

**Advances in Forecasting:**  
**An introduction in light of the debate on inflation forecasting**

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## **1. Introduction**

Since 1997 the Department of Economics of the University of Crete has organized an Annual Conference on Macroeconomic Analysis and International Finance. The articles included in this Special Issue of the *Journal of Forecasting* are peer-refereed versions of papers presented at the 26th International Conference on Macroeconomic Analysis and International Finance held at the Department of Economics at the University of Crete in Rethymno, May 26-28, 2022. The topic of this Special Issue is “Advances in Forecasting in Macroeconomics and Financial Markets.”

The ability to forecast accurately is, of course, immensely important for policy makers. To motivate this special issue, we provide a brief account of the policy miscues and policy debates that resulted from the large forecast errors in predicting the upsurge in inflation during 2021 and 2022.

## **2. Background**

In 1981, James Tobin (1981, 391) commented that: “We have not done well in modeling the inflation process.” Tobin’s remarks were with reference to both the inability of forecasters at central banks and other institutions to predict the high inflation rates that had accompanied the two oil-price shocks of the 1970s and the resulting delayed monetary-tightening responses of most major central banks to those high inflation rates, which had permitted inflation to become embedded in inflation expectations.<sup>1</sup> The consequence of the delayed responses was that, by the late-1970s and early-1980s, monetary-policy tightening had to become part of a sustained strategy to arrest inflation instead of a one-time action (Sargent and Silber, 2022). This circumstance confronted Paul Volcker when he became Chairman of the Federal Reserve in 1979. In 1980, the 10-year U.S. Treasury note averaged 11.5 percent. In 1984, it rose above that level despite a decline in inflation from more than 12 percent in 1980 to less than 4 percent in 1984 (Sargent and Silber, 2022). Effectively, the Fed had lost credibility; continuing-high interest rates reflected this circumstance despite the decline in inflation.

In the event, inflation rose; to bring inflation down, the U.S. economy had to endure a major recession in 1981-82, with the unemployment rate peaking at 10.8 percent.

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<sup>1</sup> Several central banks, including the Bundesbank and the Swiss National Bank, maintained tight monetary policies in the 1970s, with the result that West Germany and Switzerland experienced lower inflation rates than other major countries.

Thus, the failure to accurately model and forecast inflation came at a high cost to the real economy.<sup>2</sup> Similar costs were experienced by other economies whose central banks had delayed tightening their monetary policies in response to the higher inflation.

Forty years later, a replay of the 1970s and early-1980s experience appears to have occurred. As with that earlier episode, central banks' inability to accurately forecast inflation has been a major factor accounting for a delayed monetary-policy response to an upsurge in inflation. Unlike the 1970s episode, the rise in U.S. inflation in 2021-22 was, especially in its early stages, largely caused by highly accommodative monetary policy and expansionary fiscal policy. Thus, the rise in inflation in 2021-22 should have been more predictable than the earlier episode. The following narrative, based mainly on press accounts, provides a brief overview of the recent episode.

### **3. The 2021-22 Inflation Debate**

At the beginning of 2021, a debate broke out in the United States about the prospects for inflation in that country. From 2011 until 2020, the U.S. annual (CPI) inflation rate averaged 1.8 percent; in 2020, the inflation rate was only 1.4 percent. In the year to January 2021, inflation remained at 1.4 percent. There were, however, signs that “the inflation genie [was] out of the bottle, especially in the U.S.” (Wolf, 2021), reflecting expansionary fiscal and monetary policies. In December 2020, a \$ 2.3 trillion (10 percent of GDP) government spending package, the “Coronavirus Aid, Relief, and Economic Security Act,” was signed into law. It was followed by the \$ 1.9 trillion American Rescue Plan (8 percent of GDP), enacted in May 2020.<sup>3</sup> Money growth, as measured by the Divisia M4 aggregate, rose from about 5 percent in the year 2019, to 30 percent in the year to July 2020 – almost three times as fast as in any similar period since 1967 (Wolf, 2022). At the beginning of 2021, and throughout that year, the Federal funds rate was near zero percent.

