

# MIMS – Research Area

## Macro Research Team

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### Inflation expectations, rationality concerns and forecasting methods

#### Introduction

In today's macroeconomics, it is widely known and understood that inflation expectations play a fundamental role in the formulation of proper monetary policies. Policymakers must have a profound understanding of both expectations assessment and interpretation. This is because expectations shape the behavior of households and firms, which, in turn, influence overall price dynamics. As far as central banks are concerned, inflation expectations are of primary importance, especially for the setting and assessment of the monetary stance. Although money is normally borrowed and lent at a nominal interest rate, what matters most for consumption and investment decisions is the real interest rate, namely the nominal return adjusted for expected inflation. It is suggested that central banks should not only seek to set the current level of the short-term rate of interest but also monitor (and provide guidance on) its expected future values, thus influencing long-term real interest rates. These considerations can all be regarded as proof that inflation expectations are a crucial ingredient for the identification of the most appropriate monetary policies because of their fundamental contribution to determining real interest rates.

The stability of long-run inflation expectations is critical for central banks to maintain a stable economy, but the ability of policymakers to shape these expectations remains unclear. In relation to the latter, a study from M. Weber et al. highlights the challenges of communication and the importance of understanding the diverse determinants of inflation expectations across households and firms. The recent surge of inflation has made managing inflation expectations an urgent policy question and calls for more innovative communication tools. A better understanding of the effects of inflation expectations on economic choices is crucial for assessing the potential role of expectations as a monetary policy tool. Throughout the years, it has been proved that Central Banks' success in keeping inflation low and stable highly depends on their ability to anchor the economic agents' long-term inflation expectations close to their targets. When expectations are firmly anchored to the central bank's target, monetary policy can protect price stability from supply and demand shocks, and address their effects on labor, goods and financial markets over time swiftly and efficiently. On the other hand, when inflation expectations appear to be unanchored, a stronger monetary policy reaction to any shock is required, with possibly elevated costs for the real economy.

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Overall, the existence of a clear and credible anchor for inflation expectations has proved to play a key role in keeping actual inflation closer to the price stability objective.

#### A Brief overview of the theories

Going back to those theories that laid the foundations of modern macroeconomics, we find ourselves dealing with the original Keynesian economics that had little to say about the issue of inflation expectations. It was Phillips, in the 1950s, who first recognized the existence of a negative relationship between inflation (UK) and the unemployment rate. Even though the combination of the original Keynesian model and the Phillips curve was not complete enough to explain every facet of inflation's behavior, it turned out to be a very effective tool until the mid-1970s, when unexpected scenarios such as stagflation took over.

In 1968, Friedman first and Phelps later, argued that it is not correct to assume the existence of a stable relationship between inflation and unemployment. Furthermore, Nobel prize winners Lucas and Sargent stated in a 1978 paper that "Keynesian economics had ignored the full implications of the effect of expectations on behavior".

It was after all these interventions that inflation expectations finally became a key point in the formulation of monetary policy.



The new Keynesian expectations-augmented Phillips curve was implemented to describe inflation as a function of expected inflation. Furthermore, after the reinterpretation of the original curve, the economist (and former US Federal Reserve President) Ben Bernanke affirmed that “expectations greatly influence actual inflation and thus the central bank’s ability to achieve price stability”.

Diving into the measurement of inflation expectations, economists find themselves relying on two main sources of information. The first source comes from survey-based measures which are derived from surveys of households, firms, or professional forecasters. The second one is strictly linked to market-based measures which are obtained from the prices of assets linked to prospective inflation. An example is the 10-year breakeven inflation rate which is calculated by “comparing 10-year nominal Treasury yields with yields on 10-year Treasury Inflation Protection Securities (TIPS), whose yield is tied to changes in the CPI” (Brookings, 2020).

In conclusion, expectations are a signal of how credible the public finds central banks’ commitment to achieving policy goals. This implies that central banks’ communications can play an important role in keeping inflation expectations anchored with the inflation objective of the banks themselves. Via this channel, they can help mitigate the persistence of shocks to inflation since anchored expectations would be untouched, in the short term, by macroeconomic surprises.

### Are inflation expectations rational?

Whether inflation expectations are rational or not is a subject of debate among economists.

