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Energy Expenditures and CPI Inflation in 2022: Inflation Was Even Higher Than We Thought

Aftab Chowdhury and Huw Dixon

Abstract

This study finds a downward bias in the official CPI inflation figure from the second quarter to the end of 2022 due to the sudden changes in household energy expenditure. The energy price (specifically, oil price) started increasing from the last quarter of 2021 due to the rebound of economic activity and the supply-side issues after the Covid-19 pandemic, as well as the declining investment in oil and gas production after 2014. However, the sudden increase in the energy price in the second quarter of 2022 is simply derived from the Russia-Ukraine conflict that began on 24 February 2022. The sudden rise in the energy price and its inelastic nature has generated significant changes in household expenditure for energy (specifically in COICOP 04 Housing, water, electricity, gas, and other fuels and the COICOP 07 transport). These produce a significant downward bias in the official CPI inflation rate in COICOP 04 and 07, hence in the official CPI inflation rate for all items. Moreover, the input-output matrix of the national accounts helps us find the intermediate use of energy and its impact in other COICOP divisions which are not directly related to energy, such as COIOP 02 Alcoholic Beverages and Tobacco, COICOP 05 manufacture of Furniture, and COICOP 06 Health. All those together have caused the downward bias in the official CPI inflation rate in 2022.

Classification: C43, C67, D10, E01, E31, Q41

Keywords: Energy price, Inflation measurement, Household Final Consumption Expenditure (HHFCE), Consumer Price Index (CPI)

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Introduction

The ONS calculates the CPI index and inflation using past expenditure shares, as has been common practice across most Statistical offices across the world since inflation statistics started to be published after World War 2. Since expenditure shares usually evolve very slowly, with little change from year to year, this raised little debate. However, with the onset of the pandemic in 2020 this issue was brought to the fore as there were rapid shifts in expenditure patterns, especially during periods of lockdowns. The question naturally arose as to whether the published inflation figures were accurate as they were based on pre-pandemic expenditure shares that were significantly different from the reality of 2020 (see for example Cavallo 2020, Dixon 2020, Giles 2020).

We believe a similar situation arose in 2022. There has been a massive increase in energy prices during the year as a result of the Russo-Ukrainian war and ensuing sanctions imposed on Russian energy exports by Western nations¹ and the bomb-attack on the Nord Stream Pipeline. Since energy demand is inelastic, rising energy prices will lead to larger expenditure shares for energy. This raises the question of whether the published CPI inflation captures fully the inflation when it is based on the pre-war expenditure shares. It is this issue that this paper seeks to address.

The current method of using past expenditure shares is often called a “modified Laspeyres Index”. Each January the CPI weights are changed, currently using the weights from the previous year. Hence the 2022 inflation figures are calculated using the 2021 expenditure weights.² As we move through the year, the prices of goods and services are measured as “price relatives”, ratios of the current months price relative to its January level. For each of the 800 or so items in the CPI basket, a geometric average of the price relatives is taken and then each of the items is given the expenditure weights to compute the overall CPI inflation figure. This use of base weights is similar to the famous Laspeyres’ formula, except that rather than using the January or first quarter expenditure shares, the average over the previous year is used.³ The use of base weights is primarily a practical issue. Expenditure data is gathered from a large household survey and the results take time to process, so that it only becomes available with a significant lag. Also, the ONS does not want to revise the inflation figures (since they are

¹ The main countries to impose sanctions were the EU, Norway, Iceland, the UK, The USA, Canada and Australia. New Zealand, Japan, South Korea and Singapore also imposed more limited sanctions.

² Prior to 2021, the expenditure weights used were two years old. Hence the weights in 2020 were from 2018. The pandemic led to a review of this and shift to the most recent year prior to the current one.

³ More accurately, the method used is called a “Lowe” index, named after the Scottish statistician Joseph Lowe.

used for many purposes including indexation of benefits, pensions and so on) so are reluctant to update the expenditure shares after the event.

In this paper, we adopt the same methodology as we did when evaluating inflation during the pandemic (Chowdhury and Dixon 2023). With the benefit of hindsight, we are able to use the published expenditure weights from Consumer Trends for each quarter of 2022. This means we are able to measure the current weighted Paasche Index, which weights changes of a particular month relative to January using the expenditure weights of that month (or at least the quarter in which it occurred). As is well known, due to consumer substitution, the Laspeyres index tends to overestimate inflation whilst the Paasche index tends to underestimate it. We will use the Fisher Index, which takes the geometric mean of the Laspeyres and Paasche indices, as our “true” measure of inflation which we can then compare with the published figures.

The true CPI inflation rate is significantly higher than the official rate in the second and onward quarters of 2022. The downward bias⁴ in the official CPI inflation rate was mainly generated from the COICOP⁵ 04 Housing, water, electricity, gas, and other fuels and the COICOP 07 transport due to the sky-high energy price. Moreover, the input-output matrix of the national accounts has also helped us find the indirect effect of the rise in the energy price in the other COICOP divisions, such as COIOP 02 Alcoholic Beverages and Tobacco, COICOP 05 Manufacture of Furniture, and COICOP 06 Health, hence on the overall CPI inflation rate.

This paper is structured as follows. Section 2 is about the scenario of increasing energy prices in the United Kingdom and globally. Section 3 illustrates a brief review of inflation measurement errors due to the changes in the consumption basket. Section 4 explains the methodology and the data used in this study. Section 5 describes the detailed results and findings of the study. Section 6 depicts the future of energy prices and CPI inflation.

Background: Increasing energy prices in the UK and Global economies

After the end of the third lockdown in April 2021 in the United Kingdom, the social distance restrictions were significantly relaxed, and the economy started to rebound with a 6.5 per cent GDP growth rate (Quarter-on-Quarter) in the second quarter of 2021. Similarly, the quarterly

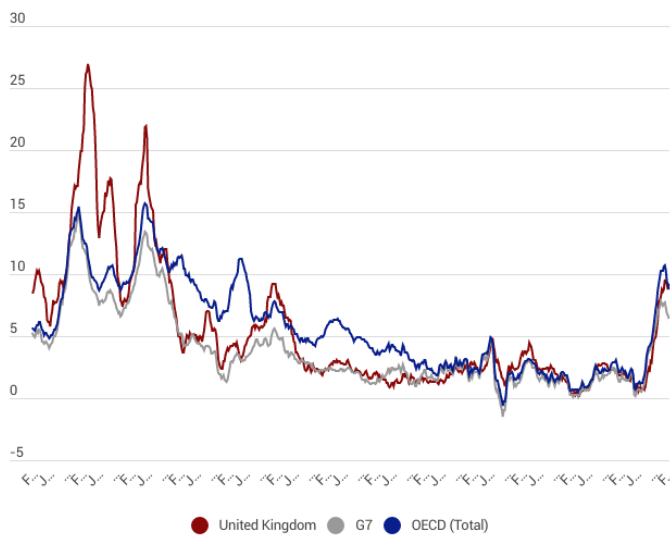
⁴ Downward bias occurs when the estimate is lower than the true parameter.

