eight quarters, the correlation increases to 0.6500. At 12 quarters it is 0.6864, and at 16 quarters it has increased to 0.7128. But of course, correlation is not causation, and the purpose of Figure A1 is to set the empirical scene.

We extract historical data of quarterly M4, nominal GDP, and CPI inflation from the Bank of England website[8] and update it from the most recent data from the Office for National Statistics and the Bank of England. The full sample period covers 1972 Q1–2021 Q2. Two measures of inflation expectations are used. The first is the Bank of England historical data on one-year-ahead inflation expectations taken from a combination of surveys and NIESR forecasts. The data that goes up to 2016 Q4 is updated from the continued Bank of England survey of inflation. A second measure tries to capture medium-term inflation expectations backed out of the bond market by subtracting five-year nominal gilt yields from equivalent maturity index-linked yields.[9] Data for this series begins in 1995 Q1 and back data were created by assuming a constant real rate of 3.5 per cent, which was used to back out the expected inflation rate.

Figure A2 plots inflation, the Bank of England survey of inflation 12-months ahead and medium-run inflation expectations. We observe a few things from the data. First, inflation is high and volatile (noisy) early in the sample, but since 1983 inflation has become quiet. Inflation ranges between 0 and 25 per cent in the full sample, but after 1983 the range narrows to a third, between 0 and 8.45 per cent. The 12-month-ahead inflation expectation tracks inflation closely. The long-run inflation expectation is, in contrast, less volatile and falls gradually – it behaves like a step function (a drop in intercept) over the sample.

Figure A3 plots the M4 growth against inflation. Here we learn two things. First, the lags of M4 growth lead inflation. Second, while inflation has reduced in range, M4 growth has not. The mean inflation rate in the noisy period (1972–82) is 12.7 per cent and the coefficient of variation is 38.5 per cent, while M4 growth has a mean of 16.0 per cent and a coefficient of variation of 24.7 per cent. The mean inflation rate in the quiet period after 1983 Q1 is 2.7 per cent and a coefficient of variation of 62.8 per cent. For M4 growth the mean is 8.1 per cent and a coefficient of variation of 68.3 per cent. While relative volatility is marginally higher, with M4 growth, there is an absolute step difference in the mean.

Figure A4 plots the nominal GDP growth, which clearly captures the Great Recession in 2008 and the Great Lockdown in 2020. There is a stronger correspondence between nominal GDP growth and M4 growth in the noisy period. The mean of both nominal GDP growth and M4 growth is 16 per cent, but relative volatility is 28.5 per cent and 24.8 per cent respectively. In the quiet period the mean growth of nominal GDP is 5.3 per cent and coefficient of variation of 66.9 per cent, compared with 8.1 per cent and 68.3 per cent.

The data show a clear difference in the behaviour of the variables between the noisy and the quiet periods of inflation. The evidence of Moessner (2021) is that inflation expectations play a stronger role in times of higher inflation than in low periods. This asymmetric effect could be evident in the full sample period; hence, including the full sample will bias the results in favour of the expectations variable driving inflation We choose to concentrate our discussion on the quiet inflation period, when it is argued that inflation expectations play a minor role if any in determining inflation.

TABLE 1 Summary statistics of economic variables (1983q1–2021q2)

	Bank of England survey of annual inflation 12-months ahead (%)	Annual money supply growth (%)	Annual inflation (%)	Annual nominal GDP growth (%)	Medium-run annual inflation expectations (%)
Mean	2.76	8.13	2.73	5.25	3.67
Median	2.36	8.05	2.43	4.91	3.25
Maximum	7.18	19.08	8.45	17.87	7.60
Minimum	1.08	−4.42	0.00	−12.70	0.52
Std. dev. (%)	1.38	5.55	1.71	3.51	1.76
Coeff. of variation (%)	50.23	68.26	62.81	66.92	48.02

Sources: Bank of England; Office of National Statistics.

Table 1 shows the properties of the data for the chosen sample period.