The expansionary fiscal and monetary measures set-off warning alarms among some economists. In a December 13, 2020 LinkedIn post, “Here Comes Inflation,”

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<sup>2</sup> To be sure, the first oil-price shock of the 1970s, that of 1973-74, could not have been anticipated by policy makers since it was the result of a crisis in the Middle East. However, the response to the rise in inflation by major central banks, including the Fed, was inadequate. There were reasons for the Fed's inadequate response to the high inflation rates of the 1970s. One such reason was the view held by Arthur Burns, Fed Chairman from 1970 to 1978, that monetary policy on its own could not control inflation. See Tavlas (2023).

<sup>3</sup> Cochrane (2021) reported that the total U.S. fiscal stimulus, including spending measures other than the above-mentioned packages, came to about 25 percent of GDP between March 2020 and December 2021.

William Silber wrote that “The [the Fed’s low interest rate policy] is a serious mistake and will enable inflation far exceeding expectations going forward.” In a February 2021 column, published in the *Washington Post*, former Treasury Secretary, Larry Summers, expressed concern that the American Rescue Plan, then making its way through Congress, could “set off inflationary pressures of a kind we have not seen in a generation” (Summers, 2021). At the time, the Fed’s median inflation forecast showed “rock-bottom inflation rates remaining in place until at least 2024” (Politi, 2021).

Reflecting these inflation forecasts, U.S. policy makers took issue with Summers’s concerns. Jared Bernstein, the Chair of the Council of Economic Advisers, pushed back. In February 2021, Bernstein was quoted as saying: “With respect to Larry [Summers] in his [*Washington Post*] piece, it’s just flat-out wrong that our team is ... dismissive of inflationary risks. Janet Yellen is our Treasury Secretary. She knows a little something about inflationary risks” (quoted from Chalfant, 2021). As for Yellen, in February 2021, she maintained “I have spent many years studying inflation and worrying about inflation, but ... we face ... tremendous suffering in the country.... That is the biggest risk.”<sup>4</sup>

Federal Reserve officials were similarly complacent about inflation in early 2021. In January 2021, Fed Chairman Jerome Powell stated: “The kind of troubling inflation that people like me grew up with seems far away and unlikely” (quoted from Ip, 2021). In the same month, Charles Evans, President of the Chicago Fed, stated: “I’m not worried about inflation going up substantially beyond 2.5 per cent. I don’t even fear 3 per cent” (quoted from Ip, 2021). In February, Mary Daly, President of the San Francisco Fed, expressed the view that “we should be less fearful about inflation around the corner and recognize that that fear costs millions of jobs -- millions of livelihoods, millions of hopes and dreams” (quoted from Ip, 2021).<sup>5</sup>

In the event, inflation started to rise – from 1.4 percent in January, to 2.6 percent in March, and to 5.4 percent in June (Figure 1). With the Federal Reserve’s forecasts, mainly based on that institution’s dynamic stochastic general equilibrium (DSGE) models, showing that inflation would remain near 2 percent through 2024, Federal Reserve officials began referring to the rises in inflation as “transitory.” In March 2021,

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<sup>4</sup> Quoted from William Silber’s February 21, 2021 LinkedIn post. Silber ended his post with the following warning about the then-incipient signs of inflation: “It is just the beginning.”

<sup>5</sup> The view that inflation would not be a problem was also widely held among financial journalists in early 2021. For example, on February 16, 2021, Binyamin Appelbaum titled his *New York Times* column “Inflation Isn’t Lurking Around the Corner. This Isn’t the 1970s.”

Fed Chairman Powell stated: “If we do see what we believe is likely a transitory increase in inflation ... I expect that we will be patient” (quoted from Liu, 2021). In May 2021, Federal Reserve governor Lael Brainard played down the rise in inflation as a “temporary surge” (quoted from Politi, 2021). Also in May 2021, the *Financial Times* reported that: “the Fed has vowed to keep U.S. interest rates on hold close to zero until the recovery hits certain milestones, including full employment, while predicting that spikes in inflation will be transitory” (quoted from Politi, 2021).