The theory of rational expectations was first developed by John F. Muth in the early 1960s. According to the Rational Expectations Hypothesis (J. Muth, 1961) “the agents know and behave according to the rules of the economy they inhabit” which in turn implies that the agents know how the economic system works. Rational expectations hypothesis does not mean perfect foresight because “expectations may be subject to error”, but not systematically.

Diving into the rational expectations theory constructed by Nobel laureate Robert Lucas, expectations can be considered rational if they reflect all available information about the future. Therefore, rational individuals are forming expectations about future economic variables making use of all available information such as market conditions, economic policies, experience. Rational expectations hypothesis was the mainstream in the academic world until 2008, when the Great Crisis questioned its validity showing the failure of macroeconomic models that were assuming the rationality of expectations.

After the Great Crisis, the attention and research of the academic world on not-rational expectations has grown. Assuming that expectations are not rational implies that individuals do not know how the economy works and therefore they are just using simple heuristics to predict and take decisions.

Among not-rational theories, adaptive expectations have significative relevance. As we will see later in the report, if expectations are adaptive then economic actors systematically use past performances to estimate future ones.

In confirmation of the complexity of the subject, it should be emphasized that rationality can be affected by several factors.

There is still an ongoing debate about the rationality of inflation expectations, and several studies have been conducted on the topic.

In the following section, we will review various literature on the rationality of inflation expectations. We will also address how individuals form inflation expectations and present a case of adaptive expectations.

### Arguing rationality and expectations formation mechanism

If we start by looking at individuals’ decisions, we can learn from the works of W. B. de Bruin et al. (2011), who examined how single consumers form their inflation expectations and considered whether focusing on specific price changes leads to more extreme and conflicting inflation expectations. Two studies were conducted, with the first showing that recalling specific large price changes leads to more extreme and conflicting year-ahead inflation expectations. The second one found that even when individuals are not prompted to recall specific price changes, those who do have more extreme inflation expectations were biased by a tendency to consider items associated with more extreme perceived price changes. The findings provided insights into expectation formation processes and had further implications for survey-based measures of inflation.

In addition to this, the Federal Reserve Bank of New York Staff Report n.489 draws attention to the propensity of people to give low estimates of inflation when specifically asked to predict a rate, while the same individuals tend to give several percentage points higher estimates when the question is asked in relation to grocery prices, and in particular to the prices of frequently purchased items. Regarding the expenses to which individuals are anchored to form their own expectations, the items purchased more frequently, and not those with a higher total expense, weigh the most.

The analysis of consumer spending also leads us to consider two indicators used to gain more information on consumers’ inflation expectations. Among the two indicators, which are presented in the study by D’Acunto, Malmendier et al. (2021), the first one is the Household CPI, which is excellent for predicting inflation in 12 months. This indicator is built based on the “alternative features of personal grocery price changes”, it has good reliability since the forecasts are very similar even among different groups of consumers. The second indicator is the Frequency CPI, which uses the frequency of purchases of individual products to weigh the price changes. This index has a strong association with actual inflation as measured later (about 20 to 40 percent stronger than the Household CPI). The latter also allows us to know an important trait of the behavior of individuals, namely that they tend to pay more attention to price increases than to price decreases.

Another study by Candia, Coibion et al. (2021) provides us with an analysis of some personal characteristics to be considered when evaluating inflation expected by individuals. First, it must be remembered that future market prices can be estimated as the average of the expectations of the various economic actors, including individuals and households. However, this market price has the negative feature of not revealing the degree of heterogeneity of individual expectations, which can be variegated or collected within a reduced range of values.

