Measuring Core Inflation in the UK

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Abstract

This PhD thesis provides a comprehensive analysis of inflation in the UK, adopting a data-driven approach to model inflation, evaluate different measures of core inflation, and investigate the impact of monetary shocks on output.

The study begins by modelling month-on-month (mom) inflation as an autoregressive process, taking into account factors such as seasonality and VAT changes. A significant 12-month lag effect on inflation was identified, leading to a degree of persistence in annual inflation. This effect was found to exist at the aggregate level and within the majority of consumer expenditure categories. The research also explored the individual components of the Consumer Price Index (CPI) basket using the System of National Accounts (SNA) COICOP expenditure divisions up to 4 digits. The study found that inflation is best explained by itself, indicating a focus on core measures of inflation without reference to other variables.

In addition to analysing mom inflation, the thesis investigated different methods for measuring core inflation and their effectiveness in predicting future inflation at the 12-month horizon. The exclusion of food and energy prices, the use of trimmed means, and the inclusion of sticky prices were evaluated. The results showed that the exclusion of food and energy measure and the sticky price index have the best forecasting performance at the 12-month horizon, while the autoregressive and seasonal autoregressive integrated moving average models have the worst performance.

In the third chapter, the thesis delves deeper into the intricacies of inflation persistence and the impact of monetary shocks on output. The Generalized Taylor Economy (GTE) model proposed by Dixon and Kara (2005b) was introduced, providing a flexible framework for capturing the heterogeneity of wage-setting processes across sectors. The research underscores the significant influence of long-term contracts on economic output and its persistence. Furthermore, the diverse range of contract lengths present in the economy and their potential influence on economic dynamics is significant.

Overall, this thesis has made a valuable contribution to the literature on macroeconomic modeling by providing a more comprehensive understanding of inflation persistence, the impact of monetary shocks on output, and the effectiveness of different measures of core inflation in forecasting future inflation. The findings of the study have important implications for policymakers and practitioners who rely on accurate inflation forecasts to make informed decisions.

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Introduction

The aim of this thesis is to model UK inflation, building up from month-on-month to annual inflation. Rather than starting from abstract theoretical DSGE models with arbitrary and often unsupported assumptions, we adopt a more data driven approach. Our starting point is from the simplest possible model: month-on-month inflation (mom) as an autoregressive process with seasonality and other events such as VAT changes captured by appropriate dummies. We do this at the aggregate level (CPI inflation), but also drill down into the individual components of the CPI "basket", as reflected in the different categories of expenditure using the System of National Accounts (SNA) COICOP expenditure divisions up to 4 digits. We simplify regressions to get down to a parsimonious form where we have only significant regressors (other than dummies). As far as we are aware, this has not been done for the UK CPI data for many years, the last significant contribution along these lines having been Osborne and Sensier (2008). Indeed, at the international level there is also a lack of this type of research, except in the sphere of forecasting models. We then seek to introduce a range of other variables, from wages, producer prices and consumer demand to see how they can improve the explanatory power.

The main focus of the research is to find out how far the behaviour of mom-inflation leads to persistence in the headline annual inflation figure, which is a backward-looking measure of how much cumulative inflation there has been over the previous 12 months. The main new finding is that there is a 12 month lag effect on inflation across a wide range of sectors. Inflation for 12 months ago has a positive effect on inflation in the current month. This is important for annual inflation, as it leads to a significant degree of inflation persistence over and above the natural 12 month effect (mom inflation remains in the headline figure for 12 months). We find this effect at the aggregate level, but it is generated within the majority of the different types of consumer expenditure types. This is a significant discovery and the analysis shows that is robust and continues to exist when we have many other cost and demand explanatory variables in the mix.

We then go on to look at alternative measure of core inflation, where the emphasis shifts to looking at how best to define "core" inflation for predicting future inflation.

Introduction

Core inflation is a measure of underlying price inflation that excludes certain volatile components, such as food and energy prices, in order to provide a more stable and predictable indicator of future inflation. There are several different methods for measuring core inflation, including the exclusion of food and energy prices from the consumer price index (EXFD), the use of 5% trimmed means (TM), and the inclusion of only those prices that are slow to change, known as sticky prices, Autoregressive (AR) and Seasonal Autoregressive Integrated Moving Average (SARIMA). In our EXFD method, we built the data not on the 12 COICOP expenditure divisions, but on data up to 4 digits. As for sticky CPI, we used the data of the most disaggregated items and constructed 244 sticky items that are less than the mean duration of 5.56 months. We also investigate the linear relationship between the unemployment rate and changes in three different price indices: the headline CPI, the flexible price index, and the sticky price index, over the past 12 months. The results show that the relationship between changes in sticky prices and unemployment is stronger than the relationship between the overall CPI and unemployment, implying that sticky prices are more responsive to economic conditions than the average.

In this study, we analysed the forecasting performance of five different measures of core inflation using annual CPI data from the United Kingdom from 2005 to 2019. We conducted a univariate regression analysis to evaluate the ability of each measure to predict future inflation. In terms of Univariate regression coefficients, RMSE, and model fitness, our results showed that the exclusion of food and energy measure had the best forecasting performance, followed by the sticky CPI measure. In contrast, the autoregressive and seasonal autoregressive integrated moving average models, which served as the benchmark models, had the worst performance. Overall, our findings suggest that the existing core measures are able to eliminate some of the transient factors affecting CPI inflation, but they are still heavily influenced by high-frequency fluctuations. Our results also highlight the importance of considering different measures of core inflation and their relative strengths and limitations in forecasting and analysing inflation trends.

There are many impacts of inflation on the economy, including consumer spending, business investment, employment rates, and tax policies. In 2022, inflation is raging fuelled by the ongoing supply chain crisis and the Russia-Ukraine conflict, which are driving up food and energy prices. The U.K. recently saw its first double-digit inflation rate in 40 years, and we can expect it to reach 15% in 2023. A 40-year high was also reached by inflation in the U.S. in 2022 at 9.1%. The increase in inflation has squeezed household budgets, impacted consumer confidence, and increased cost of living. A comprehensive understanding of inflation is crucial, not only for central banks but also for the public. This thesis discusses two of the questions: inflation persist phenomenon and inflation forecast.

The first step should be to understand the data and how it has been constructed. A monthly price index is published by the National Statistics (ONS) to calculate both a monthly month-on-month inflation rate and a quarterly quarter-on-quarter inflation rate. This thesis analyzes both the month-on-month inflation rate (called the "mom") and the monthly annual inflation rate as reported by the ONS (called "annual inflation" or "headline inflation”). However, we will also look at the quarter-on-quarter inflation, which we will call “qonq”.

In this first chapter, we first briefly describe the inflation data covering the period January 1993 to December 2019 (inclusive). If we look at mom inflation measured by CPI and CPIH, it is a noisy and highly seasonal series. There is similarity in their medians and means, negative skewness, and low Kurtosis in comparison to a normal value of 3. The main difference between CPI and CPIH is the standard deviation: OOH rental equivalence in CPIH results in less variability. Next, we undertake simple time series analysis of the data. When we look at the CPIH and CPI inflation versus its previous month's value, it appears to be very weakly correlated: there is a slight negative slope, which indicates weak mean reversion: a high absolute value will be followed by a smaller one. There is a close relationship between the constant and the mean. In terms of the difference over a 12-month period, there is a big difference: inflation has a strong seasonality, which explains the strong positive correlation (the regression coefficient is 0.75). We then see in what sense this gives rise to persistence in inflation. Our starting point is the raw data in terms of mom inflation. In a low inflation environment, such as the UK in the period 1993-2019, the annual or headline inflation is approximated very well by the sum of the twelve mom inflation rates. Our goal is to model mom inflation and then see how it affects headline inflation. An autoregressive process model is constructed to model mom CPI inflation. When the AR(12) is run with dummies for VAT changes, the crisis, and calendar months, the only significant variables (other than constant and monthly dummies) are the three VAT changes and the first and twelfth lags of inflation. What effects does this lag structure have on the persistence of headline inflation? As a result of the sparse regression, we demonstrate how headline inflation would respond to a shock if it followed the expected autocorrelation coefficients. We found headline CPI inflation is highly persistently impacted by a simple one-month shock to mom inflation.

Beside this, we adopt a similar approach but includes 12 lags of aggregate CPI inflation in the regression for the 12 different types of expenditure (COICOP divisions). This enables us to see if the 1 and 12 months lag we found in the previous is primarily the prices in each division reacting to the aggregate CPI figure or to their own division. The result suggests that the lag effect does not flow from the CPI to the divisions, but that it rather holds for several divisions. It is generally reported that there is no evidence that CPI effects occur at shorter lags (including the annual lag) as well as no evidence for any longer lags longer than 7 months. According to this, pricing behaviour is more determined by sectoral factors than aggregate ones.

In addition, the data will not be only analysed at the level of the 12 COICOP 2-digit divisions of expenditure, but also to a lesser extent at the 3- and 4-digit groups or class. On a group level, from the perspective of individual effects, one month lag holds for 21 out of 38 groups, whereas 12-month lag is always positive for 23 groups going from CPI. In terms of the overall range of results, however, there are few significant lags, indicating that the CPI does not seem to have much impact on each group. Overall, prices are influenced more by group concerns than aggregate factors. This same conclusion applies to the class level. The 1-month and 12-month effects are significant in around half of the classes. Overall, from top to bottom of COICOP, there is a consistent conclusion: the 1- and 12-month lag have an effect on inflation, but it is more determined by individual factors than aggregate factors.

Since qonq is a common measure in macroeconomic econometric analyses, replacing mom data with qonq data will produce a more accurate conclusion. From 1993Q2 to 2019Q4, the quarterly data show strong positive skewness and minimal excess kurtosis. For aggregate CPI qonq inflation, a single equation AR is used, with seasonality and

VAT dummies added. At the 5% level, the first and fourth quarter lags are significant with values of 0.31 and 0.26, respectively. Consistent with previous empirical research, we will the same examine the 12 COICOP two-digit divisions of expenditure and, to a lesser extent, the three- and four-digit levels. CPI affects individual divisions only in a few cases. The first quarter lag effect occurs in only three out of 12 divisions, and the fourth quarter lag is significant in four divisions. The effect of CPI beyond two quarters are completely absent. As a result, pricing behaviour is driven primarily by divisions rather than aggregate CPI. In terms of groups, there is a one-quarter lag effect for 10 of the 38 groups, while a four-quarter lag effect is present for 12 of the 38 groups, always showing a positive trend. The 12-month lag is much clearer in the data than the 4-quarter lag, but the sign has remained positive. In the 85 COICOP classes, the regression results demonstrate that the one and fourth quarter lag effects reach certain classes, but the proportion decreases when qonq data is applied. In summary, the quarterly results are somewhat consistent with the monthly results, but not significantly.

Furthermore, we consider output growth, average hourly wages, unemployment, and PPI inflation as possible explanatory variables for mom inflation. Additionally to the aggregate CPI, the data will be analysed at the 12 two-digit COICOP division level. Output growth, measured by UK national and domestic household final consumption expenditure. It gives us a demand variable which corresponds to the overall CPI and 12 COICOP Divisions. The data is quarterly, and we map the quarterly data to the monthly data. Wage equations of the Phillips curve are traditionally used to explain inflation. Labour costs are measured by average weekly earnings (AWE). The frequency is monthly and began in 2000.

According to the classic "Phillips curve" model, we expect inflation will rise as output increases and decrease as unemployment increases. As a cost-push variable, PPI should increase inflation. However, in contrast to our expectations, aggregate level for CPI inflation was little affected by output or unemployment rate. No consumption coefficients are significant at the 5% level, and only the fifth and sixth lags of unemployment coefficients are significant but close to zero. Apart from that, it is not always the case that PPI raises inflation. There is a positive lag in the first and ninth lags, but a negative lag in the twelfth. The lag effect of the CPI differs from previous findings. Analysis results show that the 1-month effect has disappeared and been replaced by an 11-month effect. Twelve-month effect stays the same.

Similarly, to determine whether the additional variables found in the previous section were primarily the result of the price response of each sector to the overall CPI data or their own sectors, we followed a similar approach as before. By including 12 lags of each interest explanatory variables as well as dummies and lags in a model of mom inflation for each division, we obtain the following results: the CPI does have some effect on the individual divisions. However, the significant lags are rare (most lag length is present in less than three divisions) and the most common lags are 3 and 7 months, with different signs for each across sectors. Most divisions are not affected by the 11-month lag effect. The twelve-month effect is absent from 01 (Food and Non-Alcoholic Beverages), 04 (Housing, Water and Energy), 08 (Communication), 09(Recreation and Culture) and 12 (Miscellaneous Goods and Services). It is significant in the remaining 7 COICOP divisions. Pricing behaviour appears to be driven more by sectoral considerations than aggregate developments. In the previous we found that consumption has little effect on CPI inflation, and similar findings were also found in the results of 01 (Food and Non-Alcoholic Beverages) and 08 (Communication). However, the significant lags are frequent in remaining 10 COICOP divisions (lag length is present in more than four divisions) and the most common lags are 1, 2 and 3 months, with different signs for each across sectors. At this level of disaggregation, producer prices and unemployment appear to have little effect.

Inflation persistence refers to a situation where an increase in the rate of inflation leads to a sustained higher rate of inflation in subsequent periods. In other words, higher inflation in one period tends to lead to higher inflation in subsequent periods. Now, let's turn our attention to another important concept in the study of inflation: core inflation. Core inflation is a measure of inflation that excludes certain volatile items such as food and energy prices, which tend to fluctuate more frequently. By excluding these items, core inflation provides a more stable measure of underlying inflation trends. Core inflation is often seen as a key driver of persistent inflation. When core inflation is high, it can lead to persistent inflation, as businesses may pass on the higher costs of raw materials and other inputs to consumers in the form of higher prices. In addition, persistent inflation can also be driven by expectations of future inflation. If consumers and businesses expect that prices will continue to rise in the future, they may be more likely to engage in behaviours that contribute to persistent inflation. In the next section, we will delve deeper into core inflation and explore the ways in which policymakers and businesses can manage these trends to promote stability and prosperity in the economy.

The second chapter discusses the concept of core inflation and three mainstream core inflation measures. We also re-evaluate the core inflation rates of these three methods using more disaggregated data in the UK and conclude with a short forecast.

Core inflation is widely used by researchers and central banks, but its definition is not clear and accepted. The term core inflation has two different meanings. The first is a measurement of actual inflation that is statistically robust. The second is the part of actual inflation that reflects underlying economic pressures. Official statistical agencies and researchers have proposed some measures that can be grouped into two categories: statistical and modelling approaches, which are intended to measure core inflation and remove temporary relative price changes from headline inflation indicators. In general, statistical approaches distinguish between headline inflation's temporary and persistent components through statistical analysis of price data. Modelling is mainly based on economic theory, using multivariate analysis of the relationship between headline inflation and the determinants in the past, and thus isolate core inflation.

Exclusion-based methods are the first to be discussed. Excluding highly volatile components from the CPI is the primary idea behind the exclusion method. It implies that certain parts of the CPI reflect supply-side movements rather than aggregate demand changes. In the absence of any monetary policy changes, the impact of these price changes would diminish, thereby reflecting existing inflationary pressures better. Frequently excluded items include Food and energy, indirect taxes, regulated prices, and mortgage interest payments. Exclusion methods are simple to calculate, easy to interpret, and provide timely results. An important drawback of the exclusion method is that it remains somewhat subjective to determine the excluded items, even though the determination is comparatively well-founded objectively. We considered several exclusion types of metrics and ultimately excluded food and energy measures. We get rid of the food (division 01) and energy parts of division (04) and transport (07). We examine the relative properties of these divisions (variance, St.Dev) to the other nine COICOP categories. Food and energy divisions are relatively similar in terms of annual inflation at 2%. The remaining sectors have a wide range of mean values. Food and energy and non-food and energy sectors are not very different from each other in terms of standard deviation. Using the UK CPI data at the four-digit level of COICOP expenditure classes from January 2005 to December 2019, we calculate core inflation by multiplying each non-food and energy class by its weight. The weights used in calculating consumer price inflation are updated each year, so it is easy to convert annual weights into monthly weights. The weight for each month is equal to the weight for the entire year.

Moreover, it has been demonstrated that CPI is not only influenced by monetary factors, but also by changes in relative prices resulting from nominal price rigidity. Based on menu-cost theory, some micro-enterprises with relatively high menu costs do not adjust immediately when confronted with specific impacts but do so only when they exceed the critical value when faced with specific impacts. As a result, price changes in real life tend to exhibit skewness. It is necessary to eliminate the end values of those abnormal fluctuations when calculating the trend of price changes. The following is Bryan and Cecchetti's (1994) trimmed mean method, which works as follows: significant changes in relative prices are not indicative of underlying inflation trends due to the rapid reverse of these price changes. To calculate the trimmed mean method, the indices of the CPI index are first sorted, then the tails of the sample distribution are trimmed, and then the remainder is averaged. It should be noted that the trimmed mean differs from the exclusion method in that the components of the CPI that are excluded are based on their relative price changes and not arbitrarily excluded. The trimmed mean value is not without problems. First, the nature of the shock or the cause for the extreme values needs to be determined. In some product groups, persistent price trends may differ from those in other product groups, which may lead to an incorrect removal of this trend as a persistent shock, leading to an overestimation of the overall inflation rate. The second consideration is that the trimmed mean value depends on the level of trimming the data. There is no ideal trim ratio, and it is important to consider the level of subdivision in the base data as well.

The finer the basic data is, when the sample size is sufficiently large, the more accurate the analysis. Moreover, a trimmed mean can be easily compiled, transparent, and timely. It is the responsibility of the National Institute for Economic and Social Research (NIESR) to build historical trimmed mean data. The NIESR begins by collecting microdata on the price of individual goods, based upon the Consumer Price Index for all goods in the UK. Since the 1990s, more than 30 million price quotes have been collected for 135,000 goods and services per month, resulting in about 135,000 price quotes per month. Typically, NIESR chooses a 5% trimmed mean since it outperforms CPIs as well as CPI-ex for inflation in the future. In the construction of all the above measures, there is, however, an essential conceptual shortcoming that the persistence of individual price changes is not explicitly considered. With a trimmed mean approach, more significant persistent price shocks may appear to be outliers in the inflation distribution for multiple successive periods. In such cases, the measure would fail to reveal valuable information about future inflation as such.

Inflation forecasts are influenced by a variety of factors, but not all prices are equally affected. Some commodities, for example, have "sticky" prices, meaning they do not respond as quickly to market changes as other commodities with more "flexible" prices. Further, because sticky prices change slowly, it seems reasonable to assume that they better reflect future inflation expectations when they are specific as opposed to frequently changing prices. There are several explanations for prices being sticky. Generally, it is believed that price changes can result in high costs in some markets. As price setters realize that changing prices will be expensive, they will need to account for inflation when making their price decisions between infrequent price changes. Several studies have examined the speed at which prices adjust. Bils and Klenow (2004) examined the raw data pertaining to the 350 detailed spending categories underlying the CPI. It was concluded that half of these categories had a price change at least every 4.3 months. In their work, Bryan and Meyer (2010) employed the average frequency of price change found in Bils and Klenow research to distinguish between "sticky" and "flexible" prices and to derive "core" measures of sticky and flexible prices. Dixon and Tian (2017) calculated the frequency of price changes per month for 570 UK items that were part of the Virtual Microdata Laboratory (VML) data set from January 1996 to December 2007. With such valuable data, we continue to apply a similar method to calculate the mean duration between price changes, which results in 244 items with a price change at least once every 5.56 months. By combining rich item weights and Consumer Price Index item price quotes data for the UK from 2005 to 2019, we can construct sticky CPI. This study examines a simple linear relationship between the unemployment rate and changes in the headline consumer price index, the flexible price index, and the sticky price index over the past 12 months. The relationship between changes in the rate of sticky prices and unemployment is stronger than that between changes in the overall CPI rate and unemployment, suggesting that the rate of sticky prices is more sensitive to economic conditions than the average rate. The flexible price CPI and unemployment, however, have a slight negative correlation. In addition, I have found a positive correlation between inflation and unemployment.

In addition to the core inflation measures, we also consider two stochastic models, Autoregressive process (AR) and Seasonal Autoregressive Integrated Moving Average, or SARIMA. By modelling time series using stochastic processes, one can explain how the phenomenon evolves and make predictions based on the estimated model. Historical inflation data are used as a baseline in comparison to core inflation measures in this study. On the basis of the Akaike Information Criteria, an AR (3) process was determined to be the most appropriate. SARIMA is extension of ARIMA supports time series data with seasonal components explicitly. In order to determine the best model for inflation rates, monthly CPI data (not seasonally adjusted) for the UK economy is used in this application. The number of differences is determined through repeated KPSS tests. The SARIMA coefficients are selected by minimizing the AIC after differencing the data one time. The algorithm traverses the model space in a stepwise manner. As a result of assessing the information criterion, a seasonal ARIMA (1,1,1) (0,0,2) [12] was determined to be the most parsimonious model.

To conclude, we evaluated these core inflation measures based on their forecasting ability. Essentially, core inflation refers to changes in price levels that are expected to last for an extended period of time. An evaluation of the predictive ability of various core inflation measures is carried out using univariate regression developed by Cogely (2002). We found that the exclusion of food and energy measures presented the most accurate forecasting performance in terms of univariate regression coefficients, RMSE, and model fitness. Comparatively, the autoregressive (AR) and seasonal autoregressive integrated moving average (SARIMA) models, which served as benchmark models, performed poorly. In general, our findings suggest that the existing core measures are able to eliminate some of the transient factors that affect CPI inflation, but they continue to be heavily influenced by high-frequency fluctuations of the inflation rate.

In this third chapter, I delve deeper into the intricacies of inflation persistence and the impact of monetary shocks on output. We will introduce and discuss the Generalized Taylor Economy (GTE) model proposed by Dixon and Kara (2005b), a flexible framework that accommodates multiple sectors with varying wage-setting processes. This model allows us to capture the heterogeneity of wage-setting processes across sectors, providing a more nuanced understanding of the impact of monetary shocks on output and other macroeconomic variables.

We will also explore the significant influence of long-term contracts on economic output and its persistence, and the diverse range of contract lengths present in the economy. We will investigate how these contract durations potentially link to the response of inflation to economic shocks.

Furthermore, we will examine special cases, such as the Calvo-GTE, to gain insights into how variations in contract length distributions can impact the macroeconomic dynamics in the GTE framework.

This chapter aims to deepen our understanding of inflation persistence, the impact of monetary shocks on output, and the role of wage-setting processes in these dynamics. The insights gained will further contribute to our comprehensive analysis of inflation in the UK and have important implications for economic policy and financial planning.

Chapter 1: Inflation persistence in the UK 1993-2019[1]

1.1 Background

Since December 2019, the global outbreak of the COVID-19 pushed down global oil prices, the consumer price index (CPI) has floated sharply in many countries, and there is growing interest in how core inflation is measured. In other words, how we calculated the durable or persistent component of aggregate inflation.

UK CPI rose 1.8% in January 2020 from a year earlier, up again from 1.4% the previous month. The UK Office for National Statistics said that the "lockdown" measures taken to curb the neo-crown epidemic had dampened demand for some goods. Falling motor fuel and clothing prices are the main reasons for lower inflation levels. However, in January 2020, China's CPI rose 5.4 per cent year-on-year, the highest value in eight years. A closer look at China's January data shows different commodity prices rose differently - food prices led by 20.6%, pork again "first" rose sharply by 116%, and non-food prices rose only 1.6%. Food skyrocketed because people feared an outbreak might trap them in their homes, so there would be panic hoarding of essentials, which would raise prices for a short time. In other words, demand for groceries and meat skyrocketed without a corresponding increase in supply, hence the high food prices in January.

1.1.1 Now you see it, now you don't. The simple arithmetic of inflation persistence.

A frequently misunderstood phenomenon is inflation persistence. Many people think it exists, while others believe that even while it has existed in the past (for instance, between 1970 and 1990), it is not significant today. I think it depends on how you view it. At a basic level, inflation is a non-persistent process that is nearly (but not quite) white noise. It is very persistent on a different level. The two levels are compatible with one another.

Let's start with the data and the methodology used to create it. I will use the UK Office for National Statistics (ONS) as my example, albeit the same storey would apply to most nations worldwide and to any nation in Europe (since they all adopt the same Eurostat rules) and most in the world (since they follow UN agreed conventions). The primary inflation measure used by the ONS is the CPIH, which dates back to 1988. It is

[1] This includes joint work with Professor Huw Dixon and Dr David Meenagh.

available as a monthly, quarterly, and annual figure in publications. Annual Inflation is always the number that is published. For instance, the monthly inflation rate for January 2020 is 1.8 percent, which is the difference between the general level of prices in January 2020 and January 2019. The ONS additionally releases quarterly and annual inflation rates. So, the inflation rate for 2019 Q4 shows the increase in prices overall since 2018 Q4. The ONS averages its index of prices for 2019 Q4 and compares this to the average for 2018 Q4. The average index for the year 2019 is compared to the comparable index for the year 2018, and this is how the inflation rate for 2019 is calculated. The monthly inflation rate, which is reported in the news and used to calculate the Bank of England's inflation target and index prices, wages, and pensions, is the most widely used and recognised metric in practise.[1]

Inflation is handled differently here than GDP is. GDP growth from one quarter to the next (between 2019 Q3 and Q4 GDP growth) and from one year to the next are both published (GDP growth between 2018 Q4 and 2019 Q4). Additionally, each quarter's actual GDP level is determined. As an illustration, the UK's GDP in 2019 was £2,089,402 million, or over £2.1 trillion, whereas Q4 output was £523,588 million.[2] The flow of output in 2019 is the total of the flows of the four quarters because output is a flow metric. Additionally, there is not much overlap between the output in 2019 Q4 and the output in 2019 Q1 because output is often recorded at the point of final spending. While an economic activity may last for a while, the ONS has established norms that assign the ultimate production to a specific quarter in order to prevent duplicate counting.

The statistic on inflation is different from the GDP data. When you read out the two figures for inflation from the ONS data and compare them for 2019 Q3 and Q4, you are comparing two data points that have a significant amount of overlap. Both cover pricing data over a 12-month period: the 2019 Q3 contains data from the 2018 Q3 to the 2019 Q3 (inclusive), which is data from July 2018 to September 2019; the 2019 Q4

[1] The exact inflation measure used varies: the inflation target is currently set in terms of CPI, indexation is sometimes RPI (some pensions and regulated prices). CPIH is a relatively recent measure, intordcued as the official measure in 2017.

[2] These figures are the so called CVM real output measure and the quarterly figure is seasonally adjusted.

inflation includes data from the October 2018 to the December 2019 (inclusive). Thus, there is overlap in the data from October 2018 to September 2019 when we compare the inflation rates for the two quarters (inclusive). Similarly, if you compare the inflation rates for 2018 and 2019, you'll see that they use data from all three years (2017, 2018 and 2019), with 2018's data overlapping all the others.

Of course, informed applied economists have known this for a long time. Each month, the ONS releases a price level index. The monthly month-to-month inflation rate as well as a quarterly quarter-to-quarter inflation measure can then be determined using this. The monthly annual-inflation figures issued by the ONS (which we shall refer to as "annual inflation" or "headline inflation") and the month-on-month inflation rate (which we refer to as the "mom") are the main topics of this chapter. We will also examine quarter-on-quarter inflation, or "qonq," which is frequently used by economists in quarterly economic models. We provide the mathematics of inflation combining these three variables in appendix 1. (expressing annual and qonq in terms of monthly inflation).

We provide a brief description of the inflation data for the period January 1993 to December 2019 in the following section 1. (inclusive). We analyse the data using a straightforward time series approach in section 2. In section 3, we examine how this contributes to inflation persistence.

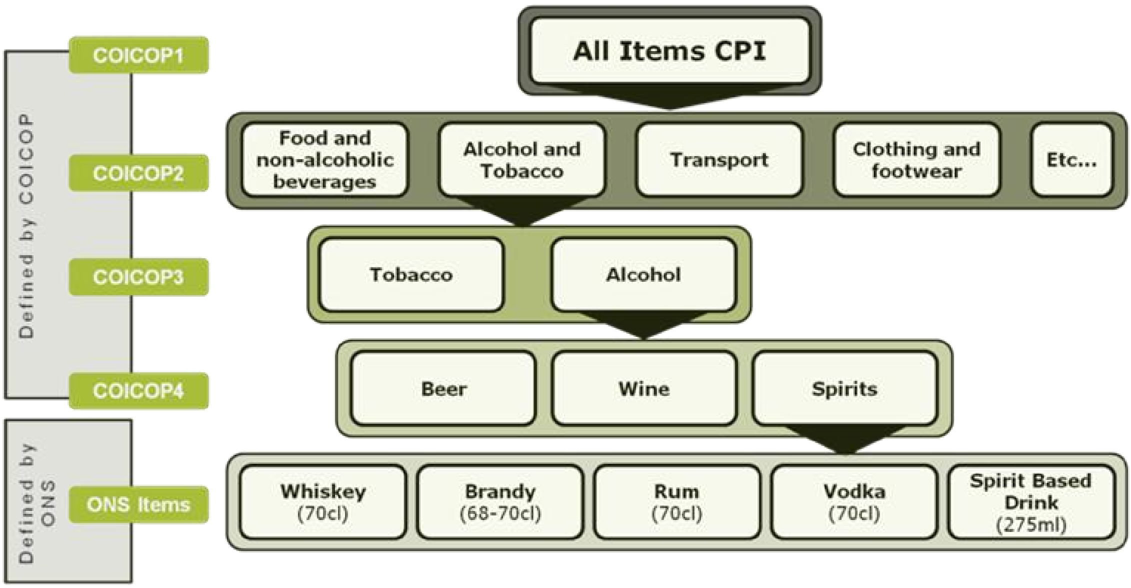
1.2 The data

We will evaluate the monthly CPIH and CPI inflation data. The current calculation dates back to January 1988 and is done on a monthly basis. However, there was a period of inflation in the early 1990s, and we'll concentrate on the UK's great period of moderation, which may be dated to begin after this event. As a result, we postpone the beginning of our analysis from January 1993 until the end of 2019. Despite a number of economic shocks, wars, and acts of terrorism, inflation has been relatively constant by historical standards during this time. The primary change in monetary policy is the switch from active inflation targeting using the interest rate before the Great Recession of 2008–2009 to maintaining an almost constant interest rate near zero and a shift in focus to maintaining output through quantitative easing and "unconventional" monetary policy. However, it should be noted that the MPC continued to consider inflation as a key factor in their decisions and deliberations, despite the constraints of the lower bound on interest rates.

1.2.1 Structure of UK consumer price indices

We also consider frequency data for three different classification levels: the 12 COICOP divisions, the 38 COICOP groups and the 71 COICOP classes. Classification of Individual Consumption According to Purpose (COICOP) is an international classification system for household consumption expenditures. The COICOP is a hierarchical classification system comprising four (4) levels, with categories increasing from a two-digit to a five-digit level as the level of detail increases: divisions (for example, 01 food and non-alcoholic beverages), groups (for example 01.1 food), classes (for example 01.1.1 bread and cereals) and subclasses (for example 01.1.1.1 rice). In the empirical analysis, we estimate models first with the UK monthly CPI ALL ITEMS data and then at the different disaggregation levels, corresponding to 12 COICOP divisions, the 38 COICOP groups and the 71 COICOP classes. The time series dataset is from the Office for National Statistics (ONS) website.

Figure 1: Example of current COICOP structure in the CPI

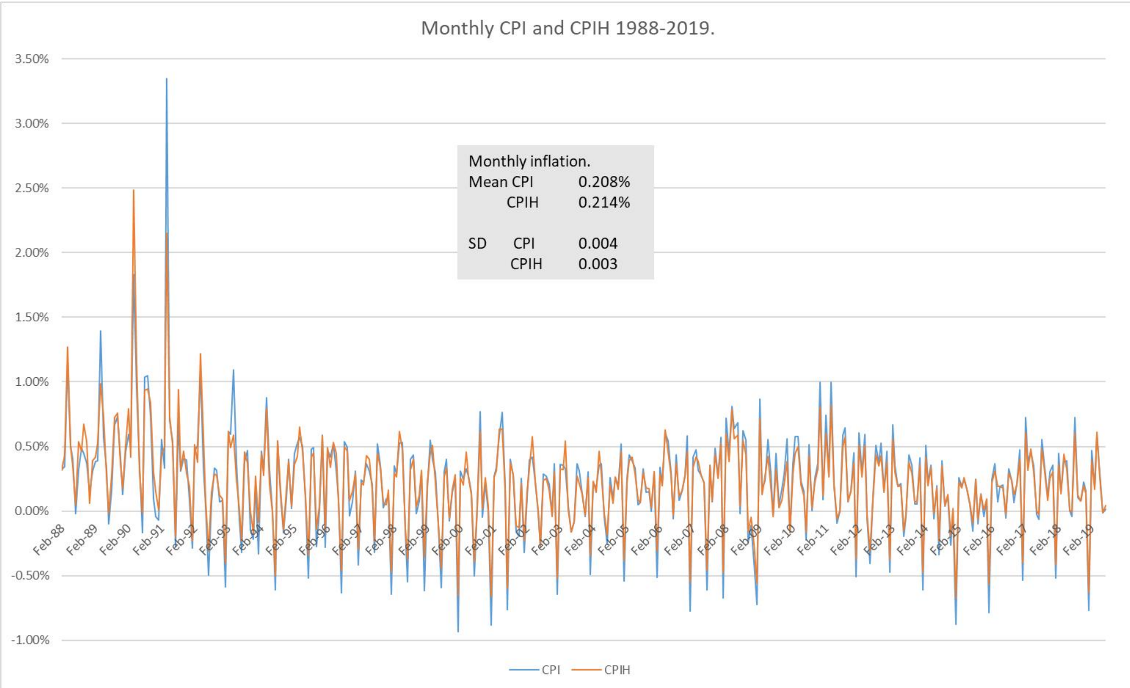


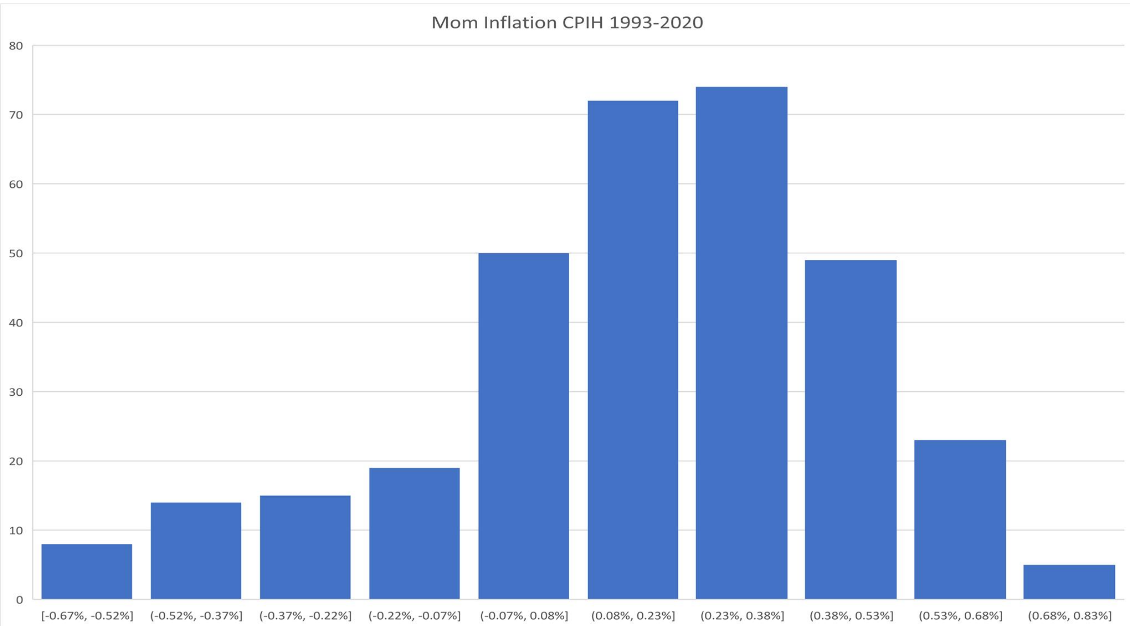
Source: Office for National Statistics

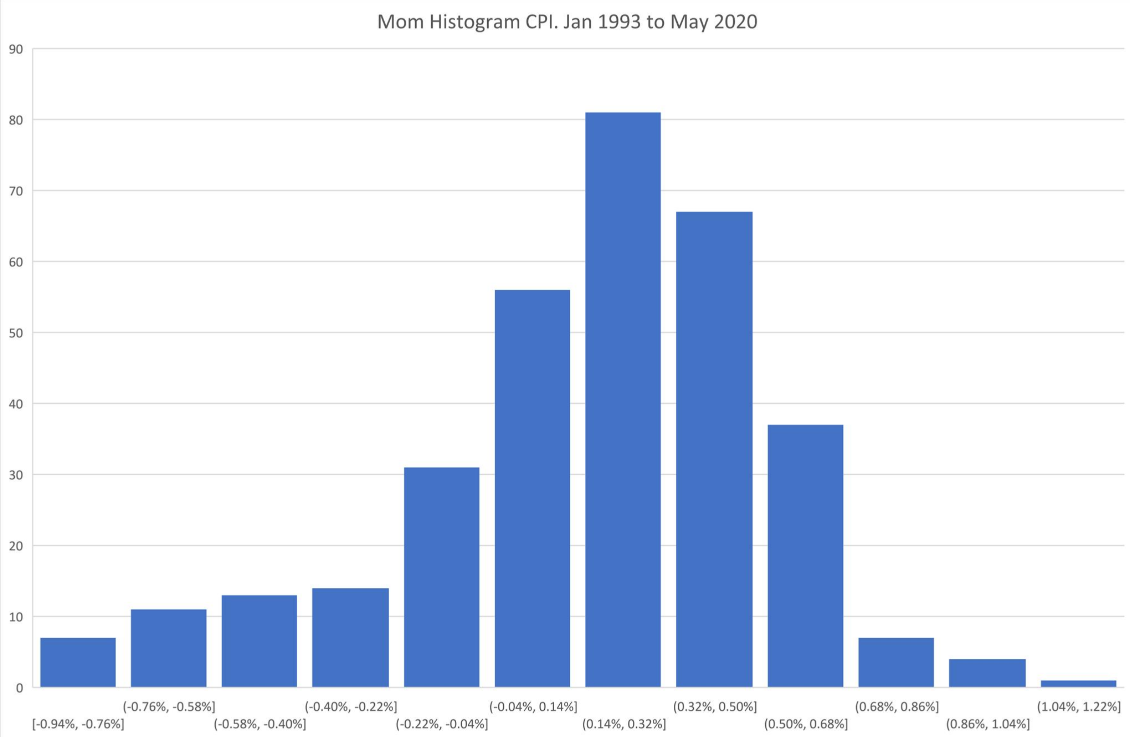
1.2.2 Monthly Inflation 1993-2019

If we examine monthly inflation as measured by the CPI and CPIH, we find that it is a noisy and highly seasonal dataset. Even though we are concentrating on the time since 1993, the last inflationary episode in the late 1980s and early 1990s, the fallout from the "Lawson Boom," is also visible.

There are a few additional ways we can examine the raw data. First, examine the frequency of the various degrees of mom inflation using a histogram.







The summary statistics for the raw inflation data are in Table 1.

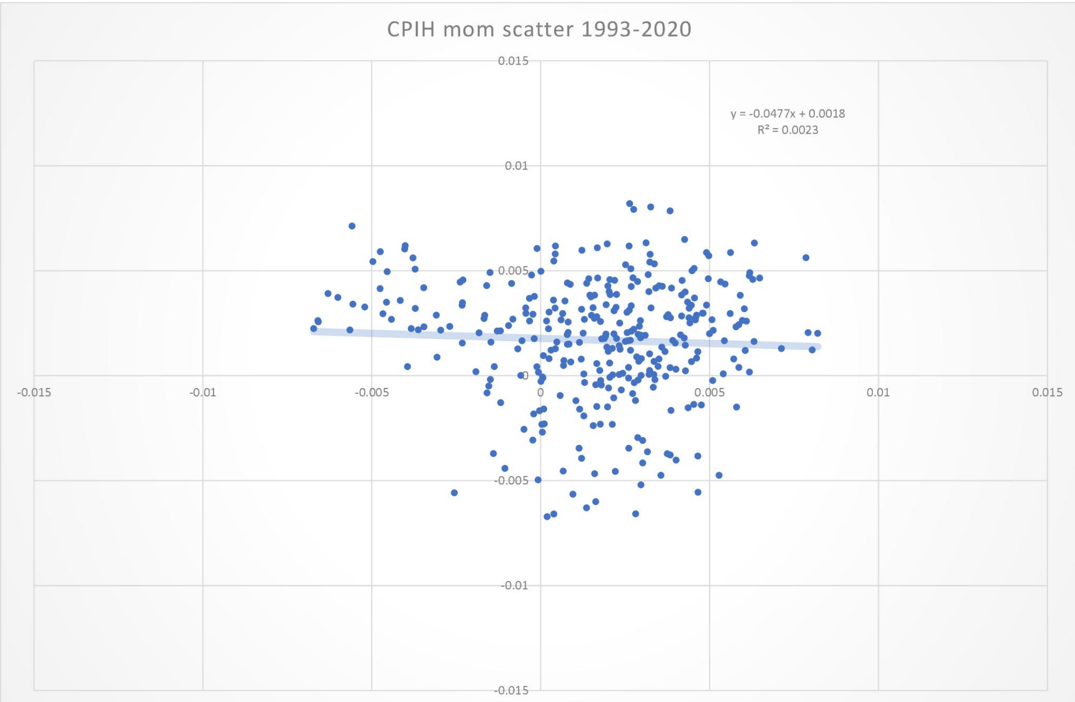
Table 1 Month on Month inflation statistics

1993-2020	mean	median	St. dev.	skewness	ex. kurt.
CPIH	0.17%	0.20%	0.0029	-0.64	0.38
CPI	0.17%	0.22%	0.0036	-0.72	0.62
1993-2007					
CPIH	0.17%	0.22%	0.0029	-0.79	0.31
CPI	0.15%	0.25%	0.0035	-1.02	0.71
2009-2020					
CPIH	0.16%	0.19%	0.0027	-0.58	0.98
CPI	0.17%	0.20%	0.0034	-0.59	1.06

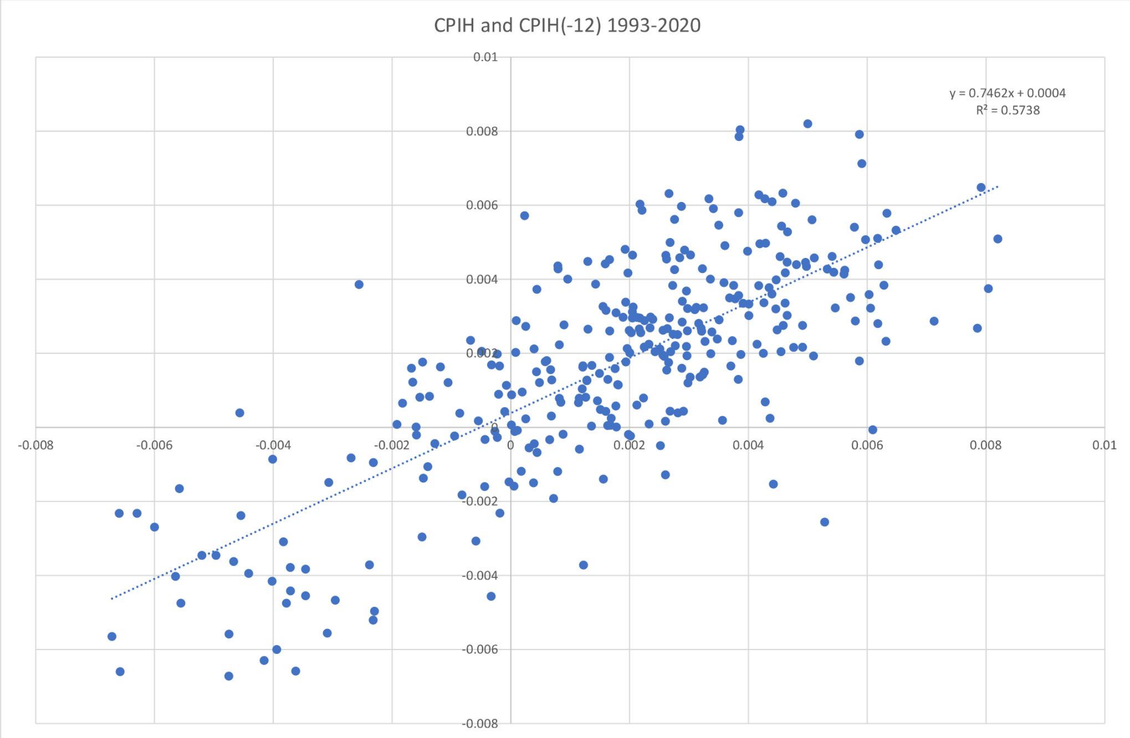
The mean is exactly what we would anticipate when annual inflation averages 2 percent across the entire period and the two sub-periods. Small amounts of negative skewness and somewhat positive excess kurtosis are present. These are far enough away from 0 to make the distribution fail standard normality tests, but not that different. Average CPIH inflation is slightly greater before the GR than after, compared to the pre-crisis period, whereas this is not the case for CPI. When comparing the time period following the GR to the one before it, both measures have more excess Kurtosis and (negative) skewness.

Histograms for the CPIH and CPI exhibit similar medians and means, negative skewness, and low Kurtosis in comparison to the expected value of 3. The greater CPI standard deviation is the primary difference of importance: the fact that CPIH includes rental equivalence for OOH indicates that it is less erratic. This is seen by the fact that with CPI rather than CPIH, the extreme numbers at the top and bottom are further away from zero.

The statistics on inflation can also be viewed as a scatter plot. With the exception of the annual interval, the monthly inflation is quite noisy and shows little sign of serial correlation. There is actually very little link between the CPIH inflation scatter plot and its value from the preceding months: a very faint mean reversion is indicated by the small negative slope: The likelihood of a reduced value coming after a high absolute value is substantial. The constant is extremely near the mean.

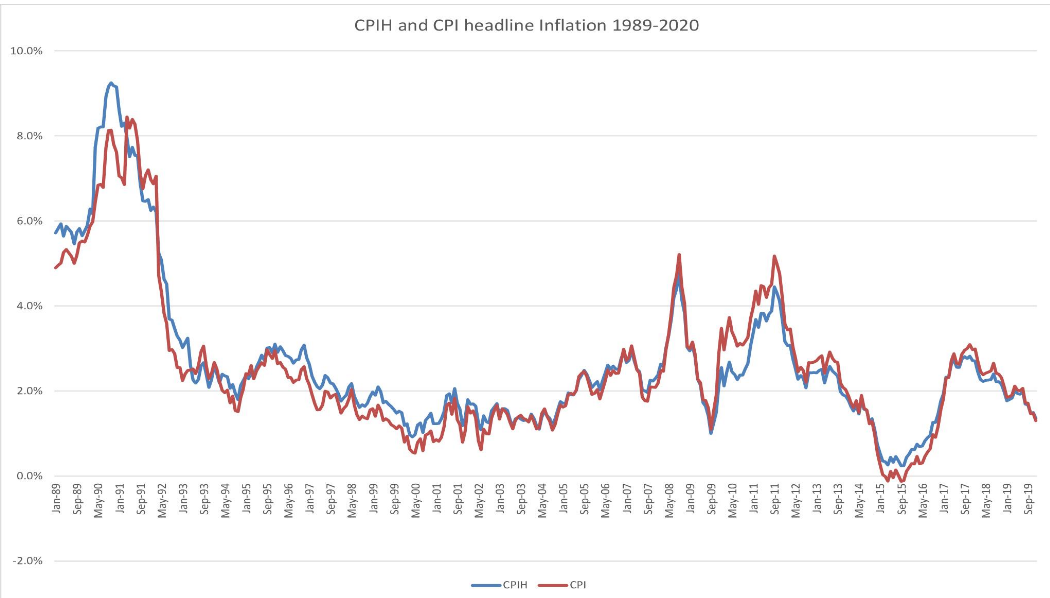


For lags longer than one month and for the CPI, the situation is essentially the same. When we compare the annual 12-month difference, we see a significant difference:



In this analysis, we find a robust and positive correlation, as indicated by a regression coefficient of 0.75. A significant contributor to this correlation is the pronounced seasonality of inflation. However, as we will discuss further, the influence of seasonality is not the only factor at play. Since 1993, monthly inflation can be reasonably well represented by a process with a stable mean, seasonality, and an error term that does not strictly follow a white noise distribution.

1.2.3 Headline Annual inflation 1989-2019.



We present both the CPI and CPIH, and if we look at the headline annual inflation published each month, we can see that it is a smooth and strongly correlated series. Both have autocorrelation coefficients that are quite near 1. Just to serve as a reminder that inflation was significantly greater prior to 1993—well above the post-1993 average—I've included the statistics from 1989 to 1993. This is merely to serve as a reminder that "trend" inflation might change. Although it has been stable over the time frame we are considering post-1993, it has the potential to rise to higher levels, as it did in the 1970s and 1980s. In fact, we have observed a similar growth in the more recent decades. Except for five months between September 1995 and November 1996, CPIH inflation remained between 1-3 percent from 1994 to March 2008. Interest rates stayed near zero during the crisis and its immediate aftermath, and no active steps were taken to control inflation. Inflation grew increasingly erratic, exceeding 3 percent twice (from April 2008 to February 2009 and from December 2010 to March 2012), and falling below 1 percent for more than 18 months (from December 2014 to August 2016) as the economy became more volatile. Of course, we may describe what was happening to headline inflation; this would include devaluations, the Brexit vote, the governor of the Bank of England's "forward guidance," and other factors. Although the inflation is, or at least seems to be stagnant near the mean of 2 percent, the departures from the mean appear to be fairly durable and can endure for extended periods of time.

1.2.4 What do we mean by the persistence of inflation?

There are several things we can imply when we discuss the mystery of inflation persistence. These fall under two categories that can be combined.

1. The empirical persistence of inflation revealed in the data was not produced by theoretical models. The question of whether different DGSE models can produce impulse response functions that resemble estimated VARs has been debated for a very long time. If there is a monetary shock, for instance, how will inflation respond? Does the model "fit" the data? Smets and Wouters (2003, 2007), Eichenbaum et al. (2004), and my supervisor work, Dixon and Kara (2011) and Dixon and Le Bihan, are a few studies from the past 20 years that have examined this topic (2012).

2. The empirical finding that inflation seems to last longer than we might anticipate. This is more of an empirical problem. Examining the time series characteristics of inflation, such as Stock and Watson's work on the "inflation gap" using the Unobserved Components technique, is one example (Stock and Watsons 2007, 2010).

In this chapter, we focus on the latter empirical issue. The descriptive data and straightforward regressions in the preceding sections demonstrate that the persistence of inflation greatly relies on whether you are examining monthly, quarterly, or overall annual statistics. When we examine monthly data, we see a little amount of first order autocorrelation as well as the enigmatic 12-month lag. In fact, the first order coefficient for CPIH is only 0.11, and the first order coefficient for CPI is not even significant. The remainder, though, is merely noise and seasonality. There is stronger first order correlation when we switch to quarterly qonq, but even at 0.3 it vanishes fairly rapidly. The relevance of the fourth quarter is rather ambiguous because it depends on the specification.

1.3 Modelling Inflation

The actual data in terms of mom inflation serves as our foundation. The sum of the twelve mom inflation rates closely approximates the annual or headline inflation in a low-inflation era, like the UK between 1993 and 2019. The behaviour of headline inflation will be modelled along with mom inflation, and we'll then examine the implications of this. Since the ending is natural, we may ignore the Covid Pandemic, which brings up a number of other problems. The beginning is somewhat less evident. However, there was a jump in inflation in the UK at the beginning of the 1990s, and some exceptional budgetary measures were used that directly affected inflation (for example, changes in indirect taxation). Osborn and Sensier (2009) investigated these, using a methodology very similar to ours for the years 1983 to 2003. Even with the Great Recession of 2008–2009 included, the period from 1993–2019 saw inflation stay below 5% for the majority of the time, averaging between 1-3%. Since RPIX is no longer in use and the findings for CPIH and CPI are essentially the same, we focus on CPI rather than CPIH or RPI.

We will also analyse the data at the 12-COICOP two-digit spending division level, as well as, to a lesser extent, at the three- and four-digit levels. The consumer price inflation tables that the ONS releases each month along with the fresh inflation estimates are the basis of our CPI data at this level of disaggregation. Our method is broken down into three steps:

Stage 1: We use historical inflation to understand current inflation. This indicates that for the headline inflation, the inflation should be modeled as an AR(12) process with seasonal and VAT dummies. The regression for CPI on itself:

$$\begin{aligned}\pi_t = \pi + \mathrm{Trend}_t + \beta_1 D_{Jan} + \ldots + \beta_{11} D_{Dec} \\ + \beta_{12} D_{recession} + \beta_{13} D_{VAT_1} + \beta_{14} D_{VAT_2} + \beta_{15} D_{VAT_3} \\ + \sum_{i=1}^{12} \lambda_i \pi_{t-i} + \sigma_t\end{aligned} \quad (1)$$

The variable π_t represents the headline inflation rate at time t, which is the overall rate at which the general level of prices for goods and services is rising. The term π is the intercept of the model. The term $\sum_{i=1}^{12} \lambda_i \pi_{t-i}$ for i from *1* to *12* represent the autoregressive part of the model, where λ are the autoregressive coefficients and π_{t-i} are the lagged values of the inflation rate. D_{Jan} to D_{Dec} are eleven dummy variables for each month. We define February as the base category against which the others are assessed to avoid the dummy variable trap. $D_{recession}$, the great recession that officially began in April 2008 and ended in June 2009, D_{VAT1} , D_{VAT2} and D_{VAT3} are three Value-add ed tax change in the United Kingdom, which were December 2008, January 2010 and January 2011.