4 | VAR EVIDENCE

We identify the macroeconomic effects of money supply and inflation expectations shocks by modelling selected macroeconomic series with a VAR model which can be represented by:

$$X_t = \Pi(L)X_t + \varepsilon_t \tag{2}$$

where X_t is a set of endogenous variables, Π is a matrix of VAR coefficients capturing the dynamics of the system, and $\varepsilon_t \sim N(0,\Omega)$ is the vector of reduced-form residuals having zero-mean and variance–covariance matrix Ω. VARs are estimated by ordinary least squares (OLS).

To identify the M4 and inflation expectations shocks (so that they are orthogonal to other innovations in the econometric framework), we model the impulse response of the variables by using a Cholesky-decomposition (from the theory) of the reduced form variance–covariance matrix Ω. The vector of the UK data is $X_t = [\text{LM4, INEXP, LNGDP, INF}]$, where LM4 is log-level M4 and multiplied by 100, INEXP is inflation expectations, LNGDP is log-level nominal GDP and INF is inflation.

We work with a VAR in levels that nests a VAR in first difference or a vector error correction model (VECM); that is, we allow for the possibility of unit roots and cointegration. Technical issues with inference on unit roots and cointegration are not fully resolved in the literature (Stock & Watson, 2017). If we are uncertain about the presence of a unit root, incorrectly imposing a unit root results in an over-differencing of the data, rendering the VAR estimator inconsistent under standard assumptions. Failing to impose a unit root when the unit root is correct, however, preserves consistency, albeit at the cost of efficiency. This also extends to imposing cointegration rank or the cointegrating vector in estimation. A VAR in levels tends

TABLE 2 Model 1: Granger non-causal null hypothesis

Excluded	Prob.
M4	
Excluded	**Prob.**
One-year-ahead inflation expectations	0.95
Nominal GDP	0.94
Inflation	0.61
One-year-ahead inflation expectations	
Excluded	**Prob.**
M4	0.02**
Nominal GDP	0.02**
Inflation	0.00***
Inflation	
Excluded	**Prob.**
M4	0.00***
One-year-ahead inflation expectations	0.00***
Nominal GDP	0.63

Notes:
**significant at 5%; ***significant at 1%.

to be more robust to alternative specifications of unit roots and cointegration (Kilian & Lütkepohl, 2017).

In the first model we use a one-year-ahead measure of inflation expectations, while in the second model we use a medium-run measure of inflation expectations. We focus on the sample 1983q1–2021q1 where inflation is quiet. The VARs feature equation-specific constants, linear and quadratic trends, and are estimated with 12 lags for model 1 and eight lags for model 2, selected by the Akaike information criterion (AIC).

Table 2 presents the causality analysis of model 1.

What Table 2 shows is that M4 is determined independently of inflation expectations, nominal GDP, and inflation; but M4, nominal GDP, and inflation all Granger cause inflation expectations, and importantly M4 and inflation expectations Granger cause inflation.

Figure A5 shows the impulse responses (IRs) to a one-standard-deviation money supply (M4) shock, with 95 per cent standard error bands. Subject to a standard deviation shock to M4, inflation would rise in the fifth quarter after the shock by 0.2 percentage points, where the peak response is 0.4 percentage points, three years after the shock. What the IRs show is that a shock to M4 drives both inflation and inflation expectations significantly.

Figure A6 shows the impulse responses to a one-standard-deviation one-year-ahead inflation expectations shock. Inflation would rise by about 0.1 percentage point on impact and by 0.2 percentage points at the peak a year after the expectation shock. What this figure shows is that a shock to inflation expectations drives inflation for ten quarters but has no significant effect elsewhere.