Academic economists joined in expressing the view that the rise in inflation in early 2021 was not a concern. In March, Alan Blinder wrote an article for the *Wall Street Journal* titled “There’s No Need to Panic About a Little Inflation.” In June, Joseph Stiglitz published an article, “The Inflation Red Herring” for *Project Syndicate*. In July, Kenneth Rogoff wrote an op-ed in the *Financial Times* titled, “Don’t Panic: A Little Inflation is no Bad Thing.” In August, Paul Krugman titled a *New York Times* column “Don’t Let Inflation Anxiety Undermine Our Future.”

Amid the optimistic prognostication that inflation would subside, inflation accelerated. In September 2021, it reached 5.4 percent. In December 2021, it was 7.0 percent. With the continued acceleration in inflation, the Fed dropped the word “transitory” from its assessment of inflation. In testimony before the Senate Banking Committee on November 29, 2021, Fed Chairman Powell stated that: “It is probably a good time to retire that word [*i.e.*, transitory]” (Reuters, 2021). In March 2022, the Fed began raising interest rates for the first time since 2018.

Inflation continued to rise in the first half of 2022, peaking at 9.1 percent in June, before falling somewhat (as of this writing in November 2022) to 7.7 percent in October. After a succession of forecasts that underpredicted the inflation rate in 2021 and the first half of 2022, in June 2022 Fed Chairman Powell made a remark that echoed what Tobin said in 1981. Powell stated: “We understand better now how little we understand about inflation” (quoted from Arnold, Smith, and Giles, 2022).

Similar patterns of rising inflation were experienced in the euro area and the United Kingdom during 2021 and 2022. In the euro area, where inflation was driven by supply bottlenecks (see below), the year-on-year increase in the harmonised index of consumer prices (HICP) accelerated from 0.9 percent in January 2021, to 1.9 percent in June, 5.0 percent in December, 8.6 percent in June 2022, and 10.6 percent in October 2022 (Figure 2). In the U.K., the comparable numbers were: 0.7 percent (January 2021), 2.5 percent (June 2021), 5.4 percent (December 2021), 9.4 percent (June 2022), and 11.1

percent in October (Figure 3). Central bank officials in Europe responded to the rise in inflation in a way that echoed Powell's – and Tobin's -- above remarks on the difficulty in understanding the drivers of inflation. For example, Pierre Wunsch, the governor of the Belgian central bank, was quoted in September 2022 as saying that “We have come to the conclusion that we know much less about inflation drivers than we thought” (quoted from Arnold, 2022).

What has made forecasting inflation so difficult during the past few years? There are two main explanations. The first has to do with the fact that the recent inflation has been a Hydra-headed monster.<sup>6</sup> In addition to expansionary fiscal and monetary policies, in the United States the high inflation rates in 2021 and 2022 reflected the supply disruptions caused by the outbreak of Covid in early 2021, sharp rises in oil prices beginning in 2021, and the further disruptions in supply chains following the Russian invasion of Ukraine in the first half of 2022.

In a recent study using VAR estimation, Hall, Tavlas, and Wang (2023) investigated the drivers of the recent inflation in three currency areas: the United States, the euro area, and the United Kingdom. For the U.S., those authors found that, beginning in early 2020, the rise in government expenditures accounted for 8.5 percentage points of the cumulative rise in the price level over the two years to April 2022, money supply (M2) growth accounted for 7.0 percentage points of the rise in the price level, while supply disruptions accounted for 1.9 percentage points of the cumulative rise in the price level. For the euro area, Hall, Tavlas, and Wang found that the major source of inflation in the two years ending in April 2022 was supply disruptions, which accounted for 9.5 percentage points of the cumulative rise in the price level in the two years through April 2022. All other variables, including various fiscal and monetary variables, had negligible effects (less than 0.5 percentage point) on the cumulative increase in the price level. For the U.K., there were three major factors that contributed to the cumulative rise in the price level: M3 growth (8.2 percentage points), wage growth (5.3 percentage points), and supply constraints (4.4 percentage points).