⁵ The Classification of Individual Consumption According to Purpose (COICOP) is the UN classification of household expenditure used by most national statistical offices. This paper uses the twelve two-digit divisions 01, 02 to 12.

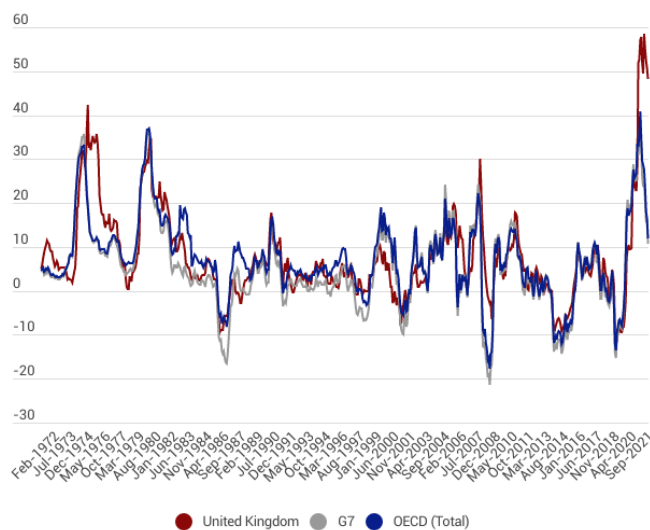
GDP growth rate in the G7 and OECD countries also increased notably to 1.8 per cent and 1.7 per cent, respectively, in the second quarter of 2021.⁶ However, the CPI inflation rate also started increasing from the low level in the Covid-19 pandemic in the United Kingdom as well as the G7 and OECD countries (see Fig. 1). In the United Kingdom, the increasing inflation rate was mainly driven by contributions from the following Classification of Individual Consumption According to Purpose (COICOP) categories: transport, housing and household services, restaurants and hotels, food and non-alcoholic beverages, furniture, and household goods (ONS, 2023).

Figure-1: Annual growth of CPI All items and energy in the UK, G7 and OECD countries. Data

CPI All items (YoY)



CPI energy (YoY)



obtained from OECD
(data.oecd.org).

Global supply-chain disruption due to the pandemic, expansionary monetary programmes and fiscal stimulus packages during the pandemic, changes in consumer expenditure patterns from services towards goods in general, especially durable goods, and the base effect were the probable reasons behind the increasing nature of inflation in 2021 in the aftermath of the pandemic (LaBelle and Santacreu, 2022; Chakraborty, 2023; Bernstein and Tedeschi, 2021; Chowdhury and Dixon, 2023). LaBelle and Santacreu (2022) identified that both domestic and foreign exposure to supply chain disruption had a positive effect on the industry PPI inflation in the United States for the period January 2021 to November 2021. Moreover, they also mentioned that the shift in

⁶ UK statistics are taken from ons.gov.uk and the G7 and OECD statistics are taken from stats.oecd.org.

the demand for durable goods and the excessive reliance on foreign suppliers to produce those goods had increased the price level due to the mismatch between demand and supply. However, by the end of 2021 it was expected that inflation would start to fall in early 2022.

However, the Russian invasion of Ukraine in February 2022 added considerable uncertainty and upward pressure on the price level through energy and food and the inflation rate reached its highest levels not seen for decades in the United Kingdom, G7 and OECD countries (Figure 1). The energy component of CPI hit its highest point since 1971 in the United Kingdom, OECD, and G7 countries, increasing by 57.1 per cent, 40.8 per cent and 39.3 per cent, respectively, at the end of second quarter of 2022 (Figure 1). The Brent crude oil spot price jumped to \$133.18 per barrel (31 per cent increase) on March 08, 2022, from \$101.29 per barrel on February 24, 2022 (Figure 2). On the other hand, the National Grid UK System average gas price has jumped to 501p per therm (around 95 per cent increase) on March 08, 2022, from 257p per therm on February 24, 2022 (Figure 2). Butler (2022) mentioned that the reason behind the explosion in the natural gas price compared to crude oil is that natural gas relies on the dedicated pipelines and liquefaction facilities, which makes it quite difficult to adjust supply in the wake of the Russian-Ukraine war. Whereas crude oil supply can be managed through marked and unmarked vessels to different parts of the world. Yagi and Managi (2023) identified that the global increase in energy prices has a significant impact on the three energy-related sectors (mining & quarrying, coke & petroleum products, electricity & gas supply), manufacturer of metal, mineral products, electrical equipment, chemical products, air transport and construction.

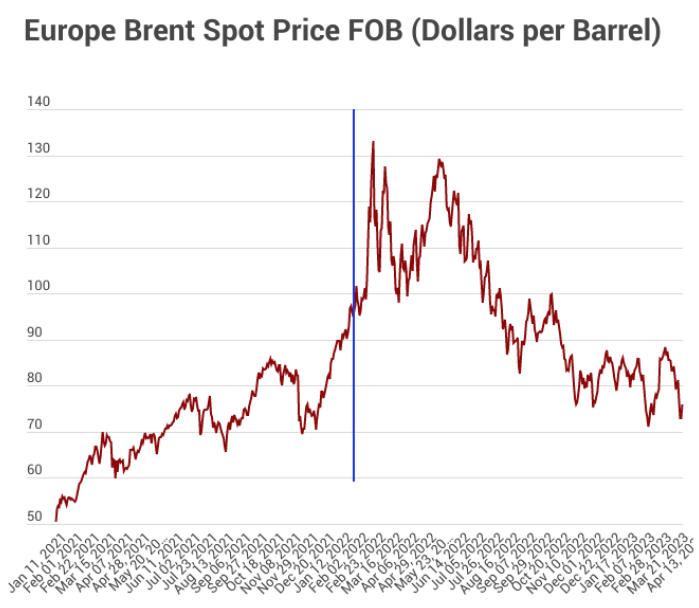
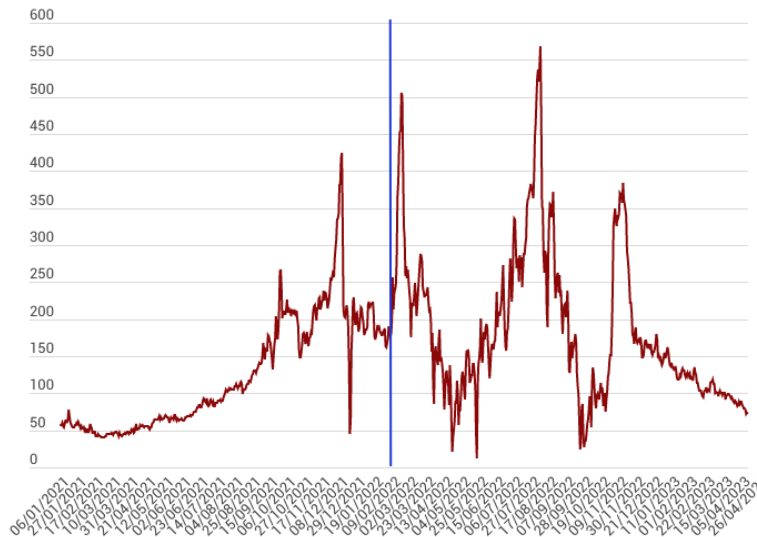