We will also examine the impact of lagged CPI and the role of lagging inflation while examining the 12 COICOP Divisions:

$$\pi_t^j = \pi_j + \text{Trend}_t + \beta_1 D_{Jan} + \ldots + \beta_{11} D_{Dec} + \beta_{12} D_{recesion} + \beta_{13} D_{VAT_1} + \beta_{14} D_{VAT_2} + \beta_{15} D_{TAT_3} + \sum_{i=1}^{12} \alpha_i^j \pi_{t-i}^j + \sum_{i=1}^{12} \gamma_i^j \pi_{t-i} + \sigma_t^j \quad (2)$$

The variable π_t^j represents the inflation rate of the j - th COICOP division at time t. The term π_j is the intercept for the j - th COICOP division. The terms $\sum_{i=1}^{12} \alpha_i^j \pi_{t-i}^j$ for i from 1 to 12 represent the autoregressive component of the model. Specifically, α_i^j is the coefficient for the inflation rate of the j - th COICOP division at time $t - i$, which captures the influence of past inflation rates in the same division on the current inflation rate. Similarly, the terms $\gamma_i^j \pi_{t-i}$ for i from 1 to 12 represent the lagged effects of the aggregate inflation rate on the inflation rate of the j - th COICOP division.

Our model applies to not only UK monthly data but also quarterly data. The monthly or quarterly dummy variable and lag dependent variable are essential for the model. Hence when we change UK monthly data to quarterly data, the corresponding variables are changed. For example, $D_{Jan} \ldots D_{Dec}$, they are eleven dummy variables for each month, we will replace monthly dummies with Q_1, Q_3 Q_4 in quarterly data. Similarly, the maximum lag-dependent period varies from 12 to 4. Since there is no official monthly CPI Quarterly Index available, the quarterly price indexes will be calculated by taking the average of the three-monthly price indexes. Therefore, the regression for CPI on itself can be defined as

$$\pi_t = \pi + \text{Trend}_t + \beta_1 Q_1 + \beta_2 Q_3 + \beta_3 Q_4 \; \beta_4 D_{recesion} + \beta_5 D_{VAT_1} + \beta_6 D_{VAT_2} + \beta_7 D_{VAT_3} + \sum_{i=1}^{4} \lambda_i \pi_{t-i} + \sigma_t \quad (3)$$

When examining the 12 COICOP Divisions:

$$\pi_t^j = \pi_j + \text{Trend}_t + \beta_1 Q_1 + \beta_2 Q_3 + \beta_3 Q_4 + \beta_4 D_{recession} + \beta_5 D_{VAT_1} + \beta_6 D_{VAT_2} + \beta_7 D_{VAT_3} + \sum_{i=1}^{4} \alpha_i^j \pi_{t-i}^j + \sum_{i=1}^{4} \gamma_i^j \pi_{t-i} + \sigma_t^j \quad (4)$$

Where π_t is the quarterly inflation, $\mathbf{Q_1}$, $\mathbf{Q_3}$ $\mathbf{Q_4}$ are three dummy variables for each quarter, we define Q_2 as base category against which the others are assessed to avoid the dummy variable trap. $D_{recession}$, $\mathbf{D_{VAT1}}$, $\mathbf{D_{VAT2}}$ and $\mathbf{D_{VAT3}}$ are the same as equation (2).

Stage 2: To provide a concise specification, we simplify the regressions. Our approach is straightforward stepwise regression, and we only want significant regressors as our outcome. Although somewhat arbitrary, this nonetheless offers a general summary of the important issues.

Stepwise regression is the step-by-step iterative construction of a regression model that involves the selection of independent variables. It usually takes the form of a series of F-tests or T-tests. Still, some researchers may also use other techniques, such as adjusting R square, Akaike information standard (AIC), Bayesian information standard, Mallow's C_P, PRESS, or false discovery rate.

Stepwise included three main approaches: forward selection, backward elimination, and bidirectional elimination.

Forward selection, i.e., no variables from the model start using the selected model fit to add a standard test case for each variable and add in the statistical fit to improve the most significant variable (if any) and repeat this process until no one can improve the model to a statistically significant degree.

Backward elimination method, starting from all potential variables, using the selected model fit criteria to test the deletion of each variable, deleting the variable (if any), the loss of which leads to the least statistically significant deterioration of the model fit. Repeat this process until no other variables can not be removed and there is no statistically insignificant fit loss.

The Bidirectional elimination checks the variables included or excluded at each step, combined with the above methods.

For each Division (CPI), we go through a systematic procedure to simplify the lag structure: first look at the aggregate and simplify using AIC. Given the results, use F-test to eliminate all insignificant variables (choose p=0.05 as the cut-off). Omit the least significant independent variable and do a F-test to see whether is significant for equations. Once it passes the test, rerun until all variables are significant at 5% or 1%. In this process, we always leave the dummy variables (VAT, monthly, crisis etc.) in regression, even if insignificant.

Stage 3: As additional variables that might serve as explanatory factors, we add them to the mix. As these:

a. Consumption at the aggregate level for CPI and each of the 12 COICOP divisions, which measures output growth[1]. The demand by households for the commodities included in the CPI measure is better captured by this output variable for consumer prices. GDP is a considerably more comprehensive indicator of output and demand, whereas industrial production is a more limited indicator and has a less correlation with final household spending.
b. Unemployment. Recent research on pricing behaviour and sales has demonstrated that this is a key variable (Kryvtsov and Vincent 2021). It captures the state of the labour market and uncertainty.
c. PPI inflation. PPI tracks producer price behaviour, and this may possibly be a pipeline effect: the prices included in PPI may be for intermediates used to create finished consumer items or for goods that are on their way to retailers.

Stage 4: Consolidate the regressions from Stage 3 to get a final parsimonious form.

We would anticipate inflation to rise as output increases and decreases with unemployment, which are both classic "Phillips curve" type factors. As a cost-push variable, PPI can be considered, and we would anticipate that inflation in PPI would increase inflation in CPI.

1.3.1 CPI inflation as an autoregressive process.

The first column in Table 2 shows that the only significant variables (other than constant and monthly dummies) are the three VAT changes and the first and twelfth lags of inflation when the AR(12) is run with dummies for VAT changes, the crisis, and calendar months. The lagged inflation coefficients are small, at 0.12 on the first lag and

[1] Data on household consumption at the level of the 12 COICOP divisions is to be found in Economic Trends.

0.24 on the twelfth. The conclusion is nearly the same if we reduce the equation to its simplest form, which has coefficients on the first lag of 0.11 and 0.27, respectively.

Table 2 Regressions for CPI on itself.

	CPI	CPI(StepwiseAIC)
CPI_LDV1	0.12**	0.11**
CPI_LDV2	−0.04	
CPI_LDV3	0.05	
CPI_LDV4	0.04	
CPI_LDV5	0.01	
CPI_LDV6	−0.01	
CPI_LDV7	0.02	
CPI_LDV8	0.01	
CPI_LDV9	0.06	
CPI_LDV10	−0.01	
CPI_LDV11	0.07	
CPI_LDV12	0.24***	0.27***
NUM.OBS.	324	324
R2	0.738	0.733
R2 ADJ.	0.713	0.717
AIC	−121.5	−135.2
BIC	−8.1	−59.6
F	29.663	46.463
RMSE	0.18	0.18

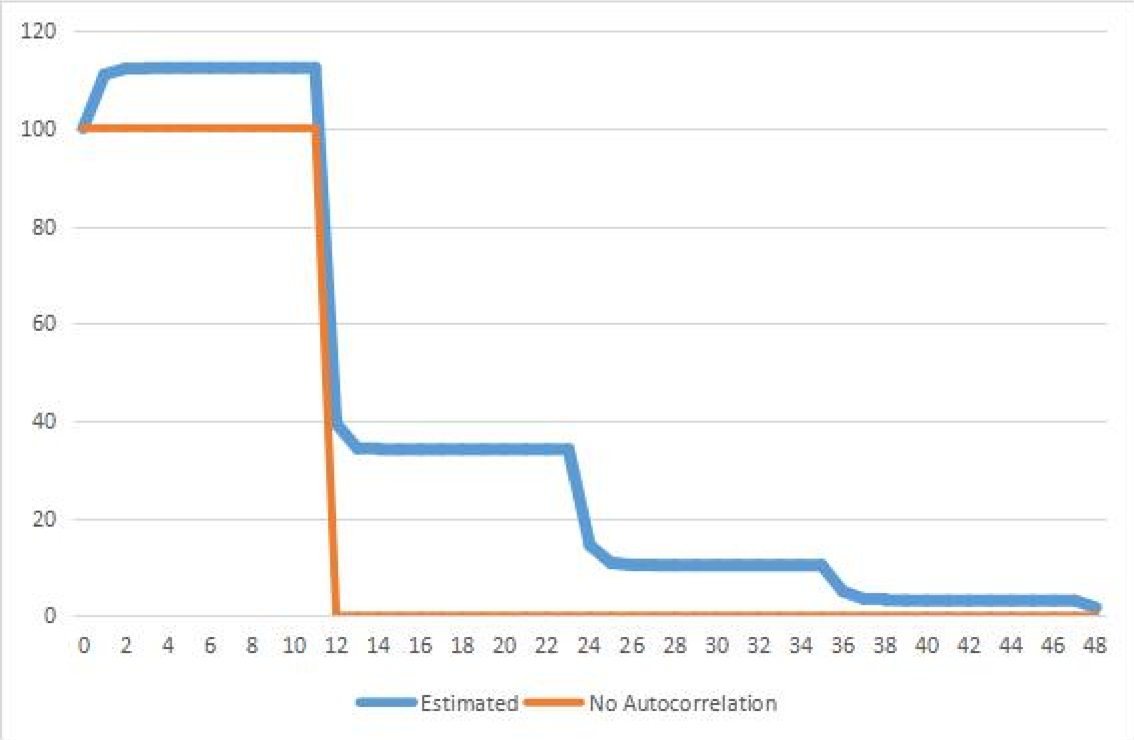
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Is there a "seasonal" component to the significant coefficient on the 12-lag? Not in the sense that each calendar month has been taken into account and the 12-month lag effect is a common effect that holds true for every single month in the regression. Simple methods for adjusting for seasonality include using "seasonal dummies," which implicitly presume that the seasonal effect is constant over the sample's years. A 12-month lag, however, is undoubtedly seasonal in that it connects a given month's inflation to that of the same month a year prior. Additionally, there are a few echoes from earlier periods of time: there is a tiny influence of 0.06 from two years ago (0.24^2).

What effects does this lag structure have on the persistence of headline inflation? The 12-month total of inflation from the current month to the 11th lag is used to approximate CPI inflation. Let us consider a scenario where there is a one-time shock that doubles the inflation rate, for example, from 2% to 4%. Assume all the lagged coefficients were zero and that mom inflation did not exhibit any significant autocorrelation. Since annual inflation in this scenario equals the total of the twelve monthly inflation rates, we experience the well-known 12-month persistence of a monthly shock, which is the period of time during which the shock persists in the inflation number until it "drops out." Figure 2 illustrates this mechanical relationship. We set the initial shock to 100 such that the vertical axis can be read as the percentage of the shock still present after x months (horizontal axis).

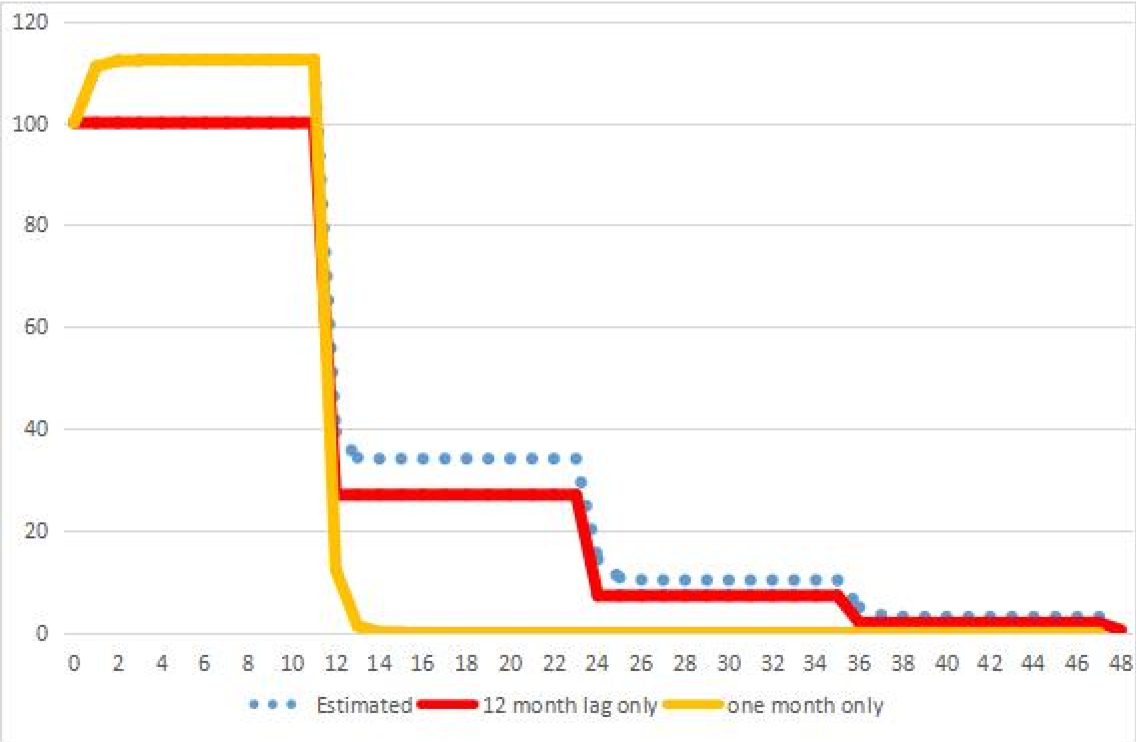
We also show how headline inflation would respond to a shock if it followed the expected autocorrelation coefficients from the sparse regression. The presence of the first order autocorrelation in mom inflation suggests that when we examine annual inflation, there is a slight increase that accumulates: if we consider the initial shock in period 1 to be 100, the next month we have an additional 11.6 and the month after that an additional 1.34, which leads to a cumulative effect of just over 13 after month 4. Consequently, we can see that the initial shock for annual inflation, which was 100, increased to 113 by month 4, and then remained almost steady thereafter (there are very small increases). The first shock fades away around month twelve. The upcoming 12-month lag, however, cushions the fall. In month 13, headline inflation drops to just under 40, and from months 13 through 23, it stays at just above 34. The inflation from month 13 disappears in month 24 and decreases to 10%. We then observe another decline in month 36 to around 3% until month 48. Additionally, we can observe that inflation exhibits a hump-shaped response: the strongest impact is not on impact in period 0, but rather there is a (flat) peak at month 11.

Figure 2: Persistence of a One-Time Inflation Shock Over Time



This is genuinely quite amazing. The headline CPI inflation is highly persistently impacted by a simple one-month shock to mom inflation. Due to the annual nature of CPI inflation, there is a mechanical "drop-in drop-out" effect. The persistence, however, increases dramatically due to the tiny amount of autocorrelation. The headline still contains 34% of the initial shock after two years and more than 10% after three. This persistence is primarily caused by the 12-month lag. We provide two more answers in Figure 3, one with just the first-order autocorrelation and the other with just the 12-month autocorrelation (with the dotted blue line being the estimated one). There is additional inflation with just a one-month lag for the first 12 months, but this quickly diminishes to nearly zero after that. There is far more persistence when the lag is only 12 months, but inflation lacks the "hump shape" surge in the early months.

Figure 3: Impact of Autocorrelation and 12-Month Lag on Inflation Persistence



The impact that results from having only first order autocorrelation is what we'll discuss next. The fact that mom inflation exhibits first order autocorrelation suggests that there is a little rise in yearly inflation that builds up: If we consider the initial shock in period 1 to be 100, the following month brings an extra 11.6; the following month brings an additional 1.34, and so on until month 4, when the total effect is slightly over 13. Consequently, we can see that the initial shock for annual inflation, which was 100, increased to 113 by month 4, and then remained almost constant thereafter (there are very small increases). The first shock fades away at month 13; inflation lowers to 13.3; at month 14, it reduces to 1.5; and then it quickly disappears. Therefore, beyond the simple mathematical effect, the first order autocorrelation has essentially no significant influence on the durability of yearly inflation. We may thus conclude that the hump-shaped reaction is caused by the first-order autocorrelation, but the persistence is caused by the twelfth lag.

This is a crucial lesson. A significant persistence in yearly inflation can result from even a small correlation in mom inflation.

1.3.2 Inflation for different expenditure types

We use a similar strategy for the 12 different forms of expenditure in this section (COICOP divisions). A weighted average of the 12 COICOP kinds makes up the headline CPI. The same dummies and lag structure are used to predict mom inflation for each division. However, there is a significant distinction: we additionally take into account total CPI inflation with up to 12 lags. This allows us to determine whether the 12-month lag we discovered in the previous section is mostly due to prices in each division responding to the overall CPI figure or to their own division. The entire regression findings will be reported in the appendix, but just the parsimonious results will be reported in the main text.

The results in Table 3 states that: when AR(12) is run with VAT changes, crisis and calendar month dummies for 12 COICOP types, the 12 month lag effect is not going from CPI to the divisions, but rather holds for several of the divisions. The twelve month effect is absent from 06 (Health) and 08 (Communication). It is significant in the remaining 10 COICO divisions and always has a positive sign (the highest being 0.47 for Education). For several divisions, the one month lag effect does not go from CPI to them. Transport (07), Communication (08) and Education(10) do not exhibit the twelve-month effect. The remaining seven sectors show a negative trend, despite the positive signs in 01(Food and Non-Alcoholic Beverages) and 04(Housing, Water, Electricity, Gas and Other Fuels).

If we look at the whole range of results, we do see there is some effect of CPI on the individual divisions. However, the significant lags are rare (no lag length is present in more than three divisions) except 3 and 6 month lag effect of CPI and the most common lags are 3 and 6 months, with different signs for each across sectors. Overall, there is only a few longer lags beyond 7 months (including the annual lag) and only limited evidence for the effects of CPI at shorter lags. This is a strong result. It seems to indicate that pricing behaviour is more driven by sectoral considerations than what is going on at the aggregate level.

Table 3 Stepwise Analysis: Divisions (Monthly data)

	01FB	*02AT*	*03CF*	*04HW*	*05FH*	*06HL*	*07TR*	*08CM*	*09RC*	*10ED*	*11RH*	*12MS*
LDV1	0.14**	−0.17***	−0.21***	0.22***	−0.28***	−0.38***			−0.18***		−0.11**	−0.12**
LDV2		−0.09*	−0.13***		−0.21***	−0.39***						
LDV3			−0.14**			0.13**						0.13**
LDV4	−0.12*		−0.12**			−0.24***		−0.11**	0.13**			
LDV5			0.10**			−0.19***			0.14***			
LDV6			0.32***		0.23***	−0.22***			0.19***			
LDV7			0.10*	0.10*	0.09*							
LDV8				−0.10*								−0.09*
LDV9			0.09*				−0.13**	0.11*			−0.11*	
LDV10		0.09*			−0.16***							
LDV11					−0.11**	−0.15***						
LDV12	0.12**	0.28***	0.30***	0.14**	0.35***		0.22***		0.21***	0.47***	0.19***	0.11**
CPI-LDV1							0.58***					0.16*
CPI-LDV3		0.37**	0.68***	0.34**			−0.56***	0.46***		0.64**		
CPI-LDV4	0.49***			0.27*							0.09*	
CPI-LDV6		0.65***		−0.32**			−0.38*		−0.18**			

CPI-LDV7		−0.51***			0.51***							
CPI-LDV8	0.32**											
CPI-LDV9							0.44*					
CPI-LDV11									0.15*			
Num.Obs.	324	324	324	324	324	324	324	324	324	324	324	324
R2	0.284	0.632	0.935	0.332	0.923	0.434	0.56	0.191	0.365	0.593	0.459	0.197
R2 Adj.	0.235	0.604	0.929	0.28	0.917	0.39	0.528	0.14	0.317	0.569	0.423	0.141
AIC	568.1	573	692.8	573.3	413.3	704.4	739.6	656.6	140.6	1028.7	−206.6	152.4
BIC	655.1	667.5	798.6	667.8	511.6	798.9	830.4	736	235.1	1104.4	−123.4	239.4
F	5.712	22.379	164.601	6.472	149.196	9.989	17.443	3.768	7.509	24.656	12.845	3.531
RMSE	0.54	0.54	0.65	0.54	0.42	0.66	0.7	0.62	0.28	1.11	0.16	0.29

** p < 0.1, ** p < 0.05, *** p < 0.01*

1.3.3 Inflation for more detailed level of COICOP classification

So far, our model has analysed inflation for aggregate CPI and the highest level of the COICOP classification, the division level, using mom inflation data. As well as the full regression results, we also present the stepwise parsimonious results. This section discusses more detailed level of COICOP classification (38 groups and 71 classes) using the same approach. The first step is to look at group levels, and then we move onto class levels. The main text only reports the parsimonious results for 38 group level and the proportion of significant variables across all class. The full regression results at class level are presented in the appendix.

It is still possible to include the aggregate CPI inflation with lags of up to 12 months as before, so we can see if the lags found in previously are primarily due to each class(group) prices responding to the total CPI figure, or their own class(group).

From Table 4 to Table 7, one month lag effect holds for 21 groups out of 38, while 12-month lag is going from CPI to the 23 groups and always has a positive sign. CPI does appear to have some effects on the individual groups when we consider the whole range of results. There are, however, few significant lags (no lag length is found in more than three groups), with the most common lags being six months, with different signs amongst the groups. Overall, there is a total absence of 5, 10, 12 months lags. There is a strong signal here, which suggests that pricing behaviour is more influenced by group concerns than by aggregate factors.

When we are looking at class levels (four-digit number), it is possible that groups (divisions) do not have sub-classes. We replace it with groups if this is the case, or we replace it with divisions if there are no groups. For example, under Education (10), there are no subbranches, whether divisions or groups, so we use division data instead. The sum of the classes, groups and divisions results in 85 regressions. Using the same dummies and lag structure, we model mom inflation for each class. To make the significance lag variables easier to understand, we created summary tables. Table 8-Table 9 shows summary tables from OLS and stepwise estimates using monthly data, respectively. Tables rows are lagging CPIs and lower price indices. The first column gives the proportion of classes where the coefficient is significant at 1%, and the second column at 5%. The following two columns are the weighted proportion (each type is CPI weighted). The following four columns would be the same as the first four but are the simplified model (i.e., after the stepwise regression program). For example, in Table 8 , we have two out of eleven classes where the coefficient is significant at 1% in food and non-alcoholic beverages, multiplying the corresponding 2014 Food and non-alcoholic beverages weights. In the same way, then calculate the remaining twelve divisions and add them up, we will get a proportion where the CPI lags by one period is significant at 1%, 4.95% in this case.

Take a close look at the summary table details. The full regressions result with monthly data are in Table 8. Whether weighted or not, at the 1% and 5% significant level, the significant proportion of most lag dependent variables is higher than the CPI lag dependent variable, which implies lag dependent variable may have a higher impact than the CPI lag dependent variable. CPI six-month lag dominates CPI lag dependent variable while lagging one-month and twelve-month have the highest proportion comparing the rest inflation lag dependent variable. From the unweighted to weighted proportion part, the number of each corresponding does not show much fluctuation. When we look at a significant level from 5% to 1%, all explanatory variables had a natural percentage decline. It is worth noting that CPI 11 month lag is not significant below 1% in any 85 class. Lag 1 and 12 still maintained a high significant proportion. More than half of the lag 1 P-value is less than 0.01.

Move toward parsimonious results, the significant coefficients proportion does not show many changes compared to full regression results. CPI lag variables have little impact on inflation. The significant proportion of CPI six-month lag coefficient in 85 regressions is also the highest. In the unweighted columns, lags one month and twelve months account for a high proportion at a 5% significant level, with 54.12% and 62.35%, indicating more than half of 85 class regressions, the one and twelve-month lag have an essential effect on inflation. As seen from the third column of Table 9, the weighted proportion shows that one-month and 12-month lag significantly impact inflation at the 5% significant level. This is a strong result, which is consistent with what we have seen on the aggregate CPI, divisions and groups level. Pricing behaviour appears to be influenced more by class considerations than by aggregate factors.

Table 4 Stepwise Analysis: Groups 1 (Monthly data)

	Dependent variable:								
	FOOD	NON-ALCOHOLIC BEVERAGES	ALCOHOLIC BEVERAGES	TOBACCO	CLOTHING	FOOTWEAR INCLUDING REPAIRS	ACTUAL RENTALS FOR HOUSING	REGULAR MAINTENANCE AND REPAIR OF THE DWELLING	WATER SUPPLY AND MISC. SERVICES FOR THE DWELLING
lag1	0.15*	-0.30*	-0.44*		-0.22*				
lag2		-0.16*	-0.27*						
lag3			-0.16*						
lag4									
lag5									
lag6					0.34*	0.17*		0.19*	
lag7		0.15*							
lag9								0.14*	
lag11						0.17*			
lag12		0.19*	0.24*	0.27*	0.29*	0.27*	0.73*		0.27*
CPI_lag1									
CPI_lag3			0.80*		0.60*				
CPI_lag4				0.58*					
CPI_lag5									
CPI_lag6			1.17*						
CPI_lag7									
CPI_lag9							-0.17*		
CPI_lag12									
Observations	324	324	324	324	324	324	324	324	324
R^2	0.25	0.33	0.72	0.40	0.93	0.84	0.86	0.24	0.57
Adjusted R^2	0.21	0.29	0.70	0.36	0.93	0.83	0.86	0.18	0.54
Residual Std. Error	0.62	0.76	0.82	0.73	0.74	0.74	0.22	0.38	1.04
F Statistic	5.74*	6.88*	35.49*	11.14*	168.42*	78.54*	96.40*	4.47*	23.57*
Note:									* p<0.01;

Table 5 Stepwise Analysis: Groups 2 (Monthly data)

	Dependent variable:								
	ELECTRICITY, GAS AND OTHER FUELS	FURNITURE, FURNISHINGS and CARPETS	HOUSEHOLD TEXTILES	HOUSEHOLD APPLIANCES, FITTING AND REPAIRS	GLASSWARE, TABLEWARE and HOUSEHOLD UTENSILS	TOOLS AND EQUIPMENT FOR HOUSE AND GARDEN	GOODS AND SERVICES FOR ROUTINE MAINTENANCE	MEDICAL PRODUCTS, APPLIANCES AND EQUIPMENT	OUT-PATIENT SERVICES
lag1	0.26*	-0.50*	-0.35*	-0.20*	-0.31*		-0.22*	-0.43*	
lag2		-0.37*	-0.16*					-0.35*	
lag3		-0.14*							
lag4							-0.17*	-0.16*	
lag5									
lag6		0.14*							
lag7		0.12*		0.15*					
lag8							-		
lag10		-0.19*							-0.20*
lag11		-0.22*							
lag12		0.26*	0.18*	0.24*	0.14*				
CPI_lag1									
CPI_lag2						0.62*			
CPI_lag3									
CPI_lag4						0.52*			
CPI_lag5									
CPI_lag6			0.66*						
CPI_lag7							0.84*		0.37*
CPI_lag8						0.63*			
CPI_lag9									
CPI_lag11					0.62*				
CPI_lag12									
Observations	324	324	324	324	324	324	324	324	230
R^2	0.13	0.91	0.88	0.40	0.68	0.25	0.26	0.39	0.29
Adjusted R^2	0.08	0.90	0.87	0.36	0.65	0.20	0.21	0.34	0.22
Residual Std. Error	1.59	0.90	0.80	0.99	0.85	0.65	0.56	0.76	0.40
F Statistic	2.63*	106.00*	103.43*	10.65*	27.66*	4.76*	5.00*	7.91*	4.44*

Note: * p<0.01;

Table 6 Stepwise Analysis: Groups 3 (Monthly data)

	Dependent variable:								
	HOSPITAL SERVICES	PURCHASE OF VEHICLES	OPERATION OF PERSONAL TRANSPORT EQUIPMENT	TRANSPORT SERVICES	POSTAL SERVICES	TELEPHONE AND TELEFAX EQUIPMENT AND SERVICES	AUDIO-VISUAL EQUIPMENT AND RELATED PRODUCTS	OTHER MAJOR DURABLES FOR RECREATION AND CULTURE	OTHER RECREATIONAL ITEMS, GARDENS and PETS
lag1		0.39*	0.31*	-0.49*					-0.42*
lag2				-0.34*					
lag3	-0.25*			-0.40*			0.17*		-0.15*
lag4				-0.27*					
lag5		-		-0.24*					
lag6	-0.21*			-0.31*			0.16*		
lag7				-0.30*					-0.15*
lag8				-0.18*			0.19*		
lag9				-0.39*					
lag10		0.15*		-0.32*					
lag11			0.18*	-0.20*					
lag12	0.47*			0.26*			0.17*		0.26*
CPI_lag2			-1.00*	1.85*					
CPI_lag3									
CPI_lag5									
CPI_lag7		-0.42*							
CPI_lag9				1.60*					
Observations	216	324	324	324	324	324	324	228	324
R^2	0.67	0.41	0.33	0.80	0.21	0.17	0.35	0.36	0.38
Adjusted R^2	0.64	0.37	0.29	0.78	0.17	0.12	0.31	0.30	0.33
Residual Std. Error	0.47	0.51	0.95	1.89	1.63	0.70	0.86	0.43	0.75
F Statistic	20.81*	10.02*	7.58*	37.07*	4.63*	3.48*	8.31*	6.53*	8.68*
Note:									* p<0.01;

Table 7 Stepwise Analysis: Groups 4 (Monthly data)

	Dependent variable:										
	RECREATIONAL AND CULTURAL SERVICES	BOOKS, NEWSPAPERS AND STATIONERY	PACKAGE HOLIDAY	CATERING SERVICES	ACCOMMODATION SERVICES	PERSONAL CARE	PERSONAL EFFECTS (NEC)	SOCIAL PROTECTION	INSURANCE	FINANCIAL SERVICES (NEC)	OTHER SERVICES (NEC)
lag1	-0.17^{*}	-0.21^{*}	0.43^{*}		-0.21^{*}	-0.21^{*}	-0.16^{*}				
lag2			0.24^{*}								
lag3									0.25^{*}		
lag6					-0.19^{*}		0.18^{*}		0.15^{*}		
lag8											
lag9										0.18^{*}	0.17^{*}
lag12	0.22^{*}	0.26^{*}		0.20^{*}		0.16^{*}	0.18^{*}	0.36^{*}	0.14^{*}		0.21^{*}
CPI_lag1							0.55^{*}				
CPI_lag2											
CPI_lag3											
CPI_lag4				0.11^{*}							
CPI_lag6					-0.56^{*}		0.44^{*}				
CPI_lag7											
CPI_lag9	0.34^{*}										
CPI_lag10											
CPI_lag11											
CPI_lag12											
Observations	324	324	311	324	281	324	324	228	324	324	324
R^2	0.62	0.34	0.47	0.53	0.34	0.23	0.74	0.61	0.25	0.08	0.28
Adjusted R^2	0.60	0.30	0.43	0.50	0.30	0.18	0.72	0.57	0.20	0.02	0.23
Residual Std. Error	0.45	0.70	0.29	0.12	0.69	0.46	0.53	0.15	1.01	1.74	0.51
F Statistic	23.95^{*}	7.19^{*}	12.66^{*}	16.34^{*}	7.21^{*}	4.67^{*}	41.44^{*}	14.41^{*}	5.06^{*}	1.43	5.87^{*}

Note: * $p<0.01$;

Table 8 OLS Analysis: Summary table (Monthly data)

	p<0.01	p<0.05	p<0.01(Weight)	p<0.05(Weight)
CPI_lag1	5.88%	11.76%	4.95%	10.21%
CPI_lag2	3.53%	12.94%	3.51%	15.17%
CPI_lag3	2.35%	11.76%	2.63%	12.32%
CPI_lag4	7.06%	9.41%	9.54%	11.66%
CPI_lag5	1.18%	5.88%	1.38%	5.64%
CPI_lag6	9.41%	16.47%	11.72%	20.98%
CPI_lag7	3.53%	8.24%	2.87%	6.30%
CPI_lag8	1.18%	4.71%	0.99%	3.72%
CPI_lag9	3.53%	9.41%	3.22%	8.41%
CPI_lag10	2.35%	7.06%	2.33%	6.60%
CPI_lag11	0.00%	2.35%	0.00%	1.69%
CPI_lag12	1.18%	3.53%	0.95%	3.22%
Lag1	48.24%	60.00%	46.53%	57.11%
Lag2	25.88%	37.65%	22.37%	36.24%
Lag3	17.65%	29.41%	14.74%	26.90%
Lag4	10.59%	20.00%	8.84%	16.81%
Lag5	4.71%	12.94%	4.75%	11.65%
Lag6	14.12%	24.71%	16.53%	26.91%
Lag7	3.53%	12.94%	3.75%	11.23%
Lag8	4.71%	14.12%	4.64%	12.94%
Lag9	7.06%	21.18%	6.13%	18.74%
Lag10	5.88%	14.12%	5.33%	12.59%
Lag11	8.24%	14.12%	7.46%	13.01%
Lag12	34.12%	54.12%	34.39%	51.35%

Table 9 Stepwise Analysis: Summary Table (Monthly data)

	p<0.01	p<0.05	p<0.01(Weight)	p<0.05(Weight)
CPI_lag1	3.53%	11.76%	2.97%	10.71%
CPI_lag2	4.71%	11.76%	4.46%	14.22%
CPI_lag3	3.53%	12.94%	3.90%	12.71%
CPI_lag4	8.24%	10.59%	10.28%	12.55%
CPI_lag5	1.18%	8.24%	0.99%	8.34%
CPI_lag6	10.59%	16.47%	12.75%	21.28%
CPI_lag7	3.53%	10.59%	2.87%	8.63%
CPI_lag8	1.18%	5.88%	0.74%	5.29%
CPI_lag9	3.53%	12.94%	3.22%	11.07%
CPI_lag10	3.53%	8.24%	3.28%	8.08%
CPI_lag11	1.18%	8.24%	0.74%	10.22%
CPI_lag12	1.18%	7.06%	0.95%	6.87%
Lag1	48.24%	54.12%	46.02%	52.46%
Lag2	25.88%	35.29%	22.35%	33.88%
Lag3	16.47%	23.53%	14.18%	20.57%
Lag4	5.88%	15.29%	5.73%	13.08%
Lag5	5.88%	9.41%	5.70%	8.51%
Lag6	15.29%	23.53%	17.93%	25.95%
Lag7	8.24%	14.12%	7.43%	11.98%
Lag8	7.06%	12.94%	7.36%	12.67%
Lag9	10.59%	17.65%	9.41%	15.53%
Lag10	7.06%	12.94%	6.38%	10.89%
Lag11	7.06%	15.29%	7.74%	14.44%
Lag12	48.24%	62.35%	45.78%	61.38%

1.3.4 Quarter on quarter inflation 1993-2019

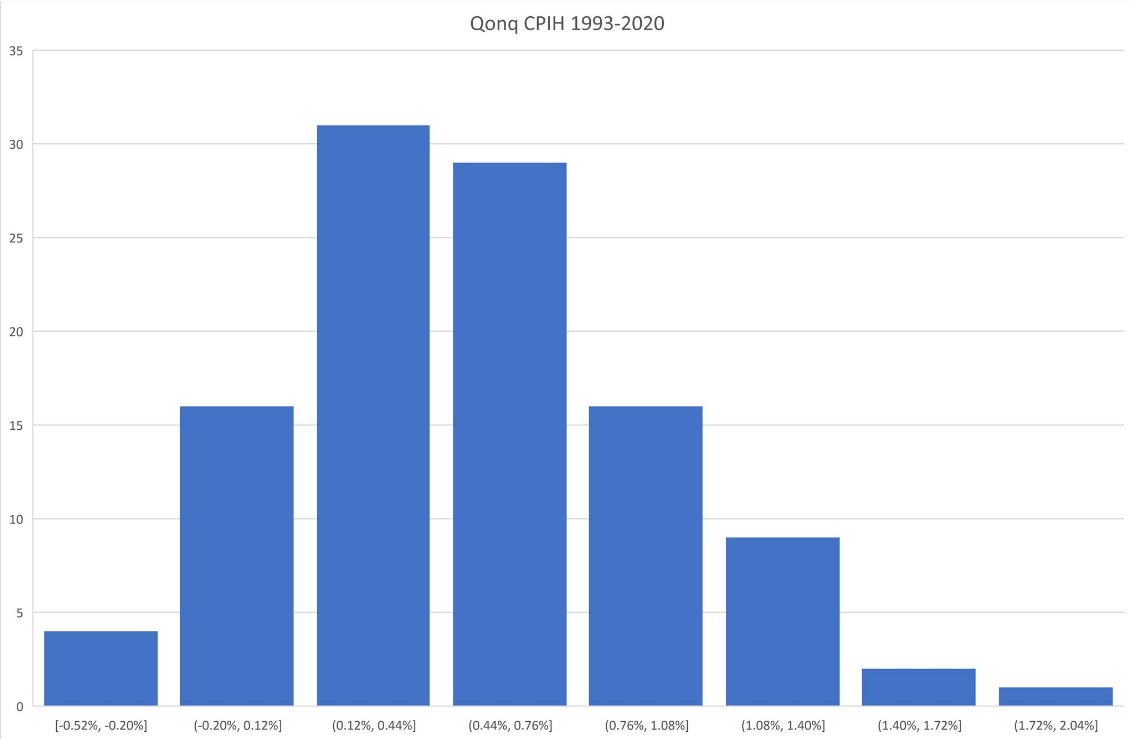
Since GDP is only accessible as a trustworthy number with a lengthy time series on a quarterly basis, quarter-on-quarter inflation (qonq) is a common measure in econometric analyses of macroeconomic data. This should not be mistaken with the ONS's quarterly inflation statistics, which represent yearly inflation averaged by quarter. The CPIH or CPI index is averaged over the three months in each quarter to determine qonq inflation, which is then used to determine the proportional change in level between quarters.

The statistics for the qonq are as follows:

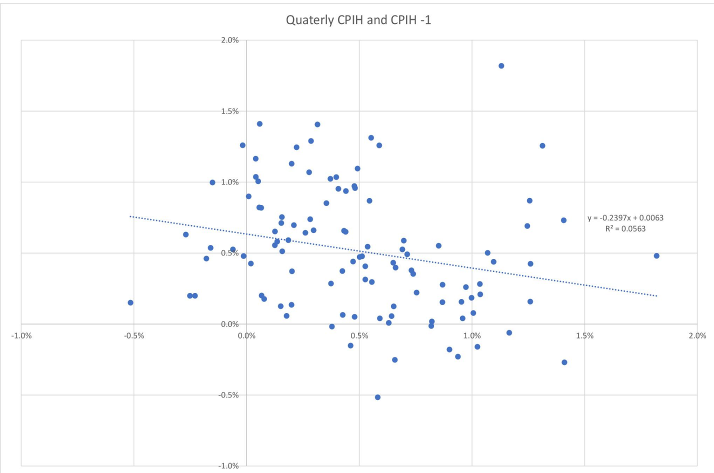
Table 10 quarter on quarter inflation statistics

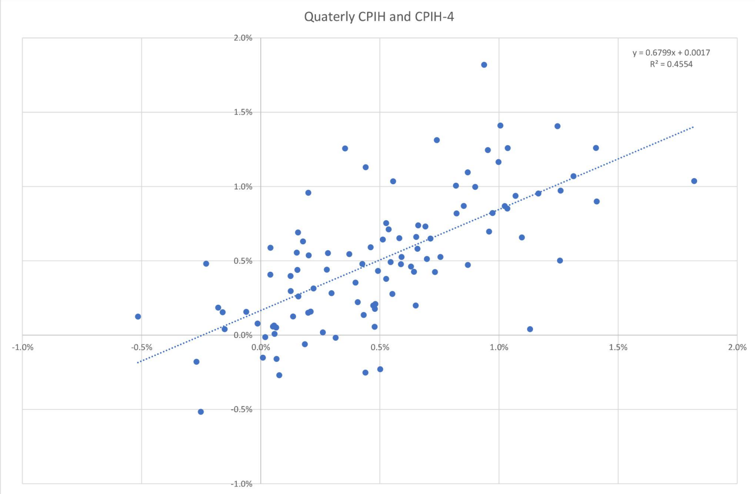
1993-2019	mean	median	St. dev.	skewness	Ex. Kurt.
CPIH	0.51%	0.50%	0.0044	0.35	-0.17
CPI	0.50%	0.50%	0.0052	0.36	0.09
1993-2007					
CPIH	0.50%	0.46%	0.0044	0.38	-0.82
CPI	0.46%	0.46%	0.0052	0.55	-0.08
2010-2019					
CPIH	0.50%	0.50%	0.0039	-0.10	0.15
CPI	0.53%	0.59%	0.0048	-0.15	0.39

The quarterly data demonstrates strong positive skewness and minimal excess kurtosis for the whole period 1993Q2 to 2019Q4 (although CPIH is slightly negative rather than positive). When comparing the pre-GR era 1993–2007, excess kurtosis is more negatively skewed whereas positive skewness is more prevalent. The median and mean inflation rates are both lower than for the entire sample (more significantly for CPI than CPIH). After GR, from 2010 to 2019, excess Kurtosis turns positive and skewness turns negative. For CPI greater than pre-GR, the median inflation rises noticeably but the mean inflation for CPIH remains constant. When the CPI is higher than before the Great Recession, the mean inflation rises dramatically but the CPIH mean inflation stays the same. Although it decreases marginally after GR, the standard deviation is mostly unchanged.



In terms of scatterplots of CPIH with CPIH lagged one quarter and two quarters, we see





The qonq indicator exhibits a strong positive association at the annual lag, similar to mom inflation. Of course, seasonality may be largely to blame for this.

1.3.5 Can the findings of the quarterly data be consistent with the monthly results?

To make a more accurate conclusion, we need to ensure that the mom data can be replaced by qonq data. A single equation AR(4) is used for aggregate CPI qonq inflation, with dummies assigned to reflect seasonality and VAT changes. Our analysis of the data will also be at the level of the 12 COICOP two-digit divisions of expenditure and indeed also to a lesser extent at the three and four digit levels.

By running the AR(4) with dummies for VAT changes, the crisis, and calendar months, we can see from the first column of Table 11 that the only significant variables (besides constant and quarterly dummies) are the first and fourth lags of inflation. We omit the quarterly dummy variables, time trend, recession, and VAT changes in regression output for saving space. As far as lagged inflation coefficients are concerned, both are very low: 0.33 for the first lag and 0.24 for the fourth lag. If we look at inflation in the first quarter of 2019, there is an effect from the previous quarter and from four quarters ago. This is consistent with the 1-month and 12-month significant effect we found in previous sections using monthly data. If we simplify the equation into a parsimonious form, we get much the same result with coefficients on the first lag of 0.31 and 0.26 respectively.

Next, we use seasonal dummies and lag structures to model qonq inflation for 12 COICOP divisions. There is, however, an important difference: we also include the aggregate CPI inflation with lags of up to four quarters. In this way, we can determine if the 1 and 4 quarter lag is primarily due to the prices in each division reacting to the aggregate CPI figure or to their own prices and test whether the conclusions we found in the previous section using monthly data still hold. The regressions from Table 12 illustrate that the 1 and 4 quarter lag effect does not flow from the CPI to the divisions. Especially, we remove 11(Restaurants and Hotels) from table since no coefficient statistically significant at 5% level. One quarter lag effect is only going to 07(Transport), 09(Recreation and Culture) and 12(Miscellaneous Goods and Services) and four quarter lag effect is significant in 02(Alcoholic Beverages, Tobacco and Narcotics), 03(Clothing and Footwear), 09(Recreation and Culture) and 10(Education). We cannot observe them in remaining COICOP divisions. Over the full range of results, we can see some impact of the one quarter lagged CPI on individual sectors, but no longer lags beyond 1 quarter and only limited evidence of effects of shorter lags. This finding is consistent with previous one that sectoral considerations influence pricing behaviour more than aggregate factors do.

A comparison of the parsimonious results at COICOP group level can be seen in Table 13 to Table 16. However, at the 5% level, four COICOP groups ("MEDICAL PRODUCTS, APPLIANCES AND EQUIPMENT”, "OUT-PATIENT SERVICES", "TELEPHONE AND TELEFAX EQUIPMENT AND SERVICES" and "FINANCIAL SERVICES (NEC)") do not have significant coefficients. According to these regressions, the 1 and 4 quarter lag effects do not go from CPI to divisions, but rather hold across several divisions. One quarter lag effect holds for 10 groups out of 38, while 4 quarter lag is going from CPI to the 12 groups and always has a positive sign. However, if the significance of the 1 and 12 month lag is much clearer in the data than the 1Q and 4Q lag.

The regression results at the class level show that the lagged dependent variable continues to have a dominant effect compared to the CPI. The regressions indicate that the first and fourth quarter lag effects reach certain classes, but the proportion decreases compared to the results using month-on-month data. Specifically, the first lag effect is 35% and the fourth lag effect is 28%, compared to the 60% and 54% lag effects at 1 and 12 months respectively. The coefficients for the 1 and 12 month lag effects are significant in 54% and 60% of all classes, respectively. However, when we switch to quarterly data, these proportions decrease to 35% and 28%. Second, a summary table of parsimonious regressions is shown in Table 18. All significant percentage figures increased relative to OLS estimates, but not much. There is little difference between weighted and unweighted.

From these results, we can conclude that while the quarterly data show some consistency with the monthly results, the monthly data provide a more robust measure of the lag effects on inflation. This suggests that the monthly results may be more reliable for understanding the dynamics of inflation at the class level. However, the quarterly data still provide valuable insights and should not be disregarded. Further research may be needed to fully understand the differences between the monthly and quarterly results.

Table 11 Regression for CPI (quarterly)

	Dependent variable:	
	CPI	CPI (Stepwise)
lag1[1]	0.33^{**}	0.31^{**}
lag2	-0.06	
lag3	0.07	
lag4	0.24^{**}	0.26^{**}
Observations	108	108
R^2	0.71	0.71
Adjusted R^2	0.67	0.68
Residual Std. Error	0.003	0.003
F Statistic	19.46^{**}	23.54^{**}
Note:		* p<0.05; ** p<0.01

Table 12 Stepwise Analysis: CPI and Divisions (Quarterly data)

	Dependent variable:											
	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	12MS
lag1[2]	0.31^{**}						-0.24^{*}	0.26^{**}		0.36^{**}		0.29^{**}
lag2				0.30^{**}		0.30^{**}	-0.22^{*}	-0.20^{*}				
lag3						-0.17^{*}						
lag4	0.26^{**}		0.38^{**}	0.31^{**}		0.19^{*}				0.29^{**}	0.42^{**}	
CPI_lag1		0.80^{**}	0.65^{**}	0.52^{*}	0.89^{**}				0.58^{*}			
CPI_lag2						0.37^{*}						
Observations	108	108	108	108	108	108	108	108	108	108	108	108
R^2	0.71	0.28	0.65	0.95	0.27	0.81	0.23	0.68	0.29	0.49	0.63	0.25
Adjusted R^2	0.68	0.21	0.61	0.94	0.21	0.79	0.15	0.65	0.23	0.44	0.60	0.18
Residual Std. Error	0.003	0.01	0.01	0.01	0.01	0.005	0.01	0.01	0.01	0.004	0.02	0.004
F Statistic	23.54^{**}	4.25^{**}	17.64^{**}	156.35^{**}	4.11^{**}	34.39^{**}	2.84^{**}	20.97^{**}	4.51^{**}	9.41^{**}	18.56^{**}	3.54^{**}
Note:												* p<0.05; ** p<0.01

1 Lag 1, 2...4 is the aggregate CPI inflation with 1 to 4 quarter lags.
2 Lag 1 to lag 4 are 1, 2...4 quarter lags of COICOP division.

Table 13 Stepwise Analysis: Groups 1 (Quarterly data)

	Dependent variable:							
	FOOD	NON-ALCOHOLIC BEVERAGES	ALCOHOLIC BEVERAGES	TOBACCO	CLOTHING	FOOTWEAR INCLUDING REPAIRS	ACTUAL RENTALS FOR HOUSING	REGULAR MAINTENANCE AND REPAIR OF THE DWELLING
lagQ1			-0.47*					
lagQ2					0.32*			0.39*
lagQ4			0.22*	0.42*	0.28*	0.33*	0.73*	
CPI_lagQ1	0.82*		1.28*					
CPI_lagQ2		0.64*	0.72*					
CPI_lagQ4		0.62*						
Observations	108	108	108	108	108	108	108	108
R^2	0.26	0.55	0.77	0.46	0.95	0.86	0.84	0.36
Adjusted R^2	0.19	0.50	0.75	0.42	0.94	0.85	0.83	0.30
Residual Std. Error	0.01	0.01	0.01	0.01	0.01	0.01	0.004	0.01
F Statistic	3.84*	10.75*	27.18*	9.44*	154.23*	67.80*	59.27*	6.01*
Note:								* p<0.01;

Table 14 Stepwise Analysis: Groups 2 (Quarterly data)

	Dependent variable:							
	WATER SUPPLY AND MISC. SERVICES FOR THE DWELLING	ELECTRICITY, GAS AND OTHER FUELS	FURNITURE, FURNISHINGS and CARPETS	HOUSEHOLD TEXTILES	HOUSEHOLD APPLIANCES, FITTING AND REPAIRS	GLASSWARE, TABLEWARE and HOUSEHOLD UTENSILS	TOOLS AND EQUIPMENT FOR HOUSE AND GARDEN	GOODS AND SERVICES FOR ROUTINE MAINTENANCE
lagQ1		0.31*	-0.33*					
lagQ2							0.24*	
lagQ3			-0.29*					
lagQ4	0.25*				0.31*			
CPI_lagQ1							1.02*	
CPI_lagQ2			0.72*				0.80*	0.57*
CPI_lagQ4								
Observations	108	108	108	108	108	108	108	108
R^2	0.53	0.18	0.78	0.76	0.37	0.57	0.42	0.26
Adjusted R^2	0.48	0.10	0.75	0.73	0.31	0.52	0.35	0.19
Residual Std. Error	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.01
F Statistic	12.04*	2.38	30.64*	30.62*	6.29*	12.78*	6.31*	3.45*

Note: * p<0.01;

Table 15 Stepwise Analysis: Groups 3 (Quarterly data)

	Dependent variable:							
	HOSPITAL SERVICES	PURCHASE OF VEHICLES	OPERATION OF PERSONAL TRANSPORT EQUIPMENT	TRANSPORT SERVICES	POSTAL SERVICES	AUDIO-VISUAL EQUIPMENT AND RELATED PRODUCTS	OTHER MAJOR DURABLES FOR RECREATION AND CULTURE	OTHER RECREATIONAL ITEMS, GARDENS and PETS
lagQ1	-0.63*	0.37*		-0.42*		0.44*		
lagQ2	-0.66*			-0.46*				
lagQ3	-0.55*			-0.41*		0.25*		
lagQ4				0.31*	0.57*			0.44*
CPI_lagQ1								
CPI_lagQ2								
CPI_lagQ3								
CPI_lagQ4		1.11*						0.53*
Observations	73	108	108	108	108	108	77	108
R^2	0.66	0.45	0.46	0.85	0.57	0.49	0.33	0.44
Adjusted R^2	0.59	0.38	0.41	0.82	0.53	0.44	0.24	0.39
Residual Std. Error	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01
F Statistic	9.79*	6.44*	9.13*	36.81*	14.23*	9.41*	3.73*	7.75*

Note: * $p<0.01$;

Table 16 Stepwise Analysis: Groups 4 (Quarterly data)

	Dependent variable:									
	RECREATIONAL AND CULTURAL SERVICES	BOOKS, NEWSPAPERS AND STATIONERY	PACKAGE HOLIDAY	CATERING SERVICES	ACCOMMODATION SERVICES	PERSONAL CARE	PERSONAL EFFECTS (NEC)	SOCIAL PROTECTION	INSURANCE	OTHER SERVICES (NEC)
lagQ1			0.82*				0.26*		0.58*	
lagQ2					-0.35*					
lagQ3										0.28*
lagQ4	0.24*							0.29*		
CPI_lagQ1				0.25*						
CPI_lagQ2							0.71*			-0.64*
CPI_lagQ3	0.45*									
CPI_lagQ4							0.58*	-0.26*		
Observations	108	108	105	108	93	108	108	76	108	108
R^2	0.70	0.17	0.56	0.69	0.53	0.28	0.60	0.70	0.38	0.41
Adjusted R^2	0.67	0.09	0.52	0.66	0.47	0.21	0.55	0.63	0.32	0.34
Residual Std. Error	0.01	0.01	0.01	0.002	0.01	0.01	0.01	0.002	0.02	0.01
F Statistic	22.81*	2.25	12.18*	19.71*	9.24*	4.20*	11.89*	10.97*	6.57*	6.01*

Note: * p<0.01;

Table 17 OLS Analysis: Summary table (Quarterly data)

	p<0.01	p<0.05	p<0.01(Weight)	p<0.05(Weight)
CPI_lagQ1	8.24%	17.65%	10.93%	18.53%
CPI_lagQ2	4.71%	11.76%	3.62%	13.24%
CPI_lagQ3	3.53%	4.71%	2.93%	4.50%
CPI_lagQ4	4.71%	12.94%	4.31%	14.13%
LagQ1	22.35%	35.29%	19.26%	35.03%
LagQ2	11.76%	21.18%	14.65%	22.56%
LagQ3	4.71%	11.76%	3.95%	9.73%
LagQ4	18.82%	28.24%	18.07%	29.74%

Table 18 Stepwise Analysis: Summary Table (Quarterly data)

	p<0.01	p<0.05	p<0.01(Weight)	p<0.05(Weight)
CPI_lagQ1	9.41%	21.18%	11.68%	21.42%
CPI_lagQ2	9.41%	16.47%	7.88%	16.07%
CPI_lagQ3	5.88%	10.59%	6.17%	14.30%
CPI_lagQ4	7.06%	17.65%	6.05%	18.44%
LagQ1	30.59%	38.82%	29.55%	38.00%
LagQ2	15.29%	25.88%	17.95%	25.99%
LagQ3	11.76%	14.12%	10.16%	12.06%
LagQ4	27.06%	34.12%	24.74%	30.85%

1.3.6 Possible explanatory variables

Beside dummies for VAT changes, the crisis, and calendar months, we include 12 lags of output growth,[1] average hourly wages, unemployment rate and PPI (Producer price inflation) as explanatory variables for modelling mom inflation.