The second factor that appears to have affected inflation-forecasting performance in the past few years is an over-reliance on DSGE models for making projections. Related to that circumstance, as Chris Giles noted in a column in the *Financial Times*:

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<sup>6</sup> The use of the Hydra-headed monster metaphor to describe inflation was first made by Philip Cagan (1974).

“All the main models used for managing inflation have been calibrated during a period of price stability and tell us very little about how far to tighten monetary policy when you’ve lost control” (Giles, 2022). Similarly, in a March 2022 editorial, “The Humbling of the Federal Reserve,” that assessed the Fed’s forecasting performance in 2021 and early 2022, the *Wall Street Journal* Editorial Board wrote: “What went wrong? .... How could they [the Federal Reserve staff] make the greatest monetary policy mistake since the 1970s? Part of the answer lies with the Fed’s economic models...”

DSGE models are especially susceptible to weak forecasting performance in periods of substantial change. Almost by definition, and certainly by construction, a general equilibrium model is one that seeks to move towards an equilibrium solution for the entire economy. It does this by finding a vector of prices for which all markets clear and a stable equilibrium is reached. Where the model is dynamic (simply meaning that it adjusts to this equilibrium solution over time), this adjustment tends to be relatively quick. This circumstance is partly due to the almost universal assumption made in this modelling tradition that agents within the model have rational expectations. A rational agent will realize that excessive wage claims, for example, will lead to future inflation which will ultimately cause a policy response leading to a recession that will be harmful to the entire economy, including that particular agent. Thus, the agent will moderate his or her wage claims, and the economy will quickly return to a low-inflation equilibrium. Unfortunately, the real world does not seem to exhibit this degree of rationality, and it is more realistic to assume that agents will typically attempt to defend their real incomes and wealth. Thus, a non-rational inflationary spiral can easily arise.

In many central banks and policy-making institutions, the DSGE modeling tradition has become highly influential, perhaps partly as a consequence of academic fashion. Twenty years of relatively stable inflation with no real positive inflationary shocks (the major shock during this period was the 2008 financial crises which was, if anything, deflationary) had left policy makers with the view that the simple rational expectations DSGE view of the world was correct and, hence, their inability to forecast the inflationary consequences of the developments over the last few years.<sup>7</sup>

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<sup>7</sup> However, some central banks use a wide range of models, including macroeconomic models with learning, in which convergence to equilibrium may not be fast, and time series models. Typically, the forecasts from these models are compared with each other in a process which involves considerable judgement. In recent years, the weight given to DSGE models by many central banks appears to have been higher than the weight assigned to other models.

#### 4. The Papers in this Issue

In the paper “Nowcasting the evolution of inflation using high frequency data,” Tesi Aliaj, Milos Ciganovic, and Massimiliano Tancioni evaluate the predictive performances of the least absolute shrinkage and selection operator (Lasso) as an alternative shrinkage method for high dimensional vector autoregressions. Their analysis extends the Lasso-based multiple equations regularization to a mixed/high-frequency data setting. Very short-term forecasting (nowcasting) is used to target the euro area's inflation rate. It is shown that this approach can outperform more standard nowcasting tools, producing nowcasts that closely follow actual data movements. The proposed tool can overcome information and policy decision problems related to the substantial publishing delays of macroeconomic aggregates.

In their paper “Forecasting inflation in open economies: what can a NOEM model do?” Roberto Duncan and Enrique Martinez-Garcia assess forecasting ability when inflation is viewed as an inherently global phenomenon through the lens of the workhorse New Open Economy Macro (NOEM) model. The NOEM model emphasizes the importance of cross-country spillovers arising through trade; its reduced form solution can be represented by a finite-order VAR which provides a tractable model of inflation forecasting. The authors use Bayesian techniques to estimate this VAR specification –calling it NOEM-BVAR—and pseudo-out-of-sample forecasts to assess its forecasting performance at different horizons in a diverse set of 18 countries. On average, the NOEM-BVAR specification produces a similar or even lower root mean square prediction error (RMSPE) than its standard competitors. In several cases, the gains in smaller RMSPEs are statistically significant, especially at short horizons. The NOEM-BVAR model is also accurate in predicting the direction of change for inflation and is often better than its competitors along this dimension as well.