Figure-2: Daily Europe Brent crude oil spot price (\$ per Barrel) and Daily National Grid Gas UK System Average price (p per Therm) from 01 Jan 2021 to 05 May 2023. The red line indicating the start of Russian invasion of Ukraine (24th Feb 2022). Data obtained from U.S. Energy Information Administration (eia.gov) and Office for National Statistics (ONS).

National Grid Gas UK System Average Price (p/therm) Daily



A brief review of inflation measurement error due to the changes in the consumption basket

Not much work has been done on weighting bias in the literature on inflation measurement because of the static nature of consumer expenditure. However, Lebow and Rudd (2003) mentioned that the common biases in the literature on CPI measurement are upper-level and lower-level substitution bias, new-outlet bias, quality change and new-item bias, including weighting bias. They identified that the consumer expenditure data in the national income and product accounts (NIPAs) in the United States are more accurate than the CPI. Similarly, Curtin (2022) has also confirmed that during the Covid-19 pandemic the data quality in the Consumer Expenditure Survey by the US Bureau of Labour Statistics is poor in comparison to the Personal Consumption Expenditure (PCE) price index by the US Bureau of Economic Analysis due to the difficulties in in-person data collection during the stringent lockdown period.

In recent years, the weighting bias has earned significant focus in the study of CPI inflation due to the massive changes in the expenditure pattern during the Covid-19 pandemic. Using real time expenditure data, such as debit and credit card expenditure, several studies have found significant bias in the CPI inflation figure during the pandemic.⁷ Moreover, Chowdhury and Dixon (2023) have also found CPI inflation bias in the 33 OECD countries based on the actual

⁷ Chronopoulos et al. (2020), Dixon (2020), Jaravel and O'Connell (2020b) in the UK; Cavallo (2020), Chetty et al. (2020), Bachas et al. (2020), Dunn et al. (2020), Baker et al. (2020) in the US; Andersen et al. (2020) in the Denmark; Carvalho et al. (2021) in Spain; Seiler (2020) in Switzerland.

household expenditure data from the national accounts. They found that the official inflation rate was overestimated and underestimated for 22 and 11 countries, respectively, in the first wave of the Covid-19 pandemic.

Most of the national statistical offices use a Laspeyres-type or fixed-base weight index where the expenditure weights come from previous years and are used to weight the price relatives across months within the current calendar year. During the Covid-19 pandemic, most countries had to apply stringent lockdowns to reduce the spread of the virus which brought sudden and enormous changes in the consumer spending pattern. Considering the recent pandemic situation, Chowdhury and Dixon (2023) mentioned that the basket based on the pre-pandemic consumption expenditure pattern cannot be a good approximation of expenditure weights during the pandemic.

Like the Covid-19 pandemic period, the recent Russia and Ukraine conflict has brought similar CPI inflation measurement issues due to the significant changes in consumer spending due to the high CPI inflation rate in the energy sector. In this study, we will calculate the true CPI inflation rate in the United Kingdom using the latest actual household expenditure data from the Office for National Statistics (ONS).

Methodology and Data

In the United Kingdom, the ONS uses the “Lowe” price index to measure the CPI inflation rate. However, the “Lowe” price index is a Laspeyres-type or fixed-base weight index. This type of index is generally calculated from a specific basket of goods and services over the period. Therefore, there is a possibility of weighting bias in CPI inflation if the expenditure share of the consumption basket has changed significantly. In this study, we will examine whether any bias happened in the CPI inflation due to the significant change in energy expenditure in 2022.

This study will adopt the Chowdhury and Dixon (2023) methodology to measure the CPI inflation rate based on actual household expenditure. In brief, this is a retrospective analysis of the impact of the changes in expenditure weight on CPI, calculated by applying the actual household expenditure share in a particular period. They adopted the Fisher price index, a superlative price index calculation method, to calculate the CPI inflation rate because it minimizes the substitution bias in Laspeyres (too high) or Paasche (too low) or fixed basket index (too high) during the pandemic period when expenditure weights changed significantly. Several studies have advocated the use of a superlative index (i.e., the Fisher price index, the Törnqvist price index) during the period of the Covid-19 pandemic, such as Diewert and Fox

(2020); Fox et al. (2022); Jaravel and O'Connell (2020a); Kantur et al. (2021); Alvarez and Lein (2020). Therefore, we will be applying the Fisher price index to calculate the CPI inflation rate for the year 2022.⁸ The detailed methodology has been outlined in Chowdhury and Dixon (2023).

Actual household expenditure is the core data required for the study, which is available on the ONS website. Consumer Trends is the quarterly statistical bulletin which contains the household final consumption expenditure (HHFCE) including all spending on goods and services by members of UK households. So far, we have all the required actual household expenditure data for all the quarters in 2022.

However, we are particularly interested in the energy expenditures of the UK consumer which are found in the two specific COICOP divisions: COICOP 04 Housing, water, electricity, gas, and other fuels; COICOP 07 Transports.⁹ If we look at the COICOP 04, the actual household expenditure is below the official weight, but it's on an increasing trend during 2022. Therefore, we need to break down this division further to get the actual scenario of energy expenditure in the household. On the other hand, the actual household expenditure in the COICOP 07 is above the official weight and also on an increasing trend during 2022.

⁸ The Fisher price index is the geometric average of the Laspeyres and the Paasche Price Indexes, which is also known as the superlative price index. The Laspeyres price index is the weighted arithmetic mean of price relatives which is based on the base period's quantity. On the other hand, the Paasche price index is a weighted harmonic mean of price relative which is based on the current period's quantity.