Figure A7 plots the forecast error variance decomposition focusing on the contribution of the money supply and inflation expectations shocks. At the one-year horizon, both money supply and expectations shocks account for 30 per cent of shocks to inflation; the contribution

TABLE 3 Model 2: Granger non-causal null hypothesis

M4 **Excluded**	**Prob.**
Long-run inflation expectations	0.05**
Nominal GDP	0.79
Inflation	0.46
Long-run inflation expectations **Excluded**	**Prob.**
M4	0.03**
Nominal GDP	0.00***
Inflation	0.37
Inflation **Excluded**	**Prob.**
M4	0.00***
Long-run inflation expectations	0.28
Nominal GDP	0.44

Note:
**significant at 5%; ***significant at 1%.

of inflation expectations shock is as high as 24 per cent, and it is much larger than money supply (6 per cent). At the two-year horizon, the contribution of both shocks rises to 55 per cent (29 per cent expectations, 26 per cent money supply). At the three-year horizon, the proportion rises to 62 per cent, but it is the money supply shocks that account for largest variation of volatility of inflation (41 per cent), higher than inflation expectations (12 per cent). At the five-year horizon, both account for 70 per cent of inflation shocks, dominated by the M4 shocks (54 per cent).

Turning to model 2, we first present the results from Granger causality tests in Table 3. Here we use the implied measure of medium-run inflation expectations from five-year bond yields to replace the Bank of England's one-year-ahead inflation expectations. Table 3 shows that M4 drives inflation and inflation expectation but that there is no interaction between inflation and medium-run inflation expectations.

Examining the IRs, we obtain similar results to a standard deviation shock to money supply, shown in Figure A8. But the results are more muted and less precise in response to a shock to long-run inflation expectations. This is understandable as the long-run inflation expectation is less variable than the one-year-ahead, making it harder to estimate effects. Subject to one-standard-deviation shock for long-run expected inflation, inflation rises by 0.1 percentage points in the second quarter, the responses are significant until the fifth quarter with a peak response of 0.15 percentage points. At the one-year horizon, both money supply and expectations shocks account for 0.7 per cent of shocks to inflation (0.5 per cent expectations, 0.2 per cent money supply). At the two-year horizon, the proportion rises to 12 per cent, expectations are a larger contributor than money supply (8 per cent expectations, 4 per cent money supply). At the three-year horizon, the proportion rises to 21 per cent (11 per cent money supply, 9 per cent expectations). At the five-year horizon, money supply accounts for 17 per cent and expectations 9 per cent.

Figure A9 shows the effect of a shock to medium-term inflation expectations. Inflation responds in a small significant way in the third quarter but thereafter medium-run inflation expectations have no significant effect.

Figure A10 plots the forecast error variance decomposition for model 2 on the contribution of M4, and inflation expectations to inflation. The figure shows that medium-run inflation expectations play only a minor role. It reaches a peak of 10 per cent in the seventh quarter while money is nearly 15 per cent. Thereafter the influence of medium-run inflation expectations declines while M4 grows to around 48 per cent by the 16th quarter.

Taken together, both money supply shocks and inflation expectation shocks drive inflation; inflation expectation shocks explain the variance of inflation more than the money supply shocks within a two-year horizon; but, beyond that, money supply shocks explain a larger fraction of inflation variance. This also matches with the impulse responses of inflation to either type of shock – inflation reacts contemporaneously to an inflation expectations shock, but inflation responds to money supply shocks with 'long and variable lags' the from fifth quarter onwards following after a shock from our estimates.

5 | SUMMARY AND CONCLUSION

This article set out to address a very specific question. In aiming to answer the question, it takes a strongly empirical approach. Which of the two variables drives inflation – inflation expectations or excess money growth? The answer is not an either–or but both. The results from data for the period 1983–2021 show that inflation expectations measured by survey data have an influence on inflation. The results also show that inflation expectations are not independent of the money supply. A VAR analysis shows from the IRs that a shock to M4 drives both inflation and inflation expectations. However, a variance decomposition analysis confirms that over the medium run the variance of M4 dominates all other variables in explaining inflation. In conclusion, expectations matter and inflation expectations matter to inflation, but their impact is small in times of low inflation; and research shows that they become more important when inflation is high. However, both the growth in the money supply and inflation expectations drive inflation. In the short run, inflation expectations play a significant role. In the medium to long run it is the money supply that dominates the determination of inflation.

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NOTES

[1] In their critique of the Pesek and Saving (1967) position of decomposing the measure of money into its 'moneyness' and 'interest-payingness', Friedman and Schwartz (1969) come down in favour of the broad measure of money. However, the insights of Pesek and Saving spawned an industry of research enquiry into the Divisia measure led by Barnett (1980) against the simple-sum measure. See for example Belongia and Ireland (2016).