In the paper “Forecasting inflation: the use of dynamic factor analysis and nonlinear combinations,” Stephen G. Hall, George S. Tavlas, and Yongli Wang address the problem of forecasting inflation. In particular, the authors consider the problem of forecasting inflation for three currency areas – the United States, the euro area, and the United Kingdom – using monthly data from 1999M1 to 2022M4. The issue of forecasting inflation during 2021 and early-2022 for these three currency areas was, of course, the subject of the previous part of this introduction. In their contribution, Hall, Tavlas, and Wang evaluate the accuracy of several procedures for forecasting inflation. Contrary to much of the recent forecasting literature, the authors find that the following

procedures do *not* improve forecasting accuracy compared with simple AR models: rolling windows-based forecasts and factor models using principal components and dynamic factors. As Hall *et al.* explain, rolling window techniques do improve forecast accuracy when the data are non-stationary, as in the period from the early-1970s to the late-1990s. During the 2000s, however, the inflation data were stationary. The authors find that with stationary data, a significant improvement in forecasting is gained through nonlinear forecast combinations. A key finding that emerges from their study is that the forecasting environment matters a great deal when it comes to choosing the appropriate method for forecasting inflation.

In the paper “Evaluation and inference estimation of inattentive features in a New Keynesian Model,” Jenyu Chou, Yifei Cao, and Patrick Minford test the standard New Keynesian Dynamic Stochastic General Equilibrium model with and without inattentive features, where inattentiveness is modelled in the form of sticky information data revision. All alternative models are tested by indirect inference. The main finding of the analysis based on real-time data provides strong support in favor of the model with sticky information consistently out-performs the baseline New Keynesian model with full information and rational expectations, while the model with imperfect information data revision fails to pass the specific testing procedure. Finally, the analysis shows that none of the alternative models passes the test when Survey of Professional Forecaster data are used for model evaluation.

In their paper “Forecasting housing investment,” Carlos Canizares Martinez, Gabe de Bondt and Arne Gieseck develop and apply a model averaging approach to conditionally forecast housing investment in the largest euro area countries and the euro area. To account for substantial modelling uncertainty, the model estimates a large and diverse number of vector error correction models using a wide set of long and short-run determinants and applies subset selection based on in-sample and out-of-sample criteria. The main findings of the paper are as follows: First, a pseudo out-of-sample forecast exercise shows that the model averaging approach consistently beats a battery of distinguished benchmark models, including BVARs, FAVARs, LASSO and Ridge regressions. Second, there is evidence of significant cross-country heterogeneity the drivers of housing investment.

In the paper “Consumer spending in the covid-19 pandemic: Evidence from card transactions,” Anete Brinke, Ludmila Fadejeva, Boriss Siliverstovs, and Karlis Vilerts

employ a novel card transaction data maintained at the Central Bank of Latvia to assess their informational content for nowcasting retail trade in Latvia. During the COVID-19 pandemic in Latvia, the retail trade turnover dynamics underwent drastic changes reflecting the various virus containment measures introduced during three separate waves of the pandemic. The authors show that the nowcasting model augmented with card transaction data successfully captures the turbulence in retail trade turnover induced by the COVID-19 pandemic. The model with card transaction data outperforms all benchmark models in the out-of-sample nowcasting exercise.

In their paper “Jump forecasting in foreign exchange markets: a high-frequency analysis,” Sevcan Uzun, Ahmet Sensoy, and Duc Khuong Nguyen use tick data for 14 emerging and developed market currencies covering the period from January 2018 until April 2021. Initially, the analysis leads to the detection of Lee and Mykland jumps type and then various machine learning algorithms are applied to forecast out of sample jump occurrences and their direction. The main findings show that the arrival and the direction of intraday jumps in the foreign exchange market can be predicted with these algorithms combined with liquidity metrics and technical indicators, even for the Covid-19 pandemic period where volatility in the foreign exchange market is very high.