⁹ According to the United Nations Classification of Individual Consumption According to Purpose (COICOP) 2018, items are classified as divisions, groups, classes, and sub-classes. However, those classifications are also known as two digits for divisions, three digits for groups, four digits for classes, and five digits for sub-classes. In the UK, the CPI is categorized as 12 divisions, 47 groups, and 117 classes according to COICOP 1999. However, this will be changed to 13 divisions, 52 groups, 188 classes, and 334 sub-classes upon the implementation of the COICOP 2018 classification.

COICOP Divisions	CPI Official Weights		HHFCE Share from Consumer Trends			
	2022 Jan	2022 Feb - Dec	2022 Q1	2022 Q2	2022 Q3	2022 Q4
01 Food and non-alcoholic beverages	115	116	101	101	103	103
02 Alcoholic beverages and tobacco	48	50	40	39	38	38
03 Clothing and footwear	62	60	61	59	57	57
04 Housing, water, electricity, gas and other fuels	137	138	117	124	124	131
05 Furniture, household equipment and maintenance	77	76	67	64	63	60
06 Health	22	21	22	22	22	22
07 Transport	140	139	151	153	153	156
08 Communication	25	25	24	23	23	21
09 Recreation and culture	134	134	118	114	115	113
10 Education	33	33	29	28	29	28
11 Restaurants and hotels	113	114	136	139	138	131
12 Miscellaneous goods and services	94	94	135	134	136	141

Table-1: CPI Official Weights for the year 2022 and the HHFCE share from Consumer Trends, ONS. Both the data set are collected from ONS website.

COICOP Groups/Classes	CPI Official Weights		HHFCE Share from Consumer Trends			
	2022 Jan	2022 Feb -Dec	2022 Q1	2022 Q2	2022 Q3	2022 Q4
04.5 Electricity, gas and other fuels	36	36	30	40	40	48
04.5.1 Electricity	20	20	18	22	23	23
04.5.2 Gas	14	14	11	16	15	23
04.5.3 Liquid fuels	1	1	1	1	2	1
04.5.4 Solid fuels	1	1	0	0	0	0
07.2 Operation of personal transport equipment	72	72	63	65	65	67
07.2.1 Spare parts and accessories	4	4	5	5	4	4
07.2.2 Fuels and lubricants	31	31	32	34	33	36
07.2.3 Maintenance and repairs	21	21	14	15	16	16
07.2.4 Other services	16	16	12	12	11	11

Table-2: CPI Official weights and actual expenditure share for the two groups in COICOP 04 and 07 which are directly related with the energy expenditure.

Table-2 provides us with a detailed breakdown of household expenditure on energy. From COICOP 04.5 and 07.2, we observed that the expenditure has increased significantly in the category of electricity, gas, and fuels & Lubricants from the second quarter of 2022, and they are all above the CPI official weights.

Result and Analysis

After adopting the Chowdhury and Dixon (2023) methodology to calculate the true CPI inflation rate in the United Kingdom, we have seen a significant difference between the official CPI inflation rate with the inflation rate based on the Fisher price index (Figure 3). The CPI inflation bias started from the second quarter of 2022 just after the Russia invasion of Ukraine on 24th February 2022. This bias prevails in CPI inflation until the end of 2022. The Russian-Ukraine conflict hit Europe badly, as Russia is the largest energy supplier to the European countries. More specifically, Europe is highly dependent on Russian gas supplies as they import around 40 per cent of natural gas from Russia (Besson, 2022). In fact, the economic sanctions imposed on Russia by the West has interrupted the supply of energy from Russia to the European Union (EU) countries. However, compared to the EU countries the United Kingdom is less reliant on Russian natural gas supplies as it imports around 5-6 per cent gas from Russia via LNG tankers (Ralston, 2022). But, the energy crisis in EU countries has pushed the international market price of natural gas sky-high, specifically LNG. This further increases the electricity price as natural gas is used to generate around 40 per cent of UK electricity (Ralston, 2022). Moreover, most UK residential heating systems rely on gas rather than electricity or other cheap renewable energies, which led to the increased household expenditure on energy at the end of 2022.

CPI inflation rate - All items

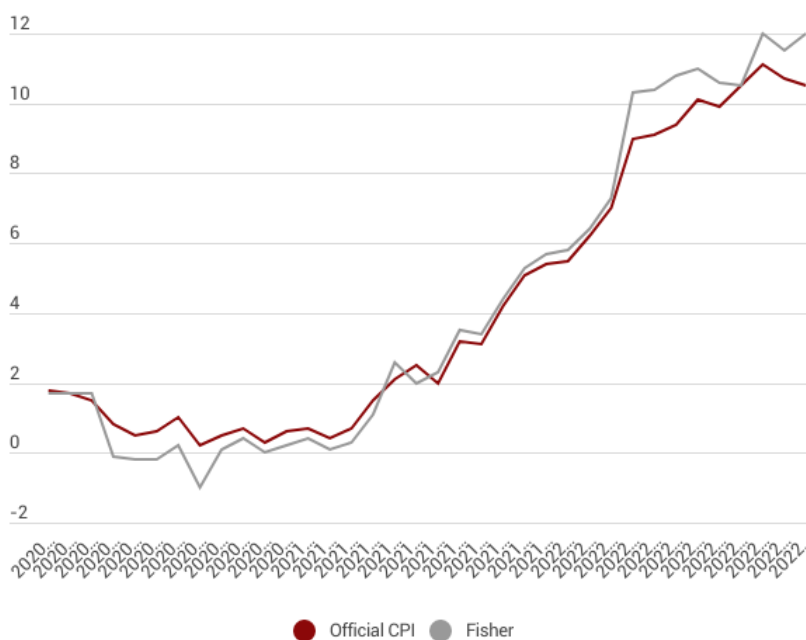


Figure-3: Official CPI inflation rate and inflation rate based on Fisher price index

As energy is price inelastic, the high inflation in the energy sector after the Russia-Ukraine conflict has certainly caused an increase in household expenditure on electricity, gas, and fuels & lubricants (see Table 2). The increased household expenditure in the energy sector along with the high inflation rate caused a downward bias in the Official CPI inflation rate in the last three quarters of 2022. However, the downward bias is much more evident in COICOP 04 and COICOP 07, where the high inflation in the energy sector has a direct impact on the household expenditure share, in the last three quarters of 2022 (Figures 4 and 5). Figure 4 suggests that the bias has increased significantly in the last quarter of 2022. The reason behind the high inflation bias is the winter when the weather is comparatively cold, and people are compelled to use heating in their home which is mostly operated by gas. However, the bias might have been more without the Energy Bills Support Scheme (EBSS) of a £400 discount to all households from October 2022 to March 2023.¹⁰ Moreover, the Energy Price Guarantee (EPG) has also helped to limit the further price increase in October 2022 by setting a price cap for the energy sector in the United Kingdom (Appendix Figure A).