Output growth, measured by UK national and domestic household final consumption expenditure. In addition to capturing more accurately the demand for the items included in the CPI measure, this is a good output variable for consumer prices. As a measure of output and demand, GDP is broader, while industrial production is narrower and less related to household consumption. The data used ranges from 1997 to the latest available data as of the release date, which is 31 March 2023. It gives us a demand variable which corresponds to the overall CPI and 12 COICOP Divisions.[2] It is quarterly but can easily be made into smoothed monthly data. To do this, we put in the quarterly figure directly into the three months of that quarter. Then we construct a 3-month moving average to get our monthly figure. Hence, each month is a weighted average of two of the quarterly figures. Thus, January puts a weight of 1/3 on Q4 and 2/3 on Q1, Feb has a weight of 1 on Q1, March a weight of 2/3 on Q1 and 1/3 on Q2 and so on. To ensure stationarity, we can use this as a monthly demand variable as a percentage growth rate. Total consumption can be used as the demand variable for the overall CPI rate. Division data can then be used for the 12 divisions.

Inflation is traditionally explained by wage equations of the Phillips curve variety. Wage and inflation research has focused on whether higher labour costs precede higher inflation or vice versa. The average weekly earnings (AWE) are used to measure labour costs.[3] The data begins in 2000 and is updated monthly. AWE at level is not stationary. It is possible to use this variable as a percentage growth rate to ensure stationarity.

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[1] Represented by household expenditure, which corresponds to the overall CPI and 12 COICOP Divisions
[2] Data on household consumption at the level of the 12 COICOP divisions is to be found in Economic Trends, This has Consumption expenditure data: I have chosen the real value (Chained Volume measure CVM) not seasonally adjusted, see the webpage: https://www.ons.gov.uk/economy/nationalaccounts/satelliteaccounts/datasets/consumertrendscurrentpricenotseasonallyadjusted
[3] AWE: Whole Economy Level (£): Seasonally Adjusted Total Pay Excluding Arrears from ONS, see the website: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/timeseries/kab9/emp.

Recent studies have demonstrated that unemployment influences pricing behaviour in relation to sales (Kryvtsov and Vincent 2021). It captures uncertainty and conditions in the labour market. Each month, the ONS publishes unemployment rate for the UK as a whole and for each country and region.[1] After it is converted to a percentage of change, the unemployed aged 16 and over becomes stationary.

PPI measures the behaviour of producer prices and this may well represent a pipeline effect: the prices included in PPI might be intermediates going into future consumption goods, or final consumer goods as they make their way to retailers. A monthly survey is used to create the PPI by the Office for National Statistics (ONS).[2] The data in the calculation I have expressed as a percentage change.

The data will also be analysed at the aggregate CPI level as well as at the COICOP two-digit divisions of expenditure. Furthermore, we provide the results for the 12 divisions with just consumption, just unemployment, just PPI, and just wages in the appendix. The percentage change in average hourly earnings is available from February 2000, and we used a 12-month lag variable. Overall, the data in the regression are from February 2001 to December 2019.

From classic "Phillips curve" model, it is expected that inflation will rise with an increase in output and decrease with an increase in unemployment. We would expect inflation in PPI to increase inflation in CPI when PPI is considered a cost-push variable. The last column in Table 19 reveals that the only significant variables (other than constant and monthly dummies) are the eleventh and twelfth lags of inflation, the first, ninth, and twelfth lags of PPI inflation, and the fifth and sixth lags of unemployment. The lagged coefficients are small. For lagged inflation coefficients, at 0.1 for the eleventh lag and 0.18 for the twelfth lag. PPI inflation and unemployment seems have a little impact on general inflation. Small lagged PPI inflation coefficients— 0.16 on the first lag, 0.07 on the nineth and -0.09 on the twelfth—are present. At -0.02 on the fifth lag and 0.01 on the sixth, the lagged unemployment coefficients are close to zero. If

[1] It can be found on the ONS website, data ID: MGSX, named "Unemployment rate (aged 16 and over, seasonally adjusted)". https://www.ons.gov.uk/employmentandlabourmarket/peoplenotinwork/unemployment/timeseries/mgsx/lms

[2] Represent by Manufactured Products for Domestic Market, Excl Duty, Source dataset: Producer price inflation time series (PPI) from ONS, ID:gb7s. see the webpage:https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/gb7s/ppi

we simplify the equation to its most basic form, the result is essentially the same. Comparing the full regressions with final stage model, the coefficients on first lag of PPI inflation and the unemployment stay the same. We were surprised to find that output had little impact on inflation, contrary to what we thought.

Table 19 CPI regression with output, unemployment, PPI and hourly wages

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
CPI_LDV1	−0.08			
CPI_LDV2	−0.10	−0.09		
CPI_LDV3	0.1	0.12**	0.09	
CPI_LDV4	0.03			
CPI_LDV5	−0.01			
CPI_LDV6	−0.02			
CPI_LDV7	−0.00			
CPI_LDV8	0.03			
CPI_LDV9	−0.03			
CPI_LDV10	−0.06			
CPI_LDV11	0.1	0.13**	0.15**	0.16**
CPI_LDV12	0.18**	0.15**	0.16**	0.17**
Con_LDV1	0.13			
Con_LDV2	−0.15			
Con_LDV3	0			
Con_LDV4	0.11			
Con_LDV5	−0.12			
Con_LDV6	−0.06			
Con_LDV7	0.17			
Con_LDV8	−0.21	−0.09		
Con_LDV9	0.07	0.11		
Con_LDV10	0.21*	0.12		
Con_LDV11	−0.25**	−0.22***	−0.06	
Con_LDV12	0.14	0.14**	0.07	
PPI_LDV1	0.16***	0.17***	0.15***	0.16***
PPI_LDV2	0			

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
PPI_LDV3	0.05			
PPI_LDV4	−0.04			
PPI_LDV5	−0.01			
PPI_LDV6	0.03			
PPI_LDV7	0.02			
PPI_LDV8	−0.01			
PPI_LDV9	0.07	0.05**	0.06***	0.06***
PPI_LDV10	−0.00			
PPI_LDV11	0.05			
PPI_LDV12	−0.09**	−0.06**	−0.07**	−0.07**
U_LDV1	0.01			
U_LDV2	−0.00			
U_LDV3	−0.01			
U_LDV4	0.01			
U_LDV5	−0.02*	−0.01*	−0.02**	−0.01*
U_LDV6	0.01	0.01**	0.01*	0.01**
U_LDV7	0.01			
U_LDV8	0			
U_LDV9	0.01	0.01*	0.01	
U_LDV10	0.01			
U_LDV11	0			
U_LDV12	−0.01			
WAGE_LDV1	0			
WAGE_LDV2	0.02			
WAGE_LDV3	0.02			
WAGE_LDV4	0.02			
WAGE_LDV5	−0.00			
WAGE_LDV6	−0.00			

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
WAGE_LDV7	−0.02			
WAGE_LDV8	0.01			
WAGE_LDV9	−0.00			
WAGE_LDV10	0.01			
WAGE_LDV11	−0.00			
WAGE_LDV12	0.01			
Num.Obs.	227	227	227	227
R2	0.82	0.8	0.789	0.782
R2 Adj.	0.729	0.769	0.761	0.757
AIC	−77.8	−143.8	−139.7	−139.8
BIC	189.4	−30.8	−40.4	−54.1
F		25.206	27.619	31.625
RMSE	0.14	0.15	0.16	0.16

* p < 0.1, ** p < 0.05, *** p < 0.01

1.3.7 Model with additional variables for different divisions

To determine whether the 12-month lagged additional variables we found in the previous section were primarily due to each sector's price response to the overall CPI data or their own sectors, we followed a similar approach as before, that is, we additionally consider total CPI inflation with up to 12 lags. Specifically, we can use the division-level consumption data for the 12 divisions. Only the frugal results will be presented in the main text; the full regression findings will be reported in the appendix.

We can observe that the CPI has some impact on the various divisions when we consider the entire set of findings in Table 20. The average lag durations for the three divisions reveal that large lags are unusual, and the most frequent lag is 7 months, each division has different signals. For lagged CPI coefficients, only 06 (Health) and 09 (Recreation and culture) are included in the eleven month effect. The twelve-month effect is only present in 07 (Transport). Turn next to explanatory factors we just added: a. Consumption. In the previous section we found that consumption has little effect on CPI inflation, and similar findings were also found in the results of 01 (Food and Non-Alcoholic Beverages) and 08 (Communication). However, the significant lags are frequent in remaining 10 COICOP divisions (lag length is present in more than four divisions) and the most common lags are 1, 2 and 3 months, with different signs for each across sectors. In addition, 6 months lag effect is absent from all divisions. b. PPI inflation. These regressions show that the 1-month PPI lag effect is present across several of the divisions rather than just the CPI. 01 (Food and non-alcoholic beverages), 05(Furnishings, Household Equipment and Routine Household Maintenance) and 07(Transport) have a one-month impact. However, these regressions show that the divisions do not experience the 9-month PPI lag effect. The twelve month effect is absent from 01 (Food and Non-Alcoholic Beverages), 02(Alcoholic Beverages, Tobacco and Narcotics), 03(Clothing and Footwear), 05(Furnishings, Household Equipment and Routine Household Maintenance), 07(Transport), 08 (Communication), 09(Recreation and Culture), 10(Education), 11(Restaurants and Hotels) and 12 (Miscellaneous Goods and Services). C. Unemployment. These regressions show that the 04 (Housing, Water, Electricity, Gas, and Other Fuels) has a 5 and 6 month lag impact from the CPI. As shown in these regressions, the 5 month unemployment lag effect does not transfer from CPI to the divisions, but rather to 04 (Housing, Water, Electricity, Gas, and Other Fuels) and 11 (Restaurants and Hotels).

Table 20 AIC stepwise analysis with output, unemployment, PPI and hourly wages: CPI and Divisions (Monthly data)

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV1							−0.23**					0.17***	0.20*
CPI_LDV2							0.16*						
CPI_LDV3			0.42**						0.83***				
CPI_LDV4		0.51**	0.55***									0.11**	
CPI_LDV5						0.39**							−0.17*
CPI_LDV6			0.79***		−0.89***	0.38**							
CPI_LDV7			−0.64***	0.61**		0.71***	0.23***			−0.26**	−1.02***		
CPI_LDV8		0.34*		0.59**				−0.47*					
CPI_LDV10											0.66**		−0.21*
CPI_LDV11	0.16**						−0.23**			0.27**			
CPI_LDV12	0.17**							0.53**					
LDV1			−0.26***	−0.22***	0.19***	−0.35***	−0.11*	−0.38***		−0.18***		−0.24***	−0.18***
LDV2			−0.16***	−0.13**		−0.24***		−0.12**	0.15***				
LDV3									0.13**		0.31***		
LDV4		−0.20***							−0.21***				
LDV5				0.23***		−0.11*		−0.12**					
LDV6				0.23***		0.20***				0.12*		−0.15**	

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV7					0.12**		−0.17**						
LDV8								0.17**					
LDV9										0.12*	−0.13**		0.15**
LDV10				−0.12**		−0.17***	−0.16**					0.14**	
LDV11						−0.12**							
LDV12			0.27***	0.22***		0.27***	0.17***	−0.15**			0.34***	0.13**	
Con_LDV1			0.22**		0.34***			0.24***			3.54***		−0.04**
Con_LDV2			−0.19*		−0.31**			−0.14**			−3.17***	0.06***	
Con_LDV3				0.24***	0.23**	0.08*	0.06*			0.09***			
Con_LDV4			0.34***			−0.13**	−0.10**						−0.09***
Con_LDV5			−0.42***			0.10*	0.07**						0.08**
Con_LDV7			0.31***					−0.13**		0.07**			−0.10***
Con_LDV8			−0.17*	−0.18**		0.09**							0.08***
Con_LDV9				0.25***									
Con_LDV10					0.30***	−0.12**					1.30***		
Con_LDV11			0.17**	−0.24***		0.12**					−1.10***		
Con_LDV12			−0.12*	0.14*									
PPI_LDV1	0.16***	0.20***				0.13**		0.97***					

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
PPI_LDV3					0.33***				−0.34***		0.38***		
PPI_LDV4										−0.08*			
PPI_LDV6					0.24***	−0.24***				−0.13**		0.04*	
PPI_LDV7		0.18**		−0.40***						0.15***			0.13***
PPI_LDV8					0.16**			−0.24**					
PPI_LDV9	0.06***												
PPI_LDV10													0.10**
PPI_LDV11					0.19**	0.11*				−0.11**			
PPI_LDV12	−0.07**				−0.19**		0.09**						
U_LDV1												−0.01*	
U_LDV3												−0.01*	
U_LDV4			−0.05*										
U_LDV5	−0.01*				−0.05**							−0.01**	
U_LDV6	0.01**				0.05**								
U_LDV7							0.02*					−0.01**	
U_LDV8				−0.06**									
U_LDV9		0.04*						0.07***			−0.08*		
U_LDV11						0.04**				0.04***		0.01*	

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
WAGE_LDV1											−0.23**		
WAGE_LDV2								0.12**			−0.19**	0.04***	
WAGE_LDV3											−0.17*		
WAGE_LDV4		0.08*				0.08*							
WAGE_LDV5					−0.14***								
WAGE_LDV6					−0.12**								
WAGE_LDV7											−0.23***		
WAGE_LDV9		0.11**	−0.11*		−0.11**								
WAGE_LDV10		0.10**	−0.11*										
WAGE_LDV11					−0.12**							0.03**	
Num.Obs.	227	227	227	227	227	227	227	227	227	227	227	227	227
R2	0.782	0.395	0.725	0.931	0.537	0.936	0.596	0.819	0.311	0.465	0.802	0.646	0.302
R2 Adj.	0.757	0.32	0.677	0.92	0.455	0.924	0.537	0.792	0.241	0.389	0.771	0.589	0.204
AIC	−139.8	375.9	400.6	495.9	345.8	289.4	42.4	401.4	406.7	138.5	637.7	−174.5	95.4
BIC	−54.1	468.4	523.9	608.9	469.1	422.9	148.6	511	485.5	241.3	750.7	−61.5	198.1
F	31.625	5.253	14.923	84.856	6.556	75.127	10.023	29.601	4.416	6.136	25.481	11.464	3.063
RMSE	0.16	0.49	0.5	0.62	0.44	0.39	0.23	0.51	0.54	0.29	0.85	0.14	0.26

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

1.4 Seemingly unrelated regressions

So far, the model is estimated by equation-by-equation using standard ordinary least squares (OLS). The estimators are only efficient if we assume the equation errors are uncorrelated. Therefore, it is essential to test whether there is a common shock across the system equation.

In econometrics, the Seemingly Uncorrelated Regression (SUR) or Seemingly Uncorrelated Regression Equation (SURE) model proposed by Arnold Zellner (1962) is an extension of the linear regression model, which consists of multiple regression equations, each has its dependent variable and possibly different exogenous explanatory variable sets. It is assumed that the error of each equation is homogeneous and linearly independent in the basic SUR model. The error of each equation may have its variance. Each equation is correlated with the others in the same period.

There are two exceptional cases when SUR can be viewed as OLS: 1. if the error terms are uncorrelated between the equations, in this case, the system is genuinely unrelated but not seemingly unrelated; 2. when each equation includes the same set of regressors.

This thesis estimates twelve divisions using SUR and then compares them with OLS results. Moreover, the twelve equations error correlation table from SUR can verify whether the system equation error is correlated.

1.4.1 Seemingly Uncorrelated Regression Analysis

The SUR and OLS estimate comparison can be found in Table 21 and Table 22. These two tables focus on twelve division estimates. From these two tables, the SUR results are similar to OLS. In other words, if we allowed the twelve divisions only related through the error terms, there is little change in the coefficients and significance. Table 23 provides the correlation table between error measures from the SUR estimation. We can see the errors have little correlation.

Table 21 OLS estimation: The twelve divisions (monthly data)

	Dependent variable:											
	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
lag1	.13	-.18*	-.24*	.21*	-.30*	-.41*	-.07	0.00	-.17*	-.06	-.14	-.12
lag2	-.01	-.09	-.11	.05	-.24*	-.39*	.05	.08	.02	.02	-.01	0.00
lag3	-.03	.03	-.15*	-.11	-.10	.12	.04	.07	.01	-.05	-.05	.12
lag4	-.15	-.05	-.14	.01	-.06	-.23*	.06	-.09	.14	.01	-.01	.04
lag5	.03	-.04	.11	-.01	-.04	-.23*	-.10	-.06	.16*	.02	0.00	.06
lag6	-.03	-.06	.32*	.03	.21*	-.25*	-0.00	-.03	.17*	-0.00	-.09	.05
lag7	-.02	-.05	.08	.06	.09	-.10	.02	.01	-.05	-.02	-.03	-.01
lag8	-.05	-.08	-.01	-.11	0.00	-.02	.07	-.03	.03	-.01	-.03	-.08
lag9	-.04	-.06	.10	.04	.05	-.01	-.12	.12	.08	.02	-.14	.07
lag10	.05	.05	.01	-.04	-.16*	.02	-0.00	.09	-.01	-.03	-.01	.01
lag11	-.10	-.01	-.01	-.08	-.13	-.17*	.06	-.06	.02	-.06	-.02	-.01
lag12	.11	.28*	.32*	.17*	.34*	-.09	.19*	-.03	.18*	.45*	.17*	.12
CPI_lag1	.13	0.00	.36	.05	-.06	-.18	.70	-.16	-.03	-.12	.08	.20
CPI_lag2	.07	-.04	-.28	.13	.15	-.09	-.11	-.06	-.06	-.31	.04	-.09
CPI_lag3	.03	.33	.68*	.41	.13	-.11	-.69	.49	.05	.84	.02	-.02
CPI_lag4	.53*	.31	.28	.19	.06	-0.00	-.22	-.23	-.12	-.19	.09	-0.00
CPI_lag5	-.09	.02	-.32	.16	.07	-.20	.31	.38	-.11	-.62	0.00	-.02
CPI_lag6	.16	.69*	-.01	-.38	.16	.12	-.32	-.16	-.14	.44	.02	-.01
CPI_lag7	.04	-.46*	.01	.09	.46*	.29	.01	-.06	-.03	-.32	.05	.09
CPI_lag8	.41	.10	.26	.04	-.01	.35	-.34	.26	.04	.05	-.02	-.08
CPI_lag9	-.02	.14	.08	.03	-.14	-.20	.38	-.13	.02	-.05	.08	-.05
CPI_lag10	-.13	.18	.19	.15	.22	-.16	.20	-.02	-.02	.43	-.02	-.03
CPI_lag11	.23	.15	.12	.19	.12	.01	-.10	.19	.13	.12	-0.00	.07
CPI_lag12	.09	-.05	-.18	-.09	-.06	.36	.07	.04	.06	-.02	-.05	-.08
Observations	324	324	324	324	324	324	324	324	324	324	324	324

Note: * $p<0.01$;

Table 22 SUR estimation: The twelve divisions (monthly data)

	Dependent variable:											
	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
lag1	.10	-.21*	-.25*	.18*	-.33*	-.38*	-.07	0	-.16*	-.07	-.12*	-.13*
lag2	-.04	-.09	-.11	.06	-.25*	-.37*	.05	.09	.03	.01	-.02	0
lag3	-.05	.03	-.13*	-.13*	-.1	.15*	.05	.09	.05	-.04	-.05	.10
lag4	-.17*	-.05	-.11	.02	-.07	-.23*	.05	-.07	.13*	.02	-.06	.03
lag5	.04	-.02	.12*	-.02	-.06	-.23*	-.07	-.04	.18*	.02	-.03	.06
lag6	-.05	-.07	.32*	.02	.17*	-.25*	.01	-.02	.17*	-.01	-.11	.07
lag7	-.03	-.04	.09	.05	.09	-.11	.02	.01	-.07	-.01	-.02	0
lag8	-.09	-.07	-.01	-.09	0	-.01	.07	-.01	-.01	-.02	-.09	-.07
lag9	-.02	-.07	.08	.03	.06	.01	-.13	.13*	.09	.01	-.12*	.07
lag10	.03	.03	0	-.02	-.15*	.05	0	.09	.01	-.02	-.05	-.01
lag11	-.09	0	-.03	-.08	-.13*	-.15*	.08	-.06	.03	-.05	-.03	.01
lag12	.12	.28*	.32*	.17*	.35*	-.09	.22*	-.02	.17*	.44*	.14*	.12*
CPI_lag1	.17	.02	.36	.08	-.02	-.17	.71*	-.14	-.04	-.10	.08	.20*
CPI_lag2	.11	-.06	-.28	.14	.15	-.11	-.11	-.06	-.06	-.33	.04	-.09
CPI_lag3	.07	.33	.65*	.43*	.12	-.10	-.71*	.48*	.04	.82*	.03	-.01
CPI_lag4	.56*	.32	.24	.19	.05	0	-.22	-.23	-.10	-.17	.10	0
CPI_lag5	-.07	.01	-.33	.19	.09	-.22	.25	.37	-.12	-.61	.02	-.02
CPI_lag6	.20	.69*	-.01	-.36*	.19	.13	-.36	-.17	-.14	.42	.02	-.01
CPI_lag7	.07	-.44*	-.01	.1	.47*	.29	.02	-.07	-.02	-.34	.06	.09
CPI_lag8	.46*	.08	.24	.03	.01	.34	-.31	.24	.05	.06	-.01	-.08
CPI_lag9	-.05	.14	.09	.04	-.17	-.21	.41	-.13	.01	-.03	.09	-.05
CPI_lag10	-.10	.20	.18	.14	.2	-.17	.19	-.02	-.03	.40	-.01	-.02
CPI_lag11	.21	.14	.12	.18	.14	.01	-.15	.19	.13	.14	0	.07
CPI_lag12	.10	-.04	-.17	-.1	-.03	.37	.02	.03	.07	.01	-.04	-.08
Observations	324	324	324	324	324	324	324	324	324	324	324	324
Note:												* p<0.01;

Table 23 The correlation between the Errors from the SUR estimates

	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
01FB	1.00											
02AT	0.00	1.00										
03CF	-0.06	0.07	1.00									
04HW	0.03	-0.15	-0.10	1.00								
05FH	0.14	0.14	0.13	-0.07	1.00							
06HL	0.00	-0.09	-0.05	0.11	0.05	1.00						
07TR	0.05	-0.01	0.02	0.02	0.04	-0.12	1.00					
08CM	0.10	-0.06	-0.03	-0.06	-0.01	0.10	-0.00	1.00				
09RC	0.07	0.05	-0.08	-0.00	-0.01	-0.04	0.01	0.02	1.00			
10ED	0.15	0.02	0.02	0.01	-0.04	0.09	0.03	0.02	-0.02	1.00		
11RH	0.10	0.12	0.05	0.11	-0.03	-0.16	-0.06	0.02	0.22	0.01	1.00	
12MS	0.09	0.03	0.15	0.07	0.01	0.07	-0.07	-0.03	-0.03	0.02	0.07	1.00

1.5 Conclusion

In conclusion, this chapter has provided a comprehensive analysis of inflation modeling in the UK using a data-driven approach. The key findings of this chapter include the significant persistence of annual inflation due to a 12-month lag effect across various sectors, and the robust relationship between headline and month-on-month inflation. This persistence in inflation is observed even when additional explanatory variables such as PPI, consumption, and unemployment are included in the model.

Furthermore, this chapter has expanded the scope of analysis beyond aggregate CPI to include COICOP divisions and more detailed levels. This approach provides a more nuanced understanding of inflation dynamics across different sectors of the economy. Additionally, the use of consumption data, rather than GDP, as a measure of output and demand aligns more closely with the components of the CPI and provides a more accurate representation of household consumption.

As we transition into the second chapter of this thesis, we will build upon these findings by exploring different methods for measuring core inflation and their effectiveness in predicting future inflation at the 12-month horizon. The second chapter will evaluate the forecasting performance of five different measures of core inflation using annual data from the UK from 2005 to 2019. The aim is to understand how well these measures can eliminate transient factors affecting CPI inflation and how they are influenced by high-frequency fluctuations. This will provide further insights into the nature of inflation and its implications for economic policy.

Chapter 2: Different meanings of core inflation

2.1 Introduction

Current and future inflation matters to monetary policy makers and market participants. The most important measure of inflation identified in most economies is the year-on-year increase in the consumer price index (CPI) or Personal Consumption Expenditures (PCE) index published by national statistics authorities. Still, there are at least three problems with these official inflation indicators:

1. Although researchers and central banks widely use core inflation, there are no clear and accepted definitions. It may find a different message from the various measures of core inflation.

2. There are two very different uses of the term core inflation. The first meaning is a statistically robust measure of actual inflation. These measures try to exclude extreme prices or unstable changes from the sample of price changes to obtain more effective and less biased inflation estimates. The second concept is very different from the first. It refers to the part of actual inflation that reflects the underlying pressure in the economy.

3. There is no consensus on the definition of core inflation that reflects the underlying economic pressure. However, all these measures are based on the observation that inflation indicators may be "noisy", making it challenging to interpret underlying inflation developments. For example, Bryan and Cecchetti (1993) proposed that core inflation is related to the growth rate of the money supply. Blinder (1997) defines core inflation as the "persistent" part of the inflation, while Quah and Vahey (1995) define core inflation as the part of inflation that has no medium - and long-term impact on actual output.

This chapter is organized as follows: Section 2.2 discusses the concept of core inflation, providing a theoretical background and its importance in economic analysis. Section 2.3 introduces various measures of core inflation, explaining their calculation and interpretation. Section 2.4 presents a comparison of these core inflation measures, highlighting their strengths and weaknesses. Section 2.5 provides estimates of UK core CPI, offering a practical application of the discussed measures. Finally, Section 2.5

evaluates these core inflation measures, assessing their effectiveness and reliability in capturing the underlying inflation trends.

2.2 The Concept of Core Inflation

The current mainstream view on core inflation is fundamentally different from changes in the cost of living. The cost of living index theory is the most complete and coherent inflation measurement framework currently in existence: the fundamental idea takes a representative household's expenditure or cost function at a given point in time as its starting point. The change in the minimum cost u to reach the reference utility level between the two periods is the change in the cost of living between the base period 0 and the subsequent comparison period 1. Proper elaboration of this theory forms the design framework of the US Consumer Price Index (CPI). However, the cost-of-living index theory is not the theoretical framework of the harmonised Consumer Price Index (HICP) used to assess inflation in the euro area. Although there is a relatively well-defined price concept, namely "final household monetary consumption", HICP lacks a complete theoretical framework. By avoiding the idea of the cost of living, the Statistical Office of the European Communities (Statistics of the European Communities) can reasonably promote excluding specific categories of prices from HICP. The most concerning type is the missing cost of owner-occupied housing. For example, in the US CPI, owner-occupied housing costs are measured based on rent equivalent, which is appropriate considering the cost of the living concept behind the US CPI. The service flow cost of consumption can better replace the cost of purchasing owner-occupied housing. Since the equivalent rental cost of monthly consumer housing services is not part of household monetary consumption, it is not priced as part of HICP. However, the net purchase cost of new housing can be part of this consumption, and Eurostat is currently studying ways to include this cost in HICP.

Indirect taxes play a significant role in the measurement of inflation, as they can significantly influence the prices consumers pay for goods and services. A standard measure of core inflation often excludes the impact of indirect tax changes from the overall inflation rate. This is due to the fact that changes in indirect taxes, such as value-added tax (VAT), can cause temporary fluctuations in the consumer price index, obscuring underlying inflationary trends. The European Central Bank (ECB) uses the Harmonised Index of Consumer Prices (HICP) at constant tax rates, assuming full and immediate pass-through of changes in indirect taxes to consumer prices, as a measure to understand the impact of indirect taxes on inflation. This index tends to overstate the effects of tax changes, given that the actual pass-through of tax changes to prices is influenced by several factors such as firms' pricing decisions, economic conditions, and the nature of tax changes, among others. For example, Koester, Dreher, and Vlad (2020) discuss how changes in indirect tax rates during the COVID-19 pandemic, especially the temporary VAT reduction in Germany, influenced HICP inflation in the euro area. The United Kingdom's Office for National Statistics (ONS) also adjusts the Consumer Prices Index for changes in indirect taxes, specifically VAT. The ONS uses a measure known as the Consumer Prices Index at constant taxes (CPI-CT), which holds indirect tax rates constant at the rate prevailing at the start of the year. This measure assumes that the entire VAT reduction is passed through at all outlets. When calculating CPI-CT, the ONS removes the item VAT rate from the average price and then applies the rate of tax at the start of the year. In this way, the CPI-CT effectively excludes the impact of changes in indirect taxes from the overall inflation rate. These practices demonstrate the importance of considering indirect taxes when measuring inflation and how they can be excluded to provide a more accurate representation of underlying inflation trends. In addition, some methods consider the impact of changes in indirect tax rates on the structure of production prices. However, a variant of the Diewert and Bossons (1987) analysis still requires the restrictive assumption that the input-output system of the economy is invariant to changes in indirect tax rates.

The different calculations are because there is no consensus on what core inflation statistics measure. If we pursue an actual cost of living index, it is unclear whether we should eliminate the impact of tax increases from our price measurement. Moreover, the above reasoning is only partially equilibrium. To correctly handle the effects of indirect taxes on measuring price levels, a detailed general equilibrium analysis of the impact of tax increases is needed, which will go far beyond current practices. Diewert and Fox (1998) proposed a method to deal with tax changes, and the purpose is to use inflation to compare welfare. The substantial price changes of the relevant products reflect changes in indirect taxes that apply to particular products but not others. The biased impact estimates of core inflation proposed by Bryan and Pike (1991) and Bryan and Cecchetti (1994) will ignore these observations when calculating inflation.

However, the considerable changes in relative prices caused by changes in indirect taxes can differ from those caused by other factors, such as developing supply and demand in the market for specific goods or services. These other factors may be more challenging to determine than changes in indirect taxes, so it may be harder to filter out their impact on the headline inflation rate.

The typical starting point for almost all analyses of core inflation is that monetary policymakers should focus on a well-defined concept of monetary inflation. This type of inflation is conceptually different from the cost of living and not adequately captured by standard price statistics. Therefore, some people believe that the central bank should target a price index whose growth rate corresponds to the cost of inflation. The central bank is trying to avoid this cost by focusing on inflation control objectives. Inflation undermines the coordination of economic activities and impedes the use of fiat money in market transactions. While changes in the cost of living may reflect some of the inflation costs, some may require broader market-traded measures. From the above discussion, we can conclude that we need a macroeconomic theory of the cost of inflation rather than a microeconomic theory of the cost of living from a monetary policy perspective. Therefore, essentially all measures of core inflation aim to measure inflation from a monetary policy perspective. (Wynne, 2008)

2.3 Measures of core inflation

To measure core inflation and remove temporary relative price changes from headline inflation indicators (mainly CPI), official statistical agencies and researchers have proposed some measures that can be broadly classified into two categories: statistical and modelling approaches.

Statistical approaches generally distinguish between headline inflation's temporary and persistent components through the statistical processing and analysis of price data, including exclusion methods, limited impact estimation methods, variance weighting methods, and trend estimation methods.

The modelling approach is mainly based on economic theory through modelling to examine core inflation, multivariate analysis of the relationship between headline inflation and the determinants in the past, and thus isolate core inflation

2.3.1 Exclusion－Based Methods

The exclusion method fixes the removal of specific components of the CPI that are highly volatile. The main idea is that some parts of the CPI reflect supply-side movements rather than changes in aggregate demand. The impact of these price changes would fade away with no change in monetary policy so that their exclusion better reflects existing inflationary pressures.

The exclusion method is simple to calculate, easy to interpret, produces timely results, and is transparent in its approach. The economic logic of the exclusion approach is that some components of the CPI reflect changes in supply rather than aggregate demand. This is done by removing certain specific commodities, reallocating the weights of the remaining basket of items and calculating the price index on a weighted average. Frequently excluded items include: (1) Food and energy, as their prices are more volatile and determined mainly by supply. (2) Indirect taxes and regulated prices because they are exogenous variables to monetary policy. (3) Mortgage interest payments because it affects the CPI in the opposite direction to what monetary policy is trying to do. Using this standard elimination method will make it less likely for the public suspects that the authorities are manipulating the inflation target. It will also make the elimination method of CPI comparable internationally.

The criteria for exclusion should be transparent. In the case of Canada, for example, the eight most volatile components excluded were selected based on historical data, and their month-on-month distance from the mean exceeded 1.5 times the standard deviation more than 25% of the time in the last 15 years. In addition, the credibility of the exclusion is also important in deciding what to exclude. For example, food and energy may be important components of consumer spending, especially in developing countries. Their elimination may create credibility problems for measures of core inflation for poorer members of society (Lehohla and Myburgh, 2002).

The elimination of all indirect taxes and subsidies removes exogenous factors that influence prices. One of the assumptions on which they are based is that: tax changes are passed through immediately. They have a one-to-one effect on consumer prices reasonable but unrealistic since taxes can affect wages and the prices of other goods and services, creating second-round effects. And it's necessary to exclude interest rates from core inflation. If interest rates are included, a rise in interest rates in an attempt to reduce inflation would instead increase inflation.

The disadvantage of the exclusion method is mainly that the determination of the excluded items, although relatively well-founded objectively, is still somewhat subjective.

2.3.2 Trimmed Mean

It is also argued that CPI is influenced not only by monetary factors but also by relative price changes caused by nominal price rigidity. According to menu-cost theory, in the face of a specific impact, some micro-enterprises with relatively high menu costs do not adjust immediately but adjust only when the impact exceeds the critical value. Therefore, price changes in real life tend to show skewness distribution. To calculate the trend of price changes, the end values of those abnormal fluctuations need to be eliminated. This is Bryan and Cecchetti's (1994) trimmed mean method, which works as follows: significant changes in relative prices do not contain information about underlying inflation trends because these price changes are quickly reversed.

The trimmed mean method requires first sorting the indices of the CPI index, trimming the tails of the sample distribution where the indices are too volatile, and then averaging the remainder.

Specifically, the data will first be sorted and obtained $\{x_1......x_n\}$. Their corresponding weights in the same order are $\{w_1...,w_n\}$, then, defined as the cumulative weights as the weight of W_i, i.e. $W_i \equiv \sum_{j=1}^{i} W_j$, $\alpha/100 < W_i < (1-\alpha/100)$, which reflects the range of observations that will be used to calculate the mean of the observed data range I_α. The formula for the α % trimmed mean $\bar{x}_\alpha$ is:

$$\bar{x}_\alpha = \frac{1}{1-2\alpha/100} \sum_{i \in I_\alpha} w_i x_i \tag{5}$$

There are two exceptional cases for trimming mean: if the value α is taken to be 50, then the weighted median is obtained; if the value α is taken to be 0, then the weighted mean is obtained. Trimmed mean values can be calculated for different trim ratios for comparison. There is a trade-off between removing extreme values and loss of information when determining the trimming ratio.

In contrast to the exclusion method, the CPI components excluded by the trimmed mean depend on the magnitude of their relative price change rather than being arbitrary. However, there are some problems with the trimmed mean value. First, the nature of the shock or the reason for the extreme values needs to be identified. For example, Mankikar and Paisley (2004) show that the sharp increase in beef prices caused by the supply shock of the 2001 foot-and-mouth disease outbreak was rightly trimmed, but the smaller readjustment in subsequent months was not. Central banks do not want to react to price fluctuations that may reverse quickly, which means that first and second-round effects should be removed from the calculation of core inflation. In addition, some product groups have persistent price trends that differ from other product groups. For example, the price of electronics can fall quickly when general inflation rises. The trimming mean method may erroneously remove this trend as a persistent shock, resulting in an overestimation of the overall inflation trend.

Secondly, the trimmed mean value varies depending on the trim level. There is no ideal trim ratio, and the level of subdivision of the base data also affects its value. Generally speaking, when the sample size is sufficiently large, the finer the basic data, the better.

Again, the trimmed means are systematically lower than the CPI, suggesting that they cut information other than random shocks (Kearns, 1998; Cutler, 2001). Roger (2000) points out that the lower value of the trimmed mean is due to empirical studies showing a positive skewness of price changes and suggests trimming more of the right-hand tail than the left. The skewness of a given country-specific price change should be determined prior to the calculation of the trimmed mean value.

The trimmed mean is also timely, transparent and easy to compile. It requires access to structural and weighting data for the CPI but has no requirement for the time series length. Once the data has been adjusted, it is unnecessary to correct the historical data, and the public quickly understands it. Trimmed mean is accepted by many countries, announced and updated online. The National Institute of Economic and Social Research (NIESR) published the UK trimmed mean inflation per month.

2.3.3 Sticky-price measures

The underlying factors that influence traditional inflation forecasts do not affect all prices equally. For example, some prices are "sticky," meaning they may not respond as quickly to market changes as other commodities with more "flexible" prices. Moreover, because sticky prices change slowly, it seems reasonable to assume that they better reflect expectations of future inflation when these prices are specific than frequently changing prices (Bryan and Meyer 2010).

There are many explanations for prices being sticky. The prevailing view is that price changes can entail high costs in some markets. Price setters realize that changing prices will be costly, so they will want to account for inflation between their infrequent price changes in their price decisions.

In addition to studying the question of what makes prices sticky, other researchers have studied the speed of recording price adjustments. Mark Bills and Peter Klenow, using unpublished data from the US Bureau of Labor Statistics (BLS) from 1995 to 1997, examine the frequency of monthly price changes for 350 consumer goods and services, accounting for about 70% of consumer spending. They find that many prices rarely change.The prices for items such as newspapers, men's haircuts, and cabs exhibit changes that are less than 5% on a monthly basis. In contrast, many prices change very frequently. The prices of gasoline, tomatoes and airline tickets vary by 70% each month. A study by Dixon and Tian (2017) used UK CPI data from 1996–2007 to estimate the cross-sectional distribution of the duration of price spells and examine how it relates to price change frequency. In the absence of sales and substitutions, they find a slightly higher statistic of the median frequency of price changes at 14%.

2.4 Comparison of various core inflation measures

It is not easy to compare and evaluate various measures of core inflation. Mark A. Wynne (1999) proposes suitable criteria for assessing core inflation: 1. Timeliness (can be calculated in real-time) 2. Foresight (has the function of predicting future inflation trends from the calculation method) 3. Consistency of trend (can accurately capture the underlying movement trend of the target inflation series 4. Intelligibility (can be understood by the public) 5. Stability (historical values remain unchanged) 6. Theoreticality (does it rely on economic theory).

The exclusion method has the advantage of being easy to understand and calculate and does not require a long time series but requires a pre-determination of those items that should be deducted.

The trimmed mean does not require a pre-determination of which items should be deducted. It has the advantage of being easy to calculate and does not require a long time series but requires detailed information on the composition of the price index and requires a practical choice of trimming ranges.

The sticky-price measure does not require a long time series but should draw the line between a sticky-price and a flexible price.

Table 24 Criteria for selecting a measure of core inflation

	Exclusion method	Trimmed mean	Sticky-price
Computable in real-time	Yes	Yes	Yes
Forward-looking	No	No	No
Track record	Yes	Yes	Yes
Understandable by public	Yes	Yes	Yes
History does not change	Yes	Yes	Yes
Theoretical basis	No	No	No

2.5 Estimates of UK core CPI

We measured the core CPI using the Consumer Price Index (CPI) compiled by The Office for National Statistics in the UK as the benchmark indicator, using the exclusion method, trimmed mean, sticky-price and ARIMA, respectively.

2.5.1 Excluding food and energy

The items excluded from core inflation by central banks are not consistent across countries. Still, they can all be grouped into the following three categories: (1)The most excluded items are unprocessed foodstuffs, which often exhibit strong seasonal price fluctuations and are typically supply-driven, even when there are non-seasonal movements; (2) most countries also exclude energy items as energy price fluctuations usually come from international markets; (3) Some countries also exclude goods whose prices are directly affected by changes in indirect taxes. These are typically goods where the tax forms a significant portion of the final price, and changes in these taxes can cause substantial price fluctuations. Examples of such goods can include household fuels, public transport, postal services, telephone services, and tobacco.

We considered several exclusion types of metrics and ultimately excluded food and energy measures (EXFD). These measures have been calculated for a long time and have received regular coverage in the media, so they are relatively easy to understand.

This type is constructed by excluding food and energy from the inflation measure. We get rid of the food (division 01) and energy parts of division (04) and transport (07). We then rescale the weights to add up to 1 and have the core inflation excluding food and energy. The data is from January 2005 to December 2019.

2.5.1.1 Inflation rates for COICOP divisions from 2005 to 2019

Additionally, we can examine the properties of these divisions (variance, St.Dev) relative to the other 9 COICOP categories. A summary of the raw inflation data can be found in Table 25 and Table 26.

Table 25 Food and energy

2005-2019	mean	SD	SE mean.	skewness	kurtosis	var
01FB	0.22	0.63	0.05	0.18	0.32	0.40
04HW	0.30	0.70	0.05	2.71	10.92	0.50
07TR	0.24	1.25	0.09	-0.51	0.27	1.55
Average	0.25	0.86	0.06	0.79	3.84	0.82

Table 26 Excluding food and energy

2005-2019	mean	SD	se.mean.	skewness	kurtosis	var
02AT	0.34	1.04	0.08	1.79	4.92	1.09
03CF	-0.08	2.38	0.18	-0.46	0.07	5.66
05FH	0.14	1.58	0.12	-0.80	0.48	2.49
06HL	0.23	0.37	0.03	0.14	1.08	0.14
08CM	0.14	0.67	0.05	0.52	2.69	0.44
09RC	0.05	0.42	0.03	-0.10	-0.15	0.17
10ED	0.62	2.06	0.15	5.58	40.14	4.24
11RH	0.24	0.26	0.02	0.44	2.28	0.07
12MS	0.14	0.29	0.02	-0.07	0.92	0.08
Average	0.20	1.01	0.08	0.78	5.83	1.60

Food and energy divisions have a similar mean to annual inflation at around 2%. There is a wide range of means in the remaining sectors (the smallest is 03 Clothing and Footwear sector with a mean of - 0.08 and the largest is 08 Education with a mean of 0.62). However, the average of the non-food and energy sector mean is 2%. A small degree of negative skewness can be observed in Transport (07) whereas this is not the case for Food and Non-Alcoholic Beverages (01) and Housing, Water, Electricity, Gas and Other Fuels sector (04). Different signs of skewness across non-food and energy sectors. There is positive kurtosis in almost all sectors (except 09 Recreation and Culture), but only 04HW and 10ED show large amounts. In terms of standard deviation, the food and energy and non-food and energy sectors are not much different.

2.5.1.2 How to calculate the excluding food and energy core inflation

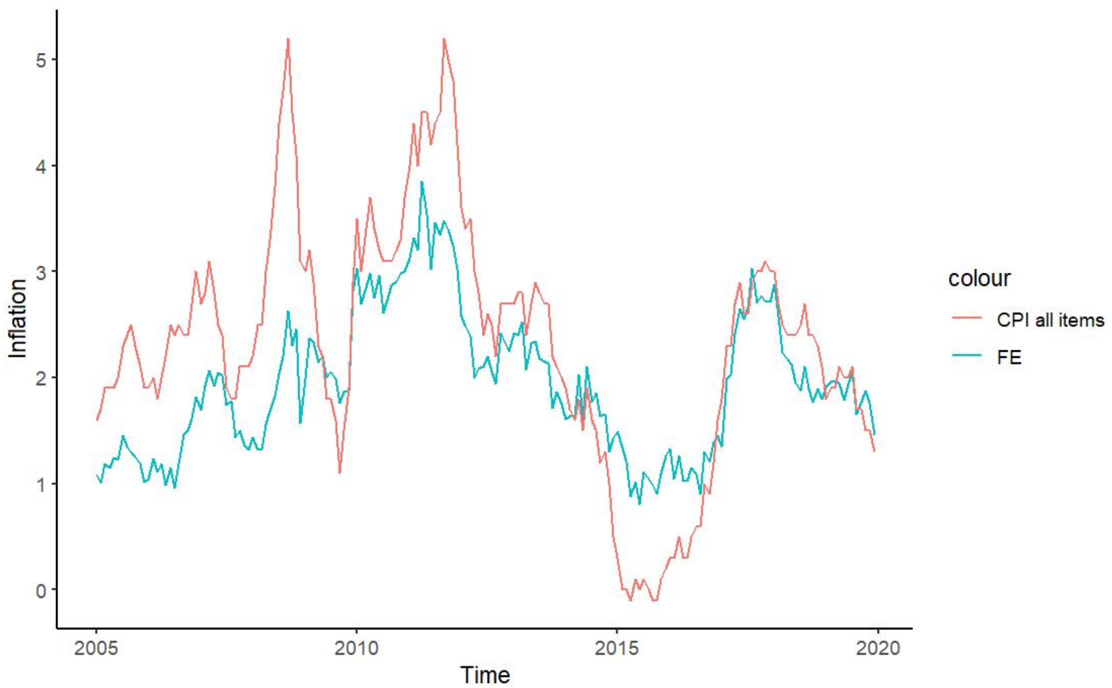
In a low inflation environment, such as the UK in the period 2005-2019, the annual or headline inflation is approximated very well by the excluding food and energy core inflation. In our baseline model, core inflation is represented by the sum of multiplying each non-food and energy class by its weight. We use the UK CPI data at the four-digit level of COICOP expenditure classes from January 2005 to December 2019. [1]The starting point is based on weight data available from 2005. The endpoint is natural, so that we exclude the Covid Pandemic which raises many other issues. 2005-2019 is a period when inflation was below 5% and mostly between 1-3%, despite the Great Recession 2008-9. The CPI is considered rather than CPIH or RPIX since RPIX has been discontinued and the results for CPIH are like those for CPI.

Our starting point is the raw data in terms of year-on-year inflation. Excluding food and energy core inflation calculation will not be at the level of COICOP divisions, but at the four-digit level of COICOP expenditure classes. To calculate core inflation excluding food and energy, multiply the inflation rates for the non-food and food classes by the appropriate weights. Some goods and services are more expensive for households than others. Because of this, price indices are weighted according to the amount we all spend on these items as consumers, to ensure that they reflect the relative importance of the various items in our shopping basket. In addition to reviewing the weights used in calculating consumer price inflation every year, the "shopping basket" is updated as well.[2] It is simple to convert annual weights into monthly weights. The weight for each month is equal to the weight for the that year.

[1] See Table 57 of the Consumer price inflation dataset: https://www.ons.gov.uk/economy/inflationandpriceindices/datasets/consumerpriceinflation
[2] The annual update of consumer price inflation weights on COICOP divisions and classes can be found : https://www.ons.gov.uk/economy/inflationandpriceindices/datasets/consumerpriceinflationupdatingweightsannexatablesw1tow3

Figure 4 plots annual CPI all items and CPI excluding food and energy. The two series trends are similar, but the fluctuations of EXFD are more stable. CPI all items diverged from this measure of underlying inflation on three prominent occasions: 2007, 2013 and 2015-2016. In 2007 both energy and food price inflation rose sharply, but this proved temporary and was unwound in 2008. Similarly, in 2013, food and energy positively contributed to CPI all items, but this was short-lived and was unwound in 2014. By the beginning of 2015, CPI all items were just lower than towards the end of 2014. It was between 0 and 1.9 during this period. By contrast, CPI excluding food and energy was much smoother, around 1.2 over this period. In both cases, changes in food and energy prices proved to be temporary, and there may be reasons to ignore these items in policy formulation.

Figure 4: CPI excluding food and energy



2.5.2 Trimmed Mean approach

The historical trimmed mean data is collected from the National Institute of Economic and Social Research (NIESR).[1] NIESR start by collecting micro-data on the prices of

[1] Thanks to the NIESR economist Janine Boshoff for providing both the historical trimmed mean data and a brief description of the methodology used to compile these statistics.

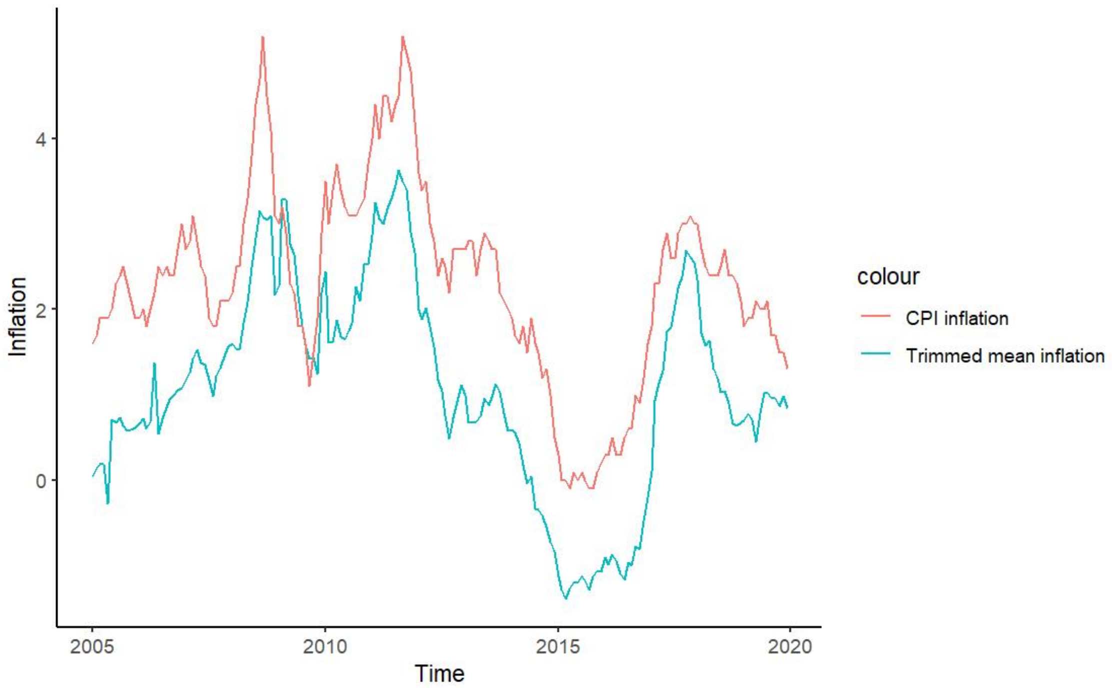
individual goods in the UK Consumer Price Index (CPI) for all goods. The data set contains prices for as many as 135,000 goods and services per month, adding up to about 30 million price quotes since the 1990s. These data will also enable us to monitor the variance, skewness, kurtosis and frequency of price changes at regional and country resolutions.

The first step is to calculate the month-to-month inflation rate for the item $i=1,2...,N$ at the time $t{:}\Delta p_{i,t}=\frac{p_{i,t}}{p_{i+1}}-1$ to calculate the trimmed mean. The next step is to choose a 5 per cent trimmed mean for each month $\prod_{j,t}^{m}$. The reason determines 5 per cent is that it outperforms the CPI and CPI-ex for future inflation, not only on a 12-month horizon but also on a 24-month and 36-month horizon. Finally, calculate the annualised trimmed mean for the jth percentage of each month:

$$\prod_{j,t}^{y}=\left(\left(I+\prod_{j,t}^{m}\right)\times\left(I+\prod_{j,t-l}^{m}\right)\times\ldots\times\left(I+\prod_{j,t-1|}^{m}\right)-I\right).$$

Figure 5 is the UK CPI and trimmed mean year-on-year inflation. The highest value for the UK trimmed mean of 3.6 in August 2011, and the lowest point was -1.4 in March 2015. Headline consumer inflation fell significantly, from 5.2 per cent in September 2008 to 3.1 per cent in September 2009. As measured by the trimmed mean, the measure of underlying inflation, which excludes 5 per cent changes in top and bottom prices, decreased to 3.3 per cent in February 2009 from 1.7 per cent recorded in September. The gap becomes much closer during this period.

Figure 5: CPI and trimmed mean inflation



Source: National Institute of Economic and Social Research

These measures appear to meet the (minimum) criteria of policy usefulness. These figures are based on the same data as the CPI, so they are as timely as the CPI and are not subject to revision. They are also easy to understand and transparent. These measures differ in their coverage.