In “The role of expectations for currency crisis dynamics: The case of the Turkish Lira,” Robert Czudaj and Joscha Beckmann examine whether and how expectations have contributed to the turbulent path of the Turkish lira since 2008. The authors derive uncertainty measures surrounding GDP growth, inflation, the interest rate, and exchange rates based on survey data from Consensus Economics. The analysis illustrates that forecasts have affected realized exchange rates and stock market returns via increased uncertainty.

In the paper “The effects of shocks to interest-rate expectations in the euro area: estimates at the country level,” Martin Mandler and Michael Scharnagl estimate the effects of shocks to interest-rate expectations on the four largest euro area economies. They identify these shocks in a Bayesian vector autoregressive (BVAR) model augmented by survey expectations. Furthermore, the analysis separates the expectations shocks from standard monetary policy shocks by assuming that they do not affect the current policy rate, whereas the sign restrictions also ensure that these shocks do not contain central bank information shocks. The main finding is that an expected decline in the future short-term rate leads to an increase in output and prices. The increases do

not become larger for changes to interest-rate expectations further in the future, i.e. there is no evidence of a forward guidance puzzle.

In “Forecasting sovereign risk in the euro area via machine learning,” Guillaume Belly, Lukas Boeckelmann, Carlos Mateo Caicedo Graciano, Alberto Di Iorio, Klodiana Istrefi, Vasileios Siakoulis, and Arthur Stalla-Bourdillon test the usefulness of machine learning (ML) for the valuation and pricing of sovereign risk in the euro area along two important dimensions: i) its predictive accuracy compared to traditional econometric methods, and ii) its assessment of the main economic factors underlying market perceptions of sovereign risk. The authors find that ML techniques can capture the dynamics inherent in the market valuation of country risk far more efficiently than traditional econometric models, both in the cross-section and in time series.

In their paper “Worse than you think: public debt forecast errors in advanced and developing economies,” Julia Estefania Flores, Davide Furceri, Siddharth Kothari, Jonathan D. Ostry compile a unique dataset of medium-term public debt forecasts for an unbalanced panel of 174 countries, based on IMF (for the period 1995–2020) and Economist Intelligence Unit (2007–20) projections. The authors find that on average: (i) there is a positive forecast error (FE) in the debt-to-GDP projections—that is, realized debt ratios are larger than forecasts; (ii) the FE increases with the projection horizon and is statistically significant and large—about 10 percent of GDP at the five-year horizon; (iii) the magnitude is similar between advanced (AEs) and emerging markets and developing economies (EMDEs), and in EMDEs is present irrespective of recessions while for AEs is associated with surprise recessions in the forecast horizon; (iv) FEs are not statistically different between IMF program and non-program cases; (v) positive FEs are only partly attributable to optimism about growth or the fiscal balance. Looking at the correlates of forecast errors, the authors find that forecast errors are larger during periods of recession, elections, fiscal stress, and high uncertainty, and in countries with more economic volatility and public debt.

In the paper “Financial stability during times of unconventional monetary policy interventions,” George Apostolakis, Nikolaos Giannellis, and Athanasios Papadopoulos examine the impact of Fed monetary policy shocks on financial stress, inflation, and output growth, considering several advanced and emerging economies. To that end, the authors use shadow rates as a proxy measure of unconventional monetary policy actions and a financial stress index as an indicator of financial instability. They apply a global vector autoregressive model and present the outcome

of impulse response functions and forecasts of macroeconomic and financial stress variables. The results of the analysis show that US output and inflation are positively affected in response to a domestic negative monetary policy shock, while financial stress is unresponsive to the same shock.

In summary, the papers collected in this issue address a range of methodological and empirical issues related to forecasting and highlight the dilemmas faced by agents within the economy and policy makers. Several best-practice methods are proposed as means of improving forecasting performance and thereby delivering better policy decisions.

### **Data Availability Statement**

All data are taken from publicly available data sources as defined in the data appendix. The particular vintage of data used in this study is available upon request from the authors.