CPI inflation rate: COICOP 04

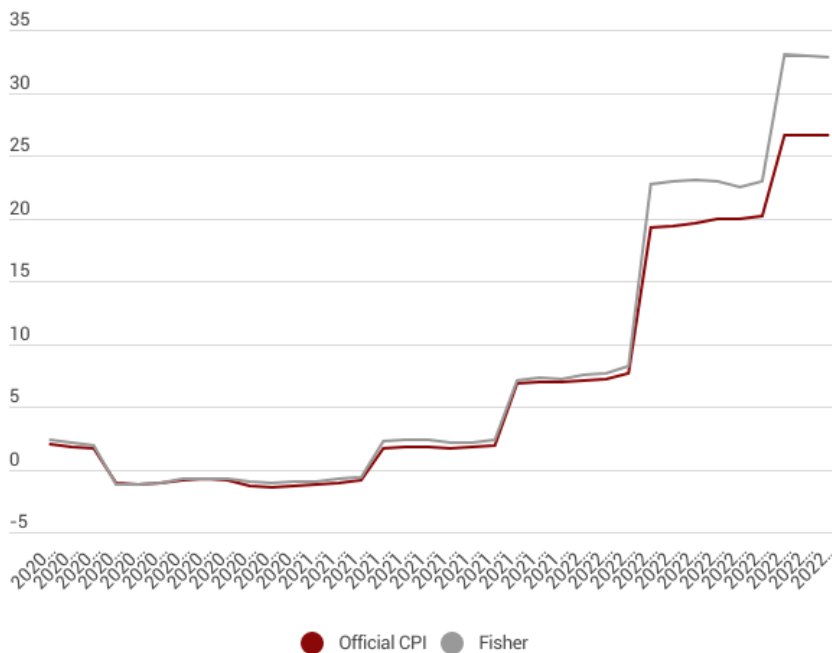


Figure-4: Official CPI inflation rate in COICOP 04 and inflation rate in COICOP 04 based on the Fisher price index. COICOP 04 indicate the household expenditure for Housing, water, electricity, gas, and other fuels.

¹⁰ The discount has applied to all the household electricity bill for 6 months starting in October 2022. All the household received £66 in October and November and £67 in December, January, February, and March.

In addition, the high inflation rate in the energy sector has also a direct impact on the COICOP 07 Transports expenditure share (Table 2). The inflation rate in fuels and lubricants started increasing from the last quarter of 2021 and jumped enormously from the second quarter of 2022. Kuik et al. (2022) mentioned that the rebound of economic activity after the Covid-19 pandemic, supply-side issues after the pandemic, and declining investment in oil and gas production after 2014 are the key reasons behind the increasing oil price in the last quarter of 2021. The gradual reduction in lockdown restrictions and increased travel raised the demand for oil after the second quarter of 2021. The supply side effect has derived from the continuous failure of the OPEC+ countries to produce the target level of oil after the Covid-19 pandemic. Moreover, the gradual reduction in investment in oil and gas production after 2014 provoked tension in the international oil market in the last quarter of 2021 (Appendix Figure B). However, the sudden increase in the oil price in the global market in the second quarter of 2022 is simply derived from the Russia-Ukraine conflict that began on the 24 February 2022 (Appendix Figure C). The increase in oil price has also led to a rise in the other components of the transport division, such as household expenditure for passenger transport by railway, road, and air. Therefore, the increased household expenditure on fuels and lubricants and other transport services has generated significant deviation from the official CPI weights, which produced a downward bias in the official CPI inflation figure in 2022.

CPI inflation rate: COICOP 07



Figure-5: Official CPI inflation rate in COICOP 07 and inflation rate in COICOP 07 based on the Fisher price index. COICOP 07 indicate the household expenditure for transports.

However, we can further investigate the indirect impact of high inflation in the energy sector on the other COICOP divisions with the help of the “combined use” matrix.¹¹ Input-output supply and use tables from ONS can be used to get the required data. The latest table gives us information up to 2020. Therefore, we have used the pre-pandemic table (i.e., Industries' intermediate consumption in 2018) to understand the intermediate demand for energy-related products (i.e., electricity, gas, oil, transport) in a normal period. The table gives us information that the intermediate demand for gas is around 40 per cent in the electric power generation, transmission and distribution sector, which is visible in Figure 4.

Other than electricity and gas, we have found that transport services as an intermediate product has an impact on the production of COICOP 02 Alcoholic Beverages and Tobacco. Around 8 per cent of the total intermediate consumption of manufacturing alcoholic beverages and tobacco products is made up from Land transport services and transport services via pipelines, excluding rail transport. Therefore, high inflation in transport services has a significant impact on household expenditure on alcoholic beverages and tobacco, hence a downward bias in the official CPI inflation (Appendix Figure D).

Similarly, transport services as an intermediate product has an impact on the manufacture of furniture (COICOP 05). This is mostly taken in the form of land transportation of furniture or furniture-related equipment. According to the 2018 combined use matrix, around 3 per cent of the total intermediate consumption of manufacturing furniture and furniture-related products is made up from Land transport services and transport services via pipelines, excluding rail transport. So, increased inflation in the transport services has an impact on household expenditure on furniture or furniture-related products. This might be the potential reason for a slight downward bias in the official CPI inflation in COICOP 05 (Appendix Figure E).

Finally, transport services as an intermediate product has an impact on the production of human health activities (COICOP 06). In this category, around 3 per cent of the total intermediate consumption of human health activities is made up from Land transport services and transport services via pipelines, excluding rail transport. Therefore, high inflation in transport services in 2022 has an impact on the expenditure share in COICOP 06 health

¹¹ Combine Use matrix helps to understand the industries intermediate consumption. This is also known as input-output matrix or Leontief Matrix.

category in a similar fashion. Hence, this might lead to a constant downward bias in the official CPI inflation in COICOP 06 (Appendix Figure F).