However, all the above measures have an essential conceptual shortcoming in that they do not explicitly consider the persistence of individual price changes in their construction. As Blinder (1997) suggested, persistent price changes contain more information about future inflation, we would like to give these high weights in core inflation. In the trimmed mean approach, more significant persistent price shocks may be outliers in the inflation distribution for some successive periods, in which case these would be excluded, and the measure would ignore potentially helpful information about future inflation.

2.5.3 Sticky price CPI

Nearly 87 years ago, John Maynard Keynes developed his General Theory, which prominently featured the concept of sticky prices. However, the implications and intricacies of this concept have been a subject of ongoing debate among economists ever since. According to the prevailing belief, changing prices can incur significant costs in some markets. Consequently, these costs can significantly reduce the incentive for companies to change their prices. As opposed to flexible prices, sticky prices may do a better job of taking inflation expectations into account, even when they are less responsive to economic conditions. Considering the fact that setting prices will be costly, price setters will want their price decisions to take inflation into account during the periods between their infrequent price increases (Bryan and Meyer 2010).

The question of what causes price instability is one that is debated by some economists, while others have taken on the difficult task of documenting how quickly prices adjust to market conditions. A comprehensive investigation was conducted by Bils and Klenow (2004) into how rapidly prices adjust and a thoroughly examined the raw data for 350 detailed spending categories that make up the Consumer Price Index. According to their research, half of these categories change their prices at least every 4.3 months. The authors divided the monthly CPI published components into "sticky-price" and "flexible-price" aggregates based on this information. A CPI component whose price changes occur less frequently than every 4.3 months is described as a "sticky-price" good. Goods with a frequent price change were referred to as "flexible-price" goods. They produced "core" measures of the sticky and flexible CPI based on the relative weights of the variables.

By examining the cross-sectional distribution average of price spell durations across firms, Dixon and Tian (2017) investigate what the frequency implies for the behaviour of price-setters. For the entire period from January 1996 to December 2007 for the UK, they provide the frequency (expressed as a percent) of prices changing per month for 570 items that were contained in the Virtual Microdata Laboratory (VML) data set covering about two thirds of total CPI. In Appendix K , first column is the COICOP item name. The frequency of prices changing per month is in Column B. The rebase weight in column C adds up to 1000 (their total share in CPI is 664). The monthly frequency of price changes averages 21.9%. The weighted median is 17.9%. Mo represents the mean duration between price changes. If prices instead change at most once per month, then the mean duration is simply 1/freq. We used this formula to calculate the Mo. column from the Freq. Column in Appendix K . As a separating point, we choose the median frequency by CPI weight, 18% changes per month, or mean duration of

5.56 months. We break down the monthly CPI's published components into "sticky price" and "flexible price" aggregates using this information. If price changes for a particular CPI component occur less often, on average, than every 5.56 months, we call that component a "sticky-price" good. We labelled " flexible price " goods as goods that change prices more frequently than this. There are 244 sticky items in total. The sticky CPI is then constructed using the Price quote data and item indices data[1] for the February 2006 to December 2019. Since the item price quotes available from February 2005 and monthly CPI data is calculated year-on-year, the CPI trend started in February 2006. Based on Figure 6, the sticky-price CPI exhibits a relatively smooth trend. There is much greater volatility in the flexible CPI than in the alternative sticky-price core measure - the amount is actually 5 times greater.

[1] Detailed data on price quotes and item indices that are used in the construction of the UK's inflation figures has now been published, providing users with unprecedented access to detailed data: https://www.ons.gov.uk/economy/inflationandpriceindices/datasets/consumerpriceindicescpiandretailpricesindexrpiitemindicesandpricequotes

Table 27 shows the variance of these measures since 2013. The variance of these measures since 2013 is particularly noteworthy. Specifically, we observe that the volatility of the flexible-price measures has remained relatively constant over time. Since 2013, there has been a considerable reduction in volatility in the sticky-price measures. These data indicate that there is an expected component in the sticky price CPI that is not evident in the flexible price indicator. Is the flexible-price CPI able to capture the other input to the expectations-augmented Phillips curve if the sticky-price CPI captures one? As a result, do flexible prices more accurately reflect economic slack due to their sensitivity to economic conditions?

Figure 7 presents three distinct graphs, each illustrating the relationship between a specific price index and unemployment. Upon initial observation, it appears that a linear relationship may not adequately represent the data. The correlation between inflation and unemployment needs to be further elucidated, particularly in the context of the next theory chapter.

Table 27 Monthly Variance of Flexible and Sticky Price CPI Aggregates

	Flexible CPI	Sticky CPI	CPI
Total sample	1.52	0.30	1.40
2013 - forward	1.55	0.12	0.99

Note: The variance was calculated from the one-month annualized percent changes in each variable.

Sources: Office for National Statistics; authors' calculations.

Figure 6: CPI by Degree of Flexibility

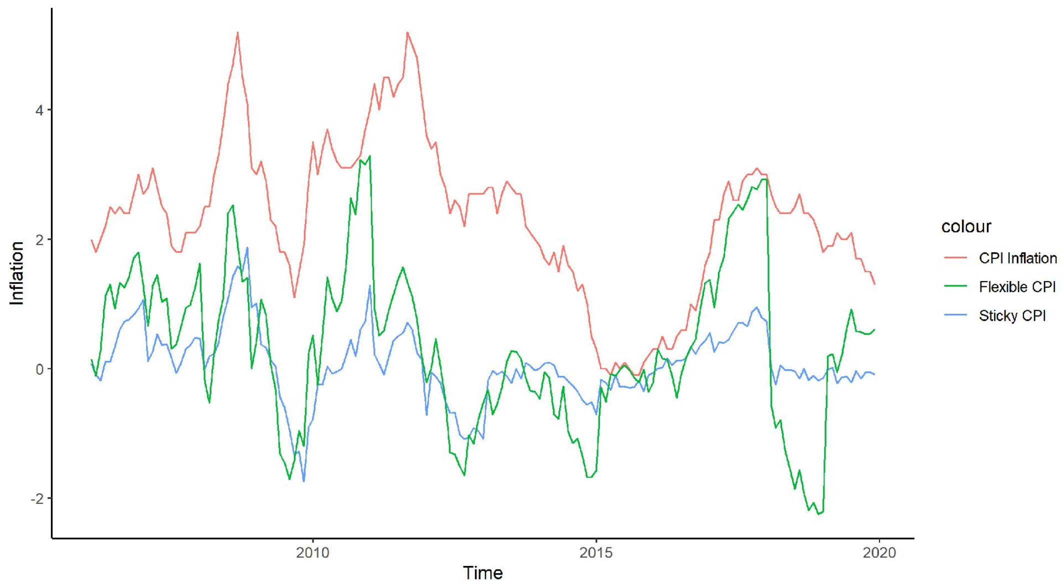


Figure 7: Relationship between a different price index and unemployment

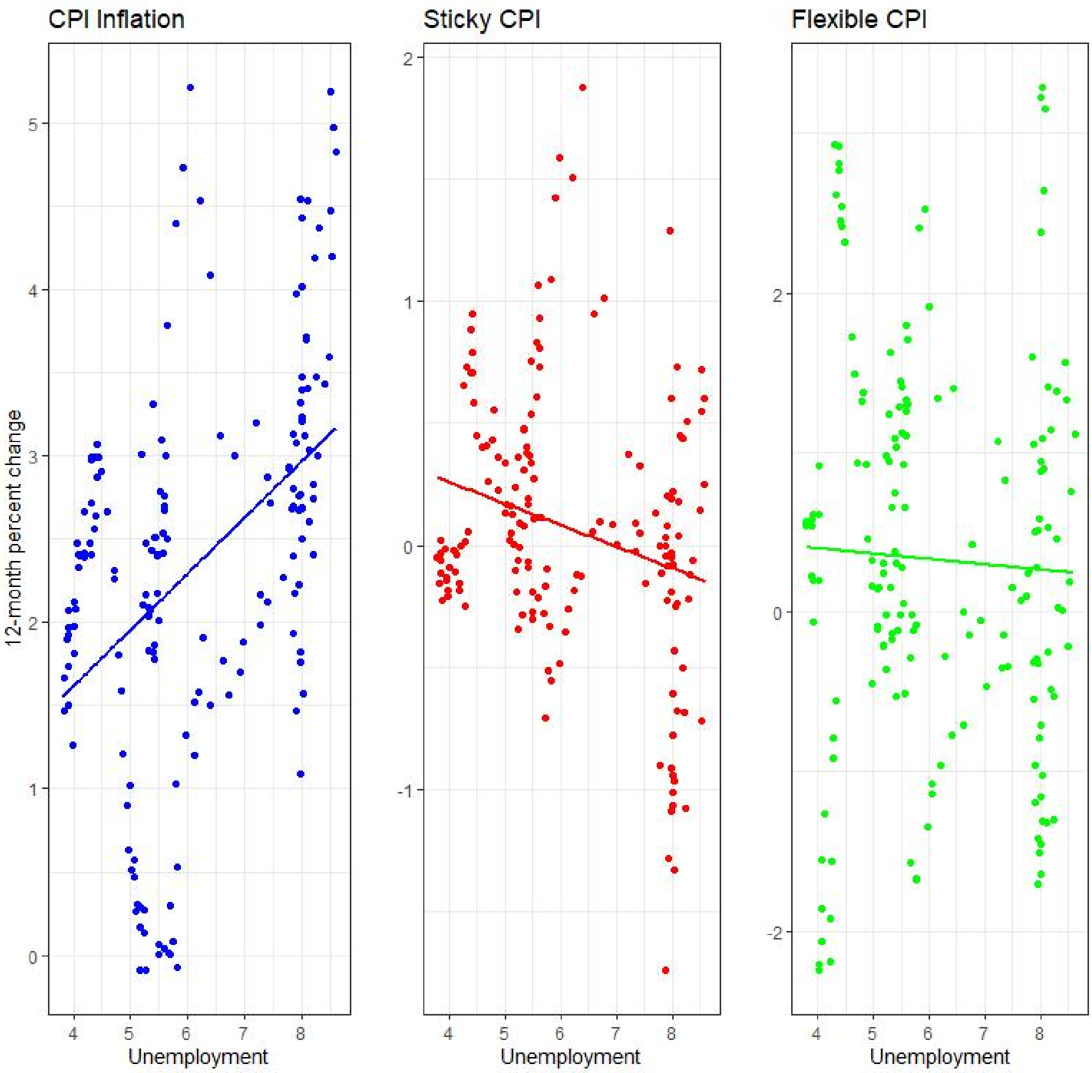
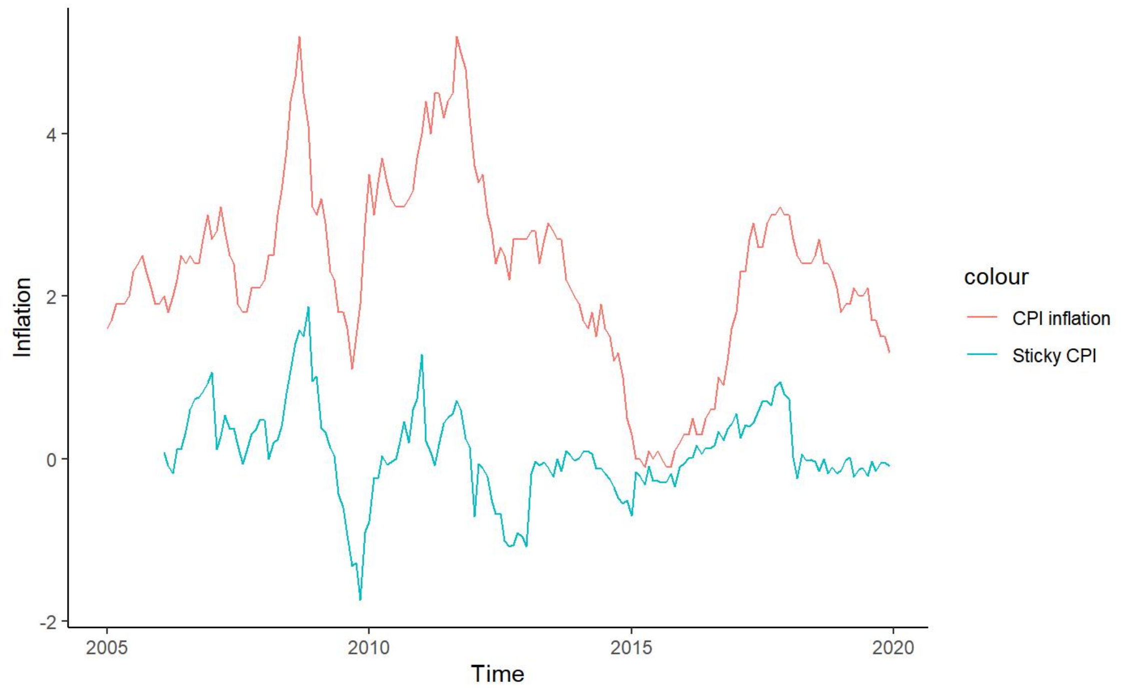


Figure 8: CPI and sticky CPI



2.5.4 Stochastic models

Besides the core inflation measures, we also include a stochastic model in our comparison. Autoregressive (AR) models are a type of statistical model that use the past values of a variable to predict its future values. In the context of forecasting inflation, an autoregressive model might use past data on inflation rates to make predictions about future inflation. This can be useful because inflation tends to be relatively predictable, and past data can provide valuable information about future trends. Additionally, autoregressive models can account for the fact that inflation tends to be highly correlated with itself over time, meaning that the current inflation rate is often a good predictor of future inflation. This can make autoregressive models more accurate than other methods for forecasting inflation.

There are several ways to forecast inflation using autoregressive models, and the specific method used will depend on the specifics of the data and the goals of the forecast. The data used are represented by the year-on-year series from January 1993 to December 2019 for the inflation rate in the UK. A stationary series π_t^{CPI} follows a process AR(p) if the condition is fulfilled:

$$\pi_t^{CPI} = \beta_0 + \beta_1 \pi_{t-1}^{CPI} + ... + \beta_p \pi_{t-p}^{CPI} + \varepsilon_t \qquad (6)$$

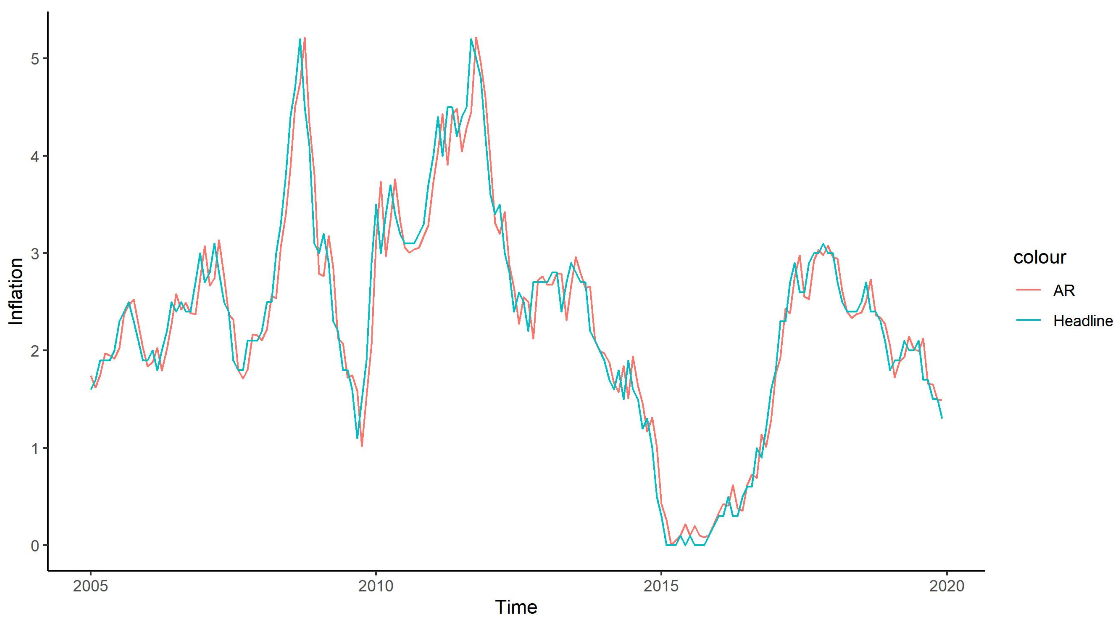
Where $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$ stationary time series, $E(\varepsilon_t) = 0, E(\varepsilon_t^2) = \sigma^2, E(\varepsilon_{t,} \varepsilon_s) = 0,$ if $t \neq s$;

The autoregressive models are characterized by the fact that the value of variable π_t^{CPI} at time t depends on the previous values of the variable. The next step is to determine the order of the autoregressive model. The order of an autoregressive model refers to the number of past values that are used to predict the future value. A model with a high order will be more flexible and able to fit the data better, but it may also be more sensitive to random fluctuations in the data. It was determined that an AR (3) process was most appropriate based on the Akaike Information Criterion. Then, the autoregressive model should be fitted to the data. This can be done using a variety of statistical software packages, such as R. The model will use the past data on inflation rates to estimate the parameters of the model. Equation (7) represents the regression of the model.

$$\pi_t = 2.2 + 1.15\pi_{t-1} - 0.03\pi_{t-2} - 0.17\pi_{t-3} + e_t \quad (7)$$

where π_t represents the monthly inflation rate. In Figure 9, an autoregressive (AR) model has been fitted to consumer price index (CPI) data and is found to fit the data very well, it means that the model has been able to accurately capture the relationship between past and current values of the CPI. This can be a useful tool for predicting future inflation rates, as it allows for the incorporation of past trends and patterns in the data. However, it is important to remember that all statistical models have limitations, and an AR (3) model is no exception. The model may not be able to accurately predict future inflation rates in cases where there are significant changes in economic conditions or unexpected events. In addition, the accuracy of the model's predictions will depend on the quality of the data used to fit the model, as well as the assumptions and methods used in the model's construction. As with any forecasting tool, it is important to carefully evaluate the assumptions and limitations of the AR model before using it to make predictions.

Figure 9: CPI and AR (3) inflation



2.5.5 Seasonal Autoregressive Integrated Moving Average (SARIMA)

Seasonal autoregressive integrated moving average (SARIMA) models are a type of time series model that can be used to forecast inflation. These models are particularly useful for modeling data that exhibits seasonality, such as inflation data, which often exhibits predictable patterns over the course of a year. SARIMA models are a combination of autoregressive (AR) and moving average (MA) models, which are used to model the dependencies between the current value of a time series and its past values. The "integrated" term refers to the differencing of the data, which can be used to remove trend and seasonality from the data. The "seasonal" term refers to the inclusion of seasonal terms in the model, which allows it to capture seasonal patterns in the data.

Studies have shown that SARIMA models can produce accurate forecasts of inflation, particularly when combined with other forecasting techniques. For example, Gikungu et al. (2015) developed the Seasonal Autoregressive Integrated Moving Average (SARIMA) model to forecast Kenya's inflation rate based on quarterly data from 1981 to 2013. A predictive ability test determined that the model was capable of accurately forecasting the Kenyan inflation rate. Another paper examines the efficacy of SARIMA models for forecasting inflation in the Turkish economy. The paper suggests a single optimal SARIMA model which provides a fair and accurate representation of Turkish inflation. (Saz 2011)

Despite its popularity and effectiveness, the ARIMA model has some limitations. One limitation is that it assumes that the time series data is stationary, meaning that the statistical properties of the data do not change over time. This assumption may not always hold in practice, and failure to adequately address non-stationarity can result in biased or inaccurate predictions. Another limitation is that the ARIMA model may require a large amount of data in order to make reliable predictions, particularly for longer time horizons.

The form of the ARMA model is as follows:

$$Y_t - \beta_1 Y_{t-1} - \beta_2 Y_{t-2} - \cdots - \beta_p Y_{t-p} = c + \varepsilon_t - \alpha_1 \varepsilon_{t-1} - \alpha_2 \varepsilon_{t-2} - \cdots - \alpha_q \varepsilon_{t-q} \quad (8)$$

Where $\{Y_t, Y_{t-1}, \cdots, Y_{t-p}\}$ is time-series data, c is constant; $\{\varepsilon_t, \varepsilon_{t-1}, \cdots, \varepsilon_{t-q}\}$ is random interference sequence; Subscript t is time;

$Y_t - \beta_1 Y_{t-1} - \beta_2 Y_{t-2} - \cdots - \beta_p Y_{t-p}$ is the autoregressive part of the model;

$\beta_1, \beta_2, \cdots, \beta_p$ is autoregressive coefficient; $\varepsilon_t - \alpha_1 \varepsilon_{t-1} - \alpha_2 \varepsilon_{t-2} - \cdots - \alpha_q \varepsilon_{t-q}$ is the moving average part of the model; $\alpha_1, \alpha_2, \cdots, \alpha_q$ is the moving average coefficient; p and q are autoregressive order and moving average order respectively.

The backward shift operator B can be introduced, where $B^j Y_t = Y_{t-j}$, and denote the ARMA (p,q) model as:

$$\left.\begin{aligned} \phi(B) Y_t &= c + \theta(B) \varepsilon_t \\ \phi(B) &= 1 - \beta_1 B - \beta_2 B^2 - \cdots - \beta_p B^p \\ \theta(B) &= 1 - \alpha_1 B - \alpha_2 B^2 - \cdots - \alpha_q B^q \end{aligned}\right\} \quad (9)$$

Where $\phi(B)$ Is polynomial of p order autoregressive coefficient; $\theta(B)$ is polynomial of moving average coefficient of order q; ε_t is white noise, and follows a normal distribution with a mean of 0 and a constant variance.

A smooth time series is a prerequisite for the ARMA model, and the determination of the smoothness of the time series is the first step in forecasting. When the time series shows a specific trend, the series can be smoothed by differencing. The ARMA(p,q) study is based on the d-order differenced series, called ARIMA(p,d,q) model, expressed as

$$\phi(B)(1-B)^d Y_t = c + \theta(B) \varepsilon_t \quad (10)$$

Seasonal time series are time series that have both a trend and a cycle, with the cycle being driven by seasonal variation or other underlying variables.

The SARIMA model is an ARIMA analysis based on the sequence following seasonal differences. It is expressed as equation (11) and is denoted as $\mathrm{SARIMA}(p,d,q)(P,D,Q)_S$.

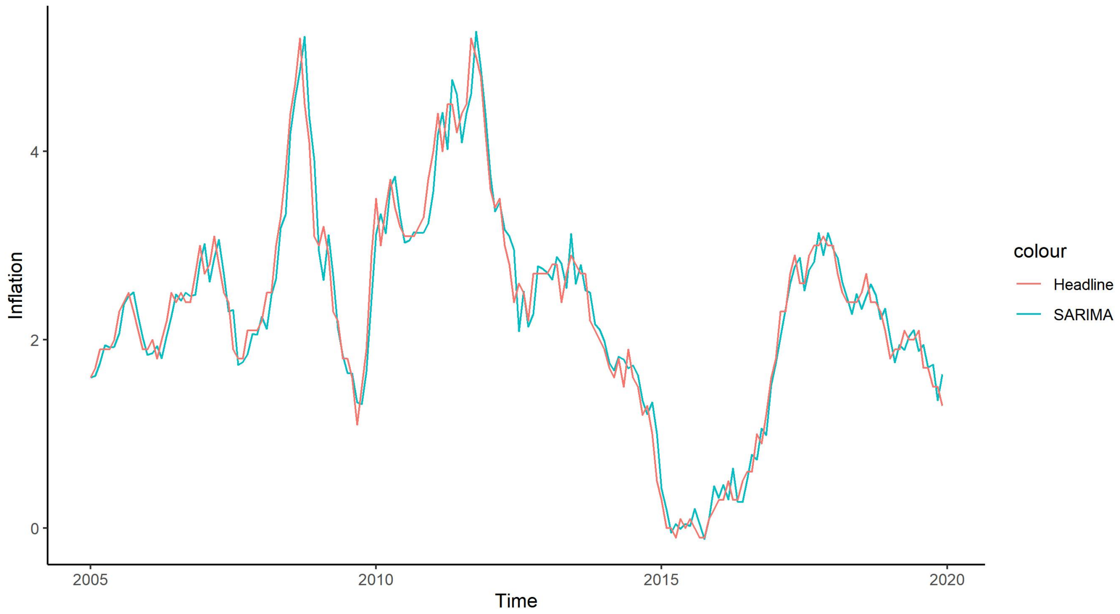
$$\left.\begin{aligned}&\phi(B)\Phi(B^S)(1-B)^d(1-B^S)^D Y_t = c+\theta(B)\Theta(B^S)\varepsilon_t\\&\Phi(B^S)=1-\beta_1 B^S-\beta_2(B^S)^2-\cdots-\beta_P(B^S)^P\\&\Theta(B^S)=1-\alpha_1 B^S-\alpha_2(B^S)^2-\cdots-\alpha_Q(B^S)^Q\end{aligned}\right\} \quad (11)$$

Where B^S is the seasonal backward shift operator; S is the seasonal cycle; $\Phi(B^S)$ is the regression coefficient polynomial; $\Theta(B^S)$ is the moving average coefficient polynomial; with p = non-seasonal AR order, d = non-seasonal differencing, q = non-seasonal MA order, P = seasonal AR order, D = seasonal differencing, Q = seasonal MA order, and S = time span of repeating seasonal pattern.

Headline CPI data (not seasonally adjusted) for the UK economy from January 2005 to December 2019 is used in this application to discover the best model for monthly inflation rates. This programme was created using the "forecast" and "uroot" packages in R Project for Statistical Computing version 4.2.0. To create a SARIMA model, the auto.arima() function in R utilises a variant of the Hyndman-Khandakar approach (Hyndman & Khandakar, 2008), including unit root tests, AICc minimization, and Maximum likelihood estimation(MLE). The inputs to auto.arima() allow for a wide range of algorithm changes.

Using repeated KPSS tests, the number of differences $0 \le d \le 2$ is determined. After differencing the data d times, the values of p and q are chosen by minimising the AIC. Instead of considering every conceivable combination of p and q, the algorithm traverses the model space via a stepwise search. The most parsimonious model was an ARIMA (1,1,1) (0,0,2) [12] after assessing the information criterion.

Figure 10: Headline CPI and SARIMA



2.6 EVALUATING CORE INFLATION MEASURES

2.6.1 Forecasting

The forecast of inflation is crucial to the conduct of monetary policy. Since monetary policy transmission has a significant lag, central banks aiming to achieve price stability also need to be forward-looking in their decisions, emphasizing the importance of inflation forecasting. Thus, the formation of expectations is at the heart of what drives (and helps predict) inflation and is at the heart of policymaking. The New Zealand statistician Phillips first proposed the famous Phillips curve (Phillips, 1958) around the issue of inflation. The curve has since been further extended to an "output-inflation" Phillips curve, which describes the deviation of inflation and the actual output level from the potential output level. The "output-inflation" Phillips curve describes the stable relationship between inflation and the deviation of the actual output level from the potential output level, i.e., the "output gap". This provides an important theoretical basis for policymakers to weigh the relationship between inflation and economic growth. Although other methods that can be used to describe and predict the inflation rate have been proposed in the existing literature, the Phillips curve still plays a critical role in the prediction of the inflation rate due to its superior prediction effect (Stock and Watson, 2008). It has been widely concerned in academic articles.

The Phillips curve shows that the economy is exposed to inflationary pressures when aggregate demand exceeds potential output, and inflation should be expected to grow. In these conditions, authorities seeking to slow price increases can consider enacting policies that limit aggregate demand. In contrast, inflation should decline when aggregate demand falls short of potential supply, prompting policymakers to consider expanding policies. When using the Phillips curve to predict inflation, policymakers need to estimate the output gap based on the data available at the time because the output gap is not observable. However, real-time and final estimates of the output gap vary widely due to factors such as the data correction effect and post-event information effect (Orphanides and Van Norden, 2002). This could lead to different inflation forecasts based on final output gap estimates from those based on real-time estimates. At the same time, as policymakers gain more data, they will update their estimates of model parameters, which may further lead to differences between real-time and final inflation forecasts. Therefore, although the Phillips curve based on the output gap is more accurate in forecasting inflation when the final data is used, and the introduction of the output gap improves the forecasting accuracy of the model, in practice, the reliability of real-time forecasting of inflation using the Phillips curve and the value of the output gap in forecasting remains questionable.

Given the large difference between the real-time forecast of the inflation rate and the analysis result based on the final data, as well as the doubt about the role of the output gap in the real-time forecast of the inflation rate, researchers have conducted extensive research on the reliability of the real-time forecast of output-inflation Phillips curve. Robinson et al. (2003), for example, found that introducing the output gap did not increase the accuracy of inflation rate forecasting, and that the role and utility of the production gap in inflation rate forecasting were relatively restricted.

Orphanides & Van Norden (2005) discovered that, while final output gap estimates are useful for inflation forecasting, real-time production gap estimates do not increase forecasting accuracy, and inflation projections based on real-time output gaps are erroneous; Clausen & Clausen (2010) concluded that analyzing the production gap based on the final estimate will overestimate the Phillips curve's value in the inflation projection for Germany, the United Kingdom, and the United States. When real-time data is used for analysis, the function of the output gap in inflation forecasting is reduced, according to the literature. The result of an inflation forecast based on real-time data and the conclusion based on final data differ significantly, and the applicability of the Phillips curve in real-time inflation forecasting is controversial.

This section discusses seasonal ARIMA inflation forecasting models, as well as our method's outcomes, strengths, and limits.

2.6.2 Why we need forecast inflation

Forecasting inflation generally improves financial planning for businesses and the private sector. Inflation affects the actual cost of expenses and stock valuations at the business level. Therefore, anticipating changes can help investors understand risks and hedge investments. Forecasting inflation also helps in the formulation and evaluation of monetary policy.

Private banks need to forecast inflation to keep their investments profitable. Inflation can reduce banks returns on fixed-rate loans, sometimes making them unprofitable. Thus, forecasting inflation can help banks meet their working capital requirements.

Forecasting corporate inflation can help companies prepare for accurate accounting of expenses. Preparing for an inflationary shift allows firms to stock up on raw materials more cheaply, avoiding price rises during periods of inflation. Forecasting inflation will also enable firms to prepare for demand for wage shifts, heralding necessary adjustments in human resources.

Companies that fail to account for predicted inflation fluctuations experience strategic growth shifts and stock price declines. Higher raw material prices often cause lower demand due to higher prices. This reduction in available cash, combined with higher borrowing costs in times of inflation, tends to slow growth strategies. The combination of reduced cash flow and growth processes can harm stock prices.

Choosing the best time to refinance and making appropriate mortgage rate decisions are two benefits to individuals of anticipating inflation. Predicting inflation can give investors information about whether to invest in the bond market since fixed-rate bonds lose value in times of inflation. Portfolio diversification can also help offset inflation.

If individuals do not consider the underlying inflation, there will be a decline in purchasing power. People living on retirement or savings accounts, for example, rely on their balances and current interest rates. Inflation pushes up prices, making today's money less valuable in the future and making their fixed income even less helpful.

Monetary policy decisions also depend on forecasts of inflation. Understanding the potential of inflation can help policymakers estimate the economic effects of their policies. For example, high inflation can affect the value of domestic products on the international market. If such inflation did not occur worldwide, price increases would reduce the competitiveness of the above-mentioned domestic products.

2.6.3 Criteria for evaluation: forecasting future inflation

When evaluating methods for predicting inflation, several commonly used evaluation metrics are typically employed. One of these is the Mean Squared Error (MSE). The

MSE measures the average of the squares of the errors—that is, the average squared difference between the estimated values and the actual value. It is a risk function, corresponding to the expected value of the squared error loss. It is always non-negative, and values closer to zero are better. There is also a metric known as mean absolute error (MAE) that is commonly used for evaluation. This indicator measures the average absolute difference between the predicted value and the actual value. The lower the MAE, the stronger the prediction ability of the model, and the higher the MAE, the weaker the prediction ability.

This work uses Cogley's model to test the forecasting ability of various core inflation measures, including excluding food and energy, sticky price, AR (3) and trimmed mean. As defined by Bryan and Cecchetti (1993), core inflation is defined as "changes in price levels that are expected to persist for a long period of time." According to this definition, a proper core inflation is one that is based on the removal of temporary factors from measured real inflation to be "pure." To evaluate the predictive power of core inflation, Cogley developed the following model:

$$\pi_{t+h} - \pi_t = \alpha_h + \beta_h(\pi_t - \pi_t^c) + u_{t+h} \tag{12}$$

Here π represents the headline inflation rate, and core π^c means some core inflation indicator, both year-on-year data. Parameter h is N (month) ahead. For sufficiently large H, the core deviation $(\pi_t - \pi_t^c)$ should be inversely related to subsequent changes in inflation ($(\pi_{t+h} - \pi_t)$. Moreover, in order for the candidate to satisfy the equation (12) , the coefficients in the regression should meet $\alpha = 0$ and $\beta = -1$.

The estimated coefficient β of importance to the forecasting model indicates whether core inflation has sufficiently purified the transitory component. Suppose the absolute value of the estimated coefficient is equal to 1. In that case, it suggests that the model is a random walk process. The components removed from the core inflation do not contain any information that predicts overall future inflation. Suppose $\beta = -1$, the forecasting capacity for core inflation is the best. It proves that core inflation has fully captured the trend components of general inflation and has a complete forecasting ability for future inflation.

1. 1. If the $|\beta| < 1$, it indicates that subsequent changes in inflation are overestimated;
2. If the $|\beta| > 1$, it shows an underestimation of the current temporary movement in headline inflation.

Therefore, the closer the absolute value of the estimated regression coefficient β is equal to 1, the better the predictive power of core inflation is. In addition, the root means square error $\mathrm{RMSE} = \sqrt{\frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}(\pi_{\mathrm{t}} - \hat{\pi}_{\mathrm{t}})^2}$ obtained by Cogley regression represents the deviation between the predicted value and the actual value. $\hat{\pi}_{\mathrm{t}}$ is the forecast value of the inflation rate. The smaller the RMSE, the more accurate the forecast and the better the estimates of core inflation.

On Figure 11, we present the headline CPI inflation, along with the National Institute of Economic and Social Research 5 percent trimmed-mean series (TM), autoregressive (AR) model, seasonal ARIMA series (SARIMA), excluding food and energy core inflation measure (EXFD), and Sticky CPI. It is based on the period from January 2005 to December 2019.[1] Table 28 shows that, with the exception of TM and sticky CPI, all other methods have a mean of inflation around 2%, as expected by the Bank of England's target for general inflation. The sticky CPI has particularly low inflation, with an average value of only 0.07. It is clear that the existing core measures have eliminated some of the transient factors affecting CPI inflation (particularly the financial crisis of 2008), but they are still heavily influenced by high-frequency fluctuations. This is also corroborated by the data on standard deviation (SD). EXFD and Sticky CPI measures have only half the SD of headline measures. TM has the greatest volatility.

[1] With the exception of sticky CPI, price quotes and item indices are used to calculate it from 2006.

Figure 11: Core CPI and Headline CPI

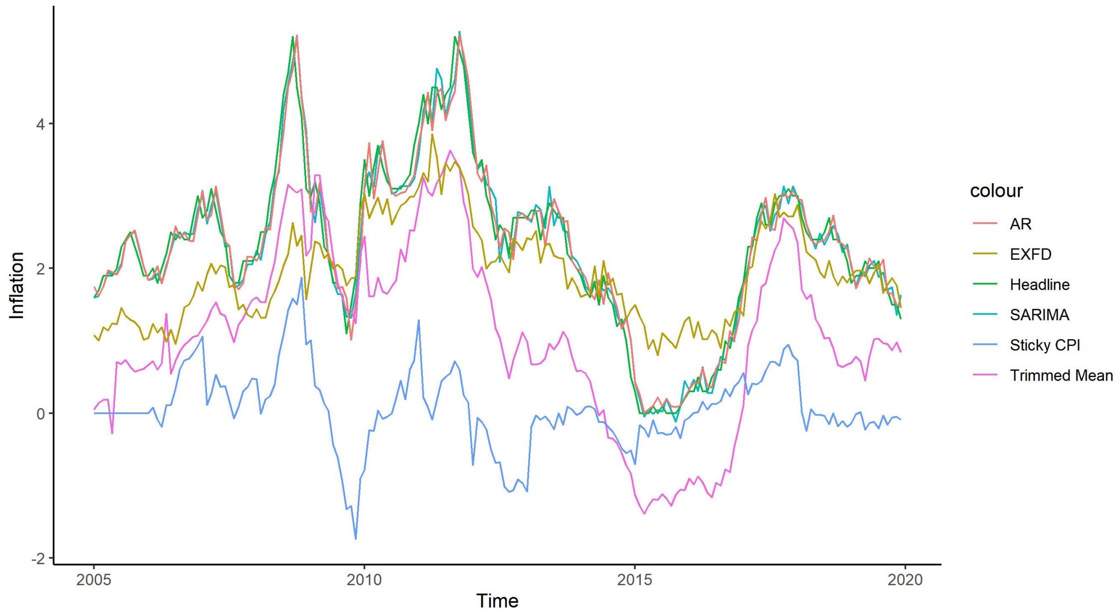


Table 28 Core inflation series description

	MEAN	MEDIAN	SD	SKEWNESS	KURTOSIS
AR	2.32	2.37	1.10	0.05	3.19
Headline	2.32	2.40	1.14	0.00	3.14
SARIMA	2.32	2.33	1.13	0.05	3.23
EXFD	1.94	1.90	0.67	0.47	2.55
TM	1.08	1.03	1.22	-0.11	2.53
Sticky	0.07	0.00	0.53	0.09	4.60

In this study, we conducted a univariate regression analysis to evaluate the forecasting performance of five different measures of core inflation. Specifically, we examined their root mean squared error (RMSE), coefficients, and R-squared values at horizons ranging from one to twelve months ahead. This allowed us to assess the accuracy and reliability of these measures in predicting future inflation. To more clearly illustrate the trends in the performance of the measures at different forecasting horizons, we present both graphical representations and numerical results. This enables a more comprehensive evaluation of the relative accuracy of the measures across a range of horizons.

The estimated values of beta in Table 29 and Figure 12, show that AR and SARIMA are generally positive, while EXFD, Sticky CPI, and TM are consistently negative. Thus, a negative correlation exists between the last three measurements of core deviation and subsequent inflation changes. It is evident that most estimates are significantly less than 1 in absolute value for forecast horizons of one to twelve months. Nevertheless, the estimates are generally lower as the forecast horizon lengthens, and for forecast horizons greater than 10 to 12 months, EXFD and TM do not differ significantly from -1. The Sticky CPI coefficient is about -0.5. At 12 months ahead, AR and SARIMA showed a significant downward trend. Therefore, the measured transients have (more or less) the right magnitude over time horizons of one year. There is a high degree of accuracy in the EXFD and TM series on this dimension, with point estimates close to -1 at 12-month time horizons. Transient components in all series tend to be underestimated.

Figure 12: Univariate Regression Coefficients (Beta)

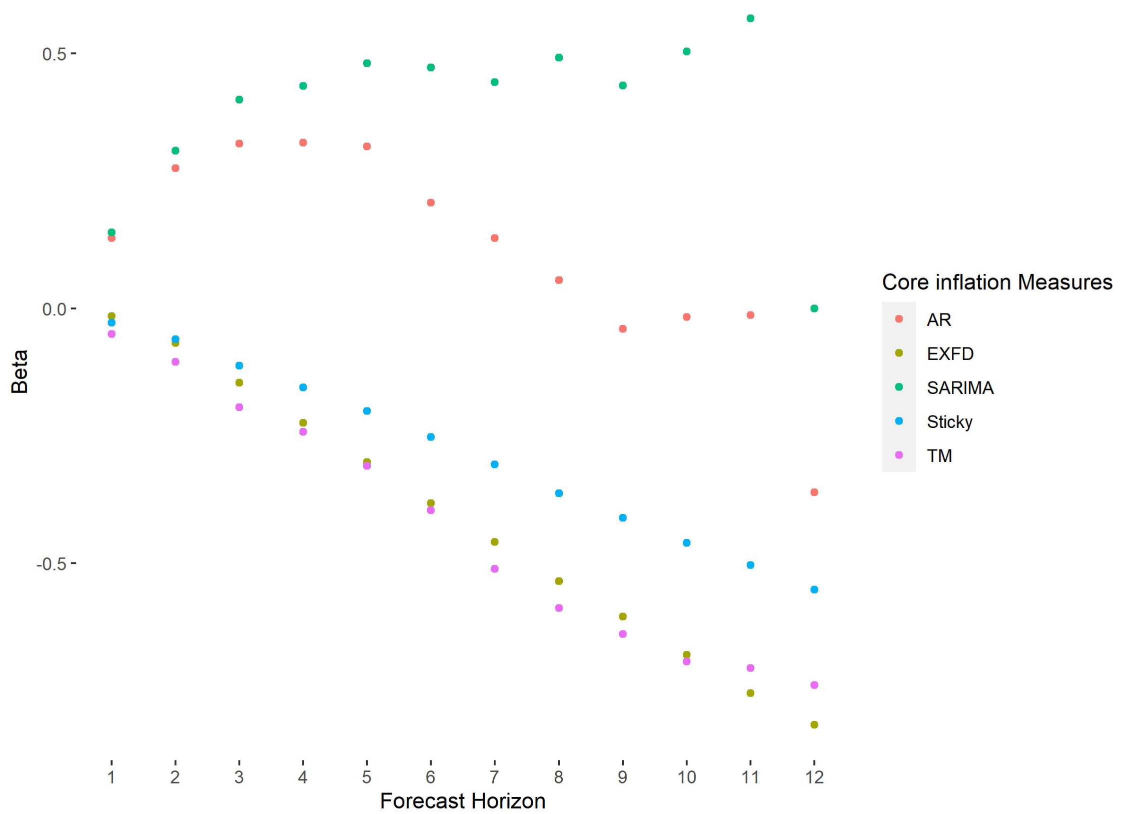
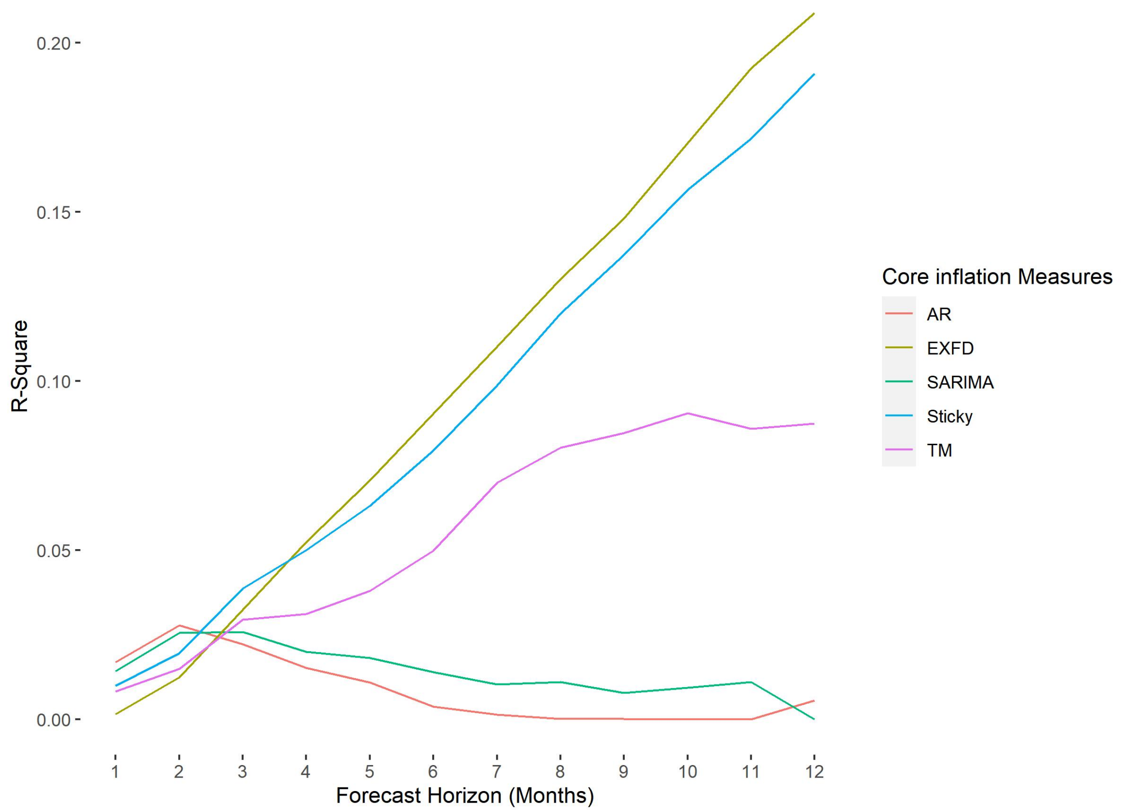


Table 29 Headline CPI Forecast Accuracy: Coefficients

	Core Inflation									
Months Ahead	AR		SARIMA		EXFD		TM		SP	
	α	β	α	β	α	β	α	β	α	β
1	0.00	0.14	0.00	0.15	0.01	-0.02	0.06	-0.05	0.06	-0.03
2	0.00	0.27	0.00	0.31	0.03	-0.07	0.13	-0.10	0.14	-0.06
3	0.00	0.32	0.00	0.41	0.05	-0.15	0.24	-0.19	0.25	-0.11
4	-0.01	0.33	-0.01	0.44	0.08	-0.22	0.29	-0.24	0.34	-0.15
5	-0.02	0.32	-0.02	0.48	0.10	-0.30	0.37	-0.31	0.44	-0.20
6	-0.03	0.21	-0.02	0.47	0.12	-0.38	0.47	-0.40	0.55	-0.25
7	-0.03	0.14	-0.03	0.44	0.14	-0.46	0.61	-0.51	0.66	-0.31
8	-0.04	0.06	-0.04	0.49	0.16	-0.54	0.69	-0.59	0.77	-0.36
9	-0.05	-0.04	-0.06	0.44	0.17	-0.60	0.74	-0.64	0.87	-0.41
10	-0.06	-0.02	-0.06	0.50	0.19	-0.68	0.80	-0.69	0.98	-0.46
11	-0.07	-0.01	-0.07	0.57	0.21	-0.76	0.81	-0.71	1.06	-0.50
12	-0.08	-0.36	-0.08	0.00	0.23	-0.82	0.84	-0.74	1.16	-0.55

Figure 13 presents the r squared values obtained from the regressions. In addition to evaluating the negative correlation and appropriate magnitude of the relationship between measured core deviations and subsequent changes in inflation, it is also necessary to determine which of the candidates exhibits the highest r squared value in this analysis. Candidates that are able to explain a larger proportion of the variance in subsequent changes in inflation are preferred to those that explain a smaller proportion, as they are able to effectively filter out transient fluctuations. At longer horizons, the EXFD and Sticky CPI series were the most informative, with r squared values ranging from 15 to 20%. As a result, for medium-term horizons of six months to one year, the EXFD series was the most useful indicator of expected inflation.

Figure 13: R - squared statistics from Univariate Regressions



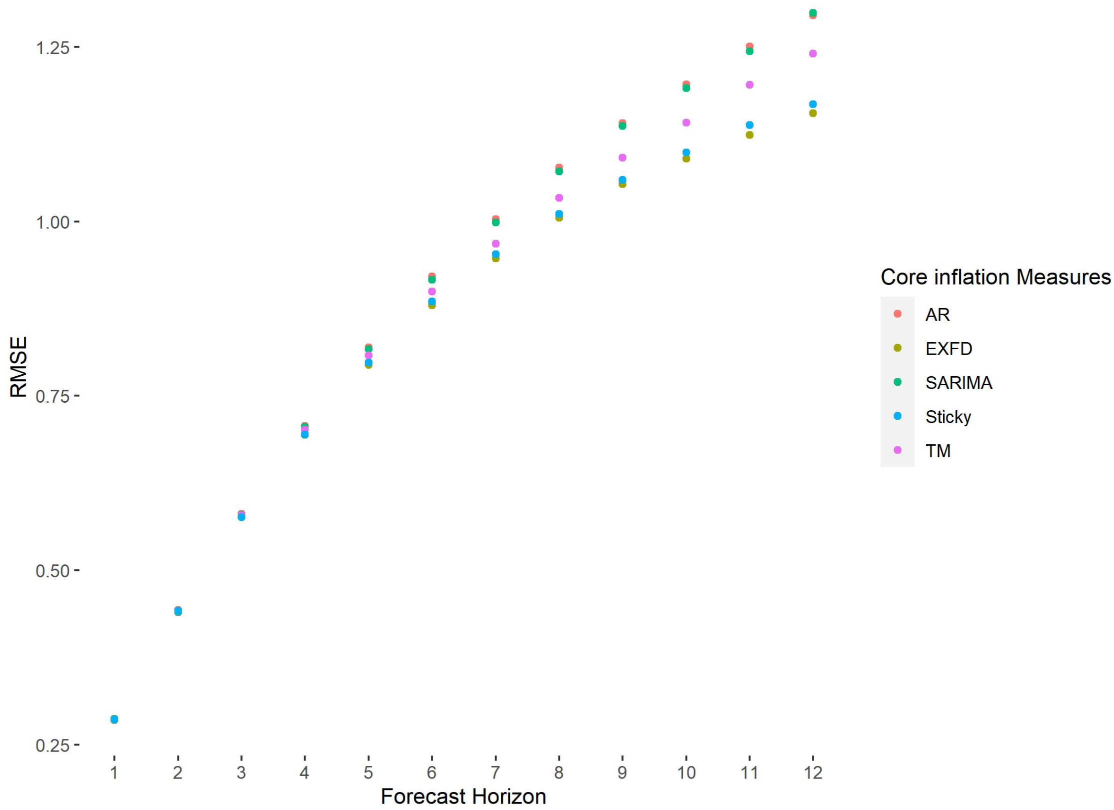
In addition to evaluating the model using coefficients, we also evaluated the fit of the univariate regression model using the root mean squared error (RMSE). The results, presented in Figure 14 and Table 30, show that forecasts of the headline consumer price index (CPI) that are based on sticky-price data and excluding food and energy data (EXFD) tend to be more accurate than the stochastic measurement and trimmed mean forecasts based on headline inflation. Furthermore, CPI predictions using EXFD data perform relatively well compared to forecasts using sticky-price data. We also found that the relative accuracy of the EXFD model increases as the forecast horizon gets longer. For instance, when forecasting one month ahead, we found that the RMSE of the sticky-price and EXFD models are similar, but when forecasting 12 months ahead, the RMSE of the latter is approximately 1.1 times that of the former. The stochastic and trimmed mean series do not seem to perform well in forecasting, and their accuracy decreases as the forecast horizon gets longer.

These results suggest that the excluding food and energy measure may be the most useful in forecasting future inflation, as it demonstrated the strongest relationship with future values of the inflation rate, the highest value of R squared, and the lowest root mean squared error. However, it is important to consider that the strength of the relationship between the independent variable (the measure of core inflation) and the dependent variable (the future value of the inflation rate) may be influenced by various factors, including the underlying assumptions of the model and the quality of the data used for the forecast.

Table 30 Headline CPI Forecast Accuracy: Root Mean Squared Errors

Months Ahead	AR	SARIMA	EXFD	TM	Sticky
1	0.28	0.29	0.29	0.29	0.29
2	0.44	0.44	0.44	0.44	0.44
3	0.58	0.58	0.58	0.58	0.58
4	0.71	0.71	0.69	0.70	0.69
5	0.82	0.82	0.79	0.81	0.80
6	0.92	0.92	0.88	0.90	0.89
7	1.00	1.00	0.95	0.97	0.95
8	1.08	1.07	1.01	1.03	1.01
9	1.14	1.14	1.05	1.09	1.06
10	1.20	1.19	1.09	1.14	1.10
11	1.25	1.24	1.12	1.20	1.14
12	1.30	1.30	1.16	1.24	1.17

Figure 14: Root Mean Squared Errors



2.7 Conclusion

In conclusion, this study on measuring core inflation in the UK has yielded significant insights into the forecasting of future inflation rates. My findings indicate that forecasts of the headline consumer price index that are based on sticky-price data and excluding food and energy data (EXFD) tend to be more accurate than the stochastic measurement and trimmed mean forecasts based on headline inflation. This suggests that the EXFD measure may be the most useful in forecasting future inflation, as it demonstrated the strongest relationship with future values of the inflation rate.

However, it is important to acknowledge the limitations of our study. The strength of the relationship between the independent variable (the measure of core inflation) and the dependent variable (the future value of the inflation rate) may be influenced by various factors. These include the underlying assumptions of the model and the quality of the data used for the forecast. Therefore, while our findings are promising, they should be interpreted with caution.

Finally, the practical applications of our research are manifold. Forecasting inflation improves financial planning for businesses and the private sector. Anticipating changes can help investors understand risks and hedge investments. Furthermore, our findings can assist in the formulation and evaluation of monetary policy. This underscores the importance of our research in both the academic and practical realms.

In next chapter, it is imperative to establish a methodological framework that will effectively elucidate the primary findings of this study. These findings, predominantly concerning the persistence of inflation and the assessment and consequences of core inflation, warrant thorough exploration. Moreover, an analytical examination of the circumstances that could potentially engender these principal outcomes is crucial. This should include an evaluation of the potential policy implications derived from these results.

Chapter 3: Understanding inflation persistence

3.1 Introduction

Inflation, a fundamental economic phenomenon, has profound implications for both macroeconomic policy and individual financial planning. Understanding its persistence and the mechanisms that drive it is crucial for economists and policymakers. This paper delves into the intricacies of measuring inflation in the United Kingdom, a task that requires a nuanced understanding of various economic factors and their interplay.