[2] Little is now heard of the 'which money?' debate that raged in the UK during the 1980 and 90s that divided the 'monetarist' camp between adherents to the narrow money measures and adherents to the broad money measures (Batchelor, 1995; Congdon, 1995; Matthews, 1995; Walters, 1995). For an overview of the policy background and debate, see Congdon (2011, Part Four).

[3] The Federal Reserve Bank of St. Louis used base money to model nominal GDP on the questionable assumption that there was a stable relationship between M0 and broad money.

[4] See the research of Charles Goodhart reproduced in Goodhart (1995, Parts I and II).

[5] See for example Ball and Mazumdar (2011), Gordon (2013), and Murphy (2014).

[6] A similar finding is reported in Nunes (2008).

[7] This also confirms the finding of Coibon and Gorodnichenko (2015) for the USA.

[8] https://www.bankofengland.co.uk/statistics/research-datasets (accessed 28 February 2022).

[9] Refinitiv: Datastream at https://www.refinitiv.com/en/products/datastream-macroeconomic-analysis (accessed 28 February 2022).

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APPENDIX

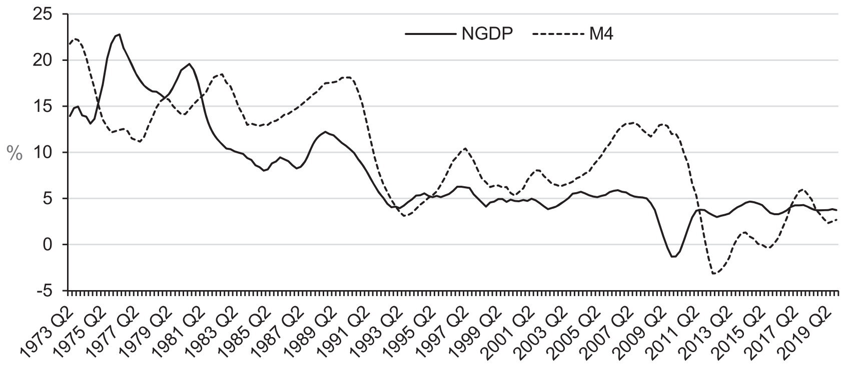

FIGURE A1 Six-quarter moving average of annual nominal GDP and M4 growth, 1973 Q2–2021 Q2
Sources: Bank of England; Office of National Statistics; author's calculations

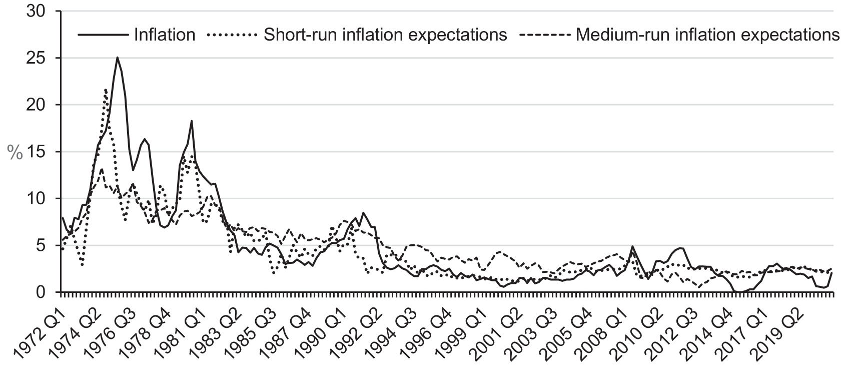

FIGURE A2 Inflation and inflation expectations, 1972 Q1–2021 Q2
Sources: Bank of England; Office of National Statistics; author's calculations