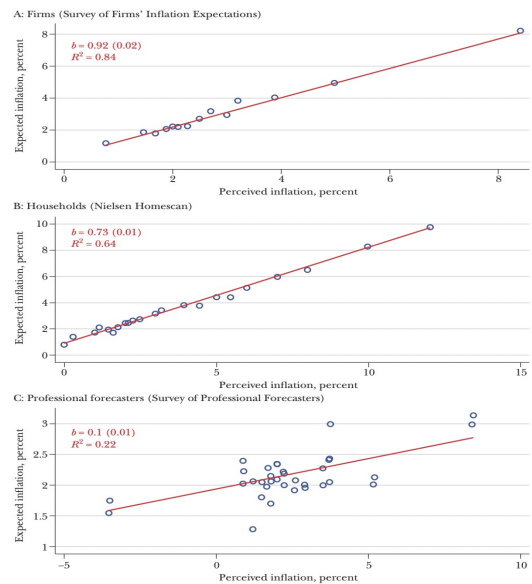
In particular, the expectations of individual actors vary substantially based on gender, age and education, as well as on their IQ as investigated in the study of D'Acunto, Hoang et al (2019). In fact, individuals with a low to medium IQ tend to make 12-month inflation forecast errors about 2.5 times larger with respect to those with high IQ. Furthermore, individuals with lower IQs tend to provide whole numbers as a prediction and are about twice as likely to predict implausible values for their expectations. When it comes to predicting an inflation rate, all three components of cognitive abilities (arithmetic, verbal, visuospatial) count towards the accuracy of the result, with arithmetic cognitive abilities having the most substantial effects.

The latter study on the importance of the IQ when formulating inflation expectations has a certain relevance since it also addresses the issue of targeted communication for different population groups based on IQ. To provide an example, to influence individual inflation expectations, policy makers should use short, plain-language messages for the lowest IQ population (like tweets), while they should share detailed technical reports for the population with higher-level cognitive abilities. It should also be noted that this study turns out to be even more relevant if we consider the fundamental role of central banks' communication in recent years (forward guidance).

The study of Candia, Coibion et al. (2021) identifies three different "expectation types" based on some personal features and decision-making processes when forming market expectations. The "Random-Walk" type (RW), or those who believe that future returns are absolutely independent and homogeneously distributed over time, the "Persistence" type (P), who instead argue that the most recent performances in the markets will be repeated in the near future, and therefore that future performances will be confirmed by past ones, and the "Mean-Reversion" (MR), who argue that past and most recent performances will be denied in the near future. In the experiment conducted in this study on a sample of individuals, it was found the following percentage division: 27% of "Random-Walk" type, 41% of "Persistence" and 32% of "Mean-Reversion".

It is also worth mentioning the relevance of inflation expectations of different firms, which is equally important for determining the result of the expected inflation and therefore of great relevance to the monetary policies of central banks. In this sense, a study by Weber, D'Acunto et al. (2021) explains the importance of inflation expectations of households, firms, and professionals in forecasting inflation. The same study shows that on average the expectations of the firms exceed the actual measured future inflation, and that these expectations differ greatly from each other due to the different items and economic environment they interact with. It has also been shown that firms with more competitors and with greater product diversification have better awareness and knowledge of inflationary dynamics. The graphs below are taken from this study and show the 1-year-ahead inflation forecasts and perceptions of households, firms, and professionals, respectively.

### Inflation Expectations and Perceptions



Source: "Exposure to grocery prices and inflation expectations", 2021

As far as firms (but also households) are concerned, there are systematic patterns which tend to occur when it comes to forming expectations. The most recurrent patterns are a systematic upward bias, a high disagreement about future inflation, a high uncertainty about expectations, and the presence of unanchored forecasts. We must also take into consideration a study by Candia, Coibon et al. (2021) which highlights the lack of information of US firm managers on current and future inflation levels and on central bank expected monetary policies. In essence, managers' expectations are no more reliable than those of households, with a negative effect on the credibility of firms when it comes to providing reliable forecasts.

### German reunification: a case of adaptive expectations.

As we have mentioned earlier in the report, it is worth considering the case of adaptive expectations among the not-rational ones. As regards this topic, what happened in Germany after the reunification gives us a clear example of how adaptive expectations work.

After the division of Germany in 1949 two types of market were introduced: a capitalist market economy in the Federal Republic of Germany (FRG) where prices and wages were allowed to adjust and adapt and a Soviet-style centrally planned economy in the German Democratic Republic (GDR) in which there were no possibilities of fluctuations for prices. For this reason, devaluations of the national currency and shortages of goods generated inflationary pressure in the GDR.

After the fall of the Berlin Wall, in 1990 the two economies were both transformed into market economies and price and wage controls were removed. For the conversion to the Deutsche mark, the Eastern Mark should have been converted on a scale of two Eastern Marks for one Western Mark. However, the conversion was one Eastern Mark for one Western Mark and the effect was a sharp inflation in East Germany due to a too-high relative purchasing power in Eastern Germany (the inflation reached a spike of 24% compared to the Western Germany Inflation which remained stable about at 3.9%).