We begin by exploring the history of inflation rates in the UK from 1920 to 2022, providing a comprehensive backdrop against which our subsequent analyses are set. This historical perspective not only offers insights into the evolution of inflation in the UK but also sets the stage for a deeper understanding of the factors influencing its persistence.

To understand the causes and dynamics of inflation, we delve into various theories of inflation, including the Monetarist Theory, the Demand-Pull Inflation Theory, the Cost-Push Inflation Theory, the Built-In Inflation Theory, and the Structuralist Theory of Inflation. Each of these theories provides a unique perspective on the causes and dynamics of inflation, and understanding them can help policymakers and economists develop effective strategies for managing inflation and promoting economic stability.

The heart of this paper lies in its examination of the Generalized Taylor Economy (GTE) model, a framework that accommodates multiple sectors with varying wage-setting processes. We delve into the behaviour of firms, the structure of contracts within the GTE, and the decisions surrounding wage-setting. This exploration is crucial as it underscores the diverse range of contract lengths present in the economy and their potential influence on economic dynamics.

We also delve into the concept of 'optimal flex wage', a theoretical construct representing the ideal wage in a scenario where wages are perfectly flexible. This concept is integral to our discussion on wage-setting rules and their implications for inflation.

In conclusion, this paper contributes to the literature on macroeconomic modeling by providing a more flexible framework for capturing the heterogeneity of wage-setting processes across sectors. We hope that our findings will shed light on the impact of monetary shocks on output and other macroeconomic variables, ultimately aiding in the formulation of effective economic policies. By leveraging the GTE model, we aim to provide a comprehensive explanation for inflation persistence, enhancing our understanding of this critical economic phenomenon.

3.2 Theories, Implications, and the Historical Context in the UK

Inflation is a complex economic phenomenon with various theories explaining its causes and persistence. It is also a significant concern due to its potential negative impacts on the economy. The history of inflation in the UK provides a rich case study for understanding these aspects.

3.2.1.1 Theories of Inflation

Various theories have been proposed to explain the phenomenon, each offering unique insights into the different factors that can lead to inflation. These theories are not mutually exclusive, but rather interrelated, each highlighting a different aspect of the complex dynamics of inflation.

In light of the new theory and the discussion on the augmented Phillips curve, it is important to consider the Monetarist Theory of inflation, often associated with Milton Friedman (1968), and its implications for the relationship between inflation and unemployment. Friedman's theory posits that inflation is primarily caused by an increase in the money supply that outpaces economic growth. He argued that in the long run, regardless of what the central bank did, unemployment would approach its natural rate. This natural rate is defined as the level that would be achieved by the Walrasian system of general equilibrium equations, given the actual structural characteristics of labor and commodity markets. Friedman's focus on expectations was key to explaining how the economy might appear to face a Phillips curve tradeoff and how that tradeoff would disappear if we tried to exploit it. He wrote that "there is always a temporary tradeoff between inflation and unemployment; there is no permanent tradeoff. The temporary tradeoff comes not from inflation by itself,, but from unanticipated inflation, which generally means, from a rising rate of inflation." The deviation of reality from expectations was what permitted the economy to depart from its classical benchmark. But because over time people catch on to what is happening, expectations and reality must eventually come into line, ensuring that these departures are only transitory.

In terms of policy implications, Friedman argued that, except in the short run, the central bank cannot peg either interest rates or the unemployment rate. The argument regarding the unemployment rate is that the tradeoff described by the Phillips curve is transitory, unemployment must eventually return to its natural rate, and so any attempt by the central bank to achieve otherwise will put inflation into an unstable spiral. The argument regarding interest rates is similar: Because we can never know with much precision what the natural rate of interest is, any attempt to peg interest rates will also likely lead to inflation getting out of control.

This understanding of the role of expectations and the long-run behavior of the economy has significant implications for the relationship between inflation and unemployment, and it should be taken into account when discussing the Phillips curve and its augmented versions. In addition to Friedman's theory, it's also worth considering the findings of a study by Bernanke and Mishkin titled "Inflation Targeting: A New Framework for Monetary Policy?" (2007). The study discusses the benefits and potential drawbacks of inflation targeting, a monetary policy strategy that aims to keep inflation within a specified range. The authors argue that inflation targeting can help to anchor inflation expectations, thereby strengthening the nominal anchor and leading to better performance for output and inflation. However, they also caution that central bank transparency can go too far if it complicates communication with the public. They suggest that providing information about the future policy path in more general terms or in terms of fan charts that emphasize the uncertainty about the future policy path might achieve most of the benefits of increased disclosure and still make clear how conditional the policy path is on future events.

In conclusion, the relationship between inflation and unemployment is complex and multifaceted, influenced by various factors including monetary policy, expectations, and the natural rates of unemployment and interest. Both the Monetarist Theory and the concept of inflation targeting provide valuable insights into this relationship, highlighting the importance of managing inflation expectations and maintaining a strong nominal anchor. These theories and their implications should be taken into account when discussing the Phillips curve and its augmented versions.

The Demand-Pull Inflation Theory is a Keynesian concept that describes how inflation can occur when demand for goods and services exceeds their supply. This imbalance can be caused by increased private and government spending, or by foreign investors pumping money into an economy. When the demand for goods and services outpaces their supply, prices rise, leading to inflation. The Keynesian system, which forms the basis of this theory, posits that governments and monetary authorities can implement fiscal and monetary policies to manage this type of inflation. For instance, during periods of high demand, a government can reduce spending or increase taxes to decrease the amount of money in circulation. Similarly, a central bank can increase interest rates to make borrowing more expensive, thereby reducing spending and demand. This theory is discussed in depth in the paper "The Keynesian System: Fiscal and Monetary Policy Guidelines" by Hiç-Birol, Özlen and Hiç Gencer, Ayşen (2014). The authors argue that despite changes in economic conditions and the emergence of anti-Keynesian views, the principles of Keynesian economics continue to inform fiscal and monetary policies in many countries.

The Cost-Push Inflation Theory posits that inflation can occur when the costs of production increase, causing producers to raise prices to maintain their profit margins. This can be due to rising wages, higher raw material prices, or increased taxes. The increased costs of production reduce the supply of goods and services, and if demand remains constant, prices rise, leading to inflation. A practical example of this theory can be seen in the study by Mariolis, Theodore et al. (2019). The authors discuss the impact of wage devaluation and currency devaluation on inflation in Greece and Italy. They found that wage devaluation, which increases production costs, can lead to cost-push inflation. However, the study also notes that the effects of wage devaluation on inflation can be slow and inefficient, suggesting that other factors, such as currency devaluation and changes in demand, can also play significant roles in inflation

Built-In Inflation Theory, also known as Inertia Inflation, suggests that inflation occurs when people expect prices to rise and adjust their behavior accordingly. This expectation can be based on past experiences of inflation, leading to a self-sustaining cycle. Workers, for example, might demand higher wages to keep up with expected price increases, and businesses might raise prices to cover expected increases in costs. This behavior can lead to a 'built-in' inflationary spiral. A real-world example of this theory can be seen in the study by Maliao, Ronald J. et al. (2023). The study discusses the socio-economic effects of the COVID-19 pandemic on artisanal fishing communities in the Philippines. The pandemic-induced lockdowns and economic disruptions led to increased prices of essential commodities, which in turn led to increased impoverishment and child labor in these communities. The study suggests that the expectation of continued economic hardship and rising prices could contribute to a cycle of built-in inflation

The Structuralist Theory of Inflation, also known as the Supply Shock Theory, suggests that inflation is often driven by structural aspects of an economy, such as the level of development, the degree of market competition, and the distribution of income and wealth. This theory posits that inflation can be caused by supply-side factors such as changes in the costs of production, the availability of key resources, or the structure of the economy itself. A practical example of this theory can be seen in the study by Ninomiya and Kenshiro (2022). The author discusses the impact of financial structures on economic stability and cycles, including inflation. The study suggests that changes in financial structures, such as shifts from hedge finance to speculative finance and Ponzi finance, can lead to economic instability and inflation. This highlights the potential for structural factors, such as the financial system, to contribute to inflation.

In conclusion, the theories of inflation - Demand-Pull, Cost-Push, Built-In, Monetarist, and Structuralist - each provide a different perspective on the causes and dynamics of inflation. Understanding these theories can help policymakers and economists develop effective strategies for managing inflation and promoting economic stability.

3.2.1.2 Why Inflation is a Problem

Inflation, fundamentally characterized as a consistent ascent in the general price level of goods and services in an economy over a time period, is a paramount economic matter. While a moderate degree of inflation is typically seen as a hallmark of a robust economy, excessive inflation can pose significant economic threats.

One of the primary problems associated with high inflation is the erosion of purchasing power. As the overall level of prices escalates, each monetary unit procures fewer goods and services. The degradation of the real value of money leads to decreased economic activity as individuals and businesses find it challenging to strategize for the future due to this uncertainty.

Additionally, inflation can instigate arbitrary redistributions of wealth. This is particularly detrimental to individuals on fixed incomes, such as retirees. As their income remains stagnant amidst rising prices, their real income and consequently, their standard of living diminish. Savers are also adversely impacted if the inflation rate surpasses the interest rate on their savings, leading to a decrease in the real value of their accumulated wealth.

High inflation also gives rise to increased 'menu costs', a term economists employ to refer to the costs incurred by businesses when they need to adjust their prices. In an environment rife with inflation, prices necessitate frequent updates, which prove to be both labor-intensive and costly.

Moreover, high and unpredictable inflation can breed uncertainty within the economy. This uncertainty can deter firms from investing, as future costs and demand levels become uncertain. This reduction in investment can hamper economic growth in the long term.

In terms of international trade, if a country's inflation rate is higher than that of its trade partners, its exports can become more expensive, while imports become cheaper. This imbalance could lead to a deterioration in the country's balance of trade.

In extreme situations, elevated levels of inflation can culminate in hyperinflation, where the inflation rate exceeds 50% per month. Hyperinflation can trigger severe economic instability and result in a collapse of the real economy. Historical instances such as the hyperinflation in Germany in the 1920s or more recent cases in Zimbabwe and Venezuela serve as stark reminders of this potential consequence.

Despite the challenges posed by inflation, it is crucial to note that deflation, defined as a decrease in the general price level, can also pose significant problems. Deflation can curtail economic activity and even instigate an economic depression. Therefore, managing inflation is a key task for economic policymakers, who aim to maintain a moderate and stable rate of inflation.

3.2.1.3 History of Inflation in the UK

The history of inflation in the UK is marked by periods of both inflation and deflation. The UK has managed to avoid any situation of hyperinflation. The highest rates of inflation were observed after the Napoleonic War in the early 19th century, during the First World War (25%), and in the 1970s, when inflation rose due to a rise in oil prices and strong wage growth. The highest peace-time inflation occurred in the 1970s, when inflation rose due to wage push and oil push inflation.

In the aftermath of the First World War, the UK experienced deflation, or falling prices, during the 1920s and early part of the 1930s. This deflation was due to tight monetary and fiscal policy and an overvalued exchange rate (Gold Standard). This period of deflation meant that the value of money increased. However, the 1920s and 30s were generally a period of low economic growth and high unemployment.

In the post-war period, the UK economy experienced strong growth with moderate inflation. However, in the 1970s, inflation rose to double figures and reached over 25%. This inflation was due to rising oil prices (oil prices tripled in the 1970s) and increasing wages as unions were bargaining for higher wages to keep up with the rising cost of living, causing a wage-inflationary spiral.

Towards the end of the 1980s, the UK experienced rapid economic growth. This growth of 4-5% a year was significantly higher than the UK's long-run trend rate of economic growth. This excessive economic growth led to demand-pull inflation of 8%.

After the late 1980s, inflation was brought under control, and for nearly two decades, during a period known as the great moderation, inflation remained relatively stable. However, since 2008, periods of inflation have been mainly due to cost-push factors. In 2008, inflation was due to rising oil prices. In 2012, it was due to higher taxes and rising import prices from devaluation. In 2022, inflation rose close to 10% due to rising oil and gas prices, rising food prices, the effect of devaluation, COVID supply chain issues, Brexit cost issues, and supply-side constraints.

Before 2008, interest rates were generally higher than inflation. However, after the financial crash of 2008, interest rates have been close to zero because of weak economic growth. This means inflation has mostly been higher than interest rates, causing negative real interest rates.

Please refer to the quoted data for a year-by-year breakdown of inflation rates in the UK from 1920 to 2022.

In conclusion, understanding the theories of inflation, the problems it poses, and its history in specific contexts like the UK can provide valuable insights for both economic policy and individual financial planning.

3.3 The Model Economy

In Dixon and Kara's (2005b) paper, the authors propose a modeling framework called the GTE that accommodates multiple sectors with varying wage-setting processes. The GTE approach provides an advantage over the standard Taylor model and includes the Calvo process as a special case.

The authors extend Ascari's (2000) model to incorporate essential features for analyzing the impact of monetary shocks on output in a dynamic equilibrium setting. While the initial exposition focuses on outlining the model's basic building blocks, the paper's novelty lies in the description of the wage-setting process. Specifically, the authors detail the behavior of firms, the contract structure in the GTE, wage-setting decisions, and monetary policy.

Overall, Dixon and Kara's (2005b) paper contributes to the literature on macroeconomic modeling by providing a more flexible framework for capturing the heterogeneity of wage-setting processes across sectors. This approach has important implications for understanding the impact of monetary shocks on output and other macroeconomic variables.

3.3.1 Firms

In this model, there is a continuum of firms indexed by $f \in [0,1]$, each producing a single differentiated good $Y(f)$, which are combined to produce a final consumption good Y. The production function is CES with constant returns and corresponding unit cost function P

$$\boldsymbol{Y_t} = \left[\int_0^1 \boldsymbol{Y_t(f)}^{\frac{\theta-1}{\theta}} \boldsymbol{df} \right]^{\frac{\theta}{\theta-1}} \tag{13}$$

$$\boldsymbol{P_t} = \left[\int_0^1 \boldsymbol{P_{ft}^{1-\theta}} \boldsymbol{df} \right]^{\frac{1}{1-\theta}} \tag{14}$$

The demand for the output of firm f is given by:

$$\boldsymbol{Y_{ft}} = \left(\frac{\boldsymbol{P_{ft}}}{\boldsymbol{P_t}}\right)^{-\boldsymbol{\theta}} \boldsymbol{Y_t} \tag{15}$$

Each firm sets the price P_{ft} and takes the firm-specific wage rate W_{ft} as given. Labor input L_{ft} is the only input so that the inverse production function is:

$$\boldsymbol{L_{ft}} = \left(\frac{\boldsymbol{Y_{ft}}}{\boldsymbol{\alpha}}\right)^{\frac{1}{\sigma}} \tag{16}$$

Where $\sigma \leq 1$ represents the degree of diminishing returns, with $\sigma = 1$ being constant returns. The firm chooses $\{P_{ft}, Y_{ft}, L_{ft}\}$ to maximize profits subject to equations (15) and (16), yields the following solutions for price, output and employment atthe firm level given $\{Y_t, W_{ft}, P_t\}$

$$P_{ft} = \left(\frac{\theta - 1}{\theta}\right) \frac{\alpha^{-1/\sigma}}{\sigma} W_{ft} Y_{ft}^{\frac{1-\sigma}{\sigma}} \tag{17}$$

$$Y_{ft} = \kappa_1 \left(\frac{W_{ft}}{P_t}\right)^{-\sigma\varepsilon} Y_t^{\frac{\varepsilon\sigma}{\theta}} \tag{18}$$

$$L_{ft} = \kappa_2 \left(\frac{W_{ft}}{P_t}\right)^{-\varepsilon} Y_t^{\frac{\varepsilon}{\theta}} \tag{19}$$

where$\varepsilon = \dfrac{\theta}{\theta(1-\sigma)+\sigma} > 1 \quad \kappa_1 = \left(\dfrac{\theta-1}{\theta}\right)^{-\sigma\varepsilon} \sigma^{-\sigma\varepsilon} \alpha^{-\varepsilon} \quad \kappa_2 = \left(\dfrac{\theta-1}{\theta}\right)^{-\varepsilon} \sigma^{\varepsilon} \alpha^{\varepsilon\left(\frac{\theta-1}{\theta}\right)}$.

The price of a good is higher than the cost of producing one more unit of it, which depends on how much workers are paid and how much the firm produces (when σ is less than one). The output and employment depend on how much workers are paid relative to the price level and how much the economy produces.

3.3.2 The Structure of Contracts in a GTE

This section describes a GTE, where different sectors have different wage-setting processes based on the Taylor model of overlapping contracts. Each sector has a fixed contract length for its workers. There is a continuum of firms that produce differentiated goods, and each firm is matched with a group of workers (a household-union) that supplies labor and sets wages. The firms and the household-unions are indexed by a number from 0 to 1. The economy consists $\boldsymbol{N}$ sectors $\boldsymbol{i = 1 \ldots N}$. The budget shares of the N sectors with uniform prices (when prices p_f are equal for all $\boldsymbol{f \in [0, 1]}$) are given by α_i with $\sum_{\mathbf{i=1}}^{\mathbf{N}} \boldsymbol{\alpha}_{\mathbf{i}} = \mathbf{1}$, the $\boldsymbol{N}$ vector $(\boldsymbol{\alpha_i})_{\boldsymbol{i=1}}^{\boldsymbol{N}}$ being denoted $\boldsymbol{\alpha}$,where $\boldsymbol{\alpha} \in \boldsymbol{\Delta}^{\mathbf{N-1}}$.

We can split the interval from 0 to 1 into smaller intervals that match each sector. We can call the sum of the budget shares of sectors $k = 1 \ldots i$ as the cumulative budget share.

$$\hat{\boldsymbol{\alpha}}_{\mathbf{i}} = \sum_{\mathbf{k=1}}^{\mathbf{i}} \boldsymbol{\alpha}_{\mathbf{k}}$$

With $\hat{\alpha}_0 = 0$ and $\hat{\alpha}_{\mathrm{N}} = 1$. The interval for sector $\boldsymbol{i}$ is then $[\hat{\alpha}_{i-1}, \hat{\alpha}_i]$.

In each sector, firms are paired with their own specific union. There are $\boldsymbol{N_i}$ groups of unions and firms within sector $\boldsymbol{i}$. Again, we can partition the interval $[\hat{\alpha}_{i-1}, \hat{\alpha}_i]$ into cohort intervals: let the share of each cohort within the sector be λ_{ij} so that $\sum_{j=1}^{N_i} \lambda_{ij} = 1$, with the N_i vector $\boldsymbol{\lambda}_i \in \Delta^{N_i - 1}$. Similarly, we can define the cumulative share $\hat{\lambda}_{ij}$ in a way that is analogous to $\hat{\alpha}_k$. The range of firm-unions that belong to cohort $\boldsymbol{j}$ in sector $\boldsymbol{i}$ is then defined as:

$$\left[\hat{\boldsymbol{\alpha}}_{\mathbf{i-1}} + \hat{\boldsymbol{\lambda}}_{\mathbf{ij-1}} \boldsymbol{\alpha}_{\mathbf{i}}, \hat{\boldsymbol{\alpha}}_{\mathbf{i-1}} + \hat{\boldsymbol{\lambda}}_{\mathbf{ij}} \boldsymbol{\alpha}_{\mathbf{i}}\right]$$

If we assume symmetry, meaning that the cohorts are of equal size, then $\boldsymbol{\lambda_{ij} = N_i^{-1}}$ is equal to $\hat{\boldsymbol{\lambda}}_{\boldsymbol{ij}} = \boldsymbol{j N_i^{-1}}$.

The sectors are differentiated by the integer [1]contract length $T_i \in Z_{++}$, all cohorts within a sector have the same contract length. The timing of the wage setting process within the sector can be summarized by an $N_i - 1$ tuple of integers $\{\boldsymbol{T_{ij}}\}_{j=2}^{N_i}$ which specifies when in the wage-setting cycle cohort $\boldsymbol{j}$ moves. It is assumed that cohort 1 moves first, in period 1, which defines the beginning of the cycle. Therefore, $1 \leq T_{ij} \leq N_i$. If $\boldsymbol{T_{ij}}$ is equal to 3, it means that cohort $\boldsymbol{j}$ sets its wage 3 periods after the first cohort. By convention, it is assumed that the $\boldsymbol{j}$ s are ordered so that $\boldsymbol{T_{ij}}$ increases strictly. There is a restriction that $\boldsymbol{N_i}$ must be less than or equal to $\boldsymbol{T_i}$, meaning that there cannot be more cohorts than contract periods. If $\boldsymbol{N_i}$ is equal to $\boldsymbol{T_i}$, then one cohort moves in each period. If, in addition, the cohorts are of equal size, then $\boldsymbol{\lambda_{ij}}$ is equal to $\boldsymbol{N_i^{-1}}$, a uniform wage setting process is defined in sector $\boldsymbol{i}$. If $\boldsymbol{N_i}$ is less than $\boldsymbol{T_i}$, then there will be some periods when no cohort moves. For example, consider a sector with 8-period contracts and two cohorts, where the second cohort moves 4 periods after the first, so $\boldsymbol{T_{i2}}$ is equal to 4. Alternatively, there might be three cohorts, with timing {2, 6}, so that the second cohort moves in period 2 and the third in period 6.

In order to fully characterize an economy with non-uniform wage setting, it is also necessary to specify the calendar date $\boldsymbol{t_i}$ when the wage-setting process starts [2]for each contract length $\boldsymbol{T_i}$. In an economy where all sectors have uniform wage setting processes, the start dates of contracts become irrelevant. This is because, in each period, the same proportion of wages are reset across all sectors, making the timing of when contracts start inconsequential to the overall wage-setting process in the economy.

The wage setting process in a GTE can be characterized by $(\mathbf{T},\boldsymbol{\alpha}) \in \mathbf{Z}_{++}^{\mathbf{N}} \times \boldsymbol{\Delta}^{\mathbf{N}-\mathbf{1}}$, this provides information on the contract lengths and sizes of the $\boldsymbol{N}$ sectors, and $(\mathbf{N_i},\boldsymbol{\lambda_i},\mathbf{t_i}) \in \mathbf{Z}_{++} \times \boldsymbol{\Delta}^{\mathbf{N_i}-\mathbf{1}} \times \mathbf{Z}_{++}$, this information describes the number and relative

[1] In Dixon and Kara (2005) paper, they use a discrete time model, although it is possible to generalize the model to continuous time.
[2] This is not the only way to determine the start dates of cycles within each sector. All that is required is to know the start date of one cycle within a sector, as this information can then be used to determine the start dates of all subsequent cycles within that sector.

size of cohorts within each sector $\boldsymbol{i}$, as well as the timing and synchronization of these cohorts within that sector:

$$GTE := \{(\boldsymbol{T}, \boldsymbol{\alpha}), \{N_i, \boldsymbol{\lambda}_i, t_i\}_{i=1}^{N}\}$$

In a situation where each sector has a uniform wage setting process, we have what is known as a uniform GTE. This type of economy can be more simply parameterized by $(\mathbf{T}, \boldsymbol{\alpha})$ since $(\mathrm{N_i}, \boldsymbol{\lambda}_\mathrm{i}) = (\mathrm{T_i}, \mathrm{T_i^{-1}})$ and $\boldsymbol{t_i}$ is irrelevant. A homogenous or simple Taylor economy is one in which there is only a single sector, and within that sector, there is a uniform wage-setting process.

The general price index, $\boldsymbol{P}$, can be defined in terms of the individual sectors within the economy, or sub intervals $[\hat{\boldsymbol{\alpha}}_{i-1}, \hat{\boldsymbol{\alpha}}_i]$ for each sector $\boldsymbol{i}$.

$$\boldsymbol{P} = \left[\sum_{i=1}^{N} \int_{\hat{\alpha}_{i-1}}^{\hat{\alpha}_i} \boldsymbol{P}_f^{1-\theta} \, \boldsymbol{df}\right]^{\frac{1}{1-\theta}}$$

This information can be further broken down into intervals for each cohort. It is important to note that all firms within the same cohort face the same wage and therefore set the same price, $\boldsymbol{p_f} = \boldsymbol{p_{ij}}$, for $\boldsymbol{f} \in \left[\hat{\boldsymbol{\alpha}}_{i-1} + \hat{\boldsymbol{\lambda}}_{ij-1}\boldsymbol{\alpha}_i, \hat{\boldsymbol{\alpha}}_{i-1} + \hat{\boldsymbol{\lambda}}_{ij}\boldsymbol{\alpha}_i\right]$

$$\boldsymbol{P} = \left[\sum_{i=1}^{N} \sum_{j=1}^{N_i} \int_{\hat{\alpha}_{i-1} + \hat{\lambda}_{ij-1}\alpha_i}^{\hat{\alpha}_{i-1} + \hat{\lambda}_{ij}\alpha_i} \boldsymbol{P}_{ij}^{1-\theta} \, \boldsymbol{df}\right]^{\frac{1}{1-\theta}} \tag{20}$$

The price equations can be log linearized around the steady state, given the wages. Firms with the same wage will set the same price. Let's define $\boldsymbol{P_{ij}}$ as the price set by firms in sector $\boldsymbol{i}$ cohort $\boldsymbol{j}$. This results in a log-linearization in terms of deviations from the steady state, where we assume $\boldsymbol{P}^* = \boldsymbol{1}$.

$$\boldsymbol{p} = \sum_{i=1}^{N} \sum_{j=1}^{N_i} \boldsymbol{\alpha}_i \boldsymbol{\lambda}_{ij} \boldsymbol{p}_{ij} \tag{21}$$

An important property of CES technology is that the demand for an individual firm depends only on its own price and the general price index. There is no sense of location, meaning that while we divide the unit interval into segments corresponding to sectors and cohorts within sectors, this does not reflect any objective factor in terms of sector or cohort-specific aspects of technology or preferences. The only commonality within a sector is the length of the wage contract, and the only commonality within a cohort is the timing of the contract. The vectors $\boldsymbol{\alpha}$ and $\boldsymbol{\lambda_i}$ are best thought of as simply measures of sector and cohort size. This property is important when showing that a Calvo economy can be represented by a GTE.

3.3.3 Household-Unions and Wage Setting

Households, represented by *h* in the interval [0,1], have preferences defined over consumption, labor, and real money balances. Their expected lifetime utility function is expressed in a specific form

$$U_h = E_t\left[\sum_{t=0}^{\infty} \beta^t u(C_{ht}, \frac{M_{ht}}{P_t}, \underbrace{1 - H_{ht}}_{L_{ht}})\right] \tag{22}$$

Where C_{ht} represents household consumption, $\left(\frac{M_{ht}}{P_t}\right)$ represents end-of-period real money balances, H_{ht} represents hours worked, and L_{ht} represents leisure. These variables are indexed by time, represented by $\boldsymbol{t}$. The discount factor is represented by $\boldsymbol{\beta}$, a value between 0 and 1. Each household has the same flow utility function, denoted by $\boldsymbol{u}$, which is assumed to have a specific form

$$\boldsymbol{U(C_{ht}) + \delta ln\left(\frac{M_{ht}}{P_t}\right) + V(1 - H_{ht})} \tag{23}$$

Each household-union is associated with a specific sector and wage-setting cohort within that sector. Each household is twinned with a firm, denoted by $f = h$. As the household acts as a monopoly union, the hours worked are determined by demand and are given by equation (19).

The budget constraint for the household is specified by the following equation

$$\boldsymbol{P_t C_{ht} + M_{ht} + \sum_{s_{t+1}} Q\left(s^{t+1} \mid s^t\right) B_h\left(s^{t+1}\right) \leq M_{ht-1} + B_{ht} + W_{ht} H_{ht} + \pi_{ht} + T_{ht}} \tag{24}$$

In this context, $B_h(s^{t+1})$ represents a one-period nominal bond that costs $Q(s^{t+1}|s^t)$ at state s^t and pays off one dollar in the next period if s^{t+1} is realized. B_{ht} represents the value of the household's existing claims given the realized state of nature. M_{ht} denotes money holdings at the end of period t. W_{ht} is the nominal wage, π_{ht} represents the profits distributed by firms, and $W_{ht}H_{ht}$ is the labor income. Finally, T_t is a nominal lump-sum transfer from the government.

The household's optimization can be divided into two parts. The first part involves choosing consumption, money balances, and one-period nominal bonds to be transferred to the next period in order to maximize expected lifetime utility, as shown in equation (22), subject to the budget constraint specified in equation (24). The first-order conditions derived from the consumer's problem are as follows.

$$u_{ct} = \beta R_t E_t \left(\frac{P_t}{P_{t+1}} u_{ct+1} \right) \tag{25}$$

$$\sum_{s_{t+1}} Q\,(s^{t+1}|s^t) = \beta E_t \frac{u_{ct+1} P_t}{u_{ct} P_{t+1}} = \frac{1}{R_t} \tag{26}$$

$$\delta \frac{P_t}{M_t} = u_{ct} - \beta E_t \frac{P_t}{P_{t+1}} u_{ct+1} \tag{27}$$

Equation (25) represents the Euler equation, equation (26) specifies the gross nominal interest rate, and equation (27) determines the optimal allocation between consumption and real balances. It is important to note that the index *h* is omitted in equations (25) and (27), reflecting the assumption of complete contingent claims markets for consumption. This implies that consumption is identical across all households in each period, denoted by $(C_{ht} = C_t)$[1].

For household *h* in sector i, the reset wage is chosen to maximize lifetime utility, subject to labor demand specified in equation (19) and the additional constraint that the nominal wage will be fixed for T_t periods, during which the aggregate output and price level, denoted by $\{Y_t, P_t\}$, are given. From the union's perspective, all of the

[1] See Ascari (2000).

terms in equation (19) that are treated as exogenous by the union can be collected together by defining the constant K_t

$$K_t = \kappa_2 P_t^{\varepsilon} Y_t^{\frac{\varepsilon}{\theta}}$$

Since the reset wage at time t is only valid for T_t periods, the following first-order condition applies.

$$X_{it} = \left(\frac{\varepsilon}{\varepsilon - 1}\right)\left[\frac{E_t \sum_{s=0}^{T_i - 1} \beta^s \left[V_L\left(1 - H_{t+s}\right)\left(K_{t+s}\right)\right]}{E_t \sum_{s=0}^{T_i - 1} \beta^s \left[\frac{u_c\left(C_{t+s}\right)}{P_{t+s}} K_{t+s}\right]}\right] \tag{28}$$

In this context, E_t represents the conditional expectation taken only over states of nature in which the household is unable to reset its wage contract. Equation (28) shows that the optimal wage is a constant 'mark-up' specified by the term $\frac{\varepsilon}{\varepsilon - 1}$. over the ratio of marginal utilities of leisure and marginal utility from consumption within the contract duration, from t to $t + T_i - 1$, equation that is being reduced to a simpler form when the value of T_t is equal to 2. This simpler form is the same as the first-order condition presented in Ascari's 2000 paper.

3.3.4 Government

There is a government that implements monetary policy through lump-sum transfers, in which it distributes a fixed amount of money to individuals or households in the economy.

$$T_t = M_t - M_{t-1} \tag{29}$$

The money supply M_t grows at a rate μ_t so that $M_t = \mu_t M_{t-1}$. To focus on the role of the GTE in generating the output persistence, according to Huang and Liu (2001), there is no serial correlation in the money growth process, and therefore $ln(\mu_t)$ follows a white noise process, i.e., $ln(\mu_t) = \xi_t$, where ξ_t is a white noise process with a zero mean and a finite variance σ_ξ^2. In particular, the assumption made is that the money supply adheres to a random walk pattern, i.e., $m_t = m_{t-1} + \xi_t$

3.3.5 General Equilibrium

In this section, the focus is on characterizing the economic equilibrium. Firstly, the equilibrium conditions for sector i are described, followed by the equilibrium conditions for the overall economy. To determine an equilibrium, these conditions are condensed into four key equations: the household's first-order condition for establishing its contract wage, the pricing equation, the household's money demand equation, and an external law dictating the growth rate of the money supply. Subsequently, these equilibrium conditions are log-linearized around a steady state. The chosen steady state is the zero-inflation steady state, a standard assumption in the relevant literature. The linearized versions of the equations are presented and discussed, with the notational convention that lowercase symbols signify log-deviations of variables from the steady state.

The linearized equation (28) for determining wages in sector i can be expressed as follows:

$$x_{it} = \frac{1}{\sum_{s=0}^{T_i-1} \beta^s} \left[\sum_{s=0}^{T_i-1} \beta^s \left[p_{t+s} + \gamma y_{t+s} \right] \right] \tag{30}$$

The coefficients related to output in the wage determination equation across all sectors are provided by

$$\gamma = \frac{\eta_{LL} + \eta_{cc}(\sigma + \theta(1-\sigma))}{\sigma + \theta(1-\sigma) + \theta\eta_{LL}} \tag{31}$$

Where $\eta_{cc} = \frac{-U_{cc}C}{U_c}$ is the parameter governing risk aversion, $\eta_{LL} = \frac{-V_{LL}H}{V_L}$ represents the reciprocal of labor elasticity, θ refers to the substitution elasticity of consumer goods.

Using equation (21) and aggregating for sector i, we get

$$p_{it} = w_{it} + \left(\frac{1-\sigma}{\sigma}\right) y_{it} \tag{32}$$

Where

$$w_{it} = \sum_{j=1}^{N_i} \lambda_{ijt} w_{ijt}$$

Applying equation (15) and combining it for sector i results in

$$y_{it} = \theta(p_t - p_{it}) + y_t \tag{33}$$

Considering the money demand equation (27), taking the logarithm and linearizing this equation produces the subsequent expression:

$$y_t = m_t - p_t \tag{34}$$

Finally, the linearized price index in the economy is simply a weighted average of the ongoing prices in all sectors and is given by

$$p_t = \sum_{i=1}^{N} \alpha_i p_{it} \tag{35}$$

3.3.6 The log-linearised economy

In the previous, Dixon and Kara (2005b) supply a comprehensive explanation of the model, including the different wage-setting equations under the four types of contracts. Dixon and Kara (2006) primarily focus on the log-linearized macroeconomic framework. This framework is shared across all approaches, with the only variation arising from the type of contract considered.

They stipulate that the sectoral price level is determined by the average wage set within the sector. Furthermore, this wage is the averaged value derived from the i cohorts in sector i. This approach highlights the importance of wage-setting practices in shaping sectoral price levels, providing a nuanced understanding of how contract types influence these dynamics.

$$p_{it} = w_{it} = \frac{1}{i} \sum_{j=1}^{i} w_{ijt}$$

In their exploration of sectoral output levels, Dixon and Kara (2006) propose a formulation where the sectoral output level y_{it} is expressed as a function of the sectoral price relative to the aggregate price level p_t, as well as the aggregate output y_{it}. Here, the coefficient θ represents the elasticity of demand. This approach underscores the interdependence between sectoral and aggregate levels of pricing and output, and the key role of demand elasticity in mediating these relationships.

$$y_{it} = \theta(p_t - p_{it}) + y_t \tag{36}$$

Dixon and Kara (2006) further develop their model by introducing the linearized aggregate price index for the economy. They suggest that this index is computed as the average of all sectoral prices, thereby providing a holistic view of the overall price level in the economy. This approach reflects the underlying premise that the aggregate price index is a composite measure derived from individual sectoral price levels.

$$p_t = \sum_{i=1}^{N} \alpha_i p_{it} \tag{37}$$

The inflation rate is given by $\pi_t = p_t - p_{t-1}$.

In their work, Dixon and Kara (2006) propose that aggregate demand is defined by a straightforward quantity theory relationship. This theory, a fundamental principle in economics, suggests that the total demand in an economy is directly proportional to the quantity of money in circulation.

$$y_t = m_t - p_t$$

According to Dixon and Kara (2006), the money supply in an economy follows an Autoregressive (AR) process of order 1. This model suggests that the current value of the money supply is a function of its immediate past value with the addition of a stochastic error term.

$$m_t = m_{t-1} + ln(\mu_t), \quad ln(\mu_t) = v \cdot ln\mu_{t-1} + \xi_t \tag{38}$$

Dixon and Kara (2006) further detail their autoregressive model, specifying that the AR(1) process is characterized by a parameter v that lies between 0 and 1. Additionally, they introduce a white noise process denoted by ξ_t. This process, an essential component of time series modeling, has a zero mean and finite variance.

3.3.7 Wage setting rules

In their paper, Dixon and Kara (2006) emphasize that all the models they employ are bound by the common macroeconomic framework, as represented by the log-linearized equations discussed in the previous sections. The models differ in the wage-setting rules that they imply, which arise from the varying nature of contracts. In this section, they briefly outline these rules.

Before defining these optimal wage-setting rules, they introduce the concept of an 'optimal flex wage', which represents the ideal wage in a scenario where wages are perfectly flexible. They further detail that the optimal flex wage in each sector is given by

$$w_t^* = p_t + \gamma y_t \tag{39}$$

which presents a quantitative understanding of how optimal wages are determined in each sector[1] under conditions of perfect flexibility. Where the coefficient on output γ is:

$$\gamma = \frac{\eta_{LL} + \eta_{cc}}{1 + \theta\eta_{LL}} \tag{40}$$

Where $\eta_{cc} = \frac{-U_{cc}C}{U_c}$ is the parameter governing risk aversion, $\eta_{LL} = \frac{-V_{LL}H}{V_L}$ represents the reciprocal of labor elasticity, θ refers to the substitution elasticity of consumer goods.

In their GTE model, Dixon and Kara (2006) describe that the reset wage in each sector i is calculated as the average (or expected) optimal flex wage over the contract length.

$$x_{it} = \frac{1}{i}\sum_{s=0}^{i-1} E_t w_{t+s}^* \tag{41}$$

[1] Dixon and Kara (2006) further explain that the optimal flex wage is identical across all sectors. This uniformity stems from the fact that it's derived from the demand relation (1), which incorporates the same two aggregate variables fpt; ytg for each sector. The authors' emphasis on this point underscores the sectoral uniformity of optimal flex wages when they are allowed to adjust freely and instantaneously to changes in demand and supply conditions.

They further clarify that reset wages will generally vary across sectors. This variation occurs because the average wages are calculated over different time horizons, which is reflective of the unique contract lengths in each sector.

Within their model, the wage trajectory is predetermined at the inception of the contract. For instance, for a contract with an i-period duration commencing at time t, the sequence of wages from time t to $t+i-1$ would be $\{E_t w^*_{t+s}\}_{s=0}^{s=i-1}$. Hence, the average wage in sector i at time t is

$$w_{it} = \frac{1}{i}\sum_{s=0}^{i-1} E_{t-s} w^*_t$$

represents each cohort's best estimate for the prevailing optimal flex wage at that time t.

Dixon and Kara (2006) highlight that in both the Calvo model and its extension featuring full indexation, the contract's duration remains uncertain at the time of wage setting[1]. Consequently, in all sectors, the reset wage remains uniform. In the context of indexation, the authors present a specific equation to calculate the reset wage, underscoring the mathematical mechanisms underlying their proposed wage-setting model.

$$x_t = \omega(p_t + \gamma y_t) + (1-\omega)x_{t+1} - (1-\omega)\pi_t$$

which is the standard Calvo reset equation with the additional inflation term.

The evolution of the aggregate wage index is given by

$$w_t = \omega x_t + (1-\omega)(w_{t-1} + \pi_{t-1})$$

The authors further elaborate on the role of indexation in their wage-setting model. They clarify that the integration of an additional inflation term into the standard Calvo equation is a key aspect of indexation. This feature represents a nuanced approach to

[1] In their previous work (Dixon and Kara, 2005b), the authors present an interpretation of the Calvo setup as a game of incomplete information. They propose that when setting the price or wage, firms or unions are uncertain about their specific sector. This perspective offers a nuanced understanding of the complexities involved in wage-setting practices, emphasizing the role of incomplete information in economic decision-making.

account for the influence of inflation on wage dynamics within their proposed framework.

3.4 Persistence in a GTE

Dixon and Kara (2005b) postulate that the central determinant of aggregate dynamics is the parameter γ. The significance of its magnitude lies in its ability to regulate the responsiveness of household-unions to present and future output fluctuations, as depicted in Equation (30). In this context, the γ coefficient plays a crucial role in dictating the manner in which wages adapt to variations in both current and future output levels. A larger γ value implies that wages exhibit a greater degree of responsiveness to output changes, thereby resulting in expedited adjustments and a short-lived output response. Conversely, when γ is small, household-unions display a lower sensitivity to alterations in present and future output. Consequently, wage adjustments are minimal in response to increased aggregate demand, leading to a higher degree of wage rigidity.

Estimating as an unconstrained parameter, Taylor found that for the US, γ is between 0.05 and 0.1. However, in a general equilibrium framework, is derived so as to conform to micro-foundations. Chari, Kehoe, and McGrattan (2000) and Ascari (2000) argue that the microfounded value of is too high to generate the observed persistence following a monetary shock, hence raising doubts over the Taylor model in this respect. A study by Ascari (2000) that shows that output is more persistent with staggered wage setting than with staggered price setting in a GTE model. However, even with staggered wage setting, the model is still not able to generate the level of persistence in output that is observed in the data. This suggests that there may be other factors, beyond staggered wage or price setting, that contribute to the observed persistence in output.

Dixon and Kara (2005b) have made a substantial contribution to the existing body of literature on the role of γ value in generating persistence. However, their study departs from the conventional focus and introduces a new dimension: different contract lengths for a given value in the context of the GTE model. The authors argue that incorporating more than one type of contract length is crucial for the model's ability to sustain output beyond the initial contract period. Interestingly, Dixon and

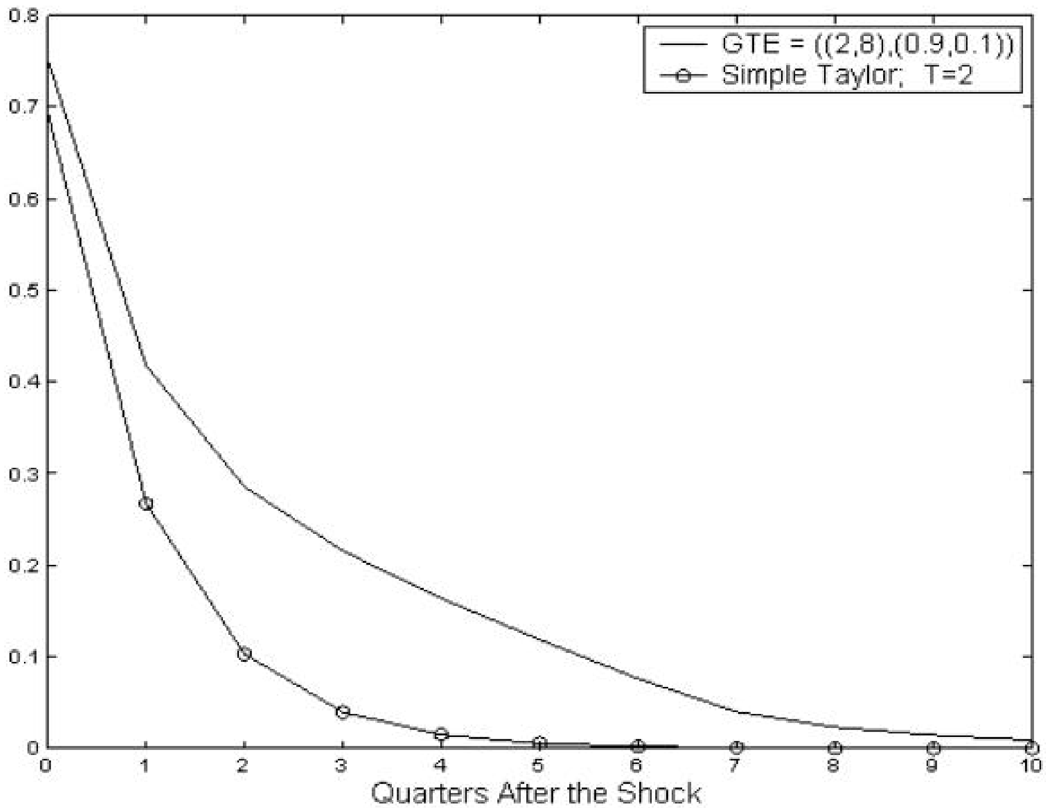
Kara's (2005b) work demonstrates that the inclusion of longer-term contracts significantly enhances persistence. Although it might seem intuitive—longer contracts naturally leading to increased persistence—it is noteworthy how even a small proportion of long-term contracts can lead to a considerable boost in persistence. The authors, throughout their research, operate with a γ value equal to 0.2, exploring how persistence varies with different contract lengths. Their exploration unfolds in three distinct stages. Initially, they provide a simple two-sector example to illustrate their case. Then, they utilize Taylor's 1993 model, calibrated for the US economy, which accommodates contract lengths from one to eight quarters. Finally, they examine the Calvo contract process, incorporating a distribution of contract lengths from one to infinity.

3.4.1 Two-sector GTEs

Dixon and Kara (2005b) present an intriguing analysis of a two-sector uniform GTE, with parameters $\{T, \alpha\} = \{(2, 8), (0.9, 0.1)\}$: In their model, sector 1 operates with two-period contracts, while sector 2 employs eight-period contracts. They illustrate that the short contract sectors generate 90% of the economy's output, while the long-contract sectors contribute the remaining 10%. The weighted average contract length across the entire economy, they note, is 2.6 quarters.

Figure 15 compares a simple Taylor economy, solely based on 2-period contracts, with a GTE that includes a 10% share of 8-period contracts. It depicts the impulse response of aggregate output following a one-percent shock in money supply. The authors highlight that the GTE and simple Taylor economy yield remarkably different implications for persistence. For the Taylor economy with 2-quarter contracts, changes in money supply have a sizable but transient effect on output. In contrast, within the GTE, the incorporation of long-term contracts not only leads to an increase in aggregate output following a surge in the money supply but also significantly enhances its persistence.

***Figure 15: Output Response in Different Settings*[1]**



Dixon and Kara (2005b) offer a compelling explanation for this phenomenon, attributing it to the influence of longer-term contracts on the wage-setting behavior of short-term contracts. They describe this as a form of "strategic complementarity". A monetary expansion, leading to a higher steady-state price, influences wage-setting decisions, which balance between the current price level and future projections. The sluggish adjustment of long-term contracts, in turn, slows the reaction of shorter contracts, as their wage setting is influenced by the general price level, which incorporates the prices of the slower-moving sectors. This spillover effect from the sluggish long-contract sectors to the short-contract sectors via the price level was also identified in Dixon (1994).

To underscore their findings, Dixon and Kara (2005b) illustrate the contrast by comparing two GTEs with a mean contract length of 2 in Figure 16 : one representing a simple Taylor economy and the other comprising primarily flexible wages with 1/7

[1] See Dixon and Kara (2005)

being 8-period contracts. Despite the majority of the economy consisting of flexible wages, the output decays slowly, with the output being larger in the mixed economy after the second quarter. The authors attribute this to the influence of 8-period contracts on the general price level, which subsequently influences the wage-setting of the flexible sector.

Figure 17 presents a comparison between a simple three Taylor economy and a mixed one with 2 and 8-period contracts. Similar to their previous findings, the mixed economy's impact is initially smaller but soon becomes more persistent. Dixon and Kara's (2005b) research thus underscores the significant influence of long-term contracts on economic output and its persistence.

Figure 16: Response of Output in two GTEs with a mean contract length of 2 [1]

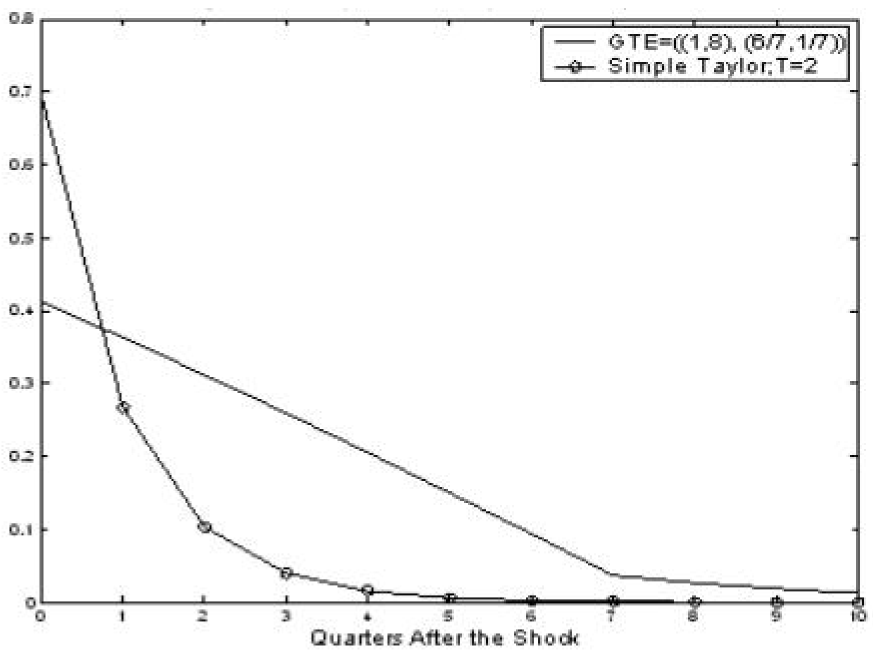
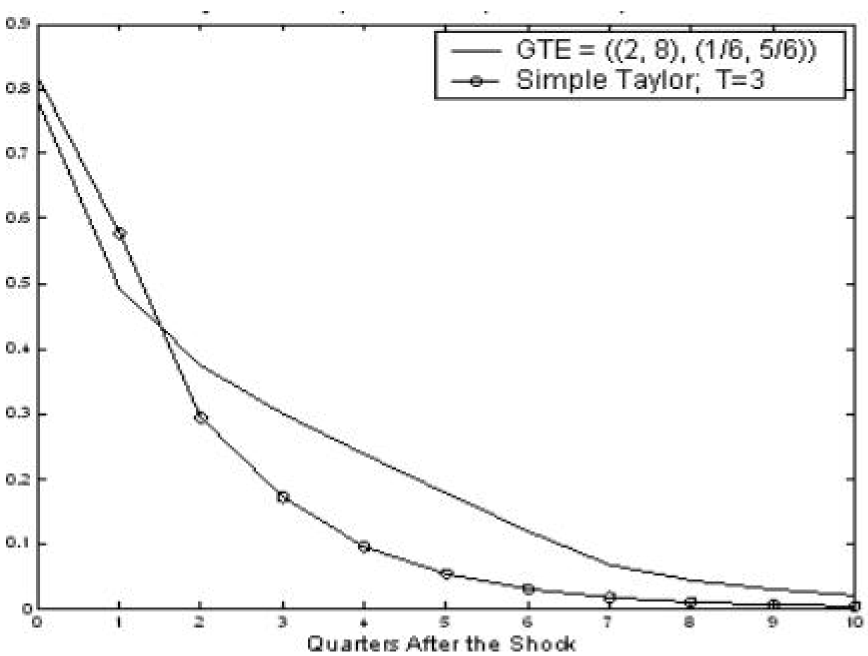


Figure 17: Response of Output in two GTEs with a mean contract length of 3



[1] See Dixon and Kara (2005)

3.4.2 Taylor's US Economy

In their exploration of contract lengths and their impact on economic persistence, Dixon and Kara (2005b) apply Taylor's (1993) calibration of the US economy. Taylor's calibration comprises contract lengths $\mathrm{T} = (1, 2, 3, 4, 5, 6, 7, 8)$ with corresponding sector shares as follows:

$$\boldsymbol{\alpha_1 = 0.07,\ \alpha_2 = 0.19, \alpha_3 = 0.23, \alpha_4 = 0.21,}$$
$$\boldsymbol{\alpha_5 = 0.15, \alpha_6 = 0.08, \alpha_7 = 0.04, \alpha_8 = 0.03.}$$

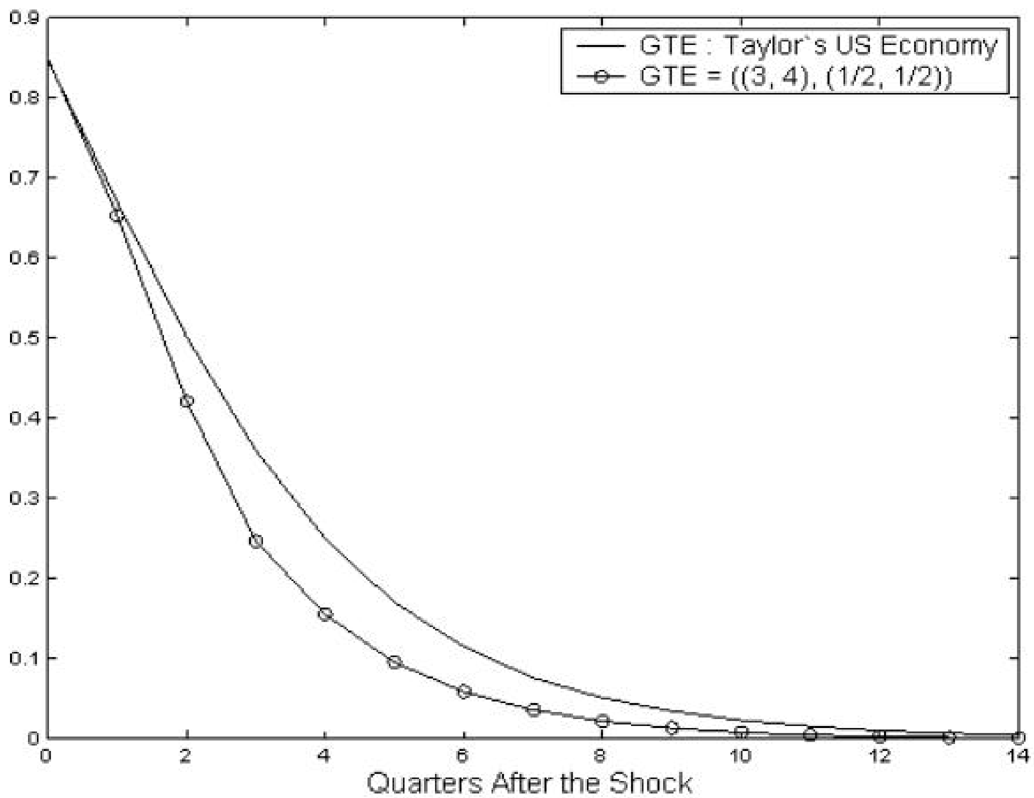
The authors highlight that the largest sector operates on 3-period contracts. The three contract lengths (3, 4, 5) each account for approximately 20%, with a "fat tail" of longer contracts (equal numbers of 7 and 8 quarter contracts as 1 quarter contracts). The mean contract length in this model of the economy is 3.6 periods.