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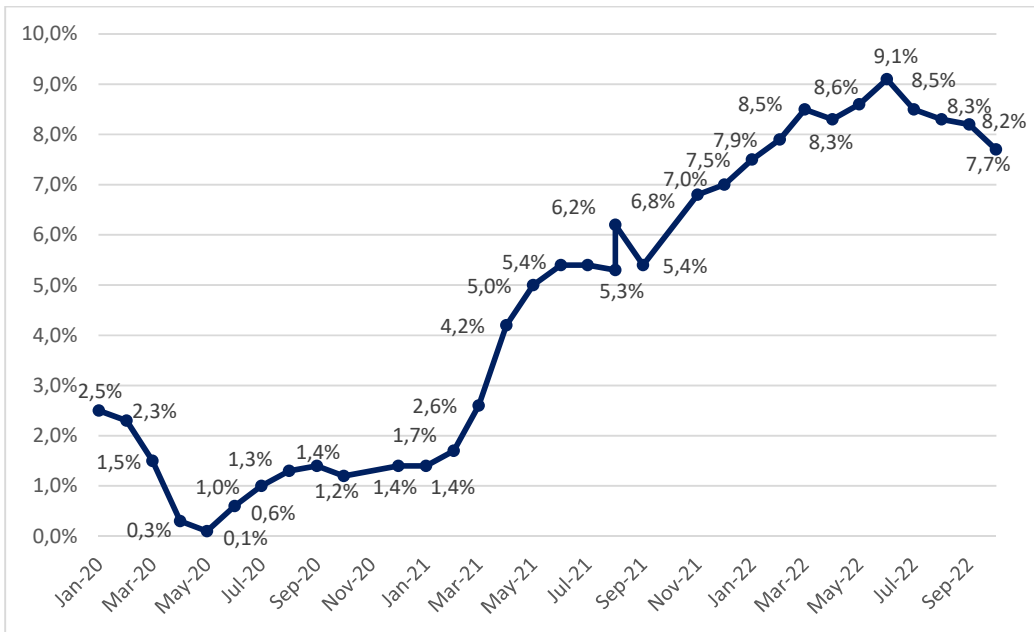
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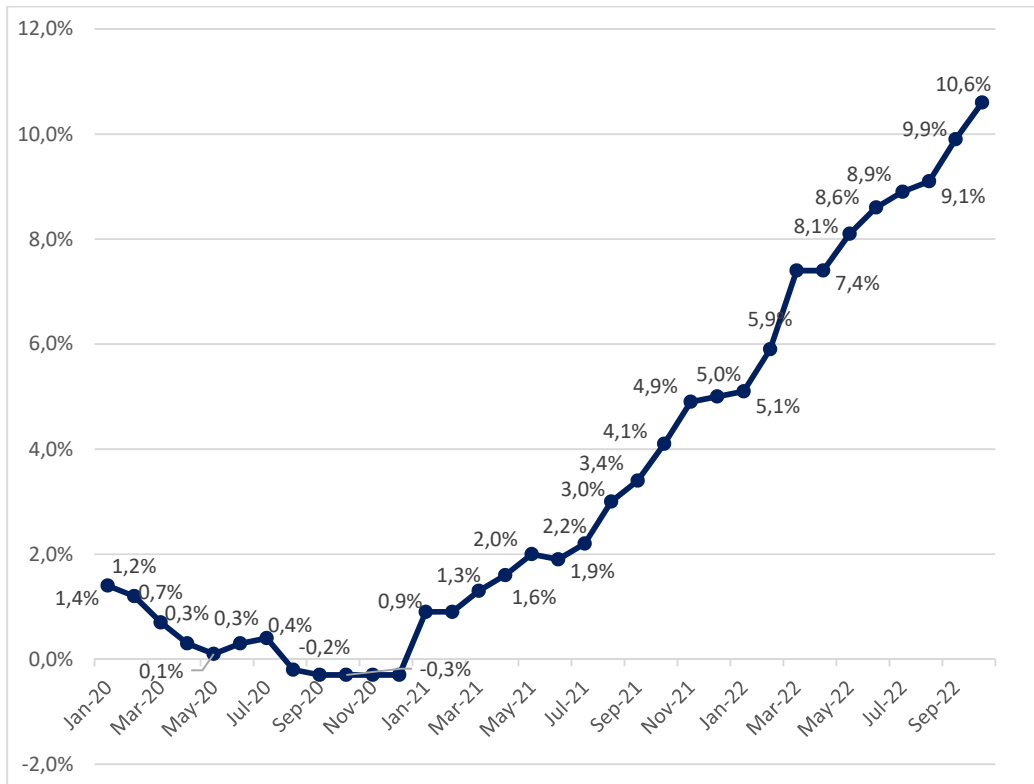
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Figure 1: U.S. CPI Inflation (year-on-year)