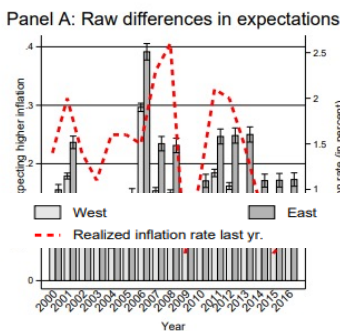
Eastern Germans had more savings than the Western ones. Moreover, the firms which had been seen operating in a socialist environment were cut off by the more profitable Western firms.

To solve this situation the Western Government tried to help the oriental part of Germany with subsidies to have a quick recovery without a rise in wages which did not achieve the expected results. Even today, the eastern part of Germany is less developed than the Western part, according to several studies and a poll of 136 German professors.

According to the OLS regression explained in a Goldfayn-Frank and Wohlfart paper of 2019, the East Germans expected constantly higher inflation than West Germans. East Germans are 9.3 percentage points more likely than West Germans to predict that prices will increase considerably across all waves and expect more than 1 percentage point higher inflation than West Germans.

East Germans were used to a strong norm of stable prices before the reunification. The new norm of positive inflation rates in 1990 also for the most basic goods and services was felt particularly hardly by East Germans during the first years after reunification. The inflation shock after reunification may have led East Germans to persistently over-adjust the level of their expectations to the norm of rising prices in the new environment. The finding that East Germans expect a larger increase in inflation and are more uncertain about future inflation than West Germans is consistent with the role of the initial inflation shock in driving the higher expectations among East Germans.

The expectations have had and still today have a crucial role in the difference between the western and eastern regions. Referring to the types outline before in the report we can consider that households in the oriental region have "Persistence-type" expectations.



Source: "Expectation Formation in a New Environment: Evidence from the German Reunification", 2019

### Forecasting inflation methods

It is widely known that the general purpose of Central Banks is to keep inflation stable and as close as possible to the target.

In recent years, households, firms, and policymakers have witnessed a higher degree of transparency of Central Banks, especially with the practice of "announcing forecasts of inflation and other key variables". Today, researchers' general idea is that including measures of inflation expectations in inflation forecasting models reduces the size of forecast errors.

Among the many forecasting models that have been created and tested, we can find both quantitative models and "fully real-time judgmental forecasts". In the first category, it is worth mentioning the following:

- RECURSIVE AUTOREGRESSION (RAR):

$$\pi_t = p_0 + \sum_{j=1}^p p_j \pi_{t-j} + \varepsilon_t$$

where  $\pi_t$  is the realization of inflation at time t which is assumed to be dependent on the realizations of inflation up to p periods before,  $p$  are parameters to be estimated from the sample and  $\varepsilon_t$  is the erratic component at time t. It is possible to construct the h-period forecast ahead by iteration of the one step ahead forecast.

- PHILLIPS CURVE motivated forecast:

$$\pi_{t+h} = p_0 + \sum_{j=1}^p p_j \pi_{t-j} + \lambda u_{t-1} + \varepsilon_t$$

where  $u_{t-1}$  is the unemployment rate in quarter t-1. It is possible to use also other economic activity measures instead of the unemployment gap, such as the output gap or industrial production growth.

- AUTOREGRESSION IN GAP FORM (AR-GAP):

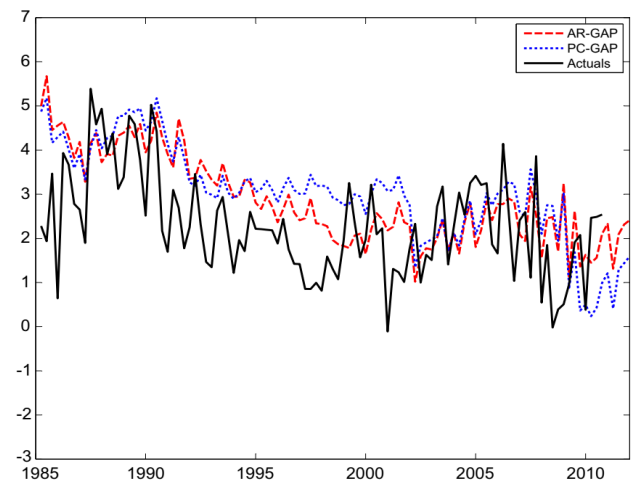
$$g_{t+h} = p_0 + \sum_{j=1}^p p_j g_{t-j} + \varepsilon_{t+h}$$

Here, instead of focusing on a fixed value for inflation, its gap is considered. This is defined as  $g_t = \pi_t - \tau_t$  where  $\pi_t$  is the realization of inflation at time t and  $\tau_t$  is the trend level of inflation, measured using the inflation forecasts of the Blue Chip Survey.