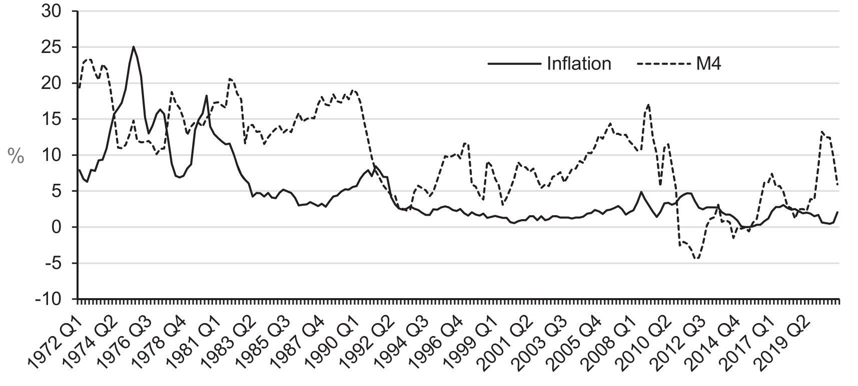

FIGURE A3 Inflation and annual M4 growth, 1972 Q1–2021 Q2
Sources: Bank of England; Office of National Statistics

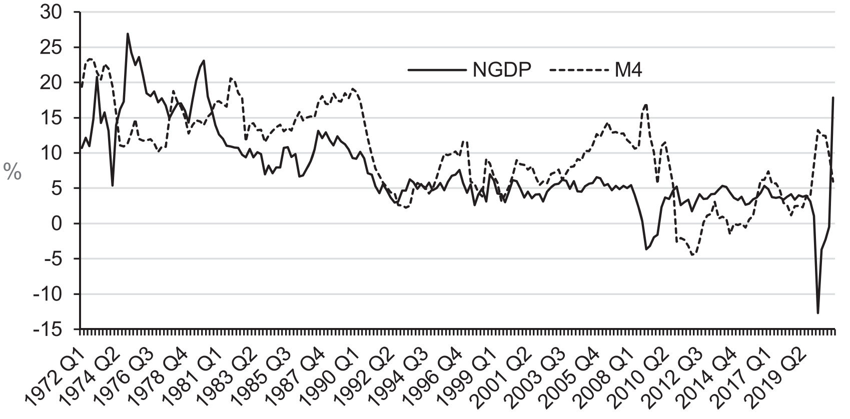

FIGURE A4 Nominal GDP growth and annual M4 growth, 1972 Q1–2021 Q2
Sources: Bank of England; Office of National Statistics