In Figure 18, Dixon and Kara (2005b) illustrate the impulse response function for output in Taylor's US economy, noting a persistent response in output. The effect of a monetary shock on output, they observe, lasts for roughly three years. This provides a clear demonstration that the inclusion of generalized wage setting in a dynamic equilibrium model significantly impacts the dynamic responses of output. They compare Taylor's US economy with a simpler GTE having an average contract length of 3.5 periods (**T** = (3, 4); $\boldsymbol{\alpha}$ = (0.5, 0.5)). Despite having nearly the same mean, Taylor's US economy exhibits greater persistence, likely due to the inclusion of longer contracts.

Summarizing their findings in Figure 19, the authors plot the output responses for four different GTEs, normalizing the responses so that the impact is set at 1. They include Taylor's US economy and the 2-sector GTE from Figure 18, and the simple Taylor economy with 2-period contracts and the case with 10% 8-period contracts from

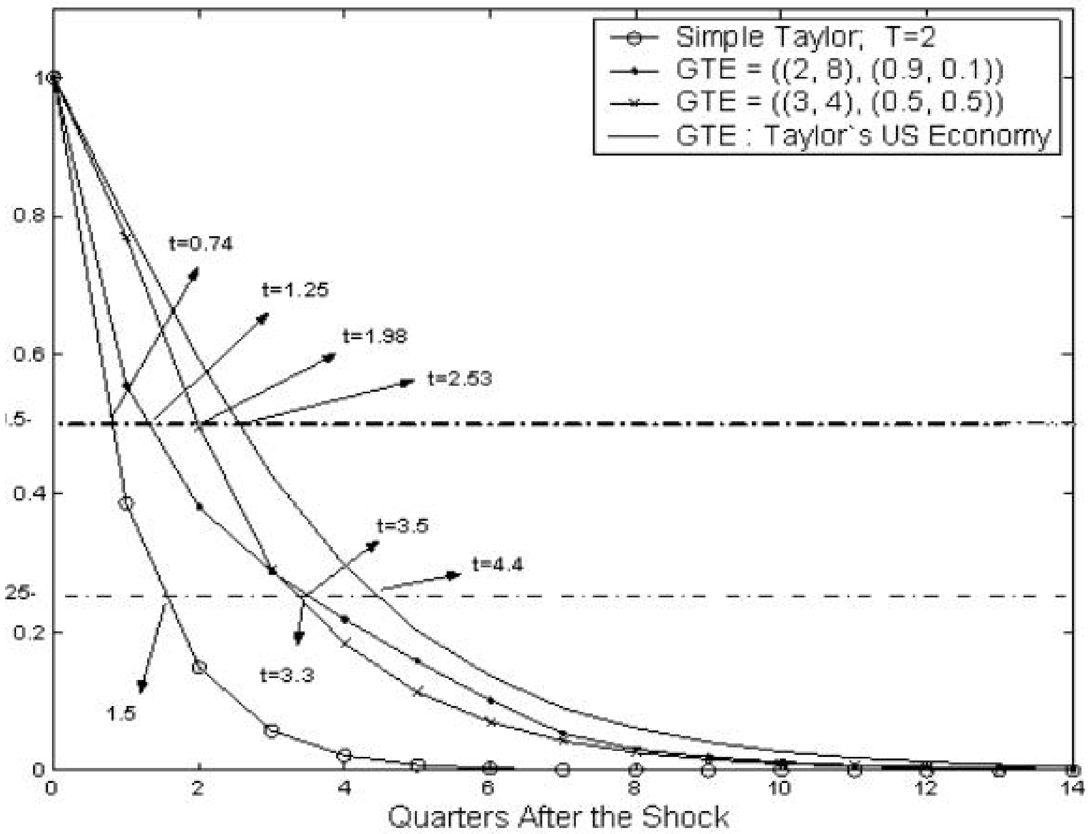
Figure 15. The authors provide a quantitative measure of the degree of persistence by determining the half-lives (and quarter lives) of the impulse-response functions. For instance, when comparing a simple Taylor economy with only 2-period contracts to a GTE with a 10% share of 8-period contracts, the half-life increases from 0.74 periods to 1.25 periods. A similar pattern is observed when comparing Taylor's US economy with the corresponding Simple Taylor Economy, where the half-life increases from 1.98 periods to 2.53 periods. In summary, Dixon and Kara's (2005b) research underscores the significant influence of contract lengths on economic output and its persistence.

***Figure 18: Output response in Taylor's US economy*[1]**



[1] See Dixon and Kara (2005)

***Figure 19: Normalized Responses*[1]**

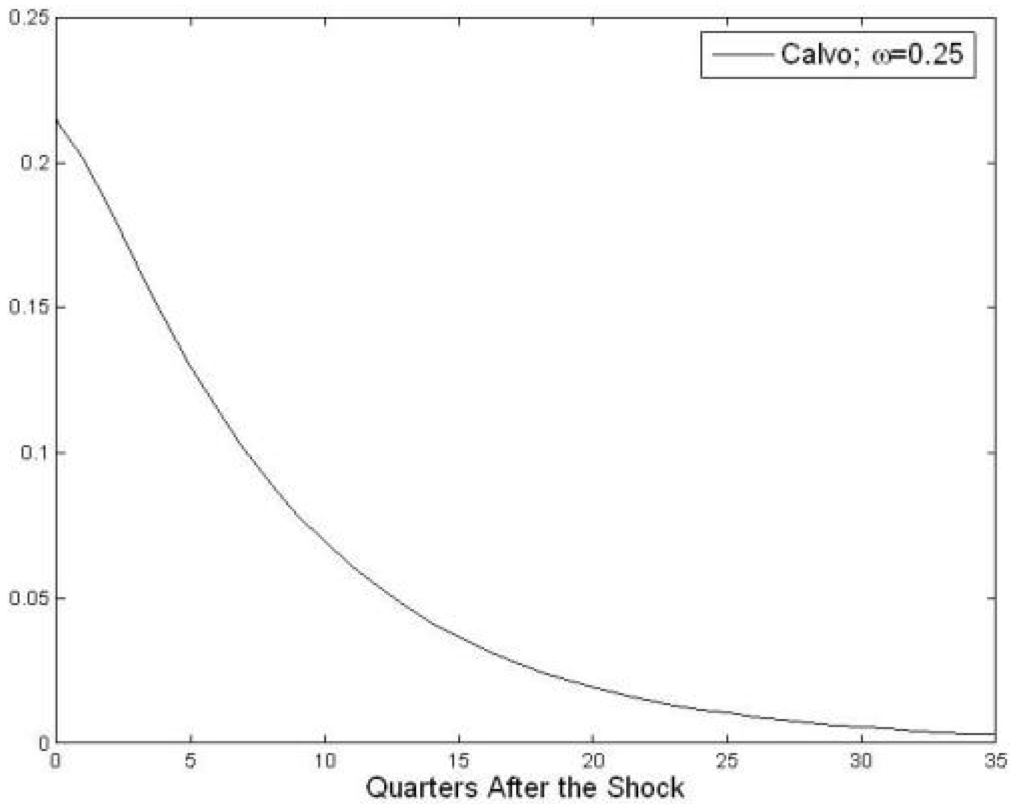


3.5 Inflation Persistence in a GTE

Prior to examining the comprehensive case of the GTE, Dixon and Kara (2006) revisit conventional models, specifically the Calvo (1983) model and the Simple Taylor (ST) model. The Calvo model is primarily characterized by a single parameter – the reset probability, or the hazard rate ω. This parameter signifies the consistent likelihood of a firm or union gaining the opportunity to reset its wage in any given period. The effect of this model on the economy is vividly demonstrated in Figure 20, which presents the impulse response function of inflation following a one percent innovation in the supply of money.

[1] See Dixon and Kara (2005)

Figure 20: Response of Inflation in the Calvo Economy[1]



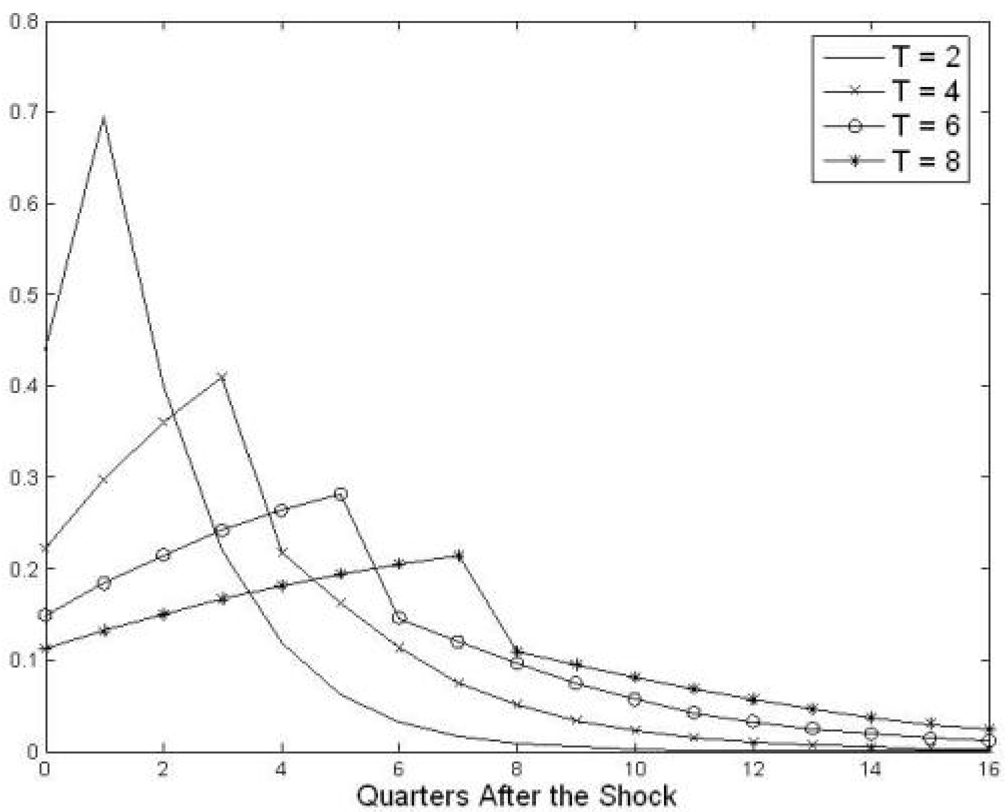
As illustrated in Figure 20, the Calvo model is unable to produce a hump-shaped inflation response. Instead, it invariably peaks in the first period, unless some form of ex-ante pricing is applied. This outcome is attributed to the purely forward-looking nature of the Calvo model, as discussed extensively by Woodford (2003). Despite this, the Calvo model is quite capable of generating persistence. Given a low enough reset probability, after 20 quarter, the effect on inflation is 1% or 5% of the maximum persistence. Due to the model's exponential decay nature, the effect persists even after 20 quarters. This is evident with commonly used values of ω = 0.25 and ω = 0.4, which correspond to average contract lengths of 7 and 4 quarters respectively, as shown in Dixon and Kara (2005a). When ω = 0.25, the model exhibits sufficient

[1] See Dixon and Kara (2006)

persistence, the biggest effect is not on impact (Hump). With ω = 0.4, it the biggest effect is after 4Q, after 8Q or after 12Q.

In Dixon and Kara's (2006) study, they also explored the Taylor staggered contract model as a potential alternative to the Calvo model. The Taylor model is based on the premise of staggered contracts, which possess both backward-looking and forward-looking intertemporal effects, a feature highlighted by Taylor himself in his 1980 publication. As per the findings of Dixon and Kara (2006), illustrated in Figure 21, the response of inflation to a monetary shock in the Taylor model was examined for various contract lengths (T = 2, 4, 6, 8). The Taylor model, with its integration of staggered contracts, was proposed as a potential mechanism to address the inability of the Calvo model to reproduce the observed inflation responses, thus offering a more nuanced understanding of economic behaviour.

Figure 21: Response of Inflation in the Simple Taylor Economy[1]



In their 2006 study, Dixon and Kara observe that the maximum inflation response in Taylor's model is indeed delayed for several quarters, peaking at $T-1$ quarters

[1] See Dixon and Kara (2006)

following the onset of the shock[1]. While this pattern does present a kind of hump shape, it is notably jagged. However, these researchers note that the simple Taylor contract only generates a hump around two years if the contract lasts that long ($T = 8$). Most researchers believe a more realistic contract length is $T = 4$, and few would argue that the economy is composed of two-year contracts with fixed nominal wages. In their research, Dixon and Kara (2006) point out that the second characteristic of their model, which refers to the timing of the most significant impact of a monetary shock, can only be accommodated with an unrealistically long contract length. In their study, Dixon and Kara (2006) provide evidence that after a time span of 20 quarters, the impact on inflation in their model reduces dramatically to either 1% or 5% of the maximum recorded value, indicating a high degree of persistence. This characteristic, labelled as Feature 3, emphasizes the temporal decay of the inflationary effect post-shock. The decline in inflation is particularly rapid after *T* periods subsequent to the shock. Specifically, for $T = 4$, the shock's effects are nearly gone by the 15th period, failing to meet even the minimal criterion. This illustrates the limitations of the simple Taylor model in capturing the persistence of inflation effects.

3.5.1 GTE

In their exploration of GTEs, Dixon and Kara (2006) propose a mechanism to generate a smoother, hump-shaped impulse response function that decays more gradually. Drawing upon their previous work (Dixon and Kara, 2005b), they introduce a distribution of contract lengths across multiple sectors in the economy. Specifically, they designate that the *i* -th sector has a simple Taylor contract length of $T = i$ periods and occupies a share of α_i in the economy. They using an *n* dimensional vector of contract lengths, denoted as $\alpha \in \Delta^{n-1}$. This vector $GTE(\alpha)$ represents the various contract lengths across the different sectors of the economy. Having defined the GTE in such a way, they then proceed to explore certain special cases or instances of GTEs. These specific GTEs are studied to understand the influence of

[1] In their 2006 study, Dixon and Kara elaborate on the mechanism of wage setting in response to a monetary shock. According to their findings, every wage-setting cohort, starting from the period of the monetary shock, is aware of the change in the money supply when they determine their wages. The final group to establish their wage without this knowledge is the one that did so in the period preceding the shock. The contract for this last uninformed cohort concludes *T-1* periods post shock, coinciding with the peak of inflation. This observation suggests that the timing of wage resets, especially the last uninformed reset, plays a crucial role in shaping the inflation trajectory following a monetary shock.

different distributions of contract lengths on the economy's inflation response to monetary shocks. These specific cases provide insights into how variations in contract length distributions can impact the macroeconomic dynamics in the GTE framework.

3.5.1.1 Calvo-GTE

In the investigation of special cases, Dixon and Kara (2006) first focus on what they refer to as the Calvo-GTE.

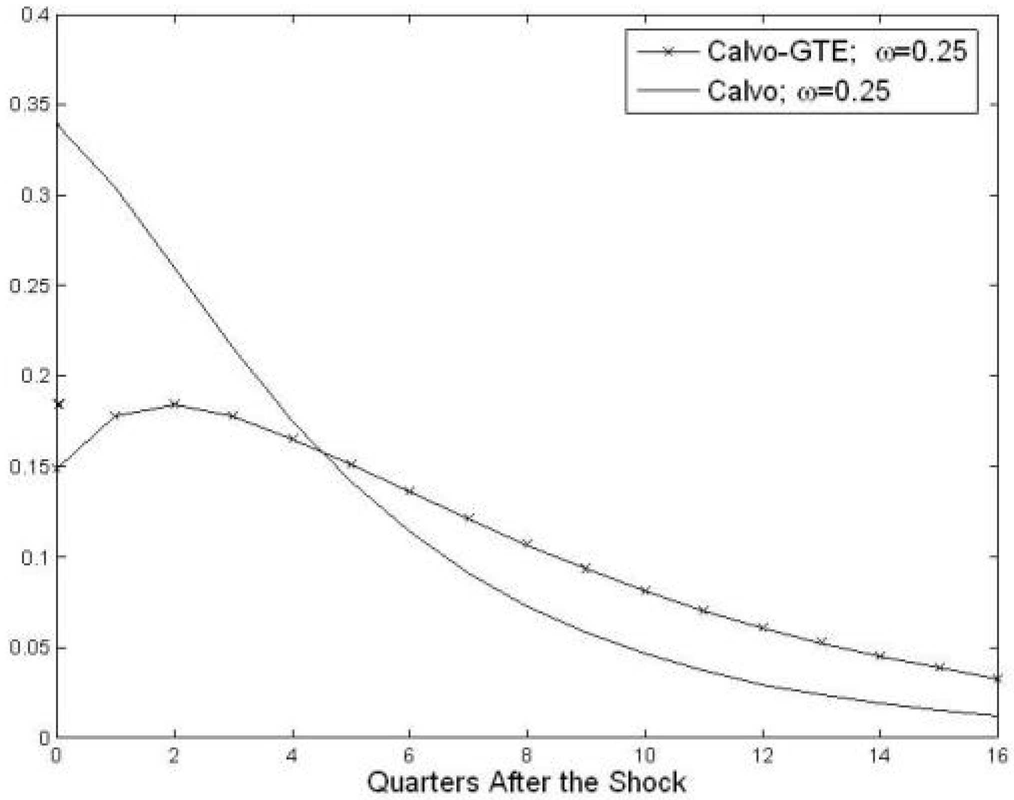
$$\alpha_i = \omega^2 i(1-\omega)^{i-1} : i = 1 \ldots \infty$$

In their study, Dixon and Kara (2006) made a practical adjustment for computation. They truncated the contract length distribution at $i = 20$, and concentrated all contracts with lengths $j \geqslant 20$ onto $i = 20$. This effectively created an upper limit on contract lengths in the model. For the Calvo-GTE, they chose a reset probability of 0.25, resulting in an average contract length of 7 quarters, with a modal length of 3 and 4 quarters. The corresponding inflation impulse-response for this specification is depicted in Figure 22, which is superimposed with the original Calvo model's impulse-response from Figure 20 for comparative purposes.

In their work, Dixon and Kara (2006) contrasted the outcomes of two economies with the same distribution of contract lengths (except for the truncation at 20 quarters in the Calvo-GTE) but differing wage-setting rules. In the Calvo model, wage-setters are unaware of their contract's duration and thus set the same wage due to the probabilistic nature of contract lengths. Conversely, in the Calvo-GTE, wage-setters are informed about their contract length when setting their wage.

As shown in Figure 22 , the Calvo-GTE does have a hump-shaped inflation response, with the peak appearing in the third quarter for a reset probability (ω) of 0.25. Reflecting the long tail of contract lengths in the Calvo distribution, persistence is quite high, with inflationary effects observable 20 quarters and beyond. However, to achieve a hump at the 8th quarter, a reset probability (ω) of 0.1 is needed. This implies an average contract length of 19 quarters, which is considerably long and arguably unrealistic.

***Figure 22: Response of Inflation in the Calvo-GTE and the Calvo Economy*[1]**



Therefore, transitioning from the Calvo pricing rule to the Taylor approach (but maintaining the same contract length distribution) allows both hump-shaped response and persistence to be satisfied. However, the timing of the hump is still notably shorter than the average contract duration in the economy.

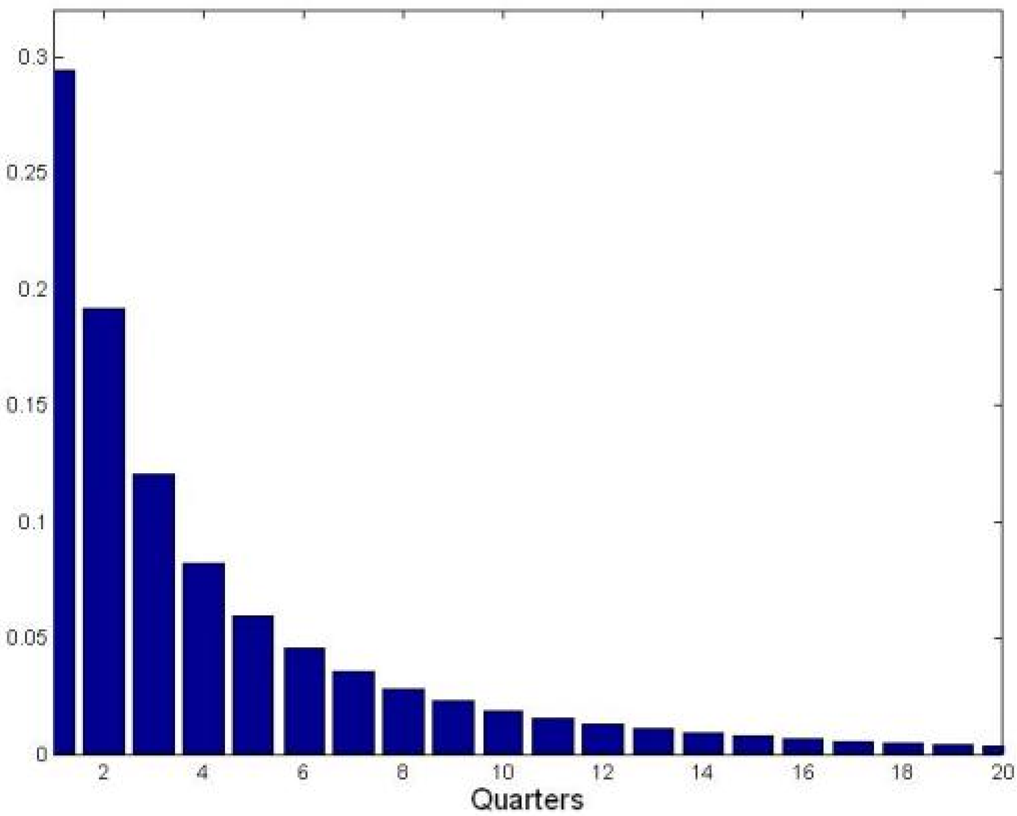
3.5.1.2 Bils-Klenow Distribution: BK - GTE

Bils and Klenow (2004) dataset is a valuable resource for understanding price dynamics. This dataset is derived from US Consumer Price Index (CPI) data collected by the Bureau of Labor Statistics and covers the period 1995-1997. It includes 350 categories that account for 69% of the CPI. The dataset provides the average proportion of price changes per month for each category. It is assumed that this is generated by a simple Calvo process within each sector, allowing the generation of a distribution of durations

[1] See Dixon and Kara (2006)

for that category using the Dixon and Kara (2005a) method. By summing over all sectors using the category weights, a comprehensive distribution of contract lengths (expressed in quarters) can be constructed. This distribution can then be represented graphically, as shown in Figure 23.

***Figure 23: BK - GTE: Distribution*[1]**



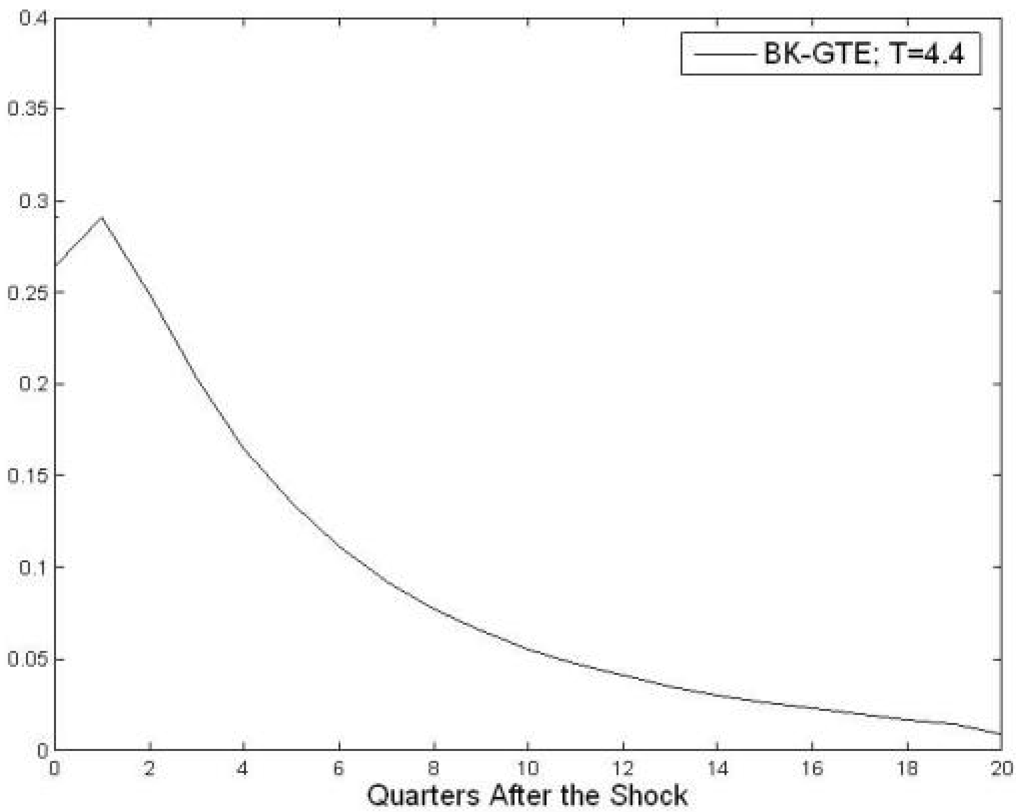
In their study, Dixon and Kara (2006) observed that the mean contract length was approximately 4.4 quarters. They further noted a long tail in the distribution, signifying the existence of a small number of notably long contracts. More than 3% of the weighted categories displayed less than 5% of price changes per month, implying average contract durations exceeding 40 months or 13.5 quarters.

However, the most frequently observed contract duration was one quarter. The distribution exhibited characteristics akin to a geometric distribution, especially with the feature that longer durations corresponded to smaller shares of the population.

[1] See Dixon and Kara (2006)

This finding is significant, as it underscores the diverse range of contract lengths present in the economy and their potential influence on economic dynamics.

Figure 24: Response of Inflation in the BK-GTE



Dixon and Kara (2006) further analyzed the impulse response (IR) for what they term as the "BK - GTE" (representing the distribution derived from the Bils and Klenow data set). The authors found that it exhibited a hump shape, peaking in the second quarter, and gradually declining thereafter. This pattern ensured that Feature 3, representing the persistence of inflation effects, was met.

Interestingly, they noted that the timing of the hump appeared to align closely with the most common contract durations. They suggested that this correlation might not be surprising. The peak corresponds to the time when the highest number of wages are being reset following the economic innovation. This observation underscores the potential link between contract durations and the response of inflation to economic shocks.

3.6 Persistence in Inflation: The Role of Contract Lengths and Lag Effects

Inflation persistence is a complex phenomenon that is influenced by a multitude of factors. According to the paper "Understanding Inflation Persistence: A Comparison of Different Models" by Huw Dixon and Engin Kara, one of the key reasons for inflation persistence is the presence of staggered contracts, which can lead to a delay in the adjustment of prices and wages in response to shocks. This delay can cause inflation to persist even after the initial shock has subsided.

The authors further explain that the current level of inflation is often not far away from inflation in the previous quarters, indicating a high autocorrelation. This is one of the main sources of evidence supporting the idea that inflation is persistent.

In addition, the paper discusses the shape and timing of the response of inflation to monetary policy. It is widely agreed that there is a delayed response of inflation to monetary policy: the maximum effect of policy occurs sometime after the policy. This is the so-called hump-shaped response.

In the paper "Persistence and Nominal Inertia in a Generalized Taylor Economy: How Longer Contracts Dominate Shorter Contracts" by Huw Dixon and Engin Kara, the authors argue that the length of contracts plays a crucial role in determining the degree of inflation persistence. They show that even a small proportion of longer contracts can significantly increase the degree of persistence.

Overall, both the length of contracts and the delayed response of inflation to monetary policy contribute to the persistence of inflation. This understanding can further clarify why even a minimal degree of persistence in month-on-month inflation can contribute to the emergence of annual or headline inflation.

Inflation persistence is a critical issue for both policy makers and theorists. The persistence of inflation influences how far policy makers should look forward and how rapidly their policy actions take effect.

Firstly, the length of contracts can create a form of 'inertia' in the economy. When contracts, such as wage agreements or rental leases, are set for extended periods, they can slow the adjustment of prices in response to changes in monetary policy. This means that even if a central bank implements measures to curb inflation, the effects may not be immediately apparent due to these long-term contracts.

Secondly, the delayed response of inflation to monetary policy further compounds this issue. Monetary policy actions, such as changes in interest rates or money supply, do not instantaneously affect inflation. There is typically a lag between the implementation of policy and its impact on inflation, known as the 'inside lag'. This lag can make it challenging for policymakers to accurately predict and respond to inflation trends.

These factors underscore the need for policymakers to take a forward-looking approach when dealing with inflation. They must consider not only the current state of the economy but also anticipate future inflation trends based on these persistence factors. Furthermore, understanding the sources of inflation persistence can help in designing more effective monetary policies that take into account the delayed and prolonged effects of policy actions on inflation.

3.7 Conclusion

In conclusion, understanding the theories of inflation, the problems it poses, and its history in specific contexts like the UK can provide valuable insights for both economic policy and individual financial planning. The Generalized Taylor Economy (GTE) model proposed by Dixon and Kara (2005b) provides a flexible framework for capturing the heterogeneity of wage-setting processes across sectors, which has important implications for understanding the impact of monetary shocks on output and other macroeconomic variables.

The research underscores the significant influence of long-term contracts on economic output and its persistence. Furthermore, the diverse range of contract lengths present in the economy and their potential influence on economic dynamics is significant. The response of inflation to economic shocks is potentially linked to contract durations.

The investigation of special cases, such as the Calvo-GTE, provides insights into how variations in contract length distributions can impact the macroeconomic dynamics in the GTE framework. The Calvo-GTE does have a hump-shaped inflation response, with the peak appearing in the third quarter for a reset probability of 0.25. Persistence is quite high, with inflationary effects observable 20 quarters and beyond.

Overall, the study contributes to the literature on macroeconomic modeling by providing a more comprehensive understanding of inflation persistence and the impact of monetary shocks on output.

Conclusion

In conclusion, this PhD thesis has provided a comprehensive analysis of inflation in the UK, contributing valuable insights to our understanding of inflation dynamics and their implications for economic policy and financial planning.

The study began by modelling month-on-month (mom) inflation as an autoregressive process, taking into account factors such as seasonality and VAT changes. A significant 12-month lag effect on inflation in the UK was identified, leading to a degree of persistence in annual inflation. This effect was found to exist at the aggregate level and within the majority of consumer expenditure categories.

In addition to analysing mom inflation, the study explored alternative measures of core inflation, including the exclusion of food and energy prices from the CPI, the use of 5% trimmed means, and the inclusion of only sticky prices. It was found that sticky prices are more responsive to economic conditions than the overall consumer price index. When analysing the forecasting performance of different measures of core inflation, the exclusion of food and energy measure was found to have the best performance, followed by the sticky CPI measure. The autoregressive (AR) and seasonal autoregressive integrated moving average (SARIMA) models, which served as the benchmark models, had the worst performance.

The Generalized Taylor Economy (GTE) model proposed by Dixon and Kara (2005b) was also explored, providing a flexible framework for capturing the heterogeneity of wage-setting processes across sectors. The research underscores the significant influence of long-term contracts on economic output and its persistence. Furthermore, the diverse range of contract lengths present in the economy and their potential influence on economic dynamics is significant. The response of inflation to economic shocks is potentially linked to contract durations.

However, it is important to note that the study may have considered a limited range of factors that influence inflation and may not have fully captured the complexity of the inflation process. Inflation forecasting is a challenging task and the accuracy of any model will depend on various factors, including the possibility of errors or unexpected events.

In terms of future research, there are several directions that could build upon the findings of this study. These include extending the analysis to other countries or regions, exploring the potential causes of the 12-month lag effect on inflation, investigating other potential predictors of inflation, such as changes in monetary policy or economic activity, and extending the analysis to include data from after 2019, particularly in the context of the COVID-19 pandemic and the high inflation in the UK.

Overall, this thesis has made a valuable contribution to the literature on macroeconomic modeling by providing a more comprehensive understanding of inflation persistence and the impact of monetary shocks on output. The findings of the study have important implications for policymakers and practitioners who rely on accurate inflation forecasts to make informed decisions.

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List of Abbreviations

01FB	Food and Non-Alcoholic Beverages
02AT	Alcoholic Beverages, Tobacco and Narcotics
03CF	Clothing and Footwear
04HW	Housing, Water, Electricity, Gas and Other Fuels
05FH	Furnishings, Household Equipment and Routine Household Maintenance
06HL	Health
07TR	Transport
08CM	Communication
09RC	Recreation and Culture
10ED	Education
11RH	Restaurants and Hotels
12MS	Miscellaneous Goods and Services

Appendix A: CPI Weights: 2008

		2008
CPI (overall index)		1000
01	Food and non-alcoholic beverages	109
02	Alcoholic beverages and tobacco	42
03	Clothing and footwear	63
04	Housing, water, electricity, gas and other fuels	115
05	Furniture, household equipment and maintenance	67
06	Health	22
07	Transport	152
08	Communication	23
09	Recreation and culture	152
10	Education	19
11	Restaurants and hotels	137
12	Miscellaneous goods and services	99

Appendix B: Regressions for CPI on itself (P Value)

	CPI	CPI(AICstepwise)		CPI	CPI(AICstepwise)
CPI_LDV1	0.12 (0.04)**	0.11 (0.03)**	D.January	-0.90 (0.00)**	-0.78 (0.00)**
CPI_LDV2	-0.04 (0.53)		D.July	-0.61 (0.0000)**	-0.50 (0.00)**
CPI_LDV3	0.05 (0.35)		D.June	-0.34 (0.001)**	-0.31 (0.0000)**
CPI_LDV4	0.04 (0.42)		D.March	-0.21 (0.06)**	-0.11 (0.03)**
CPI_LDV5	0.01 (0.91)		D.May	-0.18 (0.10)	-0.14 (0.01)**
CPI_LDV6	-0.01 (0.88)		D.November	-0.34 (0.002)**	-0.25 (0.0000)**
CPI_LDV7	0.02 (0.66)		D.October	-0.28 (0.0001)**	-0.30 (0.0000)**
CPI_LDV8	0.01 (0.86)		D.September	-0.23 (0.03)**	-0.16 (0.003)**
CPI_LDV9	0.06 (0.24)		Trend	-0.0000 (0.84)	-0.0000 (0.88)
CPI_LDV10	-0.01 (0.81)		Constant	0.34 (0.0000)**	0.31 (0.00)**
CPI_LDV11	0.07 (0.19)				
CPI_LDV12	0.24 (0.0000)**	0.27 (0.0000)**	Observations	324	324
VAT1	-0.89 (0.0000)**	-0.89 (0.0000)**	R^2	0.74	0.73
VAT2	0.42 (0.04)**	0.44 (0.03)**	Adjusted R^2	0.71	0.72
VAT3	0.52 (0.01)**	0.49 (0.01)**	Residual Std. Error	0.19	0.19
Recession	0.07 (0.20)	0.10 (0.06)	F Statistic	29.66**	46.46**
D.August	-0.03 (0.73)	0.03 (0.61)			
D.December	-0.09 (0.34)	-0.06 (0.30)	*Note:*		* p<0.05; ** p<0.01
D.February	0.02 (0.81)	0.07 (0.33)			

Appendix C: Stepwise AIC Method Analysis (P Value): Divisions (Monthly data)

	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV1	0.14**	-0.17***	-0.21***	0.22***	-0.28***	-0.38***			-0.18***		-0.11**	-0.12**
	p = 0.02	p = 0.002	p = 0.0001	p = 0.0001	p = 0.00	p = 0.00			p = 0.002		p = 0.04	p = 0.04
LDV2		-0.09*	-0.13***		-0.21***	-0.39***						
		p = 0.09	p = 0.01		p = 0.0000	p = 0.00						
LDV3			-0.14**			0.13**						0.13**
			p = 0.02			p = 0.04						p = 0.03
LDV4	-0.12*		-0.12**			-0.24***		-0.11**	0.13**			
	p = 0.06		p = 0.02			p = 0.0002		p = 0.05	p = 0.02			
LDV5			0.10**			-0.19***			0.14***			
			p = 0.04			p = 0.002			p = 0.01			
LDV6			0.32***		0.23***	-0.22***			0.19***			
			p = 0.00		p = 0.0000	p = 0.0002			p = 0.002			
LDV7			0.10*	0.10*	0.09*							
			p = 0.06	p = 0.10	p = 0.06							
LDV8				-0.10*								-0.09*

	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
				p = 0.08								p = 0.10
LDV9			0.09*				-0.13**	0.11*			-0.11*	
			p = 0.08				p = 0.05	p = 0.06			p = 0.06	
LDV10		0.09*			-0.16***							
		p = 0.08			p = 0.0004							
LDV11					-0.11**	-0.15***						
					p = 0.02	p = 0.002						
LDV12	0.12**	0.28***	0.30***	0.14**	0.35***		0.22***		0.21***	0.47***	0.19***	0.11**
	p = 0.03	p = 0.0000	p = 0.00	p = 0.02	p = 0.00		p = 0.0002		p = 0.0004	p = 0.00	p = 0.001	p = 0.04
CPI-LDV1							0.58***					0.16*
							p = 0.01					p = 0.07
CPI-LDV3		0.37**	0.68***	0.34**			-0.56***	0.46***		0.64**		
		p = 0.02	p = 0.001	p = 0.04			p = 0.01	p = 0.01		p = 0.05		
CPI-LDV4	0.49***			0.27*							0.09*	
	p = 0.01			p = 0.10							p = 0.06	
CPI-LDV6		0.65***		-0.32**			-0.38*		-0.18**			
		p = 0.0001		p = 0.05			p = 0.06		p = 0.04			

	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI-LDV7		-0.51***			0.51***							
		p = 0.003			p = 0.0001							
CPI-LDV8	0.32**											
	p = 0.05											
CPI-LDV9							0.44*					
							p = 0.08					
CPI-LDV11									0.15*			
									p = 0.07			
VAT1	-0.55	-0.37	-3.65***	-0.64	-2.96***	-0.68	-0.04	-2.37***	-1.03***	-0.08	-0.42**	-0.49
	p = 0.36	p = 0.55	p = 0.0000	p = 0.29	p = 0.00	p = 0.36	p = 0.96	p = 0.001	p = 0.002	p = 0.95	p = 0.03	p = 0.13
VAT2	-0.31	1.80***	-1.34*	0.53	0.58	0.57	0.92	1.13*	0.59**	-0.11	0.31*	0.51*
	p = 0.59	p = 0.003	p = 0.06	p = 0.37	p = 0.21	p = 0.42	p = 0.23	p = 0.10	p = 0.05	p = 0.93	p = 0.08	p = 0.10
VAT3	-0.03	2.09***	-0.65	0.29	1.45***	0.3	1.13	0.85	0.22	-0.16	1.27***	-0.36
	p = 0.96	p = 0.0005	p = 0.37	p = 0.62	p = 0.002	p = 0.68	p = 0.14	p = 0.22	p = 0.47	p = 0.90	p = 0.00	p = 0.25
Recession	0.40**	0.11	-0.26	0.21	0.42***	0.01	-0.22	0.17	0.21**	-0.12	0.02	0.08
	p = 0.02	p = 0.48	p = 0.23	p = 0.22	p = 0.001	p = 0.96	p = 0.30	p = 0.35	p = 0.02	p = 0.71	p = 0.69	p = 0.36
D.August	0.17	-1.72***	0.16	-1.12***	0.50**	-0.23	0.17	-0.51**	-0.14	-0.56	-0.33***	0.08

	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
	p = 0.30	p = 0.00	p = 0.76	p = 0.0000	p = 0.04	p = 0.25	p = 0.62	p = 0.04	p = 0.12	p = 0.18	p = 0.00	p = 0.41
D.December	0.39**	-1.55***	0.63	-0.96***	0.77***	-0.73***	0.27	-0.63***	0.01	-0.52	-0.36***	-0.17**
	p = 0.02	p = 0.00	p = 0.23	p = 0.0001	p = 0.0005	p = 0.0002	p = 0.38	p = 0.01	p = 0.96	p = 0.21	p = 0.00	p = 0.05
D.February	0.66***	-1.30***	-1.06**	-0.97***	0.33	-0.42**	0.14	-0.46**	-0.08	-0.41	-0.17***	0.14
	p = 0.0002	p = 0.0000	p = 0.04	p = 0.0000	p = 0.16	p = 0.03	p = 0.69	p = 0.03	p = 0.37	p = 0.27	p = 0.001	p = 0.20
D.January	-0.03	0.13	-1.97***	-1.37***	-0.87***	-0.45**	-1.43***	-0.73***	-0.56***	-0.37	-0.38***	-0.23***
	p = 0.84	p = 0.52	p = 0.0002	p = 0.00	p = 0.0000	p = 0.03	p = 0.0001	p = 0.001	p = 0.0000	p = 0.33	p = 0.00	p = 0.01
D.July	-0.2	-0.81***	-1.78***	-1.47***	-0.2	-0.50***	-0.04	-0.85***	-0.33***	-0.66	-0.18***	-0.20**
	p = 0.23	p = 0.002	p = 0.0004	p = 0.0000	p = 0.26	p = 0.01	p = 0.92	p = 0.001	p = 0.002	p = 0.15	p = 0.0003	p = 0.03
D.June	-0.02	-1.38***	-0.06	-1.22***	-0.34*	-0.67***	-0.51	-0.76***	-0.02	-0.56	-0.20***	-0.19**
	p = 0.91	p = 0.00	p = 0.91	p = 0.0000	p = 0.09	p = 0.001	p = 0.18	p = 0.002	p = 0.87	p = 0.19	p = 0.0001	p = 0.02
D.March	0.27	-0.99***	-1.26***	-1.21***	0.04	-0.41**	-0.24	-0.79***	-0.14	-0.56	-0.16***	-0.06
	p = 0.16	p = 0.0001	p = 0.003	p = 0.0000	p = 0.85	p = 0.04	p = 0.41	p = 0.001	p = 0.11	p = 0.18	p = 0.002	p = 0.46
D.May	0.95***	-0.85***	-0.65	-1.35***	0.1	-0.3	-0.48	-0.72***	-0.03	-0.62	-0.01	-0.15*
	p = 0.0001	p = 0.0003	p = 0.15	p = 0.0000	p = 0.57	p = 0.13	p = 0.16	p = 0.004	p = 0.74	p = 0.16	p = 0.87	p = 0.08
D.November	0.55***	-1.74***	0.34	-1.17***	-0.17	-0.71***	-0.97***	-0.76***	-0.01	-0.61	-0.24***	-0.09
	p = 0.003	p = 0.00	p = 0.45	p = 0.0001	p = 0.39	p = 0.0003	p = 0.01	p = 0.002	p = 0.91	p = 0.17	p = 0.0001	p = 0.31

	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
D.October	0.07	-1.12***	0.72**	-0.82***	0.31**	-0.77***	-0.98***	-0.42**	0.14	1.66***	-0.28***	0.0001
	p = 0.65	p = 0.00	p = 0.02	p = 0.0001	p = 0.03	p = 0.0001	p = 0.0002	p = 0.03	p = 0.13	p = 0.0000	p = 0.0000	p = 1.00
D.September	0.29	-0.99***	1.78***	-0.84***	-0.03	-0.22	-1.83***	-0.60***	0.06	1.03***	-0.23***	-0.03
	p = 0.18	p = 0.0000	p = 0.0001	p = 0.0001	p = 0.87	p = 0.27	p = 0.00	p = 0.004	p = 0.51	p = 0.01	p = 0.0000	p = 0.75
Trend	-0.0002	-0.0002	0.001**	-0.0002	0.0004	0.0001	-0.0002	0.002***	0	0	-0.0005***	-0.001***
	p = 0.65	p = 0.54	p = 0.03	p = 0.50	p = 0.13	p = 0.87	p = 0.64	p = 0.0000	p = 0.81	p = 0.95	p = 0.0001	p = 0.004
Constant	-0.23	1.26***	-0.19	1.20***	-0.14	0.98***	0.75***	0.09	0.11	0.38	0.56***	0.34***
	p = 0.14	p = 0.00	p = 0.57	p = 0.00	p = 0.30	p = 0.00	p = 0.003	p = 0.63	p = 0.16	p = 0.24	p = 0.00	p = 0.0001
Observations	324	324	324	324	324	324	324	324	324	324	324	324
R2	0.28	0.63	0.94	0.33	0.92	0.43	0.56	0.19	0.37	0.59	0.46	0.2
Adjusted R2	0.23	0.6	0.93	0.28	0.92	0.39	0.53	0.14	0.32	0.57	0.42	0.14
Residual Std. Error	0.56	0.56	0.68	0.56	0.44	0.69	0.73	0.64	0.29	1.15	0.17	0.3
F Statistic	5.71***	22.38***	164.60***	6.47***	149.20***	9.99***	17.44***	3.77***	7.51***	24.66***	12.85***	3.53***
Note:	*p<0.1; **p<0.05; ***p<0.01											

Appendix D: CPI regression with output, unemployment, PPI and hourly wages (Complete results)

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
CPI_LDV1	-0.08			
	p = 0.37			
CPI_LDV2	-0.1	-0.09		
	p = 0.25	p = 0.14		
CPI_LDV3	0.1	0.12**	0.09	
	p = 0.25	p = 0.05	p = 0.13	
CPI_LDV4	0.03			
	p = 0.78			
CPI_LDV5	-0.01			
	p = 0.87			
CPI_LDV6	-0.02			
	p = 0.78			
CPI_LDV7	-0.003			
	p = 0.98			
CPI_LDV8	0.03			
	p = 0.77			
CPI_LDV9	-0.03			
	p = 0.69			
CPI_LDV10	-0.06			

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
	p = 0.44			
CPI_LDV11	0.1	0.13**	0.15**	0.16**
	p = 0.24	p = 0.04	p = 0.02	p = 0.02
CPI_LDV12	0.18**	0.15**	0.16**	0.17**
	p = 0.05	p = 0.03	p = 0.03	p = 0.02
Con_LDV1	0.13			
	p = 0.20			
Con_LDV2	-0.15			
	p = 0.21			
Con_LDV3	0.0002			
	p = 1.00			
Con_LDV4	0.11			
	p = 0.44			
Con_LDV5	-0.12			
	p = 0.41			
Con_LDV6	-0.06			
	p = 0.70			
Con_LDV7	0.17			
	p = 0.27			
Con_LDV8	-0.21	-0.09		
	p = 0.15	p = 0.17		

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
Con_LDV9	0.07	0.11		
	p = 0.59	p = 0.18		
Con_LDV10	0.21*	0.12		
	p = 0.09	p = 0.11		
Con_LDV11	-0.25**	-0.22***	-0.06	
	p = 0.03	p = 0.01	p = 0.30	
Con_LDV12	0.14	0.14**	0.07	
	p = 0.11	p = 0.04	p = 0.23	
PPI_LDV1	0.16***	0.17***	0.15***	0.16***
	p = 0.0001	p = 0.00	p = 0.00	p = 0.00
PPI_LDV2	0.003			
	p = 0.96			
PPI_LDV3	0.05			
	p = 0.22			
PPI_LDV4	-0.04			
	p = 0.39			
PPI_LDV5	-0.01			
	p = 0.91			
PPI_LDV6	0.03			
	p = 0.54			
PPI_LDV7	0.02			

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
	p = 0.67			
PPI_LDV8	-0.01			
	p = 0.75			
PPI_LDV9	0.07 p = 0.11	0.05** p = 0.02	0.06*** p = 0.01	0.06*** p = 0.01
PPI_LDV10	-0.005			
	p = 0.92			
PPI_LDV11	0.05			
	p = 0.26			
PPI_LDV12	-0.09** p = 0.03	-0.06** p = 0.03	-0.07** p = 0.02	-0.07** p = 0.02
U_LDV1	0.01			
	p = 0.58			
U_LDV2	-0.001			
	p = 0.90			
U_LDV3	-0.01			
	p = 0.51			
U_LDV4	0.01			
	p = 0.31			
U_LDV5	-0.02* p = 0.09	-0.01* p = 0.09	-0.02** p = 0.04	-0.01* p = 0.06
U_LDV6	0.01 p = 0.33	0.01** p = 0.05	0.01* p = 0.09	0.01** p = 0.04

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
U_LDV7	0.01			
	p = 0.22			
U_LDV8	0.005			
	p = 0.63			
U_LDV9	0.01	0.01*	0.01	
	p = 0.26	p = 0.06	p = 0.14	
U_LDV10	0.01			
	p = 0.42			
U_LDV11	0.003			
	p = 0.78			
U_LDV12	-0.01			
	p = 0.45			
WAGE_LDV1	0.003			
	p = 0.87			
WAGE_LDV2	0.02			
	p = 0.30			
WAGE_LDV3	0.02			
	p = 0.43			
WAGE_LDV4	0.02			
	p = 0.32			

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
WAGE_LDV5	-0.004			
	p = 0.87			
WAGE_LDV6	-0.003			
	p = 0.90			
WAGE_LDV7	-0.02			
	p = 0.44			
WAGE_LDV8	0.01			
	p = 0.79			
WAGE_LDV9	-0.003			
	p = 0.91			
WAGE_LDV10	0.01			
	p = 0.81			
WAGE_LDV11	-0.001			
	p = 0.96			
WAGE_LDV12	0.01			
	p = 0.57			
VAT1	-0.91***	-0.71***	-0.66***	-0.61***
	p = 0.002	p = 0.0003	p = 0.001	p = 0.002
VAT2	0.15	0.3	0.21	0.26
	p = 0.54	p = 0.11	p = 0.26	p = 0.15
VAT3	0.34	0.33*	0.37**	0.36**
	p = 0.11	p = 0.08	p = 0.05	p = 0.05
Recession	0.11	0.12**	0.12**	0.13**

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
	p = 0.23	p = 0.04	p = 0.04	p = 0.03
D.August	-0.2	-0.31*	-0.04	0.05
	p = 0.54	p = 0.10	p = 0.58	p = 0.42
D.December	0.39	0.14	0.08	0.13*
	p = 0.26	p = 0.45	p = 0.62	p = 0.09
D.February	0.42	0.36*	0.17	0.05
	p = 0.27	p = 0.06	p = 0.30	p = 0.36
D.January	-0.64	-1.10***	-0.84***	-0.80***
	p = 0.18	p = 0.0000	p = 0.0000	p = 0.00
D.July	-0.4	-0.54***	-0.54***	-0.44***
	p = 0.27	p = 0.0000	p = 0.00	p = 0.00
D.June	-0.32	-0.32***	-0.30***	-0.21***
	p = 0.32	p = 0.0002	p = 0.0004	p = 0.002
D.March	-0.13	-0.26**	-0.15**	-0.08
	p = 0.72	p = 0.02	p = 0.05	p = 0.16
D.May	-0.04	-0.21**	-0.17**	-0.08
	p = 0.91	p = 0.02	p = 0.04	p = 0.14
D.November	-0.09	-0.28	-0.48***	-0.24***
	p = 0.80	p = 0.13	p = 0.004	p = 0.0001
D.October	0.08	0.1	-0.24***	-0.20***
	p = 0.84	p = 0.57	p = 0.0002	p = 0.001
D.September	0.1	-0.15	-0.15**	-0.09
	p = 0.77	p = 0.42	p = 0.04	p = 0.12
Trend	0.0002	0.0001	0	0
	p = 0.42	p = 0.69	p = 0.96	p = 0.94
Constant	0.14	0.28***	0.29***	0.25***
	p = 0.61	p = 0.01	p = 0.0004	p = 0.0000
Observations	227	227	227	227
R^2	0.82	0.8	0.79	0.78
Adjusted R^2	0.73	0.77	0.76	0.76

	CPI	CPI(AIC)	CPI(Stage1)	CPI(Final)
Residual Std. Error	0.18	0.16	0.17	0.17
F Statistic	9.01***	25.21***	27.62***	31.63***
Note:	*p<0.1; **p<0.05; ***p<0.01			

Appendix E: AIC stepwise analysis with output, unemployment, PPI and hourly wages: CPI and Divisions (Monthly data)

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV1							-0.23^{**}					0.17^{***}	0.20^{*}
							p = 0.02					p = 0.005	p = 0.06
CPI_LDV2							0.16^{*}						
							p = 0.08						
CPI_LDV3			0.42^{**}						0.83^{***}				
			p = 0.04						p = 0.0005				
CPI_LDV4		0.51^{**}	0.55^{***}									0.11^{**}	
		p = 0.02	p = 0.01									p = 0.05	
CPI_LDV5						0.39^{**}							-0.17^{*}
						p = 0.03							p = 0.09