Looking forward

Despite an announcement from OPEC+ countries in April 2023 regarding a cut to crude oil production of 1.2 million barrels per day, the Brent oil price has declined from an average of \$85 per barrel in April to an average of \$74 per barrel in May because of the increase in the implied stock, which has grown due to higher world production compared to the world consumption of crude oil in the last three quarters (Appendix Figure G). Moreover, the weakening global economic condition, increased risk in the financial sector, and the higher inflation compared to the time of the initial increase in the oil price have caused the lower prices in May. However, the US Energy Information Administration (2023) has forecasted upward pressure on the oil price due to the increase in seasonal demand and OPEC countries' drop in oil production. Similarly, IEA (2023a) also predicts slight upward pressure in the next few months due to the record demand by China after the lifting of Covid-19 restrictions and the U. Department of Energy's announcement of buying 3 million barrels of crude oil for delivery in August 2023. However, some supply-side factors to consider are the recent halt in the Iraq-Turkey export pipeline, wildfires in Canada, workers' protests in Nigeria, and maintenance-related cuts in Brazil. Considering the global demand and supply in the rest of 2023, the crude oil price will be around \$80 per barrel which is far below the second quarter of 2022 and similar to the price before the Russia-Ukraine War in 2022.

During the 2022/23 heating season, natural gas consumption in OECD Europe declined by 16 per cent year-on-year, which is a significant drop in the gas demand (IEA, 2023b).

Comparatively milder weather conditions, energy-saving measures, lower electricity demand, and depressed distribution network-related demand were the primary reason behind the significant decline in OECD Europe gas demand (Appendix Figure H). However, the global gas supply in 2023 will remain tight and might be vulnerable due to weather factors (dry summer or cooler winter), lower availability of LNG, and the possibility of further cuts to the Russian pipeline to Europe (Appendix Figure I). Despite the continuous decline in European gas consumption in 2023, global gas demand will be flat due to the increased demand in Asia Pacific (mostly driven by the increased demand of China and India) and the Middle East (specifically, by Iran and Saudi Arabia) (Appendix Figure J). However, the gas price in the upcoming months of 2023 is still highly dependent on the flow of Russian gas to Advanced European economies (IEA, 2023b). Due to the sharp reduction in the Russian pipe gas supply to

the European market in 2022, LNG was the major source of natural gas that caused a significant rise in the natural gas price in Asia and Europe. Though, IEA (2023b) forecasts that the global LNG supply in 2023 will increase by 4 per cent, the tension in the global gas price will remain intact due to the increased supply of global LNG not being sufficient to offset the expected decline in the Russian Pipe gas supply to Europe in 2023.¹² Therefore, the natural gas price in the upcoming months of 2023 will be quite uncertain and expected to increase at the end of the year.

Household expenditure on electricity and gas will increase after the first quarter of 2023 as the EBSS payment stopped in March. Considering this issue as well as the high expenditure share in the previous year, the official CPI weights for COICOP 04.5 Electricity, gas and other fuels have increased from 36 in 2022 to 49 in 2023, hence the official CPI weights for COICOP 04 Housing, water, electricity, gas and other fuels has also increased from 138 in 2022 to 141 in 2023 (Appendix Figures K and L). After the end of the EBSS in March 2023, the Energy Price Guarantee (EPG) cap of £2,500 has been extended from April to June. Moreover, Ofgem announced a reduction in the price cap to £2,074 from July to September in May 2023. There is also the possibility of a further reduction in energy prices in England, Wales, and Scotland in October 2023. The official CPI inflation rate has already started to decrease from April 2023, and it will further decline due to the energy price drop in summer 2023 and onwards in the United Kingdom. As the official weights for energy used in calculating the CPI inflation rate were increased by ONS in 2023 (Appendix Figures K and L), the continuous drop in the energy price and the downward pressure in the CPI inflation rate in the United Kingdom from the second quarter might again generate a potential downward bias in the official CPI inflation rate at least in the second and third quarter of 2023.

7. Conclusion

Changes in household expenditure generate bias in the official CPI inflation. The degree and direction of the bias depends on how official expenditure weights deviate from the actual household expenditure share. Our initial hypothesis is a potential downward bias in the official CPI inflation rate due to the changes (increases) in the actual household expenditure for energy consumption in the last three quarters of 2022. As this problem is similar to the official CPI inflation bias in the Covid-19 pandemic period due to sudden changes in the expenditure share, we have applied the Chowdhury and Dixon (2023) methodology to analyse the above-

¹² The increased global LNG supply in 2023 is mostly supported by the USA as the increasing supply in the Calcasieu Pass LNG terminal and the restart of Freeport LNG. In addition to the USA, LNG supply from Africa and South and Central America is projected to increase in 2023.

mentioned hypothesis. Using the actual household expenditure data of 2022, we have found a significant downward bias in the official CPI inflation rate (all items) in the last three quarters of 2022 (see Fig. 4).

The bias is mainly generated by the increase in household expenditure for the COICOP 04 Housing, water, electricity, gas, and other fuels and the COICOP 07 transport categories because of the high inflation in the energy sector. Tensions in the global energy market (specifically, oil prices) started increasing from the last quarter of 2021 due to the rebound of economic activity after the Covid-19 pandemic, supply-side issues after the pandemic, and declining investment in oil and gas production after 2014 Kuik et al. (2022). However, the Russia-Ukraine conflict is the main reason for the sudden increase in energy prices (specifically, the gas price) in the international market. As energy is price inelastic, the high inflation in energy has caused an immediate increase in household expenditure on electricity, gas, and fuels & lubricants in the second quarter of 2022 (Table 2). High inflation and significant deviation in household energy expenditures from the official weights led to a downward bias in the official CPI inflation rate in the last quarter of 2022.

Moreover, energy is an intermediate product for many products and services. The input-output matrix of the national accounts helps us to find the intermediate use of energy and energy-related products in the manufacturing process of many products and services. This analysis also helped us to find out the potential impact of high energy prices in other COICOP divisions not directly related to energy, such as COIOP 02 Alcoholic Beverages and Tobacco, COICOP 05 manufacture of Furniture, and COICOP 06 Health. All those together have caused the downward bias in the official CPI inflation rate in 2022.

However, a limitation of this type of study is the use of backdated data. The true household expenditure data are published a quarter lagged by the ONS. On the other hand, Chowdhury and Dixon (2023) also showed that real-time expenditure data (such as debit and credit card data) cannot be used as a good approximation of actual household expenditure shares due to the sampling bias. Therefore, a quarter lagged actual household expenditure share data is the only solution to the problem of inflation measurement issues if it arises due to the weighting bias.