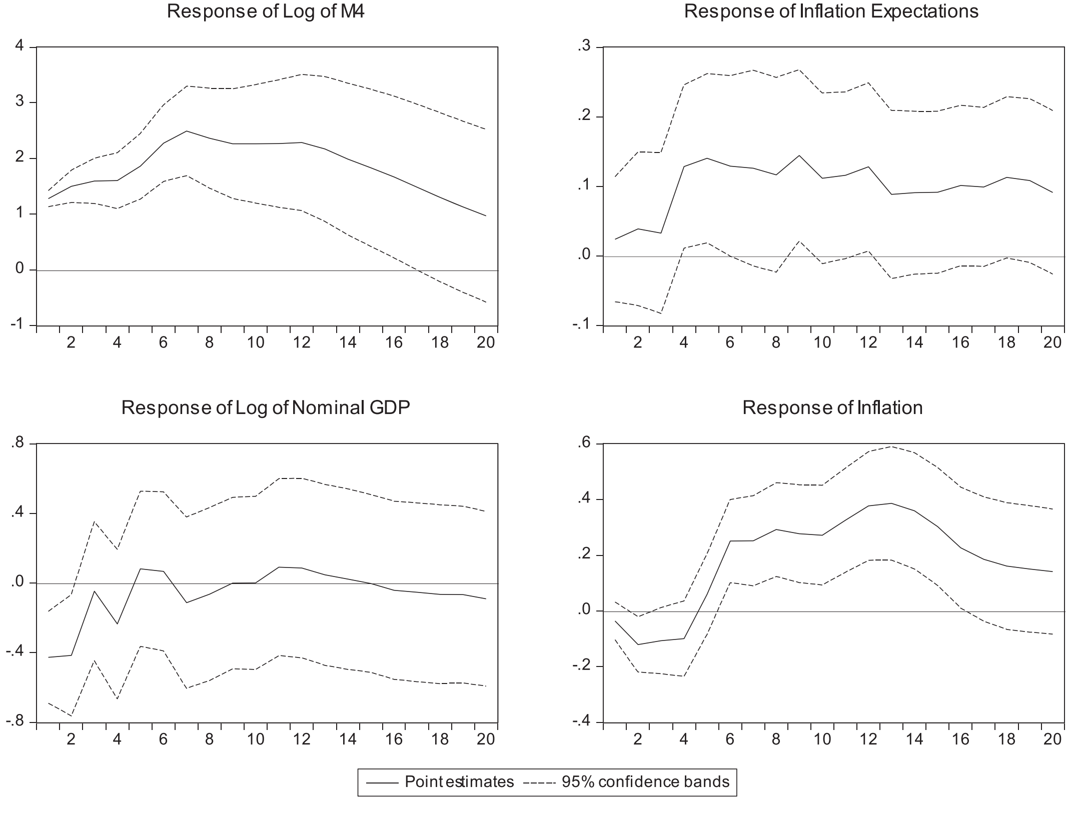

FIGURE A5 Model 1: Response to Cholesky one S.D. money supply (M4) shock

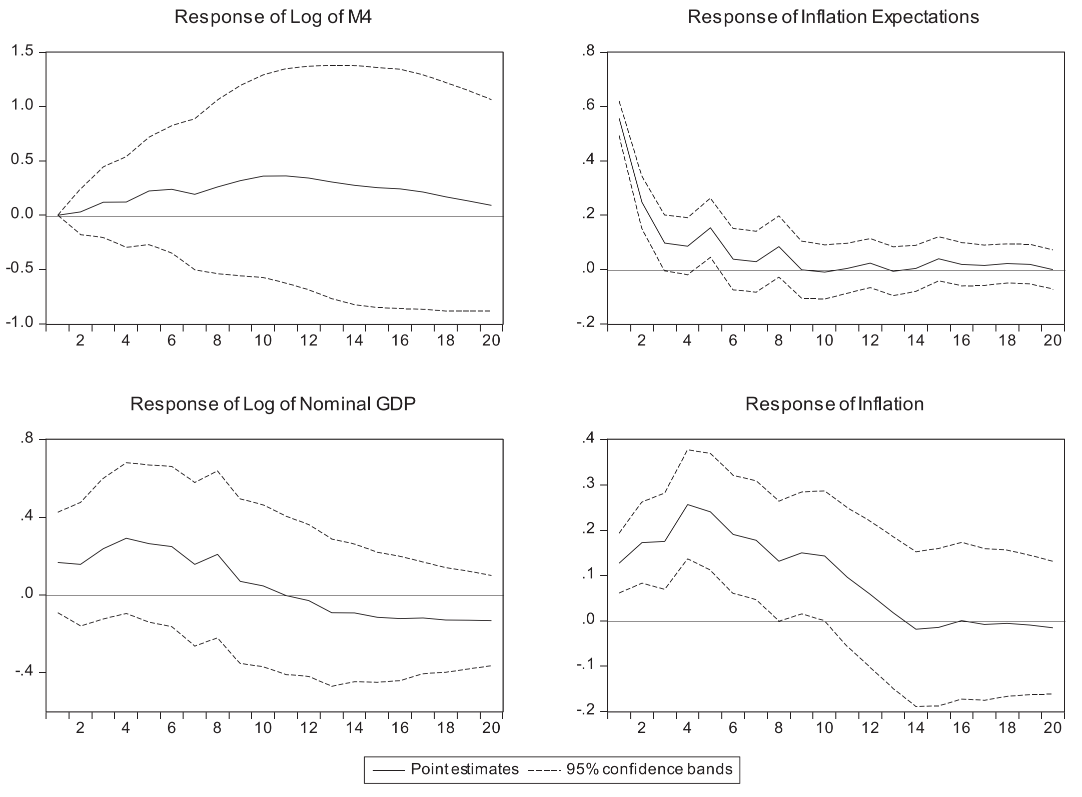

FIGURE A6 Model 1: Response to Cholesky S.D. inflation expectations shock