- PHILLIPS CURVE FORECAST IN GAP FORM (PC-GAP): in this case we have the application of the Phillips curve to the inflation gap, g:

$$g_{t+h} = p_0 + \sum_{j=1}^p p_j g_{t-j} + \lambda u_{t-1} + \varepsilon_t$$

where  $u_{t-1}$  is the unemployment rate in quarter t-1.



Source: "Forecasting inflation", 2013

This graph highlights the forecasting precision of the Autoregression in gap form model (AR-GAP) and of the Phillips curve forecast in gap form model (PC-GAP). As we can see, there is not a model that perfectly forecasts the actual trend of inflation, but the overall paths seem to be quite consistent with the real values.



Belonging to the other group of inflation forecasting models, we find:

- BLUE CHIP SURVEY (BC): forecasting tool for both the GDP and CPI. Its predictions are the basis for the results of the AR-GAP analyzed before.
- SURVEY OF PROFESSIONAL FORECASTS (SPF) which also provides quarterly GDP deflator and CPI forecasts.
- The Fed's GREENBOOK which provides GDP deflator, CPI and CPI-Core forecasts.

After several comparison exercises, the conclusion that can be drawn is that the subjective forecast models tend to perform better than the strictly quantitative ones. The last three listed forecasting tools are the only ones that consistently proved to improve on the benchmark. For many experts, this news does not come as a total surprise since it is widely known that the private sector and Fed forecasters make use of econometric models but they also incorporate expert judgment.

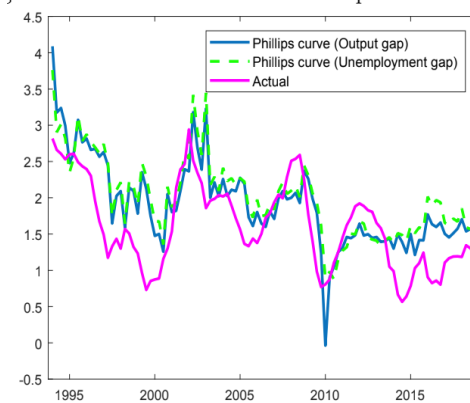
So, it seems that purely judgmental forecasts of inflation are right at the frontier and it might be better to use survey forecasts as measures of expected inflation. Indeed, survey measures of inflation expectations tend to outperform other, more standard, inflation forecasting specifications.

Nevertheless, it is worth mentioning that many of the quantitative forecasting methods have a high degree of correlation with each other. Several ideas have been raised regarding how to improve predictive accuracy by performing a combination of forecasts. However, even if there could be gains from such combinations, survey forecasts are still very hard to beat.

Shifting our focus towards the Phillips curve model, it must be highlighted how data are not always supportive of its forecasting capabilities. Especially regarding the simplest Phillips curve models, there is evidence of high instability, with accurate forecasts being defined as highly episodic. So, the question here is whether the basic Phillips curve structure could be improved, maybe by adding other variables to its model. Tests have been made with the implementation of one variable among the inflation trend, a measure of economic slack, and cost-push shocks and external developments.

For what concerns inflation trends, the test shows that incorporating a time-varying inflation trend in the Phillips curve helps (Bobeica et al., 2020). An improvement of the original Phillips curve is obtained even if slack measures are implemented. However, in this case, much attention should be put into the choice of the proper measure: for what concerns the product market, the output gap seems to be the best variable, but on the labor market, it is "harder to pin down an indicator which performs well across the entire period" (Bobeica et al., 2020) among unemployment gap, unemployment rate, employment gap, and short-term unemployment rate. This is mostly due to the deep structural changes that affected both the euro area economy and the labor market in the latest decades.