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV6			0.79^{***}		-0.89^{***}	0.38^{**}							
			p = 0.0001		p = 0.0001	p = 0.04							
CPI_LDV7			-0.64^{***}	0.61^{**}		0.71^{***}	0.23^{***}			-0.26^{**}	-1.02^{***}		
			p = 0.002	p = 0.03		p = 0.0000	p = 0.01			p = 0.04	p = 0.002		
CPI_LDV8		0.34^{*}		0.59^{**}				-0.47^{*}					
		p = 0.07		p = 0.02				p = 0.07					
CPI_LDV10											0.66^{**}		-0.21^{*}
											p = 0.04		p = 0.07
CPI_LDV11	0.16^{**}						-0.23^{**}			0.27^{**}			
	p = 0.02						p = 0.02			p = 0.03			
CPI_LDV12	0.17^{**}							0.53^{**}					
	p = 0.02							p = 0.03					
LDV1			-0.26^{***}	-0.22^{***}	0.19^{***}	-0.35^{***}	-0.11^{*}	-0.38^{***}		-0.18^{***}		-0.24^{***}	-0.18^{***}

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
			p = 0.0001	p = 0.0002	p = 0.004	p = 0.00	p = 0.10	p = 0.0000		p = 0.005		p = 0.0001	p = 0.01
LDV2			-0.16***	-0.13**		-0.24***		-0.12**	0.15***				
			p = 0.01	p = 0.03		p = 0.0000		p = 0.04	p = 0.01				
LDV3									0.13**		0.31***		
									p = 0.03		p = 0.0000		
LDV4		-0.20***							-0.21***				
		p = 0.01							p = 0.001				
LDV5				0.23***		-0.11*		-0.12**					
				p = 0.0003		p = 0.06		p = 0.04					
LDV6				0.23***		0.20***				0.12*		-0.15**	
				p = 0.0003		p = 0.001				p = 0.07		p = 0.02	
LDV7					0.12**		-0.17**						
					p = 0.05		p = 0.02						

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV8								0.17**					
								p = 0.03					
LDV9										0.12*	-0.13**		0.15**
										p = 0.07	p = 0.03		p = 0.03
LDV10				-0.12**		-0.17***	-0.16**					0.14**	
				p = 0.05		p = 0.002	p = 0.02					p = 0.03	
LDV11						-0.12**							
						p = 0.04							
LDV12			0.27***	0.22***		0.27***	0.17***	-0.15**			0.34***	0.13**	
			p = 0.0000	p = 0.0001		p = 0.0000	p = 0.01	p = 0.03			p = 0.00	p = 0.04	
Con_LDV1			0.22**		0.34***			0.24***			3.54***		-0.04**
			p = 0.02		p = 0.003			p = 0.001			p = 0.00		p = 0.04
Con_LDV2			-0.19*		-0.31**			-0.14**			-3.17***	0.06***	

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
			p = 0.06		p = 0.02			p = 0.04			p = 0.00	p = 0.003	
Con_LDV3				0.24***	0.23**	0.08*	0.06*			0.09***			
				p = 0.0002	p = 0.03	p = 0.10	p = 0.06			p = 0.01			
Con_LDV4			0.34***			-0.13**	-0.10**						-0.09***
			p = 0.01			p = 0.04	p = 0.02						p = 0.003
Con_LDV5			-0.42***			0.10*	0.07**						0.08**
			p = 0.0004			p = 0.06	p = 0.04						p = 0.02
Con_LDV7			0.31***					-0.13**		0.07**			-0.10***
			p = 0.003					p = 0.02		p = 0.03			p = 0.002
Con_LDV8			-0.17*	-0.18**		0.09**							0.08***
			p = 0.06	p = 0.04		p = 0.05							p = 0.005
Con_LDV9				0.25***									
				p = 0.005									

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
Con_LDV10					0.30^{***}	-0.12^{**}					1.30^{***}		
					p = 0.0004	p = 0.03					p = 0.0000		
Con_LDV11			0.17^{**}	-0.24^{***}		0.12^{**}					-1.10^{***}		
			p = 0.02	p = 0.01		p = 0.03					p = 0.0001		
Con_LDV12			-0.12^{*}	0.14^{*}									
			p = 0.07	p = 0.09									
PPI_LDV1	0.16^{***}	0.20^{***}				0.13^{**}		0.97^{***}					
	p = 0.00	p = 0.003				p = 0.03		p = 0.00					
PPI_LDV3					0.33^{***}				-0.34^{***}		0.38^{***}		
					p = 0.0000				p = 0.0001		p = 0.002		
PPI_LDV4										-0.08^{*}			
										p = 0.07			
PPI_LDV6					0.24^{***}	-0.24^{***}				-0.13^{**}		0.04^{*}	

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
					p = 0.002	p = 0.002				p = 0.02		p = 0.06	
PPI_LDV7		0.18**		-0.40***						0.15***			0.13***
		p = 0.02		p = 0.0003						p = 0.01			p = 0.001
PPI_LDV8					0.16**			-0.24**					
					p = 0.02			p = 0.02					
PPI_LDV9	0.06***												
	p = 0.01												
PPI_LDV10													0.10**
													p = 0.03
PPI_LDV11					0.19**	0.11*				-0.11**			
					p = 0.02	p = 0.06				p = 0.04			
PPI_LDV12	-0.07**				-0.19**		0.09**						
	p = 0.02				p = 0.02		p = 0.03						

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
U_LDV1												-0.01*	
												p = 0.07	
U_LDV3												-0.01*	
												p = 0.06	
U_LDV4			-0.05*										
			p = 0.06										
U_LDV5	-0.01*				-0.05**							-0.01**	
	p = 0.06				p = 0.02							p = 0.05	
U_LDV6	0.01**				0.05**								
	p = 0.04				p = 0.02								
U_LDV7							0.02*					-0.01**	
							p = 0.07					p = 0.04	
U_LDV8				-0.06**									

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
				p = 0.04									
U_LDV9		0.04*						0.07***			-0.08*		
		p = 0.07						p = 0.01			p = 0.06		
U_LDV11						0.04**				0.04***		0.01*	
						p = 0.03				p = 0.01		p = 0.07	
WAGE_LDV1											-0.23**		
											p = 0.02		
WAGE_LDV2								0.12**			-0.19**	0.04***	
								p = 0.02			p = 0.05	p = 0.01	
WAGE_LDV3											-0.17*		
											p = 0.06		
WAGE_LDV4		0.08*				0.08*							
		p = 0.08				p = 0.06							

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
WAGE_LDV5					-0.14***								
					p = 0.002								
WAGE_LDV6					-0.12**								
					p = 0.02								
WAGE_LDV7											-0.23***		
											p = 0.01		
WAGE_LDV9		0.11**	-0.11*		-0.11**								
		p = 0.03	p = 0.06		p = 0.03								
WAGE_LDV10		0.10**	-0.11*										
		p = 0.05	p = 0.06										
WAGE_LDV11					-0.12**							0.03**	
					p = 0.02							p = 0.05	
VAT1	-0.61***	-0.64	-0.26	-2.73***	-0.81	-2.62***	-1.11***	0.41	-2.53***	-1.02***	0.82	-0.42**	-0.75**

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
	p = 0.002	p = 0.30	p = 0.68	p = 0.0005	p = 0.16	p = 0.0000	p = 0.0001	p = 0.52	p = 0.0001	p = 0.01	p = 0.41	p = 0.02	p = 0.02
VAT2	0.26	-1.06*	2.93***	-0.76	0.12	0.26	0.60**	0.99	1.19**	0.4	0.87	0.42**	0.50*
	p = 0.15	p = 0.08	p = 0.0000	p = 0.30	p = 0.83	p = 0.60	p = 0.03	p = 0.13	p = 0.05	p = 0.24	p = 0.38	p = 0.03	p = 0.10
VAT3	0.36**	0.02	1.88***	-0.82	0.61	1.03**	0.2	1.12*	1.02*	0.44	-0.84	1.18***	-0.85***
	p = 0.05	p = 0.98	p = 0.004	p = 0.26	p = 0.25	p = 0.03	p = 0.46	p = 0.06	p = 0.09	p = 0.18	p = 0.39	p = 0.00	p = 0.01
Recession	0.13**	0.53***	0.12	-0.16	0.08	0.46***	-0.05	0.07	0.11	0.32***	-0.15	0.16***	-0.13
	p = 0.03	p = 0.001	p = 0.51	p = 0.46	p = 0.62	p = 0.005	p = 0.58	p = 0.72	p = 0.51	p = 0.002	p = 0.60	p = 0.003	p = 0.19
D.August	0.05	0.14	-2.23***	-5.27***	-1.55***	1.39**	0.01	0.68	-0.64**	-0.29	-1.01**	-0.77***	0.26
	p = 0.42	p = 0.44	p = 0.0002	p = 0.0005	p = 0.0000	p = 0.02	p = 0.95	p = 0.22	p = 0.02	p = 0.34	p = 0.02	p = 0.0000	p = 0.11
D.December	0.13*	0.74***	-2.27***	-6.44***	-2.11***	1.08*	-0.74***	2.15***	-0.91***	-0.41	-1.13***	-0.54***	0.16
	p = 0.09	p = 0.0001	p = 0.0001	p = 0.0001	p = 0.0000	p = 0.08	p = 0.0002	p = 0.0005	p = 0.0005	p = 0.13	p = 0.002	p = 0.00	p = 0.32
D.February	0.05	0.85***	-1.91***	-4.38**	-1.17***	0.59	-0.25	-0.24	-0.72***	-0.39	-0.64*	-0.16**	0.33*
	p = 0.36	p = 0.0000	p = 0.002	p = 0.02	p = 0.002	p = 0.31	p = 0.19	p = 0.67	p = 0.01	p = 0.15	p = 0.07	p = 0.04	p = 0.08
D.January	-0.80***	0.15	0.3	-9.77***	-1.53***	0.91	0.31	-1.26	-0.91***	-1.06***	-1.52***	-0.70***	0.12
	p = 0.00	p = 0.44	p = 0.69	p = 0.00	p = 0.0000	p = 0.21	p = 0.14	p = 0.18	p = 0.001	p = 0.0002	p = 0.001	p = 0.00	p = 0.55
D.July	-0.44***	-0.02	-1.43*	-6.97***	-2.86***	1.49**	0.06	1.19**	-1.18***	-0.13	0.1	-0.83***	-0.06
	p = 0.00	p = 0.93	p = 0.07	p = 0.0000	p = 0.00	p = 0.05	p = 0.78	p = 0.05	p = 0.0001	p = 0.65	p = 0.81	p = 0.0001	p = 0.76
D.June	-0.21***	0.23	-2.49***	-4.05***	-0.85***	-0.34	-0.51***	-0.69***	-0.88***	-0.56***	-0.28	-0.87***	0.02
	p = 0.002	p = 0.20	p = 0.0001	p = 0.001	p = 0.01	p = 0.57	p = 0.005	p = 0.01	p = 0.002	p = 0.01	p = 0.44	p = 0.0001	p = 0.93

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
D.March	-0.08	0.44**	-0.84	-0.67	-1.15***	1.24**	0.13	-0.2	-1.28***	0.28*	0.03	-0.20***	0.07
	p = 0.16	p = 0.04	p = 0.14	p = 0.14	p = 0.001	p = 0.05	p = 0.54	p = 0.73	p = 0.0001	p = 0.10	p = 0.93	p = 0.0004	p = 0.65
D.May	-0.08	0.90***	-1.23**	0.96	-1.76***	0.57	-0.07	-0.05	-1.04***	-0.12	-0.11	-0.62***	0.05
	p = 0.14	p = 0.0002	p = 0.04	p = 0.17	p = 0.0000	p = 0.30	p = 0.68	p = 0.87	p = 0.0005	p = 0.29	p = 0.73	p = 0.005	p = 0.78
D.November	-0.24***	0.79***	-0.9	-2.16	-1.72***	0.31	-0.19	-0.42	-1.28***	-0.21	0.51	-0.36***	0.03
	p = 0.0001	p = 0.0001	p = 0.18	p = 0.13	p = 0.0001	p = 0.57	p = 0.27	p = 0.49	p = 0.0001	p = 0.19	p = 0.17	p = 0.0000	p = 0.84
D.October	-0.20***	0.19	-2.83***	-1.25	-2.26***	0.42	-0.48***	0.55	-0.42**	0.05	2.45***	-0.67***	0.68***
	p = 0.001	p = 0.30	p = 0.0001	p = 0.27	p = 0.0001	p = 0.49	p = 0.001	p = 0.38	p = 0.05	p = 0.73	p = 0.00	p = 0.0001	p = 0.001
D.September	-0.09	0.57**	-0.8	0.65	-1.58***	1.10**	-0.22	-2.16***	-0.88***	0.44*	1.39***	-0.71***	0.2
	p = 0.12	p = 0.03	p = 0.20	p = 0.57	p = 0.0000	p = 0.05	p = 0.16	p = 0.0003	p = 0.0003	p = 0.10	p = 0.0001	p = 0.0001	p = 0.20
Trend	0	-0.0005	0.0001	0.002**	-0.001	0.001	-0.0004	0.0003	0.001**	0.001***	-0.002**	-0.001***	-0.001***
	p = 0.94	p = 0.42	p = 0.89	p = 0.03	p = 0.11	p = 0.16	p = 0.17	p = 0.67	p = 0.03	p = 0.003	p = 0.03	p = 0.001	p = 0.0002
Constant	0.25***	-0.44**	1.52***	2.70***	1.82***	-0.98**	0.49***	0.23	0.68***	0.08	0.43	0.76***	0.18
	p = 0.0000	p = 0.02	p = 0.001	p = 0.0003	p = 0.00	p = 0.03	p = 0.002	p = 0.54	p = 0.002	p = 0.65	p = 0.12	p = 0.00	p = 0.18
Observations	227	227	227	227	227	227	227	227	227	227	227	227	227
R^2	0.78	0.4	0.73	0.93	0.54	0.94	0.6	0.82	0.31	0.46	0.8	0.65	0.3
Adjusted R^2	0.76	0.32	0.68	0.92	0.46	0.92	0.54	0.79	0.24	0.39	0.77	0.59	0.2
Residual Std. Error	0.17	0.52	0.54	0.67	0.48	0.42	0.25	0.55	0.56	0.31	0.92	0.15	0.28
F Statistic	31.63***	5.25***	14.92***	84.86***	6.56***	75.13***	10.02***	29.60***	4.42***	6.14***	25.48***	11.46***	3.06***
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$												

Appendix F: AIC stepwise analysis with just wage: CPI and Divisions (Monthly data)

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV1	0.14*	0.29	0.02	0.16	0.14	−0.07	−0.24**	0.72**	−0.37	0.04	0.09	0.14**	0.30**
CPI_LDV2	0.01	0.06	0.11	−0.02	−0.01	−0.02	0.24**	0.05	−0.11	−0.16	−0.26	0.05	−0.11
CPI_LDV3	0.11	0.03	0.66***	0.78***	0.32	0.28	−0.07	−0.64*	0.41*	0.11	0.91*	0.05	0.01
CPI_LDV4	0.03	0.50**	0.59**	0.36	0.2	0.18	−0.00	−0.09	0.02	−0.23	−0.38	0.14*	−0.07
CPI_LDV5	−0.03	0.01	0.02	−0.41	0.29	0.17	0.05	0.06	0.24	−0.17	−0.88*	−0.06	−0.07
CPI_LDV6	0.02	0.38	0.95***	−0.06	−0.47**	−0.00	0.09	−0.76**	0.06	−0.04	0.42	0.04	0.05
CPI_LDV7	0.03	−0.06	−0.54**	−0.12	0.11	0.43**	0.18*	0.08	−0.10	−0.07	−0.46	0.13**	0.20*
CPI_LDV8	0.06	0.53**	0.2	0.55**	0.40*	0.12	0.01	−0.46	0.16	−0.01	0.53	0.07	−0.01
CPI_LDV9	0.06	0.13	0.19	0.06	0	−0.13	0.11	0.35	−0.14	0.02	0.24	0.02	−0.01
CPI_LDV10	−0.02	0.04	0.17	0.33	−0.01	0.31*	−0.02	0.03	−0.01	−0.03	0.51	−0.01	−0.08
CPI_LDV11	0.06	0.01	−0.00	−0.08	0.32	0.08	−0.15	−0.13	0.24	0.15	−0.29	−0.00	0
CPI_LDV12	0.13*	0.06	0.07	−0.23	−0.15	−0.03	0.12	0.82**	−0.29	0.12	−0.29	−0.03	0.07
WAGE_LDV1	0.01	0	0	−0.14*	0.09	−0.01	−0.03	−0.02	−0.06	−0.01	−0.24	0.01	0.07**
WAGE_LDV2	0.03	0.03	0.04	−0.04	0.07	−0.01	−0.00	0.13	−0.13*	−0.04	−0.15	0.06***	0.08**

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
WAGE_LDV3	0.03	0.05	0.09	−0.11	0.08	0.08	−0.01	−0.09	−0.08	0.01	−0.06	0.04**	0.08**
WAGE_LDV4	0.05**	0.17**	0.07	−0.09	0.05	0.10*	−0.02	0.14	−0.12	−0.03	−0.02	0.03	0.09**
WAGE_LDV5	0.04*	0.16**	0.03	−0.05	−0.04	0.05	−0.00	0.14*	−0.13*	−0.04	−0.08	0.03*	0.05
WAGE_LDV6	0.03	0.14**	−0.01	0.03	0.06	−0.01	0.01	0.06	−0.10	−0.02	−0.07	0.01	0.03
WAGE_LDV7	0.01	0.07	−0.14**	−0.17**	0.17**	−0.05	−0.02	0.05	−0.06	0.04	−0.28*	0.02	0.01
WAGE_LDV8	0.02	0.09	−0.13*	−0.10	0.25***	−0.04	−0.01	−0.08	−0.12	−0.00	0.11	0.02	−0.00
WAGE_LDV9	0.01	0.16**	−0.14**	−0.06	0.05	−0.09	0.01	−0.03	−0.12*	0	0.08	0.02	0.01
WAGE_LDV10	−0.01	0.11	−0.20***	−0.08	0.02	−0.12**	0.04	−0.14*	0.04	0.01	0.06	0.02	0.02
WAGE_LDV11	−0.02	0.07	−0.07	−0.17**	−0.06	−0.07	−0.00	−0.06	−0.00	0.02	0.1	0.03	−0.01
WAGE_LDV12	0.01	0.06	−0.07	−0.12	0.09	−0.02	0	−0.02	−0.07	0.03	−0.02	−0.00	0.02
VAT1	−0.79***	−0.69	−0.64	−3.34***	1.14	−3.26***	−1.06***	−0.17	−2.83***	−1.13***	−0.41	−0.50**	−0.60
VAT2	0.39*	−0.25	2.37***	−2.12**	0.03	0.89	0.4	0.78	0.47	0.83**	0.01	0.27	0.36
VAT3	0.56***	0.05	2.18***	−0.73	0.27	1.38***	0.27	1.13	0.93	0.45	−0.34	1.26***	−0.55
Recession	0.10*	0.54**	0.05	−0.79**	0.15	0.46***	−0.05	−0.01	0.04	0.23**	−0.23	0.03	0.14
D.August	−0.01	0.01	−2.01***	−0.06	−0.66*	0.17	−0.26	0.67	−0.64	−0.40*	−1.22	−0.25**	0.26
D.December	−0.07	0.46	−2.02***	0.28	−0.25	0.68*	−0.80***	1.19*	−0.34	−0.14	−1.57	−0.45***	−0.11
D.February	0.09	0.91**	−1.36***	−1.18	−0.39	0.23	−0.56***	−0.11	−0.70*	−0.22	−1.27	−0.10	0.32

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
D.January	−0.99***	0.04	−0.05	−2.28***	−1.45***	−0.90**	0.12	−1.43*	−0.76*	−0.74***	−0.93	−0.52***	−0.08
D.July	−0.56***	0.18	−0.62	−2.04***	−1.30***	−0.22	−0.10	0.63	−1.05**	−0.30	−0.55	−0.23*	−0.10
D.June	−0.41***	−0.09	−1.61***	−0.57	−0.62*	−0.57	−0.59***	−0.73	−0.38	−0.24	−1.94*	−0.36***	−0.15
D.March	−0.20	0.25	−0.83	−0.94	−0.86**	0.07	−0.19	−0.41	−0.69	−0.41	−1.14	−0.16	−0.22
D.May	−0.24*	0.66	−0.32	−0.27	−0.96**	0.15	−0.36	−0.17	−0.55	−0.36	−1.22	0.01	−0.22
D.November	−0.39***	0.67	−1.53***	0.64	−1.03***	−0.20	−0.44**	−1.47**	−0.94**	−0.29	−1.05	−0.27**	−0.17
D.October	−0.25***	0.06	−0.80**	0.69	−0.61**	0.27	−0.58***	−1.22**	−0.42	0.14	3.07***	−0.24**	0.07
D.September	−0.24*	0.43	−0.78	2.16***	−0.21	0.01	−0.39*	−3.49***	−0.37	−0.04	1.27	−0.19	−0.07
Trend	0	−0.00	0	0.00**	−0.00	0	−0.00**	−0.00	0	0	−0.00	−0.00*	−0.00*
LDV1		0.07	−0.33***	−0.29***	0.24***	−0.32***	−0.14*	−0.01	0.01	−0.22***	−0.01	−0.25***	−0.18**
LDV2		−0.10	−0.21***	−0.18**	0.11	−0.22***	−0.09	0.05	0.13*	0.03	−0.00	−0.01	−0.05
LDV3		−0.04	−0.04	−0.20***	−0.13	−0.07	−0.12	0.1	0.09	0.02	−0.02	−0.09	0.05
LDV4		−0.19**	−0.09	−0.21**	−0.01	−0.09	−0.08	0.09	−0.21***	0.15*	0.04	−0.02	0.07
LDV5		0.03	−0.07	0.12	−0.06	−0.15**	−0.07	−0.12	−0.10	0.16*	0.02	−0.01	0.03
LDV6		0.02	−0.12	0.21**	−0.00	0.26***	−0.15**	0.18*	−0.02	0.17**	−0.02	−0.24***	−0.03
LDV7		0.01	−0.06	0.04	0.14*	0.07	−0.21***	−0.01	−0.03	−0.06	0	−0.12	−0.04
LDV8		−0.03	−0.09	−0.08	−0.21**	0.01	−0.11	0.05	−0.03	0.01	−0.01	0.01	−0.09

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV9		−0.05	−0.07	0.05	0.05	−0.00	−0.02	−0.02	0.06	0.05	0.02	−0.07	0.1
LDV10		0.07	0.05	−0.04	−0.08	−0.18**	−0.20***	−0.01	0.1	−0.04	−0.02	0.07	−0.02
LDV11		−0.05	−0.03	−0.06	−0.03	−0.11	0.02	0.15*	−0.07	0.04	0.01	−0.01	−0.06
LDV12		0.05	0.23***	0.24***	0.07	0.28***	0.08	−0.16*	−0.00	0.11	0.23***	0.07	0.06
Num.Obs.	227	227	227	227	227	227	227	227	227	227	227	227	227
R2	0.737	0.41	0.72	0.931	0.455	0.932	0.614	0.738	0.35	0.446	0.631	0.612	0.294
R2 Adj.	0.681	0.234	0.636	0.91	0.291	0.911	0.499	0.66	0.156	0.28	0.521	0.496	0.082
AIC	−63.5	424.1	441	539.4	419.1	335.3	78.1	529.7	455.5	194.5	821	−112.0	146.2
BIC	80.4	609	626	724.3	604.1	520.2	263.1	714.7	640.4	379.4	1005.9	72.9	331.1
F		2.33	8.605	44.828	2.788	45.661	5.322	9.419	1.805	2.689	5.722	5.285	1.39
RMSE	0.17	0.49	0.5	0.63	0.48	0.4	0.23	0.61	0.52	0.29	1.16	0.15	0.26

* p < 0.1, ** p < 0.05, *** p < 0.01

Appendix G: AIC stepwise analysis with just PPI: CPI and Divisions (Monthly data)

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV1	−0.10	−0.05	−0.09	0.19	0	−0.25	−0.21*	0.16	−0.23	0.04	0.32	0.09	0.26*
CPI_LDV2	−0.09	−0.20	0.17	−0.11	−0.15	−0.03	0.26**	−0.05	0.21	0.03	−0.63	−0.01	−0.12
CPI_LDV3	0.13*	−0.14	0.77***	0.78**	0.16	0.41*	−0.08	−0.17	0.68**	0.30**	0.88	0.02	0.04
CPI_LDV4	0.04	0.36	0.50*	0.39	0.25	0.23	−0.02	−0.11	0.05	−0.18	0.07	0.09	−0.01
CPI_LDV5	−0.02	−0.25	0.22	−0.36	0.04	0.44**	0.08	0.2	0.2	−0.12	−0.98*	−0.09	−0.13
CPI_LDV6	−0.01	0.03	1.06***	0.27	−0.87***	0.39*	0.17	−0.42	0.02	0.02	0.29	−0.03	−0.08
CPI_LDV7	0.03	−0.34	−0.26	0.4	−0.44*	0.65***	0.21*	0.44	−0.14	−0.19	−0.36	0.07	−0.03
CPI_LDV8	−0.02	0.28	−0.03	0.57*	−0.01	−0.00	0.03	−0.20	0.36	−0.14	0.25	−0.00	−0.21*
CPI_LDV9	0.04	−0.16	0.17	0.12	−0.15	−0.08	0.15	0.44	−0.03	0.07	−0.17	0.01	−0.18
CPI_LDV10	−0.05	−0.10	0.28	0.29	−0.04	0.26	−0.06	−0.26	−0.06	−0.02	0.99*	−0.05	−0.20
CPI_LDV11	0.14*	0.19	0.21	−0.08	0.27	0	−0.19	0.31	0.13	0.29**	0.26	−0.03	−0.01
CPI_LDV12	0.19**	0.36	−0.19	−0.33	−0.24	−0.15	0.05	0.41	−0.16	0.09	0.05	−0.03	0.06
PPI_LDV1	0.18***	0.16	0.34***	0.1	−0.01	0.24***	0.02	0.90***	−0.01	0.08	−0.42*	0.03	0

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
PPI_LDV2	−0.01	0.1	−0.33**	0.04	−0.01	−0.07	−0.03	0.08	0.01	−0.09	0.67**	−0.02	−0.02
PPI_LDV3	0.03	0.15	0.09	−0.10	0.32**	−0.05	−0.03	−0.03	−0.37***	−0.06	−0.12	0.03	0.03
PPI_LDV4	−0.04	−0.09	−0.17	−0.08	−0.08	−0.02	0.05	−0.07	0.04	−0.09	−0.48	0.02	−0.07
PPI_LDV5	0.01	0.06	0.12	0.14	0.04	−0.01	−0.00	−0.22	−0.03	0.1	0.06	0.02	0.05
PPI_LDV6	0.01	0.11	−0.12	−0.13	0.29**	−0.27***	−0.07	−0.00	0.04	−0.19***	0.33	0.04	0
PPI_LDV7	0.01	0.16	−0.22*	−0.33**	0.05	−0.01	0.03	−0.26*	0.12	0.17**	0.02	−0.01	0.11*
PPI_LDV8	−0.00	0.03	0.14	0.04	0.15	0.01	−0.01	−0.35**	−0.17	−0.01	−0.15	0.03	0.06
PPI_LDV9	0.05	0.05	0.17	−0.08	0.13	−0.03	−0.04	0.07	−0.06	0.03	0.38	0.01	0.03
PPI_LDV10	0.03	0.12	−0.23*	−0.03	0.06	−0.03	−0.01	0	0.01	0.03	−0.31	0.01	0.13**
PPI_LDV11	0.01	−0.03	−0.03	0.05	0.1	0.13	0.01	0.02	−0.06	−0.15**	−0.06	0.05	−0.03
PPI_LDV12	−0.09**	−0.20*	0.08	0.03	−0.13	−0.06	0.06	0.03	0.03	−0.00	−0.22	0.01	0.04
VAT1	−0.79***	−0.88	−0.45	−3.05***	−0.31	−3.06***	−0.97***	1.27	−2.36***	−1.26***	−1.37	−0.42*	−0.89**
VAT2	0.32	−0.38	2.05***	−1.64*	0.55	0.54	0.59**	0.14	0.76	0.57	−0.60	0.31	0.54
VAT3	0.40**	−0.36	1.94***	−0.95	0.25	1.31**	0.31	0.98	1.06	0.31	−0.19	1.27***	−0.60*
Recession	0.13**	0.46**	0	−0.52	0.07	0.43***	−0.06	0.03	0.15	0.30***	0.13	−0.03	0.01
D.August	−0.10	−0.07	−1.78***	0.72	−0.89**	0.05	−0.28	0.41	−0.79*	−0.53**	−0.65	−0.30**	0.16

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
D.December	−0.02	0.74*	−1.66***	0.6	−0.33	0.65*	−0.77***	0.82	−0.54	−0.06	−1.51	−0.46***	−0.09
D.February	−0.11	0.88**	−1.54***	−0.63	−0.59	−0.11	−0.55***	−0.54	−0.74*	−0.43*	−0.56	−0.14	0.26
D.January	−0.87***	0.57	−0.13	−2.13***	−1.55***	−0.82**	0.09	−1.09	−0.82**	−0.79***	−0.39	−0.56***	−0.09
D.July	−0.58***	0.32	−0.74*	−1.76**	−1.42***	−0.21	−0.07	0.31	−1.09***	−0.34	−0.28	−0.28**	−0.11
D.June	−0.33***	0.21	−1.55***	−0.23	−0.71*	−0.60*	−0.61***	−0.18	−0.50	−0.35	−1.95*	−0.34***	−0.13
D.March	−0.25*	0.33	−1.03*	−0.70	−0.71*	−0.09	−0.19	−0.91*	−0.61	−0.39	−1.72	−0.20	−0.23
D.May	−0.18	0.93**	−0.35	−0.01	−0.71*	−0.01	−0.44*	−0.15	−0.79*	−0.44*	−0.44	−0.02	−0.14
D.November	−0.42***	0.81*	−1.50***	0.95	−0.84**	−0.26	−0.46**	−2.36***	−1.10**	−0.45*	−0.51	−0.29**	−0.18
D.October	−0.21**	0.22	−1.02***	0.94*	−0.52*	0.15	−0.53***	−1.98***	−0.42	0.08	2.76***	−0.22**	0.08
D.September	−0.22*	0.62	−0.86*	2.63***	−0.30	−0.19	−0.42*	−2.96***	−0.30	−0.07	1.13	−0.24*	−0.10
Trend	−0.00	−0.00	0	0.00**	−0.00	0	−0.00***	−0.00	0.00*	0.00*	−0.00	−0.00***	−0.00**
LDV1		0.1	−0.26***	−0.29***	0.18**	−0.34***	−0.14*	−0.34***	−0.00	−0.18**	−0.02	−0.25***	−0.18**
LDV2		−0.09	−0.16**	−0.17**	0.05	−0.23***	−0.09	−0.10	0.15**	0	0.05	−0.04	−0.07
LDV3		−0.02	−0.03	−0.19**	−0.20**	−0.10	−0.14*	0.08	0.15**	−0.03	−0.03	−0.12	0.01
LDV4		−0.18**	−0.11	−0.14*	0.02	−0.10	−0.06	0.11	−0.16**	0.16**	−0.01	−0.02	0.01
LDV5		0.1	−0.09	0.15*	−0.03	−0.13*	−0.07	−0.03	−0.10	0.14*	0.04	−0.04	−0.01

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV6		0.09	−0.14*	0.22***	−0.03	0.24***	−0.17**	0.12	−0.05	0.13	−0.02	−0.23***	−0.05
LDV7		0.06	−0.04	0.08	0.22***	0.06	−0.22***	0.07	−0.04	−0.05	−0.01	−0.12	−0.02
LDV8		0	−0.10	0	−0.13	0.01	−0.11	0.17*	0.01	0.03	0.04	−0.03	−0.05
LDV9		0.01	−0.04	0.04	0.1	0.01	−0.06	−0.03	0.09	0.07	0.03	−0.09	0.15**
LDV10		0.1	0.02	−0.05	0.04	−0.16**	−0.20***	0.04	0.12*	−0.05	−0.08	0.04	0.01
LDV11		−0.03	−0.06	−0.05	−0.04	−0.13**	0.03	0	−0.06	0.02	−0.01	−0.03	−0.04
LDV12		0.04	0.25***	0.25***	0.12	0.29***	0.11	−0.13	−0.00	0.13	0.28***	0.06	0.08
Num.Obs.	227	227	227	227	227	227	227	227	227	227	227	227	227
R2	0.786	0.428	0.73	0.929	0.46	0.934	0.614	0.814	0.369	0.487	0.636	0.606	0.312
R2 Adj.	0.74	0.257	0.649	0.907	0.298	0.915	0.498	0.758	0.181	0.334	0.528	0.489	0.106
AIC	−110.0	417.1	433	545.9	416.9	326.9	78.3	452.2	448.8	176.8	817.7	−108.6	140.3
BIC	33.9	602	618	730.9	601.9	511.8	263.3	637.1	633.7	361.8	1002.7	76.4	325.2
F		2.507	9.034	43.454	2.849	47.506	5.314	14.62	1.96	3.177	5.854	5.155	1.515
RMSE	0.16	0.48	0.5	0.63	0.48	0.39	0.23	0.52	0.51	0.28	1.16	0.15	0.26

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix H: AIC stepwise analysis with just unemployment: CPI and Divisions (Monthly data)

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV1	0.15**	0.21	−0.03	0.31	0.09	−0.05	−0.20**	0.86***	−0.44*	0.07	0.15	0.17**	0.31**
CPI_LDV2	−0.00	0.11	0	−0.21	0.11	−0.07	0.29***	0.09	−0.09	−0.12	−0.15	0.01	−0.14
CPI_LDV3	0.1	0.11	0.55**	0.44	0.53**	0.18	−0.10	−0.56*	0.31	0.08	0.73	0.06	0.03
CPI_LDV4	0.06	0.54**	0.53**	0.21	0.47**	0.1	0	−0.14	−0.12	−0.26*	−0.67	0.19***	−0.03
CPI_LDV5	−0.04	0.03	0.04	−0.52*	0.22	0.19	0.04	−0.29	0.25	−0.14	−0.80	−0.04	−0.08
CPI_LDV6	0.04	0.45*	0.86***	−0.01	−0.55**	0.13	0.06	−0.76**	0.03	0.02	0.77	0.08	0.05
CPI_LDV7	−0.01	−0.10	−0.46**	−0.05	−0.06	0.41**	0.17*	−0.05	−0.09	−0.13	−0.19	0.08	0.17
CPI_LDV8	0.06	0.46**	0.1	0.45	0.43*	0.09	0.03	−0.39	0.16	0.01	0.15	0.05	−0.00
CPI_LDV9	0.01	−0.08	0.1	−0.04	0.06	−0.22	0.1	0.16	−0.11	0.03	0.19	0.04	−0.07

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV10	−0.03	0	0.22	0.2	0.09	0.31*	−0.07	−0.15	−0.15	−0.04	0.48	−0.02	−0.06
CPI_LDV11	0.11	0.13	0.04	0.03	0.17	0.16	−0.10	0.06	0.2	0.14	−0.13	0.03	−0.02
CPI_LDV12	0.09	0.14	0.15	−0.28	−0.45*	−0.06	0.11	0.3	−0.24	0.07	0.01	−0.03	0.02
U_LDV1	0.01	0.03	0.02	0.02	0.03	−0.01	0	−0.01	0.04	−0.01	−0.04	−0.01*	−0.00
U_LDV2	−0.00	−0.01	0.01	0.02	−0.01	−0.01	−0.01	−0.02	−0.01	−0.00	0.06	0.01	0.02
U_LDV3	−0.01	−0.02	0.01	0.01	0.04	−0.00	−0.01	−0.02	0.04	−0.01	−0.10	−0.01	0.02
U_LDV4	0	−0.02	−0.06**	0.04	0.01	0.02	0.02	−0.01	−0.03	0.01	−0.01	0.01	0.02
U_LDV5	−0.03***	−0.02	−0.02	−0.01	−0.07**	−0.02	−0.00	−0.03	0.03	0	−0.00	−0.02*	−0.01
U_LDV6	0.01	−0.04	0	0.01	0.03	0.01	0.01	0.06	−0.02	0.01	−0.03	−0.01	0.02
U_LDV7	0.01	0.01	0.01	−0.00	0.01	0.03	0.03**	0.07*	−0.00	0.01	0.02	−0.02**	−0.00
U_LDV8	0	0.03	−0.01	−0.09**	0.02	−0.00	−0.00	0.02	0.04	−0.01	0.02	−0.00	0
U_LDV9	0.01	0.03	0.02	0.01	−0.01	−0.00	−0.00	0.05	0.03	−0.02	−0.09	0	−0.01
U_LDV10	−0.00	−0.02	0.02	0.01	−0.04	0.02	−0.00	0.01	−0.03	0	0.01	−0.00	−0.01

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
U_LDV11	0	−0.01	−0.02	0.04	−0.04	0.04*	−0.02	0.01	0.02	0.04**	0.02	0.01	−0.01
U_LDV12	−0.01	−0.01	0.01	0.04	−0.02	−0.02	−0.00	0.02	0.01	−0.02	0.11*	−0.01	−0.00
VAT1	−0.93***	−0.76	−0.46	−4.03***	0.15	−3.35***	−1.06***	−0.36	−2.16***	−1.09***	−0.60	−0.43**	−0.64*
VAT2	0.25	−0.42	2.10***	−1.90**	0.67	0.25	0.60**	−0.04	0.49	0.61	−0.46	0.15	0.56
VAT3	0.62***	0.13	2.27***	−1.12	0.43	1.46***	0.27	1.40*	0.76	0.37	−0.79	1.25***	−0.56
Recession	0.07	0.54**	0.04	−0.48	0	0.40**	−0.06	−0.09	−0.01	0.24*	0.23	0.08	−0.06
D.August	−0.04	−0.06	−1.80***	0.79	−1.01***	0.16	−0.20	0.8	−0.58	−0.42*	−0.68	−0.30**	0.22
D.December	0.01	0.64*	−1.81***	0.84	−0.60	0.85**	−0.71***	0.97	−0.28	−0.12	−1.01	−0.43***	−0.18
D.February	0.1	0.81**	−1.24**	−0.50	−0.71*	0.24	−0.50***	0.02	−0.65*	−0.23	−1.11	−0.09	0.34*
D.January	−1.00***	0.18	0.21	−2.06***	−1.89***	−0.86**	0.11	−1.77**	−0.60	−0.74***	−0.32	−0.55***	−0.14
D.July	−0.54***	0.21	−0.54	−1.26*	−1.69***	−0.11	−0.07	0.27	−0.90**	−0.24	−0.17	−0.23**	−0.13
D.June	−0.39***	−0.04	−1.33***	0.21	−1.09***	−0.43	−0.52***	−0.83	−0.24	−0.28	−1.65	−0.35***	−0.20

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
D.March	−0.20	0.22	−0.84	−0.59	−0.90**	0.09	−0.13	−0.63	−0.53	−0.34	−1.24	−0.21*	−0.25
D.May	−0.18	0.79*	−0.13	0.25	−1.08**	0.2	−0.34	−0.33	−0.60	−0.40	−1.22	−0.00	−0.21
D.November	−0.38***	0.75*	−1.29**	0.98	−1.14***	−0.16	−0.44**	−1.79***	−0.91**	−0.29	−1.02	−0.28**	−0.21
D.October	−0.26***	0.04	−0.68*	0.94*	−0.78***	0.15	−0.48***	−1.43***	−0.38	0.12	2.82***	−0.22**	−0.00
D.September	−0.22*	0.51	−0.64	2.74***	−0.30	−0.00	−0.31	−3.01***	−0.26	−0.00	0.8	−0.23*	−0.10
Trend	−0.00	−0.00*	0	0.00**	−0.00**	0	−0.00**	0	0.00**	0	−0.00	−0.00***	−0.00**
LDV1		0.13	−0.28***	−0.27***	0.26***	−0.31***	−0.15*	−0.09	0.03	−0.22***	−0.01	−0.23***	−0.15*
LDV2		−0.08	−0.15**	−0.14*	0.08	−0.21***	−0.09	0.01	0.14*	0.03	0	−0.04	−0.03
LDV3		−0.03	0.01	−0.16*	−0.16*	−0.09	−0.13*	0.1	0.11	0	−0.04	−0.08	0.08
LDV4		−0.20**	−0.09	−0.10	−0.01	−0.12	−0.06	0.03	−0.21***	0.15*	0.02	−0.04	0.03
LDV5		0.04	−0.09	0.19**	−0.02	−0.16**	−0.05	−0.05	−0.08	0.14*	0.01	−0.03	−0.01
LDV6		0.01	−0.13	0.26***	0	0.23***	−0.15**	0.14	−0.04	0.13	−0.01	−0.20***	−0.07

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV7		0	−0.06	0.1	0.15*	0.04	−0.20***	0.04	−0.00	−0.07	−0.02	−0.12	−0.05
LDV8		−0.02	−0.08	−0.01	−0.18**	−0.01	−0.10	0.06	−0.03	0.04	−0.01	0.03	−0.07
LDV9		−0.03	−0.06	0.04	0.04	0.01	−0.02	−0.02	0.09	0.07	0.03	−0.09	0.13*
LDV10		0.05	0.07	−0.08	0.02	−0.15**	−0.16**	0.03	0.11*	−0.03	−0.05	0.09	−0.03
LDV11		−0.08	−0.00	−0.06	−0.01	−0.10	0.05	0.15*	−0.07	0.03	0.02	−0.03	−0.06
LDV12		0.03	0.25***	0.25***	0.08	0.29***	0.12	−0.02	0.06	0.15*	0.29***	0.11	0.04
Num.Obs.	227	227	227	227	227	227	227	227	227	227	227	227	227
R2	0.745	0.389	0.706	0.929	0.426	0.93	0.624	0.736	0.354	0.454	0.63	0.628	0.277
R2 Adj.	0.691	0.206	0.618	0.908	0.254	0.91	0.511	0.657	0.161	0.29	0.52	0.517	0.061
AIC	−70.7	432.2	452.2	544.2	430.8	339.3	72.2	531.3	454.3	191.2	821.4	−121.3	151.3
BIC	73.1	617.1	637.1	729.2	615.8	524.2	257.2	716.2	639.3	376.1	1006.3	63.7	336.3
F		2.13	8.032	43.809	2.481	44.797	5.55	9.332	1.832	2.777	5.707	5.643	1.284
RMSE	0.17	0.49	0.52	0.63	0.49	0.4	0.22	0.61	0.52	0.29	1.16	0.15	0.27

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS

* p < 0.1, ** p < 0.05, *** p < 0.01

Appendix I: AIC stepwise analysis with just consumption: CPI and Divisions (Monthly data)

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV1	0.14**	0.23	−0.09	0.25	−0.14	−0.01	−0.18*	0.91***	−0.35	−0.03	0.55	0.13**	0.28**
CPI_LDV2	−0.01	0.04	0.09	−0.22	0.17	−0.00	0.22**	0.08	−0.02	−0.23*	−0.12	0.03	−0.12
CPI_LDV3	0.11	−0.07	0.42*	0.56*	0.37	0.16	−0.05	−0.31	0.26	0.13	0.35	0.03	0.06
CPI_LDV4	0.04	0.47*	0.53**	0.07	0.54**	0.08	−0.03	0.06	−0.02	−0.15	0.26	0.16**	−0.03
CPI_LDV5	−0.04	0.03	0.1	−0.15	0.18	0.23	0.08	0.05	0.28	−0.07	−0.01	−0.04	−0.10
CPI_LDV6	0.07	0.42*	0.84***	−0.00	−0.46**	0.04	0.04	−0.49	0.03	−0.10	0.17	0.02	0.1
CPI_LDV7	0.02	−0.04	−0.62***	−0.10	−0.00	0.50***	0.23**	0.01	−0.11	−0.19	−0.79**	0.08	0.18
CPI_LDV8	0.06	0.52**	0.19	0.46*	0.25	0.02	−0.03	−0.62*	0.2	0.05	−0.09	0.02	0.01
CPI_LDV9	0	−0.04	0.18	−0.02	0.19	−0.21	0.1	−0.06	−0.12	0.07	−0.29	0.04	−0.05
CPI_LDV10	0.01	−0.04	0.14	0.46*	0.18	0.34*	−0.07	−0.32	−0.15	−0.01	0.76**	−0.03	−0.07

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
CPI_LDV11	0.03	0.02	−0.03	−0.11	0.24	0.11	−0.14	0.09	0.24	0.08	−0.09	0.01	0.02
CPI_LDV12	0.12*	0.14	0.18	0.02	−0.26	−0.00	0.16*	0.5	−0.22	0.14	−0.26	−0.04	0.05
Con_LDV1	0.20**	0.18*	0.27***	0.02	0.31*	0.05	0.02	0.37***	0.01	−0.06	3.44***	0.01	−0.05
Con_LDV2	−0.09	−0.03	−0.27**	−0.11	−0.28	0.02	−0.04	−0.04	0.01	−0.02	−3.19***	0.07	0.03
Con_LDV3	−0.05	−0.14	0.03	0.34***	0.38*	0.02	0.09*	−0.11	0	0.16**	0.39	−0.01	0
Con_LDV4	0.1	0.33*	0.39***	−0.06	−0.15	−0.08	−0.11**	0.17	−0.02	−0.08	−0.10	0.03	−0.09*
Con_LDV5	0.01	−0.08	−0.47***	−0.09	−0.02	0.12	0.07	0.08	−0.00	−0.09	0.02	−0.02	0.09
Con_LDV6	−0.10	−0.13	−0.09	−0.02	0.26	−0.07	−0.02	−0.05	−0.04	0	−0.05	0.04	−0.01
Con_LDV7	0.14	0.24	0.48***	0.23	−0.10	0.02	0.02	0.01	−0.02	0.08	0.42	−0.00	−0.06
Con_LDV8	−0.13	−0.03	−0.29*	−0.29*	−0.00	0.14	−0.03	−0.04	0.08	−0.02	−0.31	0.02	0.04
Con_LDV9	0.03	−0.10	−0.08	0.11	0.05	−0.08	0.06	0.01	−0.12	0	−0.00	0.02	0.04
Con_LDV10	0.21*	0.09	0.18	0.21*	0.3	−0.15	−0.03	−0.04	0.05	−0.04	1.20***	0.01	0.02
Con_LDV11	−0.27**	0.03	0.06	−0.33***	−0.00	0.21**	0.01	0.05	0.05	0.07	−1.18***	−0.02	−0.03
Con_LDV12	0.14*	−0.01	−0.13	0.15	0.14	−0.09	−0.01	−0.09	−0.05	−0.06	0.31	0.02	0.04
VAT1	−1.03***	−0.80	−0.10	−3.55***	−0.28	−3.26***	−0.99***	0.16	−2.14***	−1.04***	0.46	−0.35*	−0.65*
VAT2	0.47**	−0.04	2.57***	−0.77	0.67	0.72	0.54*	1.02	0.53	0.71*	0.54	0.40**	0.55
VAT3	0.47**	−0.04	1.49**	−0.47	0.78	1.43***	0.17	1	0.79	0.5	−0.61	1.20***	−0.93**

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
Recession	0.16**	0.46**	−0.13	−0.51*	0.08	0.50***	−0.01	0.34	0.17	0.23**	0.03	0.1	−0.03
D.August	−0.15	0.2	−2.28***	−2.12	−1.99***	1.1	−0.04	0.05	−0.56	−0.84*	−0.77	−0.48	0.18
D.December	0.27	0.81	−1.90**	−2.74	−2.40***	0.71	−0.69**	2.12*	−0.24	−1.15**	−0.71	−0.79*	0.12
D.February	0.87**	0.98*	−2.33***	−2.53	−1.39**	0.28	−0.38	0.17	−0.75	−1.07**	0	−0.14	0.48*
D.January	−0.67	0.2	0.26	−7.77***	−1.85***	0.83	0.57	−2.89*	−0.63	−1.44**	−1.46*	−0.88*	0.04
D.July	−0.25	0.46	−1.18	−3.35	−2.97***	1.04	0.31	−1.18	−1.29**	−0.67	−0.11	−0.80*	−0.07
D.June	−0.29	0.15	−2.68***	−4.28**	−0.76	−0.55	−0.47	−0.91	−0.33	−1.53***	−0.47	−0.64	−0.16
D.March	0.08	0.1	−0.53	1.51	−1.17*	1.09	0.32	−0.21	−0.26	0.21	−0.51	−0.18	−0.15
D.May	0.06	0.73	−0.79	1.83	−1.53**	0.48	0.02	−1.57	−0.86	−0.70	0.06	−0.69	0.01
D.November	−0.27	0.49	−0.83	−0.19	−1.75**	0.04	−0.05	−1.04	−0.95*	−0.09	0.78	−0.52	0.02
D.October	0.07	−0.39	−2.59***	−0.53	−2.26***	−0.50	−0.33	0.33	−0.42	−0.11	2.17***	−0.56	0.60**
D.September	−0.00	0.47	−0.41	2.08	−1.53**	0.9	0.07	−4.93***	−0.75	0.24	1	−0.77*	0.08
Trend	−0.00	−0.00	0	0.00**	−0.00	0	−0.00***	−0.00	0	0	−0.00*	−0.00***	−0.00***
LDV1		0.11	−0.26***	−0.25***	0.26***	−0.31***	−0.12	−0.14	0.02	−0.20***	−0.04	−0.24***	−0.16**
LDV2		−0.10	−0.13*	−0.16**	−0.00	−0.23***	−0.13*	−0.05	0.15**	0.1	−0.10	−0.02	−0.03
LDV3		−0.02	0.02	−0.11	−0.12	−0.05	−0.09	0.05	0.15**	0.06	0.24***	−0.08	0.06
LDV4		−0.19**	−0.11	−0.13	−0.01	−0.09	−0.10	−0.02	−0.19**	0.08	−0.08	−0.03	0.04

	CPI	01FB	02AT	03CF	04HW	05FH	06HL	07TR	08CM	09RC	10ED	11RH	12MS
LDV5		0.03	−0.07	0.18**	−0.03	−0.17**	−0.08	−0.09	−0.09	0.1	−0.02	−0.03	0.01
LDV6		−0.00	−0.09	0.19**	0.01	0.22***	−0.16**	0.11	−0.01	0.15*	−0.01	−0.21***	−0.05
LDV7		−0.02	−0.05	0.03	0.13	0.07	−0.21***	0.04	−0.00	−0.01	−0.02	−0.10	−0.04
LDV8		−0.03	−0.13*	−0.07	−0.19**	0.04	−0.13*	0.12	−0.01	−0.03	−0.04	0.01	−0.05
LDV9		−0.05	−0.03	0.02	0.01	0.04	−0.02	0.09	0.1	0.07	−0.10	−0.06	0.15*
LDV10		0.06	0.08	−0.11	−0.06	−0.16**	−0.19**	0.07	0.14**	0.02	−0.03	0.08	0
LDV11		−0.07	0.01	−0.02	−0.11	−0.07	0.02	0.12	−0.05	0.07	−0.01	−0.01	−0.05
LDV12		0.04	0.24***	0.22***	−0.01	0.31***	0.1	−0.09	0.02	0.04	0.35***	0.07	0.03
Num.Obs.	227	227	227	227	227	227	227	227	227	227	227	227	227
R2	0.745	0.378	0.732	0.933	0.446	0.932	0.621	0.747	0.33	0.479	0.791	0.61	0.298
R2 Adj.	0.69	0.193	0.652	0.914	0.28	0.911	0.508	0.672	0.129	0.324	0.729	0.494	0.088
AIC	−70.4	436.1	431.3	529.5	422.8	335.9	74.1	521.4	462.7	180.2	691.7	−110.8	144.9
BIC	73.4	621.1	616.3	714.4	607.8	520.9	259	706.3	647.6	365.1	876.6	74.2	329.8
F		2.036	9.128	46.968	2.689	45.52	5.479	9.897	1.644	3.082	12.685	5.237	1.417
RMSE	0.17	0.5	0.49	0.61	0.48	0.4	0.22	0.6	0.53	0.28	0.88	0.15	0.26

* p < 0.1, ** p < 0.05, *** p < 0.01

Appendix J1: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	01.1.1 Bread and cereals	01.1.2 Meat	01.1.3 Fish	01.1.4 Milk, cheese and eggs	01.1.5 Oils and fats	01.1.6 Fruit	01.1.7 Vegetables including potatoes and tubers	01.1.8 Sugar, jam, syrups, chocolate and confectionery
lag1	-0.27*		-0.32*		-0.33*			-0.32*
lag2		0.21*	-0.20*		-0.14	-0.17*	-0.15*	
lag3						-0.11		
lag4		-0.12				-0.11		
lag5					-0.17*	-0.13		
lag7			0.13		0.14*			
lag8	0.20*					-0.14	-0.12	
lag9				0.16*	0.15*			
lag10								-0.12
lag11	-0.11							
lag12						0.22*	0.13	0.32*
CPI_lag1	0.63*	0.57*						0.53
CPI_lag3			0.81		1.30			
CPI_lag4	0.50	0.65*						
CPI_lag5			0.80					
CPI_lag6								0.49
CPI_lag8		0.44					1.83	
CPI_lag10								0.44
Observations	324	324	324	324	324	324	324	324
R^2	0.32	0.24	0.22	0.11	0.22	0.48	0.24	0.42
Adjusted R^2	0.27	0.19	0.17	0.06	0.16	0.44	0.19	0.37
Residual Std. Error	0.70	0.76	1.29	0.83	2.15	2.26	2.42	0.78

	Dependent variable:							
F Statistic	6.74*	4.52*	4.08*	2.21*	3.90*	12.69*	4.85*	9.76*
Note:								* p<0.01;