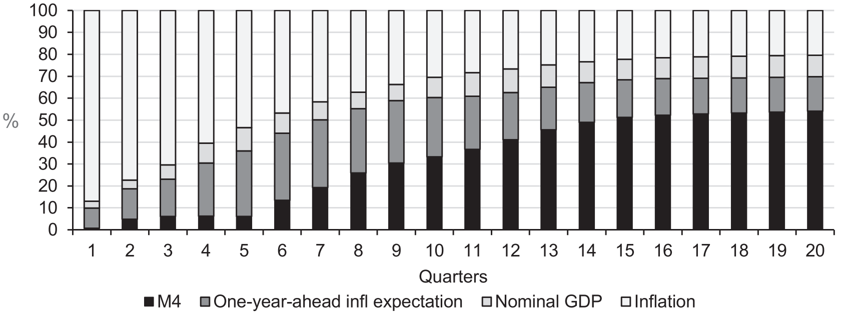

FIGURE A7 Model 1: Forecast error variance decomposition

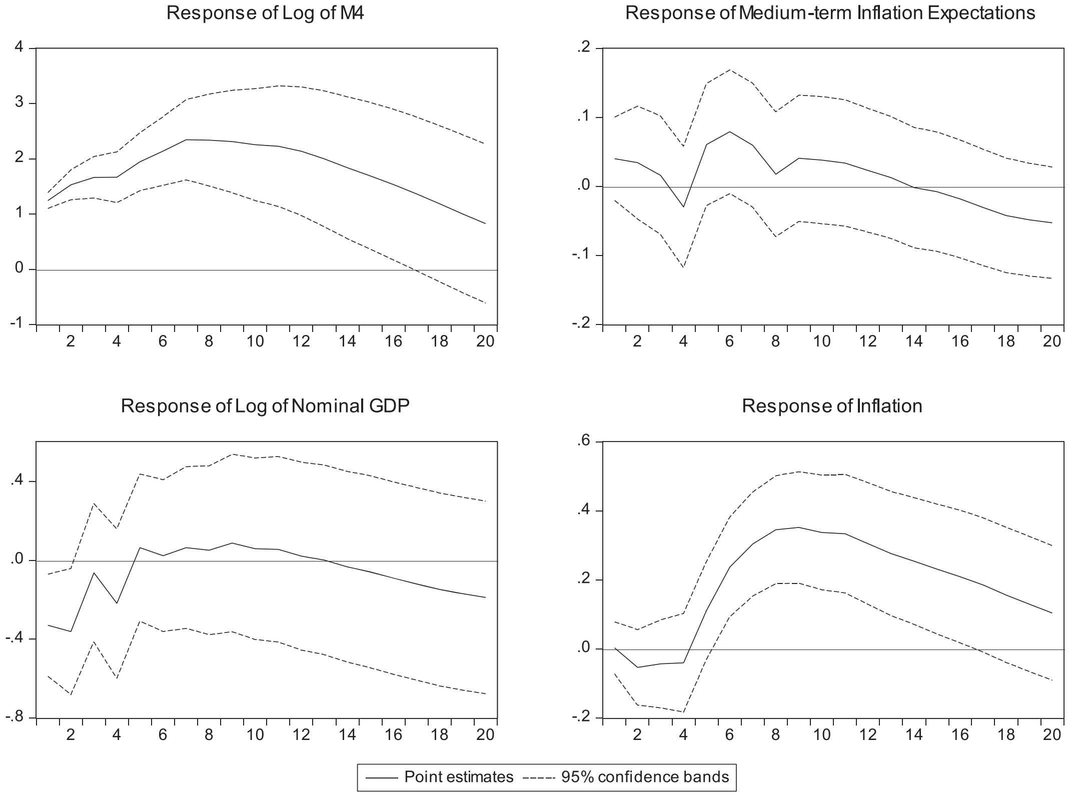

FIGURE A8 Model 2: Response to Cholesky one S.D. money supply (M4) shock