Furthermore, it is important to mention that a promising model is represented by the "New Generation" Phillips curve which incorporates time-varying features possibly bringing forecast gains.



Source: "Forecasting inflation" 2013

As a conclusion of the analysis presented, it must be said that some hedging against the instability in the forecast performance could be done by pooling results from different models and averaging over certain modeling choices and included variables.

### Market-based measures for inflation

In the last decades many alternative market-based measures for inflation have emerged, such as an over-the-counter market for inflation swaps. Inflation swaps involve two parties entering a contract where one party agrees to pay a fixed interest rate on a specified amount, while the other party agrees to pay the actual inflation rate on the same amount. Only the difference between the two payments is exchanged. In a risk-neutral scenario, the fixed rate should be equivalent to the expected inflation rate for the duration of the contract. Short-horizon inflation swaps are also traded, providing insights into investors' perception of short-term inflation prospects, although they do not purely reflect expectations. Moreover, there has been a recent surge in trading activity for inflation options, specifically in the form of caps and floors.

Among inflation options, simple caps hold particular significance. With the term "simple cap" we refer to a contract that grants the holder a payment upon maturity, which is a fraction  $(\max((1+\pi)n - (1+s)n, 0))$  of a specified principal amount tied to an underlying factor. In this case,  $\pi$  represents the actual average inflation rate observed during the contract's duration,  $s$  denotes the strike price, and  $n$  indicates the contract's lifespan in years. The holder is required to make an upfront payment for this contract. Inflation floors operate similarly, except the holder receives a payout when inflation falls below a certain level. By examining the prices of these financial instruments, it is possible to infer investors' probability distribution for inflation, assuming they are risk-neutral. However, it is important to note that investors are not actually risk-neutral and may be willing to pay an extra cost to protect against the risks associated with deflation or a sudden increase in inflation.

Although inflation caps and floors do not provide precise density forecasts, except under risk neutrality, they do offer insights into the concerns some investors have regarding inflation.



## Direct forecast or forecast individual components?

The issue of forecasting accuracy has long been debated also in terms of whether it is more effective to directly forecast overall inflation aggregates or to forecast the individual components of inflation and then combine these forecasts. There are advantages and disadvantages associated with both methods when considering real-time forecasting of the Consumer Price Index (CPI) inflation.

More specifically, the advantages of aggregating individual components can often be overshadowed by errors in parameters estimation. However, by imposing parameters restrictions that are not entirely accurate but serve the purpose, we can derive some benefits from a "bottom-up" forecasting approach.

Furthermore, decomposing the Consumer Price Index (CPI) into its constituent categories such as food, energy, and other items can prove to be an effective method for central banks to distinguish between inflation fluctuations that are more persistent and those that are less persistent, providing a better tool for planning monetary policies.

If we have knowledge of the data generating process, the combination of individual forecasts should be at least as effective as creating a single forecast directly (Lütkepohl, 1987). However, when we need to estimate the process of data generation, the direct aggregate forecast may be more accurate because it involves estimating fewer parameters.

It is always important to acknowledge that there are inherent costs associated with estimating models using disaggregated data, especially when dealing with a substantial number of component series. Consequently, researchers understandably hesitate to adopt this approach unless it is expected to generate favorable outcomes as pointed out by D'Agostino, Birmingham (2014).

When the individual forecasts exhibit similar patterns, using aggregate forecasts is expected to be more reliable with limited amounts of data. Conversely, aggregating disaggregate forecasts is likely to yield better results if the individual forecasts demonstrate strong persistence.

In recent publications, Hendry and Hubrich (2006, 2011) discovered that incorporating disaggregated information does not provide significant benefits in forecasting euro area inflation. However, the limited availability of data spans somewhat hampers this analysis. Conversely, findings from studies conducted on larger datasets in the United States favor the inclusion of disaggregated data in forecasting. Birmingham and D'Agostino (2014) are generally more inclined towards aggregating disaggregate forecasts.

Ultimately, determining which method is more accurate depends on empirical evidence.

Based on a literature review, surprisingly simple methods that minimize or avoid parameter estimation in many forecasting scenarios tend to work remarkably well: extremely straightforward inflation forecasts, that however consider nowcasting and long-term changes in the average inflation rate, are among the most effective approaches for our purpose.

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