Appendix J2: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	01.1.9 Food products (nec)	01.2.1 Coffee, tea and cocoa	01.2.2 Mineral waters, soft drinks and juices	02.1.1 Spirits	02.1.2 Wine	02.1.3 Beer	02.2 Tobacco	03.1.2 Garments
lag1	-0.60*	-0.33*	-0.26*	-0.56*	-0.53*	-0.26*		-0.20*
lag2	-0.30*		-0.13	-0.24*	-0.26*	-0.24*		-0.15*
lag3						-0.28*		-0.13
lag4								-0.13*
lag5	-0.16*							
lag6	-0.16							0.28*
lag7	-0.15*		0.15*					
lag9		0.15*			-0.10			
lag10						0.15*		
lag11	-0.11	-0.11						
lag12			0.19*	0.13*	0.16*	0.16*	0.27*	0.32*
CPI_lag1						0.76		
CPI_lag3				1.41*	0.60			0.80*
CPI_lag4		1.34*					0.58*	
CPI_lag5	0.77*							
CPI_lag6	0.60			1.45*	0.97*	1.45*		

CPI_lag7						-0.72		
CPI_lag8	0.66							0.47
CPI_lag11	0.66							
Observations	324	324	324	324	324	324	324	324
R^2	0.38	0.21	0.31	0.66	0.64	0.50	0.40	0.93
Adjusted R^2	0.33	0.16	0.27	0.64	0.61	0.46	0.36	0.93
Residual Std. Error	1.01	1.33	0.90	1.47	0.91	1.24	0.73	0.78
F Statistic	7.14*	4.14*	6.82*	28.00*	23.91*	12.31*	11.14*	167.59*
Note:								* p<0.01;

Appendix J3: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	03.1.3 Other clothing and clothing accessories	03.1.4 Cleaning, repair and hire of clothing	03.2 Footwear including repairs	04.1 Actual rentals for housing	04.3.1 Materials for maintenance and repair	04.3.2 Services for maintenance and repair	04.4.1 Water supply	04.4.3 Sewerage collection
lag1	-0.23*	-0.31*	-0.12					
lag2	-0.15*							
lag3						0.15*		
lag6	0.14		0.17*		0.17*	0.22*		
lag9					0.12			
lag11			0.17*					
lag12			0.27*	0.73*		0.14	0.40*	0.14
CPI_lag5		0.22		0.13				
CPI_lag6						-0.27*		
CPI_lag9	0.64			-0.17*				

CPI_lag10	0.58				0.39			
CPI_lag11						-0.18		
CPI_lag12				0.14				0.75
Observations	324	324	324	324	324	324	324	324
R^2	0.72	0.21	0.84	0.86	0.19	0.47	0.63	0.50
Adjusted R^2	0.70	0.17	0.83	0.86	0.14	0.43	0.61	0.47
Residual Std. Error	1.04	0.32	0.74	0.22	0.66	0.33	0.88	1.25
F Statistic	37.05*	4.64*	78.54*	96.40*	3.86*	12.60*	31.12*	16.77*
Note:								* p<0.01;

Appendix J4: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	04.5.1 Electricity	04.5.2 Gas	04.5.3 Liquid fuels	04.5.4 Solid fuels	05.1.1 Furniture and furnishings	05.1.2 Carpets and other floor coverings	05.2 Household textiles	05.3.1/2 Major appliances and small electric goods
lag1	0.23*	0.29*			-0.55*	-0.49*	-0.35*	-0.21*
lag2					-0.39*	-0.17*	-0.16*	
lag3					-0.11	-0.17*		
lag6					0.15*			
lag7								0.15*
lag8				-0.18*				
lag9					-0.11			
lag10					-0.25*			

lag11			0.15*		-0.28*			
lag12					0.23*	0.28*	0.18*	0.24*
CPI_lag2	0.86	1.40					-0.45	
CPI_lag3				0.76*				
CPI_lag4	0.91							
CPI_lag6			-4.54*			1.08*	0.66*	
CPI_lag7					1.10*			
CPI_lag9					-0.66		0.49	
Observations	324	324	324	324	324	324	324	324
R^2	0.14	0.15	0.15	0.55	0.90	0.68	0.88	0.41
Adjusted R^2	0.08	0.10	0.10	0.53	0.89	0.66	0.87	0.38
Residual Std. Error	1.47	2.02	5.80	0.99	1.08	1.32	0.80	1.11
F Statistic	2.57*	3.10*	3.08*	21.08*	105.64*	30.74*	103.43*	11.33*

Note: * p<0.01;

Appendix J5: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	06.2.2 Dental services	06.3 Hospital services	07.1.1A New cars	07.1.1B Second-hand cars	07.1.2/3 Motorcycles and bicycles	07.2.1 Spare parts and accessories	07.2.2 Fuels and lubricants	07.2.3 Maintenance and repairs
lag1			-0.18*	-0.13	0.46*	-0.13	0.34*	
lag2			-0.22*	0.11				
lag3		-0.25*		0.14*				
lag5								0.10
lag6		-0.21*		0.12				
lag7								0.13
lag8			0.11					
lag10			0.11	0.16*				
lag11							0.23*	
lag12	0.63*	0.47*					-0.13	0.12
CPI_lag1					0.46			
CPI_lag2							-1.98*	
CPI_lag5							-1.15	
CPI_lag7			0.72		-0.72*			
CPI_lag12					0.52			
Observations	228	216	324	277	324	324	324	324
R^2	0.63	0.67	0.20	0.35	0.46	0.23	0.33	0.52
Adjusted R^2	0.60	0.64	0.14	0.29	0.43	0.18	0.29	0.49
Residual Std. Error	0.39	0.47	1.15	0.40	0.80	0.43	1.86	0.30
F Statistic	20.97*	20.81*	3.56*	6.43*	13.17*	5.24*	7.14*	17.02*
Note:								* p<0.01;

Appendix J6: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	07.2.4 Other services	07.3.1 Passenger transport by railway	07.3.2/6 Passenger transport by road and other transport services	07.3.3 Passenger transport by air	07.3.4 Passenger transport by sea and inland waterway	08.1 Postal services	08.2/3 Telephone and telefax equipment and services	09.1.1 Reception and reproduction of sound and pictures
lag1		-0.27*	-0.22*	-0.59*	-0.47*	-0.12		
lag2				-0.42*	-0.33*			
lag3			-0.12	-0.37*	-0.40*			0.18*
lag4				-0.27*	-0.33*			
lag5				-0.27*	-0.27*			
lag6			-0.11	-0.28*	-0.25*			
lag7				-0.27*	-0.26*			
lag8			0.14*	-0.22*	-0.20*			
lag9				-0.34*	-0.34*		0.12	
lag10				-0.29*	-0.22*			
lag11			-0.13	-0.23*	-0.23*			0.12
lag12	0.28*	0.22*	0.21*	0.19*				
CPI_lag1			0.41					
CPI_lag2				5.97*				
CPI_lag3							0.48	
CPI_lag5				4.89				
CPI_lag9						1.07		
CPI_lag10			-0.47*					-0.80*
CPI_lag11								0.57
Observations	324	324	324	275	276	324	324	324
R^2	0.22	0.64	0.33	0.83	0.71	0.21	0.17	0.27
Adjusted R^2	0.17	0.61	0.28	0.81	0.68	0.17	0.12	0.22
Residual Std. Error	0.55	0.69	0.61	6.84	5.13	1.63	0.70	0.98
F Statistic	4.94*	29.57*	6.28*	38.76*	22.30*	4.63*	3.48*	5.52*

Note:	* p<0.01;

Appendix J7: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	09.1.2 Photographic, cinematographic and optical equipment	09.1.3 Data processing equipment	09.1.4 Recording media	09.2.1/2/3 Major durables for in/outdoor recreation and their maintenance	09.3.1 Games, toys and hobbies	09.3.2 Equipment for sport and open-air recreation	09.3.3 Gardens, plants and flowers	09.3.4/5 Pets, related products and services
lag1			-0.28*		-0.41*	-0.14	-0.23*	-0.19*
lag2		0.14	-0.16*		-0.12		-0.17*	
lag3	0.16*		-0.13		-0.14*			
lag4								-0.14*
lag5	0.16*							
lag6		0.13						
lag7					-0.18*			
lag8	0.12							
lag9		0.15*		0.14				
lag11							-0.13	
lag12		0.16*	0.31*	0.13	0.21*			0.13
CPI_lag1	-1.26							
CPI_lag2						0.87*		
CPI_lag4								0.41*
CPI_lag7			-1.18				0.74	
CPI_lag9			1.12					
CPI_lag11					0.76			
Observations	324	324	324	228	324	286	324	324

R^2	0.20	0.17	0.40	0.36	0.36	0.43	0.24	0.18
Adjusted R^2	0.14	0.11	0.36	0.30	0.32	0.40	0.19	0.13
Residual Std. Error	1.99	2.02	1.97	0.43	1.27	0.87	1.14	0.47
F Statistic	3.72*	3.10*	9.28*	6.53*	7.77*	11.38*	4.79*	3.43*

Note: * p<0.01;

Appendix J8: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	09.4.1 Recreational and sporting services	09.4.2 Cultural services	09.5.1 Books	09.5.2 Newspapers and periodicals	09.5.3/4 Misc. printed matter, stationery, drawing materials	09.6 Package holidays	10.0 Education	11.1.1 Restaurants
lag1		-0.21*	-0.29*			0.43*		
lag2			-0.13			0.24*		
lag3			-0.22*					
lag4	-0.10		-0.13					
lag8					0.15*			
lag9						0.11		
lag10				-0.13				
lag12	0.63*	0.14*	0.25*		0.18*	-0.10	0.47*	0.20*
CPI_lag2		-0.41		-0.43				0.07
CPI_lag3							0.64	
CPI_lag4								0.11*
CPI_lag6								0.08
CPI_lag9	0.32*	0.34						
CPI_lag10	-0.24		-1.54*					
CPI_lag11								-0.08
CPI_lag12	-0.30*							

Observations	324	324	324	324	324	311	324	324
R^2	0.77	0.55	0.39	0.13	0.30	0.47	0.59	0.52
Adjusted R^2	0.75	0.52	0.35	0.08	0.26	0.43	0.57	0.48
Residual Std. Error	0.36	0.60	2.00	0.78	0.61	0.29	1.15	0.13
F Statistic	47.82*	18.31*	8.78*	2.54*	7.40*	12.66*	24.66*	15.42*

Note: * p<0.01;

Appendix J9: Stepwise analysis : class level(Monthly data)

	Dependent variable:							
	11.1.2 Canteens	11.2 Accommodation services	12.1.1 Hairdressing and personal grooming establishments	12.1.2/3 Appliances and products for personal care	12.3.1 Jewellery, clocks and watches	12.3.2 Other personal effects	12.4 Social protection	12.5.2 House contents insurance
lag1		-0.21*		-0.19*		-0.25*		
lag2	-0.11					-0.17*		
lag4						-0.12		
lag6		-0.19*	0.20*		0.17*	0.13		
lag7			0.11					
lag8							0.12	
lag12	0.14		0.15*	0.17*	0.21*	0.15*	0.36*	0.16*
CPI_lag1			0.11		0.39	0.71*		
CPI_lag3							-0.12	
CPI_lag4								-1.33*
CPI_lag6		-0.56*			0.51*		-0.13	
CPI_lag7							0.12	
CPI_lag12						-0.50	-0.10	
Observations	324	281	324	324	324	324	228	324
R^2	0.32	0.34	0.48	0.21	0.56	0.72	0.61	0.10
Adjusted R^2	0.28	0.30	0.45	0.16	0.53	0.70	0.57	0.05
Residual Std. Error	0.31	0.69	0.17	0.63	0.58	0.90	0.15	1.45

F Statistic	7.83*	7.21*	13.98*	4.52*	19.46*	34.12*	14.41*	1.96
Note:								* p<0.01;

Appendix J10: Stepwise analysis : class level(Monthly data)

	Dependent variable:			
	12.5.3/5 Health insurance and other insurance	12.5.4 Transport insurance	12.6.2 Other financial services (nec)	12.7 Other services (nec)
lag3	-0.20*	0.23*		
lag4		0.12		
lag6		0.17*		
lag9			0.18*	0.17*
lag12	0.42*	0.15*	-0.11	0.21*
CPI_lag3			1.02	
CPI_lag6				-0.37
CPI_lag9		-1.18*		-0.28

Observations	228	324	324	324
R^2	0.66	0.23	0.08	0.28
Adjusted R^2	0.63	0.17	0.02	0.23
Residual Std. Error	0.76	1.54	1.74	0.51
F Statistic	22.71*	4.19*	1.43	5.87*

Note: * $p<0.01$;

Appendix K The Frequency of Price Changes by Category

item	Freq	Weight	Mo
Automatic car wash, drive through basic charge	3.7	2.17	27.02703
Contact lens, Soft pair (state type/condition)	4.1	1.63	24.39024
BOTTLE OF CHAMPAGNE	4.5	1.55	22.22222
PRINT OFF UPTO 50 DIGITAL PHOTOS	4.5	0	22.22222
Car Park Charges	5.1	1.54	19.60784
TEA -TAKE-AWAY	5.2	1.55	19.23077
Daily film rental, new release (specify DVD/Video)	5.2	0.6	19.23077
Prescription lenses (point focal, 70mm diameter)	5.5	1.63	18.18182
Develop & print (135/24 colour film)	5.5	1.2	18.18182
COFFEE -TAKE-AWAY	5.6	1.55	17.85714
Daily disposable contact lenses	5.7	1.54	17.54386
POTATO CRISPS-INDIVIDUAL PACK	5.8	1.55	17.24138
CHINESE TAKEAWAY	5.9	3.1	16.94915
KEBAB- TAKEAWAY	5.9	3.1	16.94915
FLORIST - DELIVERY COST	5.9	2.15	16.94915
TV repair (state hour/min/complete)	6	0.75	16.66667
STAFF RESTAURANT FIZZY DRINK	6.1	3.52	16.39344
Eyesight Test charge	6.1	0.6	16.39344
BURGER IN BUN- TAKEAWAY	6.2	3.1	16.12903
CHILD MINDER - HOURLY RATE	6.2	1.81	16.12903
Restaurant - Main Course 1st	6.3	4.65	15.87302
RESTAURANT CUP OF COFFEE	6.3	3.1	15.87302
PASTY/SAVOURY PIE - TAKEAWAY	6.4	3.1	15.625
Woodscrew's - Steel/zinc plated specify length	6.4	1.32	15.625
INDIAN TAKEAWAY	6.5	3.1	15.38462
Washing machine repair (state hour/min/complete)	6.5	0.75	15.38462
Non-NHS Medicine (Physiotherapy per session)	6.6	1.2	15.15152
Window cleaning, 3 bed semi (outside only)	6.7	0.09	14.92537
Minicab fare for journey of 2 miles	6.7	3.61	14.92537
Basic Manicure	6.8	1.57	14.70588
RESTAURANT - SWEET COURSE	7	4.65	14.28571
PIZZA TAKEAWAY OR DELIVERED	7	3.1	14.28571
WATCH REPAIR-CLEAN AND SERVICE	7	1.05	14.28571
Night-club entry, no flyer, (Saturday 11.30pm)	7.1	1.2	14.08451
BASIC WILL FOR A SINGLE PERSON	7.2	2.35	13.88889
PC repair (state hour/min/complete)	7.3	0.75	13.69863
Man's Haircut	7.3	2.89	13.69863
Full leg wax (both legs)	7.4	1.93	13.51351
Spectacle frames (basic without lenses)	7.5	1.63	13.33333
Self Drive Van Hire transit type (24 hr charge inc. VAT)	7.5	1.99	13.33333
Chewing Gum/Bubble Gum, single pack	7.6	0.5	13.15789

Plumber (Daytime, hourly rate inc. call out & VAT)	7.7	2.29	12.98701
BOTTLE OF WINE 70-75CL	7.8	4.65	12.82051
Driving school, 1 hour lesson (after 5pm)	7.8	0.27	12.82051
Non NHS Chiropractor	7.8	1.2	12.82051
TAKEAWAY COFFEE LATTE	7.9	1.55	12.65823
Gas service charge (state hourly or complete)	8	0.96	12.5
Basic private dental examination (no X-rays)	8	1.32	12.5
Car repairs - labour per hour - local garage	8	7.23	12.5
Decorator-daily rate (specify number of hours)	8.1	2.17	12.34568
Dry Cleaning (Man's Suit)	8.1	1.51	12.34568
Home office desk	8.3	1.51	12.04819
Knitting wool, double knit, (acrylic/wool or mix), 100g	8.3	1.67	12.04819
Dog kennel fees, boarding (daily charge)	8.4	1.58	11.90476
Hourly rate for Domestic Help (paid by customer)	8.4	3.88	11.90476
Catering 50 people, set menu, cost per head	8.4	1.55	11.90476
Liquid Foundation specify size	8.4	1.45	11.90476
Women's Hairdressing (Cut & Blow Dry)	8.4	3.73	11.90476
Electrician (Daytime, hourly rate inc. call out & VAT)	8.5	2.17	11.76471
Annual booster injection (medium size dog)	8.5	1.37	11.76471
Women's highlighting	8.5	1.93	11.76471
Windscreen wiper blade (state length/type)	8.5	1.17	11.76471
Oil filter (specify car)	8.6	1.26	11.62791
RESTAURANT MAIN COURSE 1	8.7	4.65	11.49425
Vet fees, spay kitten 6 months (not Pedigree)	8.7	1.48	11.49425
Ball Point (individual), disposable, (eg Bic)	8.8	0.98	11.36364
Private health club/gym annual member (exc. Joining fee)	8.9	1.08	11.23596
STAFF RESTAURANT PUDDING	9	3.52	11.11111
Home Removal - 1 Van	9	3.16	11.11111
MOT test fees, VAT EXEMPT	9	1.45	11.11111
Pub, cold filled roll/sandwich, state filling	9.1	4.65	10.98901
Bookcase, flatpack, self assembly (no drawers)	9.1	1.13	10.98901
Spectacle frames, designer (without lenses)	9.2	1.54	10.86957
Car repairs - labour per hour - main dealer	9.2	7.23	10.86957
Power Point (double socket)	9.3	2.35	10.75269
Greetings card (state code)	9.3	1.35	10.75269
HOURLY RATE FOR SOLICITOR	9.4	2.15	10.6383
Car Service - Local Garage	9.4	4.34	10.6383
Paint Brush (2inch/5cm width)	9.5	0.83	10.52632
Hire domestic steam wallpaper stripper	9.5	0.36	10.52632
Leisure centre, charge for exercise class upto 1hr	9.5	0.6	10.52632
BOTTLED MINERAL WATER	9.6	3.1	10.41667
STAFF RESTAURNT HOT SNACK ITEM	9.6	3.72	10.41667
Bottle of mixer, 113-180ml size (eg tonic water)	9.7	1.55	10.30928

Weekly Nanny Fees	9.7	2.35	10.30928
Pub, Hot meal (please specify)	9.8	6.2	10.20408
LEMONADE/COLA DRAUGHT	9.8	3.1	10.20408
PRIMARY SCHOOL- FIXED CHARGE	9.8	0.39	10.20408
FRUIT JUICE	9.9	3.1	10.10101
NURSERY FEES: CHILD 0-4	9.9	1.81	10.10101
Brake pads, two pairs (state car make/model)	9.9	1.26	10.10101
RESTAURANT MAIN COURSE 2	10	4.65	10
IN STORE CAFETERIA MEAL	10.1	4.65	9.90099
TAKEAWAY SOFT DRINK	10.1	1.55	9.90099
Door Handle, (pack for one door)	10.1	2.35	9.90099
Gardener Hourly Rate	10.1	2.71	9.90099
SECONDARY SCHOOL- CAFETERIA	10.3	0.59	9.708738
Liqueur per nip (see help screen) specify ml	10.3	1.55	9.708738
Private Rented Furnished property (see note)	10.3	15.56	9.708738
Sheet Of Wrapping Paper	10.3	1.43	9.708738
Private Rented Unfurnished property (see note)	10.4	14.86	9.615385
Swim Pool Admission, standard adult (off-peak)	10.4	0.6	9.615385
Ten-pin bowling, eve. session (per game)	10.4	0.6	9.615385
STAFF RESTAURANT SANDWICH	10.6	3.91	9.433962
WHISKY (PER NIP) SPECIFY ML	10.6	3.1	9.433962
VODKA (PER NIP) SPECIFY ML	10.6	4.65	9.433962
Hardboard, specify sheet size, (e.g. 2440x1220mm/8x4ft)	10.6	1.32	9.433962
Car battery	10.8	1.26	9.259259
Self Drive Car Hire (24 hour basic charge inc. VAT)	10.8	2.08	9.259259
FISH & CHIPS TAKEAWAY	10.9	3.1	9.174312
WINE (175ML GLASS)	10.9	4.65	9.174312
Light Bulb, each (specify wattage)	10.9	0.9	9.174312
Lipstick	10.9	1.45	9.174312
Coarse Fishing Rod	10.9	0.96	9.174312
NEWSPAPER AD NON TRADE 20 WORD	11	2.35	9.090909
BOTTLE OF LAGER IN NIGHTCLUB	11.1	4.65	9.009009
Chicken Kiew 2 Pack 250g (chilled not frozen)	11.2	0.63	8.928571
SPIRIT BASED DRINK 275ML	11.3	1.55	8.849558
Squash court, evening session (specify length)	11.3	0.6	8.849558
Pair of basin taps (not mixer)	11.4	4.14	8.77193
Sink, single drainer (specify material)	11.4	3.39	8.77193
Lady's Umbrella (Folding)	11.5	0.6	8.695652
Original Polo Mints	11.6	0.5	8.62069
Mascara	11.6	1.81	8.62069
Child's swing	11.6	0.69	8.62069
Canned Sweetcorn, (198g-340g)	11.7	0.84	8.547009
Carpenter Hourly Rate	11.7	2.17	8.547009
Screwdriver (specify size and type)	11.7	0.45	8.547009
Drycell Battery, pack of 4, state size (eg AA)	11.8	0.9	8.474576

IN CARE HOME ASSISTANT RATE	11.8	2.89	8.474576
Potting compost (specify size)	11.8	0.98	8.474576
Residential Home	11.9	5.78	8.403361
Potato Crisps, 25g/40g	12	1.26	8.333333
MONTHLY SELF STORAGE FEE	12	2.15	8.333333
Annual leisure centre membership (not private)	12	1.08	8.333333
Envelopes (specify size and number in packet)	12.1	0.98	8.264463
Softwood, 1.6m-2.4m length	12.2	1.49	8.196721
Women's Tights	12.3	1.57	8.130081
Bar of Toilet Soap (100-125G)	12.3	0.72	8.130081
CIDER-1/2PT OR 275-340ML BOT	12.4	3.1	8.064516
35mm colour film (24 exposures)	12.4	0.45	8.064516
Clear sticky tape, eg cellotape (specify size)	12.5	0.98	8
Nursing Home	12.5	5.55	8
Oil Per Litre (multigrade)	12.5	0.53	8
CINEMA POPCORN	12.7	1.55	7.874016
Multi-vitamins capsules/tablets (eg Sanatogen)	12.7	1.51	7.874016
Child's Wellington Boots	12.8	0.27	7.8125
Peanuts, 100g (roasted or salted) specify	12.9	1.08	7.751938
DRAUGHT STOUT PER PINT	12.9	3.1	7.751938
Wallpaper Paste, specify coverage (5-20 rolls)	12.9	0.83	7.751938
Metal Model Toy, Diecast car (eg Matchbox)	12.9	2.42	7.751938
Mars Bar (approx 62.5g)	13	2.48	7.692308
BOTTLED PREMIUM LAGER 4.3-7.5%	13	3.1	7.692308
Ceramic tile plain 15x15 - 25x20cm, (box of 6-44)	13	0.83	7.692308
Ready mixed Filler, interior use (430gm-1.8kg)	13.1	0.83	7.633588
STAFF RESTAURANT MAIN COURSE	13.2	3.91	7.575758
PLAYGROUP FEES - PER SESSION	13.2	2.53	7.575758
Solid gold ring, no stones, 9ct	13.2	1.48	7.575758
Beginner's Acoustic Guitar	13.3	0.54	7.518797
Golf Balls	13.3	0.96	7.518797
SANDWICH-TAKE-AWAY	13.4	4.65	7.462687
Men's Socks	13.4	0.78	7.462687
Indigestion Tablets, pack of 24, (eg Rennies)	13.4	1.51	7.462687
Chocolate covered Ice Cream bar (e.g. Magnum)	13.5	0.83	7.407407
PREMIUM LAGER - PINT 4.3-7.5%	13.5	9.3	7.407407
18 ct Gold Gemstone Ring	13.5	2.63	7.407407
Sterling silver earrings, plain (per pair)	13.6	0.84	7.352941
Condoms (pack of 3 to 5)	13.6	0.54	7.352941
Garden Spade	13.6	0.72	7.352941
DRAUGHT BITTER (PER PINT)	13.7	15.5	7.29927
Brake fitting in fast fit centre for Ford Focus	13.8	4.34	7.246377
Small Caged Mammal	13.9	0.53	7.194245
Rowntrees Fruit Pastilles- tube	14	1.49	7.142857
Dustbin Liners (pack of 10)	14	0.68	7.142857
LAGER - PINT 3.4-4.2%	14.1	9.3	7.092199

Dog food, can (390-400gm)	14.2	1.16	7.042254
Men's Tie	14.3	1.22	6.993007
Disposable camera with flash (24-27 exp)	14.3	0.6	6.993007
Gloss paint, white (750ml - 2.5 litres)	14.4	1.32	6.944444
Animal cage (e.g for gerbil/mouse)	14.4	0.63	6.944444
Tomato Ketchup (340-345g) bottle	14.5	0.36	6.896552
Steering lock device	14.5	1.54	6.896552
Seeds, packet of vegetable (specify variety)	14.5	0.68	6.896552
Scissors (Kitchen)	14.6	1.26	6.849315
Doughnut, each	14.7	0.68	6.802721
Gent's Watch - Analogue Face	14.7	2.11	6.802721
Bag of sweets, boiled/jellies, not choc (200-250g)	14.8	1.82	6.756757
Car Service - Main Dealer	14.9	4.34	6.711409
Varnish, clear gloss, 750ml - 1 litre	15	0.83	6.666667
Wallpaper Per Roll	15	1.32	6.666667
Book, illustrated for under 5's	15	1.28	6.666667
Dry Spaghetti or pasta 500g	15.1	0.23	6.622517
Car tyre, Tubeless Radial (state size)	15.2	1.26	6.578947
Individual meat pie (eg steak and kidney)	15.3	1.9	6.535948
Smarties, small tube	15.3	0.83	6.535948
Cadburys dairy milk (49g bar)	15.3	3.64	6.535948
Paint, Emulsion, white (2.5 to 5 litres)	15.3	1.49	6.535948
Cat food, can (390-400gm)	15.3	1.9	6.535948
9ct Gold Chain (16-18"/ 40-46cm)	15.3	1.48	6.535948
Pain Killer Tablets (pack of 16 or 24)	15.3	1.51	6.535948
Plain Biscuits (e.g. Digestive Biscuits) 200-300g	15.4	1.81	6.493506
Shop Milk, pasteurised, 4pt or 2ltr carton (specify)	15.4	2.54	6.493506
Shop milk, semi-skimmed, per 2 pints/1.136 litres	15.4	4.31	6.493506
Baby Food Can/Jar (state main meal/dessert, size)	15.4	0.12	6.493506
Gas fire (state make & model)	15.4	1.69	6.493506
Men's Pants/Boxer shorts	15.4	0.78	6.493506
Tampons, pack of 10-16 (specify pack size)	15.4	1.81	6.493506
Aluminium cooking Foil, 300mm wide, state length	15.5	0.45	6.451613
Toothpaste (specify size)	15.6	2.53	6.410256
Women's Pants	15.7	1.57	6.369427
Canned Fruit, 400-450g, (specify type)	15.9	0.84	6.289308
Fabric roller blind	15.9	2.29	6.289308
Basmati rice (500g)	16	0.68	6.25
Cheese Edam, per kg	16	0.59	6.25
Perfume/eau de toilette (men or women)	16	1.81	6.25
CD Single (Top 40)	16	0.3	6.25
FUNERAL-CREMATION	16.3	2.54	6.134969
Girl's Knickers (one pair)	16.3	0.78	6.134969
Book, Reference, specify title/type (eg Atlas/Dictionary)	16.4	0.23	6.097561
Decorative plant pot not plastic (10-20" diameter)	16.4	0.3	6.097561

Child's Socks	16.5	0.78	6.060606
Cooking Oil - Vegetable 1 Litre	16.6	0.78	6.024096
Aluminium step ladder (specify number of steps)	16.6	0.45	6.024096
Pack of Plasters (20-24 assorted)	16.6	0.54	6.024096
Sleeping Bag	16.6	0.96	6.024096
Crunchie	16.7	0.66	5.988024
Pork Pie, individual, (not buffet)	16.8	1.58	5.952381
Football, stitched, size 5 (specify material)	17	0.96	5.882353
Kitkat (4 Finger Bar)	17.1	0.9	5.847953
Jar of jam, 340-454g, specify flavour	17.1	0.5	5.847953
Squash/tennis racquet	17.2	0.96	5.813953
Cooked ham, loose, spec type (per 100g)	17.3	1.9	5.780347
Sugar - Granulated, white, per kg	17.3	0.33	5.780347
Black Inkjet Cartridge (single pack)	17.3	0.9	5.780347
Adults Bicycle	17.4	1.4	5.747126
Canned Tomatoes, approx. 390-400g	17.5	0.42	5.714286
Men's Shoe, Leather uppers (1)	17.5	0.54	5.714286
Baked Beans, (415-420g tin)	17.6	0.84	5.681818
HAIR DRYER	17.6	1.45	5.681818
Brassiere	17.6	1.57	5.681818
Floor rug, state size and material	17.7	1.79	5.649718
Men's Shoe	17.7	0.68	5.649718
Camera 35mm, Compact (not disposable)	17.7	0.6	5.649718
Rosebush Floribunda/Hybrid Tea not full/half stnd	17.8	1.2	5.617978
Canned Meat Stewed Steak approx. 400-425g	18	0.95	5.555556
Apple Juice, 1 litre carton	18	0.95	5.555556
Vending Machine Cigarettes	18	1.96	5.555556
Plain Glass Tumbler	18	0.84	5.555556
Babygro or sleepsuit (each)	18	0.78	5.555556
Child's trike for under 5's	18	2.42	5.555556
Frozen chicken breasts 500g-1.5kg	18.1	0.32	5.524862
Household Cleaner Cream/Liquid (450-500ml)	18.1	1.58	5.524862
Cream Crackers, packed, 200g	18.2	0.45	5.494505
Cold/flu drink powder packet of 10 sachets	18.2	1.51	5.494505
Blank Video Cassette (VHS/E180)	18.2	0.15	5.494505
Mineral water, still, 2 litre bottle	18.3	1.08	5.464481
Women's swimwear	18.3	0.78	5.464481
Stainless steel cutlery set specify no of settings	18.4	0.53	5.434783
Washing Up Liquid (400-600ml)	18.4	0.68	5.434783
AFTER SCHOOL CLUB CHARGES	18.4	1.63	5.434783
Outdoor adventure boot (eg Timberland)	18.4	0.95	5.434783
Childs Bicycle	18.4	1.35	5.434783
Energy drink, 250-500ml (eg Red Bull, Lucozade)	18.5	1.08	5.405405
Sausages-pork-per kg	18.7	2.53	5.347594
Butter, Home produced, 250g	18.7	0.24	5.347594
Vegetable Pickle, 280-310g (e.g. Branston)	18.7	0.21	5.347594

Large Loaf, White unsliced, 800g	18.8	0.68	5.319149
Flour, self raising 1.5kg	18.8	0.23	5.319149
Boy's Shoes	19	0.54	5.263158
Exhaust fitting in fast fit centre for Ford Focus	19	4.34	5.263158
6 Bread Rolls White/Brown	19.2	0.9	5.208333
Fizzy Canned Drink 330ml	19.2	1.63	5.208333
MENS JEANS	19.2	2.35	5.208333
Yoghurt/fromage frais (small individual)	19.3	1.76	5.181347
Fresh single cream 284ml	19.3	0.39	5.181347
Electric Convector Heater	19.4	1.32	5.154639
Single plastic food storage container with lid	19.6	1.26	5.102041
Fabric Conditioner (1 Litre)	19.6	0.68	5.102041
Men's Leather Boot	19.6	0.27	5.102041
Picture/Photo Frame (silver plated)	19.6	1.99	5.102041
Shampoo (250-400ml)	19.6	1.08	5.102041
Laminate flooring (eg tongue & groove) per sq.m	19.7	1.37	5.076142
Saucepan (milk - non-stick)	19.7	1.37	5.076142
Pure Orange Juice, 1 litre carton	19.9	1.49	5.025126
Home Killed beef, Braising steak per kg	20	0.63	5
Cook-in sauce jar/can, 350-520g (eg bolognese)	20	0.45	5
Child's soft toy/teddy bear	20	1.38	5
Mens training shoe-footwear	20.1	1.08	4.975124
Red Wine - European	20.2	3.39	4.950495
Washable Carpet, (e.g. Kitchen/Bathroom) per sq. metre	20.2	1.79	4.950495
Fruit drink carton with straw, 3 pack (200-290ml)	20.3	0.81	4.926108
Potted shrub	20.3	1.2	4.926108
Power Drill, Hammer Action	20.4	0.36	4.901961
Margarine/Low Fat Spread, 500g	20.5	1.45	4.878049
Girl's Shoes (School)	20.5	0.54	4.878049
Womens' Shoes - Flat	20.5	1.63	4.878049
Cereal snack eg. Wotsits, Skips, single packet	20.7	1.35	4.830918
Cider, (1-2 litre bottle)	20.7	0.68	4.830918
Earrings, fashion, not solid gold or silver (state type)	20.7	0.95	4.830918
Chilled pot dessert (non yoghurt) 50-200g	20.8	1.37	4.807692
MEN'S FORMAL SHIRT-LONG SLEEVE	20.8	2.35	4.807692
Boxed board game, not travel type (specify)	20.8	2.42	4.807692
Spirit based drink 275ml (see help screen)	20.9	0.68	4.784689
Table lamp, with shade	20.9	1.13	4.784689
Trousers, suitable for school (5-15 years)	20.9	1.57	4.784689
Child's trainers-footwear	20.9	0.54	4.784689
Plastic Doll, child's (eg Barbie/Action Man)	20.9	2.42	4.784689
Fizzy Bottled Drink 500ml	21	1.35	4.761905
Canned Soup (390-425g)	21	0.27	4.761905
Butter, Imported, 250g	21.1	0.54	4.739336

MEN'S FORMAL RDY-MADE TROUSERS	21.1	0.78	4.739336
Construction toy, specify kit no. (eg Lego)	21.1	4.15	4.739336
Tissues (large size box)	21.2	2.53	4.716981
Cooked meat, turkey sliced (100-113g)	21.3	0.95	4.694836
Lemonade, 2 litre bottle	21.3	0.41	4.694836
Flower vase	21.3	2.42	4.694836
Pitta bread (state type, number in pack and weight)	21.5	0.9	4.651163
Chilled Ready-meal, serve one, (specify weight)	21.5	1.05	4.651163
Mayonnaise (400g-500g)	21.5	0.3	4.651163
Hair gel (150-200ml)	21.6	1.08	4.62963
Smokeless Fuel, boiler/heater 50kg (specify brand)	21.7	0.27	4.608295
Deodorant, specify eg spray/roll-on (50-150ml)	21.7	1.45	4.608295
Breakfast cereal 1 sweetened/chocolate coated	21.8	2.26	4.587156
Frozen Beefburgers, Pack of 4, specify weight	21.9	0.63	4.56621
Frozen Garden Peas (900-910g bag)	21.9	1.05	4.56621
White Wine - European	21.9	2.57	4.56621
Frozen vegetarian ready meal	22	0.21	4.545455
Coal - Household best quality (Group A) 50kg	22	1.23	4.545455
Dishwasher Tablets	22	0.68	4.545455
Complete dry dog food (2-2.5kg)	22	1.9	4.545455
MEN'S TRACKSUIT/JOGGIN BOTTOMS	22	0.78	4.545455
Wall hanging mirror	22	1.51	4.545455
20 Berkeley mentholated cigarettes	22.1	1.57	4.524887
Moisturising (100-150ml)	22.2	1.45	4.504505
Concentrated fruit drink eg orange (1 litre)	22.3	1.35	4.484305
Wine box - 3 litres min abv 11%	22.3	0.81	4.484305
Glass Ovenware Casserole dish	22.3	0.84	4.484305
Disposable Nappies (specify type/pack size)	22.3	3.61	4.484305
Hard Regional Cheese	22.4	0.59	4.464286
Men's training shoe-sportswear	22.4	1.35	4.464286
Womens' Shoes High - Sensible	22.4	0.81	4.464286
Box/carton of chocolates, 450-500gm	22.5	1.99	4.444444
Shower gel (150-250ml)	22.5	0.72	4.444444
Potato Crisps, Multi-pack	22.6	1.69	4.424779
Coffee, Instant (100g jar)	22.7	2.26	4.405286
Recordable CD	22.7	0.6	4.405286
Cheese spread, tub, 200g	22.8	0.98	4.385965
Frying Pan 20-24cm	22.9	1.16	4.366812
Car CD/radio autochanger (exclude fitting cost)	23.1	0.18	4.329004
Canned Fish, Tuna, specify oil/brine/water (180-200g)	23.2	0.72	4.310345
Tea bags 1, packet of 80 (250g)	23.2	1.4	4.310345
Washing powder, automatic, 1 to 2kg (specify size)	23.2	0.68	4.310345
Frozen ready-cooked meal, to serve one	23.3	0.45	4.291845
Hand Rolling Tobacco 25g	23.3	1.57	4.291845

Women's Jeans - Own Brand	23.3	1.57	4.291845
Cheese Cheddar, Imported, per kg	23.6	0.78	4.237288
Whole sponge cake, not frozen, eg Victoria sponge (specify)	23.7	1.13	4.219409
Women's permanent hair colourant (60-120ml)	23.7	1.08	4.219409
Cut flowers, carnations (price per stem)	23.7	1.28	4.219409
Cooked Ham Prepacked Sliced (100-125g)	23.9	3.48	4.1841
Eggs, Large, per dozen or 2 x 6	23.9	0.78	4.1841
Womens shorts	24	0.78	4.166667
Bath sheet	24.1	2.29	4.149378
Women's Training Shoe	24.1	1.49	4.149378
Frozen Prawns	24.2	0.54	4.132231
Frozen Veg Burger/grills, pack of 4, (200-400g)	24.2	0.63	4.132231
Electric Shower Unit	24.2	1.32	4.132231
Coffee, ground, filter fine (227-250g)	24.3	0.41	4.115226
Preschool Activity Toy	24.3	3.81	4.115226
ADULT OFFICIAL FOOTBALL SHIRT	24.4	0.78	4.098361
MEN'S BRANDED SPORT SWEATSHIRT	24.4	0.78	4.098361
Fresh Veg-mushrooms-per kg	24.5	1.05	4.081633
Bacon, Back, per kg	24.7	3.79	4.048583
Pre-packed salad	24.7	0.21	4.048583
Girl's skirt, suitable for school (5-15 years)	24.8	0.78	4.032258
Frozen Fish Fingers	25	1.08	4
Carpet, Axenminster or traditional Wilton (eg per sq. m)	25	1.79	4
Crockery set (specify contents/no place settings)	25.1	0.84	3.984064
Home Killed Beef, Best Mince, per kg	25.2	0.95	3.968254
Mattress, 3ft/90cm (interior sprung)	25.2	1.51	3.968254
House plant (eg African Violet)	25.2	0.6	3.968254
5 cigars, specify brand (eg Hamlet, Café Crème)	25.3	2.35	3.952569
Bleach (750ml bottle)	25.3	1.58	3.952569
Cordless phone (specify digital/analogue)	25.4	1.81	3.937008
Razor Cartridge Blades	25.4	2.53	3.937008
Portable CD radio cassette	25.4	0.54	3.937008
Kitchen Base Unit, self assembly, width 1000mm	25.7	3.39	3.891051
Frozen Chicken Nuggets (250-500g)	25.9	0.63	3.861004
Frozen Chips (908g approx.)	25.9	1.26	3.861004
DRIED POTTED SNACK 50-120G	25.9	0.68	3.861004
Womens' Shoes - High - Stiletto	25.9	0.95	3.861004
Push Chair	26	0.48	3.846154
20 Lambert & Butler kingsize	26.1	8.22	3.831418
Fitted bed sheet, specify size	26.2	1.69	3.816794
Bacon, Gammon, per kg	26.3	1.26	3.802281
Cheese Cheddar, Home produced, per kg	26.3	1.76	3.802281
Individual Fruit Pies, 6 Pack	26.4	1.13	3.787879
Eggs, Medium, per dozen or 2 x 6	26.4	0.78	3.787879

Apples, cooking (per kg)	26.4	0.48	3.787879
Breakfast Cereal 1 unsweetened	26.5	3.61	3.773585
Fortified wine eg Sherry/Port (70-75cl)	26.5	0.41	3.773585
Lady's leather handbag/ shoulder bag	26.5	1.38	3.773585
HIFI - 2006	26.5	1.08	3.773585
Carpet, Tufted, per square metre	26.6	1.79	3.759398
Women's Jeans - Branded	26.6	1.57	3.759398
Fresh boneless chicken breast per kg	26.7	1.9	3.745318
MEN'S CASUAL TROUSERS	26.7	2.35	3.745318
Womens short sleeve sports top	26.7	0.78	3.745318
Cola flavoured drink, 2 litre bottle	26.8	2.17	3.731343
Childs trainers-sportswear	26.8	0.54	3.731343
Duvet cover, specify size and if pillow cases incl.	26.9	1.69	3.717472
Cheese Brie, per kg	27	0.39	3.703704
Carpet, Tufted - 2 (per sq.metre)	27	2	3.703704
Men's Football Boots	27	0.9	3.703704
20 Superkings	27.2	5.48	3.676471
Brandy (68-70cl bottle)	27.3	0.68	3.663004
POTATOES- BAKING PR KG	27.4	0.21	3.649635
Lager 4 Cans - Premium	27.4	1.2	3.649635
Lager 4 Bottles - Premium	27.4	1.69	3.649635
20 Benson & Hedges King Size	27.4	4.31	3.649635
Women's nightdress/pyjamas (specify)	27.4	1.57	3.649635
Lady's Scarf (State material and type)	27.4	1.63	3.649635
Premium Potato Crisps/Chips	27.5	0.84	3.636364
Bananas, (per kg)	27.5	2.17	3.636364
Frozen imp lamb loin chops with bone (per kg)	27.6	0.32	3.623188
Gas cookers (specify make & model)	27.6	0.48	3.623188
Curtains, Ready Made, approx. 66x72inch/168x183cm	27.8	2.41	3.597122
Vodka, (70cl bottle)	28	2.56	3.571429
MENS BRANDED T-SHIRT	28	0.78	3.571429
MENS SUIT-READY MADE	28.1	2.35	3.558719
Women's Sandals (1)	28.1	0.68	3.558719
WOMEN'S TROUSERS-FORMAL	28.2	2.35	3.546099
Ice cream specify flavour (500ml - 1 litre)	28.5	0.99	3.508772
Boy's branded sports top (5-15 years)	28.5	1.57	3.508772
20 Silk Cut, Ultra Low Tar	28.6	2.74	3.496503
MEN'S CASUAL S/SLEEVE SHIRT	28.6	0.78	3.496503
Mower electric (flymo, cylinder)	28.6	0.54	3.496503
Pack of 5-6 individually wrapped cakes	28.7	0.9	3.484321
Television, Colour (14inch/34cm Portable)	28.7	1.08	3.484321
Boy's jeans (5-15 years)	28.8	1.57	3.472222
Duvet, double, polyester filled TOG 10-13.5	28.9	1.69	3.460208
TOILET ROLLS	28.9	3.61	3.460208
Tea bags 2, packet of 240 (approx 750g)	29	0.45	3.448276

Home Killed Pork, Loin Chops with bone, per kg	29.1	0.95	3.436426
Yoghurt/fromage frais, 4pk (50-125g each)	29.1	1.37	3.436426
Fresh Veg-onions-per kg	29.6	1.26	3.378378
20 King size filter, other Brand (eg Marlboro Lights)	29.6	5.09	3.378378
Electric Kettle (jug-type) 3 pint/ 1.5-1.7 litre	29.6	0.6	3.378378
FROZEN PIZZA-MED SIZE-300-450G	29.7	1.58	3.367003
Kitchen Roll	29.7	0.53	3.367003
Hotel 1 Night Price	30.1	9.48	3.322259
Sunglasses, non-designer, UV lenses	30.2	0.18	3.311258
Compact Disc Album (top 40)	30.4	5.42	3.289474
Pre-Packed Veg Eg Baby Corn	30.5	0.21	3.278689
Red Wine - New World	30.5	2.3	3.278689
MEN'S JUMPER OR SWEATSHIRT	30.5	1.57	3.278689
Fresh/chilled orange juice eg: tropicana (1l)	30.7	0.81	3.257329
WOMEN'S T-SHIRT	30.7	0.78	3.257329
MEN'S CASUAL SHIRT-LONG SLEEVE	30.8	0.78	3.246753
Book, non-fiction, paperback (top 10 best seller)	30.8	1.35	3.246753
Microwave oven (state if combined)	30.9	0.12	3.236246
Child's Pyjamas	31	0.78	3.225806
Child's Baby Doll	31.1	2.42	3.215434
Electric iron	31.2	0.36	3.205128
Fresh Veg-cabbage-whole-per kg	31.3	0.63	3.194888
Electric Cooker, 4 rings, grill and oven	31.3	1.2	3.194888
Kiwi Fruit, (each)	31.6	0.6	3.164557
Lager Stubbies 4.3-7.5(ABV) [24 L	31.6	0.78	3.164557
Sunscreen cream/lotion (specify size/SPF)	31.6	2.17	3.164557
Fresh fish -salmon fillets (per kg)	31.7	1.26	3.154574
Whisky (70cl bottle)	31.7	3.61	3.154574
MEN'S JUMPER-KNITTED	31.7	1.57	3.154574
Women's casual trousers 2	31.7	1.57	3.154574
Home Killed Pork, boneless shoulder, per kg	31.8	0.95	3.144654
Single bed (width approx. 3ft/90cm)	31.8	2.26	3.144654
Large Wholemeal Sliced Loaf	31.9	0.9	3.134796
Chest of Drawers	31.9	2.26	3.134796
Coffee Table	32	1.88	3.125
White Wine - New World	32.1	2.03	3.115265
White Sliced Loaf	32.2	1.58	3.10559
Home Killed Beef, Rump Steak/Popes eye steak, per kg	32.5	1.26	3.076923
WOMEN'S SKIRT: WORK/FORMAL	32.6	2.35	3.067485
Draught flow bitter, 4 cans (440-500ml)	32.8	1.08	3.04878
Double Wardrobe	32.8	2.26	3.04878
Book, Fiction, paperback, top 10 best seller)	33	2.63	3.030303
Childs Trousers eg Jeans	33.1	0.78	3.021148
Girl's trousers not denim (5-15 years)	33.1	0.78	3.021148
Fresh/Chilled Chicken, per kg, state size (eg small)	33.5	0.63	2.985075

MEN'S CASUAL JACKET/FLEECE	33.6	2.35	2.97619
WOMEN'S TROUSERS-CASUAL	33.6	1.57	2.97619
VHS Video Recorder	33.8	0.72	2.95858
Double Bed (width approx. 4ft 6inch/135cm)	33.9	2.26	2.949853
Luggage Trolley Case	33.9	1.38	2.949853
Sofa Bed	34.5	1.88	2.898551
Fresh white fish fillets, per kg (eg cod)	34.7	2.41	2.881844
Apples-dessert-(per kg)	35	1.2	2.857143
WOMEN'S FORMAL JACKET	35	1.57	2.857143
Home Killed, Beef Topside, 1st Quality, no bone, per kg	35.1	0.95	2.849003
Bottle of champagne 70-75cl	35.2	1.35	2.840909
Cola flav/other fizzy drink 330ml, pack of 6/8	35.3	0.41	2.832861
Armchair (upholstered)	35.3	2.26	2.832861
Fresh Turkey Steaks	35.4	0.63	2.824859
Dining room table & 4-6 chairs (specify no. chairs)	35.5	1.13	2.816901
WOMEN'S CARDIGAN	35.9	0.78	2.785515
ELECTRIC RAZOR	36	1.81	2.777778
POTATOES- OLD WHITE PER KG	36.2	1.48	2.762431
Women's vest/strappy top	36.4	0.78	2.747253
DVD player	36.5	1.08	2.739726
Dishwasher (12 Place Setting)- 2005	36.6	0.72	2.73224
Fresh veg, lettuce, round (each)	36.9	0.42	2.710027
WOMEN'S BLOUSE LONG/SHORT SLV	36.9	2.35	2.710027
MP3 Player	37.2	0.72	2.688172
Women's premium branded dress	37.3	0.78	2.680965
WOMEN'S JUMPER	37.4	0.78	2.673797
Home Killed Lamb, Loin Chops with bone, per kg	37.8	0.63	2.645503
Vaccum cleaner - 2006	38	0.84	2.631579
Girls's summer jacket (5-15 years)	38.3	0.78	2.610966
Women's Ankle Boot	38.4	0.68	2.604167
Oranges, class 1, (each)	38.5	0.84	2.597403
Fridge/freezer - 2006	38.5	1.32	2.597403
Women's showerproof Jacket	38.6	0.78	2.590674
Frozen imported lamb, leg (per kg)	38.7	0.63	2.583979
Grapefruit, (each)	38.7	1.2	2.583979
Lager - Pack of 12 Cans	39	1.26	2.564103
WOMEN'S CASUAL OUTER JACKET	39.4	1.57	2.538071
MEN'S 3/4 LENGTH CASUAL COAT	39.7	1.57	2.518892
WOMEN'S SKIRT: CASUAL	40.1	2.35	2.493766
WOMEN'S CAS OUTER JKT-FLEECE	40.3	1.57	2.48139
DVD RECORDER	40.3	0	2.48139
MEN'S SHORTS	40.4	0.78	2.475248
Fresh Veg-carrots-per kg	40.6	0.63	2.463054
Bag of organic dessert apples (state number)	40.7	0.6	2.457002
Home Killed Lamb, Shoulder with bone, per kg	40.8	0.63	2.45098

Widescreen TV - 2006	40.9	1.9	2.444988
3 Piece Non-Leather Suite	41	2.26	2.439024
Girl's winter jacket (5-15 years)	41.1	0.78	2.43309
Leather Settee	41.2	4.89	2.427184
Girl's Fashion Top (12-15Y)	41.4	0.78	2.415459
WOMEN'S LONG SLV TOP-NT BLOUSE	41.8	0.78	2.392344
Cut Flowers Lillies	41.9	1.28	2.386635
Pre-Recorded Video	42.7	0.6	2.34192
Potatoes-new-loose-per kg	42.9	0.63	2.331002
Women's 3/4 length casual coat	43.3	0.78	2.309469
Fresh Veg-organic carrots,kg	43.4	0.21	2.304147
Gas BBQ	43.5	0.3	2.298851
Washing Machine - 2006	44.1	2.05	2.267574
Avocado pear, (each)	44.7	0.96	2.237136
20 Richmond King Size	44.7	5.87	2.237136
Wooden Patio Set	45.2	0.75	2.212389
Womens dress (casual/formal)	45.6	3.13	2.192982
Child's jumper (18 months - 4 years)	46.6	0.78	2.145923
Pears, dessert (per kg)	47.1	0.6	2.123142
Book, non-fiction, hard cover (top 10 best seller)	47.2	1.35	2.118644
WOMENS SHORT SLEEVE TOP	48.6	2.35	2.057613
Flat panel TV	50.5	1.72	1.980198
Pre-Recorded DVD	51.4	4.06	1.945525
Theatre Admission Eves, Front Stalls (adult)	55.4	2.11	1.805054
Fresh Veg-tomatoes-per kg	59	1.9	1.694915
Fresh Veg, Cucumber (whole)	61.5	0.63	1.626016
Fresh Veg-sprouts-per kg	62.5	0.21	1.6
Digital Camcorders	62.9	2.56	1.589825
Ultra low sulphur diesel (per 10 litres)	63.5	8.96	1.574803
Ultra low sulphur/unleaded petrol (per 10 litres)	67.7	43.2	1.477105
Peaches, (each)	68.4	0	1.461988
Grapes, (per kg)	69.6	1.45	1.436782
Fresh Veg, Lettuce - Iceberg	71.6	0.63	1.396648
Fresh Veg, Cauliflower, each	76.1	1.48	1.31406
Strawberries, (per kg)	81.2	0	1.231527
Kerosene per litre (1000 litres local bulk delivery)	93.8	3.01	1.066098

Notes:

The frequency (expressed as a %) of prices changing per month are from “What We can Learn About the Behaviour of Firms from the Average Monthly Frequency of Price-Changes: An Application to the UK CPI Data”, by Dixon, H.D. and Tian, K, 2017, Oxford Bulletin of Economics and Statistics, 79(6), pp.907-932.

Freq = denotes the frequencies of prices changes, which are reported in percent per month.

Mo = the mean duration between price changes implied by λ = 1/Freq.

Weight = Share of the Level Item in the VML data set for the whole period January 1996 to December 2007 (These sum to 1000).