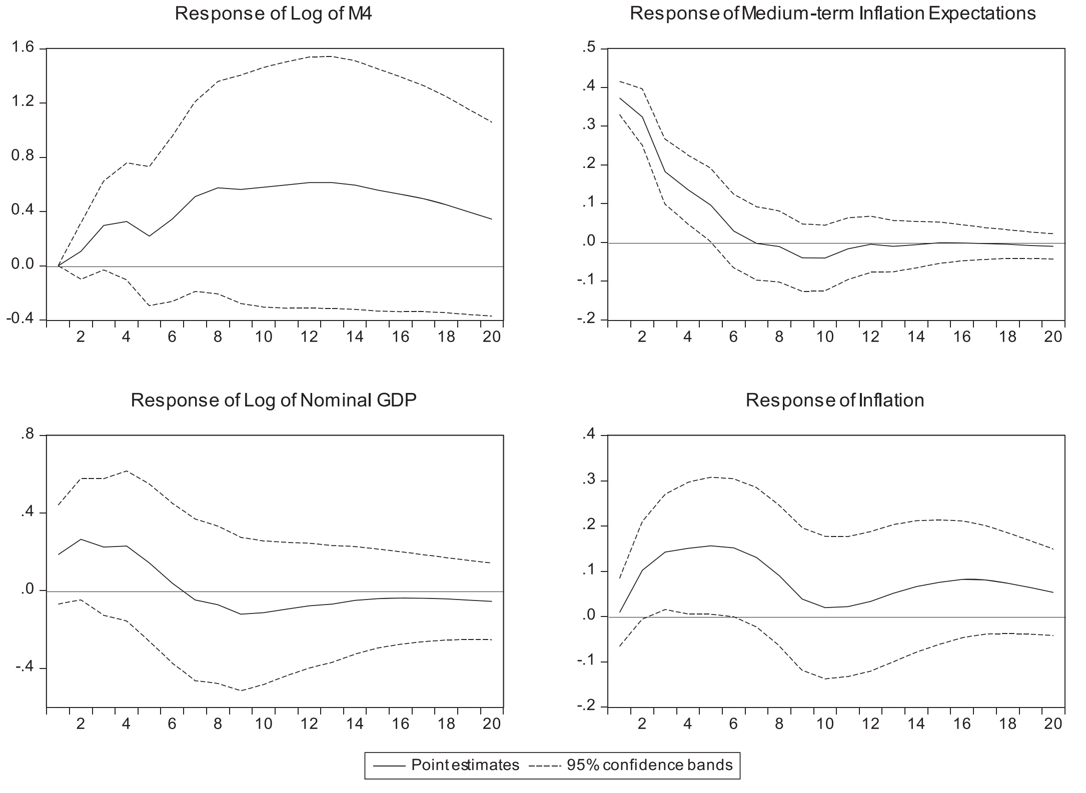

FIGURE A9 Model 2: Response to Cholesky one S.Dicolonus medium-term inflation expectations shock

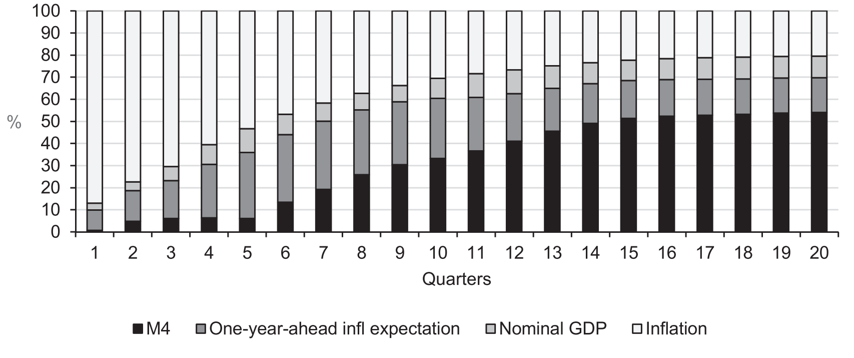

FIGURE A10 Model 2: Forecast error variance decomposition