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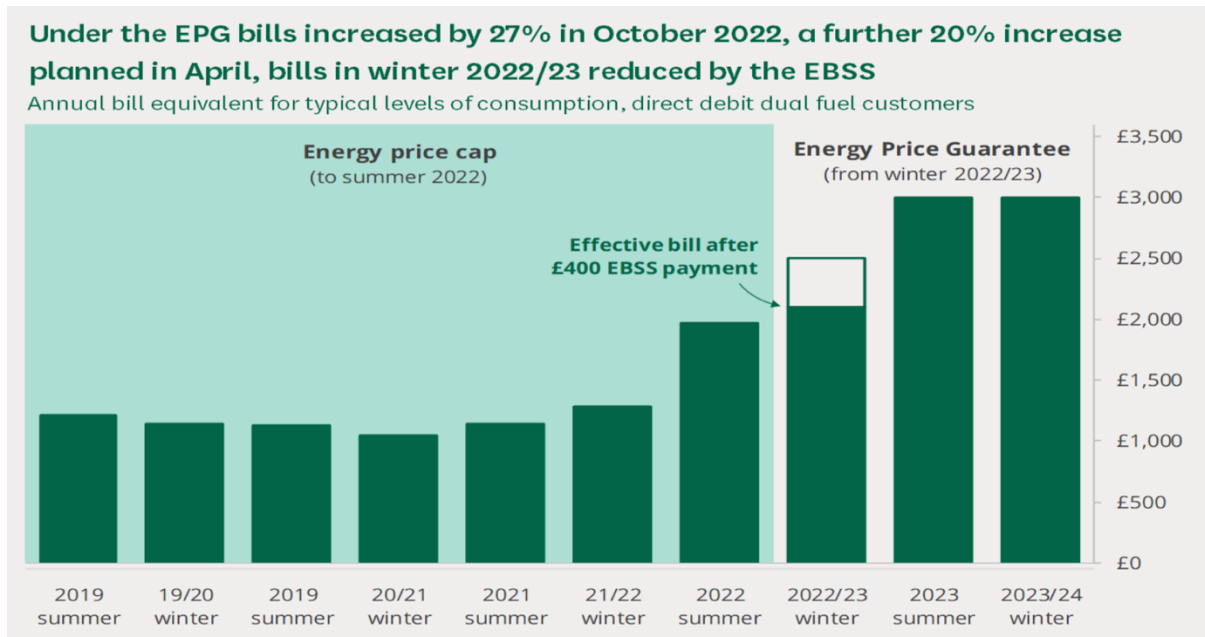
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Appendix

Figure A. Energy Price Guarantee (EPG) and Energy Bills Support Scheme (EBSS)

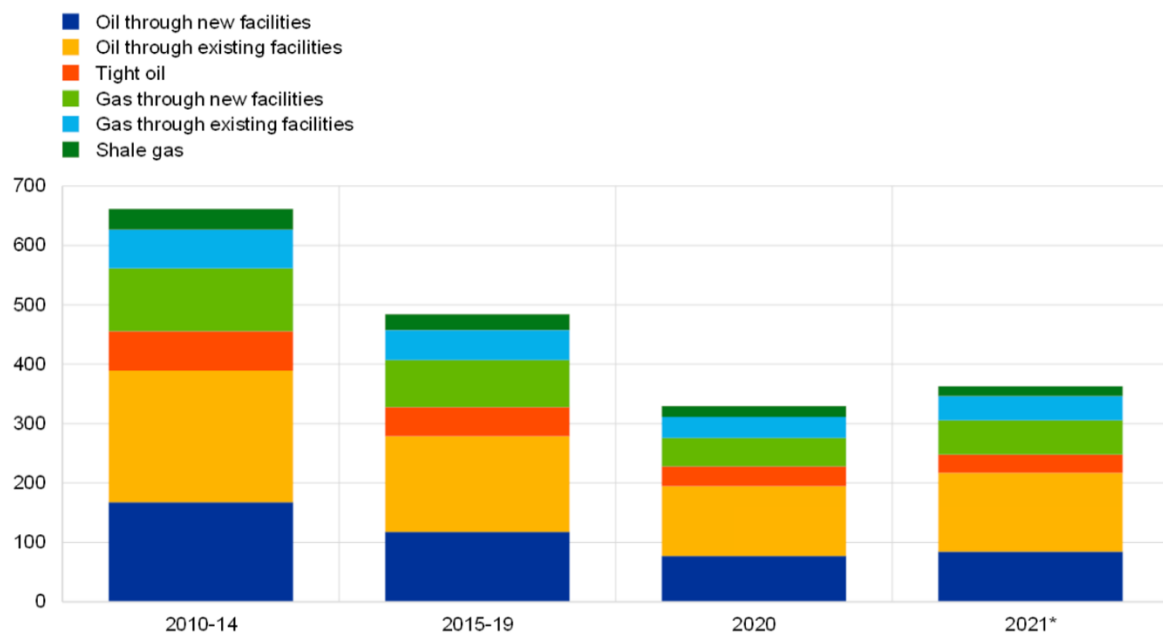


Source: Bolton and Stewart (2023)

Figure B. Investment in oil and gas production

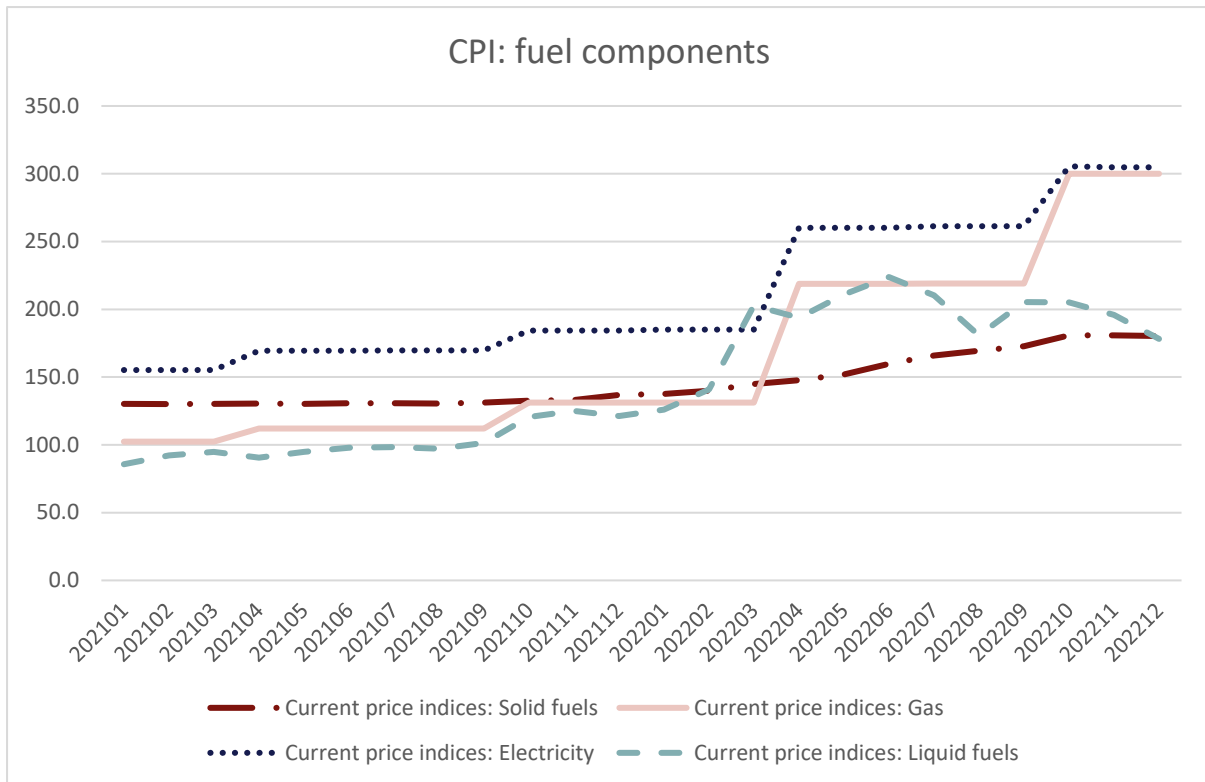
Declining investment in oil and gas since 2014