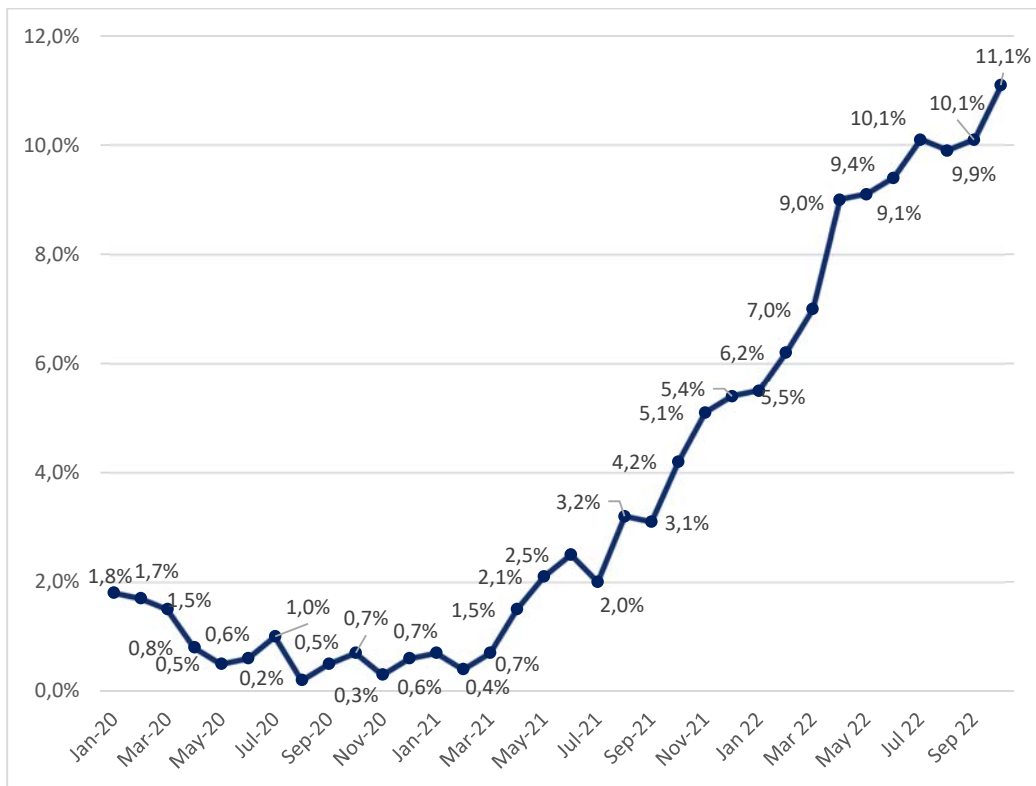
Source: Statista, November 2022, <https://www.statista.com/statistics/273418/unadjusted-monthly-inflation-rate-in-the-us/>

Figure 2: Euro Area HICP Inflation (year-on-year)



Source: Eurostat, November 2022, <https://ec.europa.eu/eurostat/web/products-datasets/-/teicp000>

Figure 3: U.K. CPI Inflation Rate (year-on-year)



Source: Statista, November 2022, <https://www.statista.com/statistics/306648/inflation-rate-consumer-price-index-cpi-united-kingdom-uk/>

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