(USD billions, 2019 values)



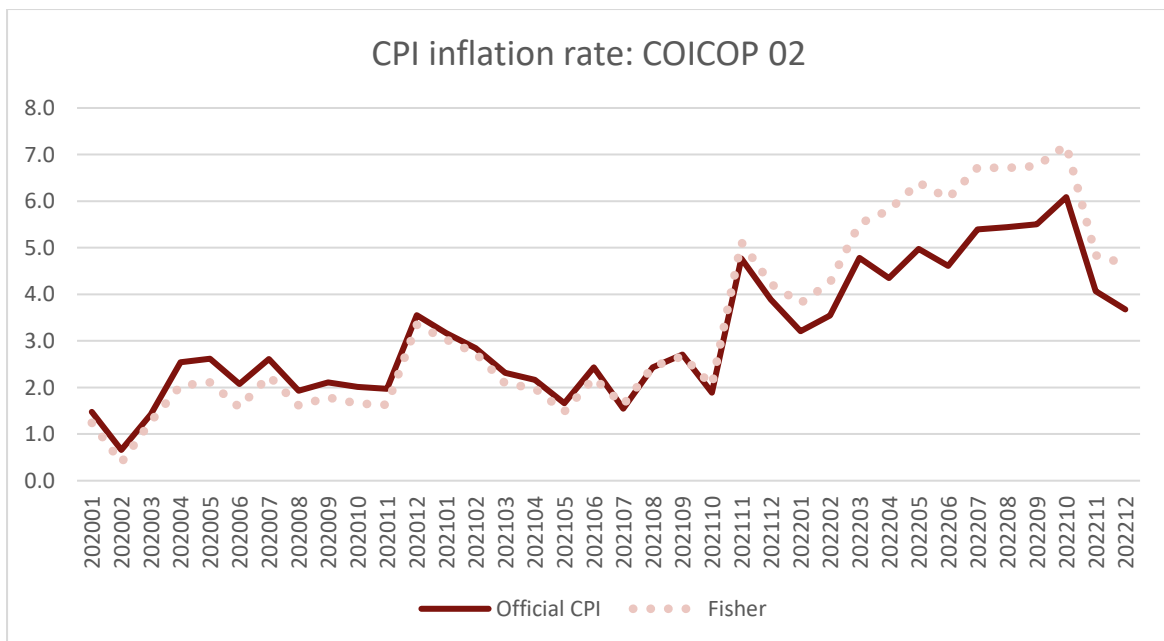
Source: Kuik et al. (2022)

Figure C. Consumer Price Index, UK: Fuel Components



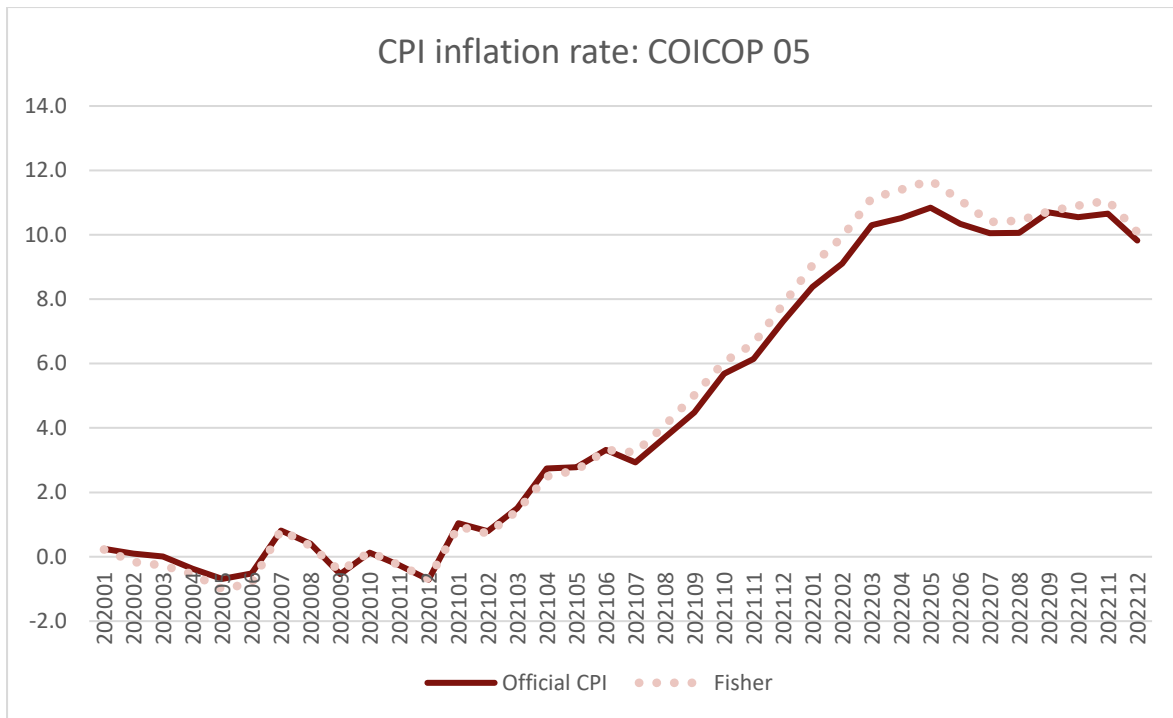
Source: Department for Energy Security and Net Zero

Figure D. CPI inflation rate: COICOP 02 Alcoholic Beverages and Tobacco



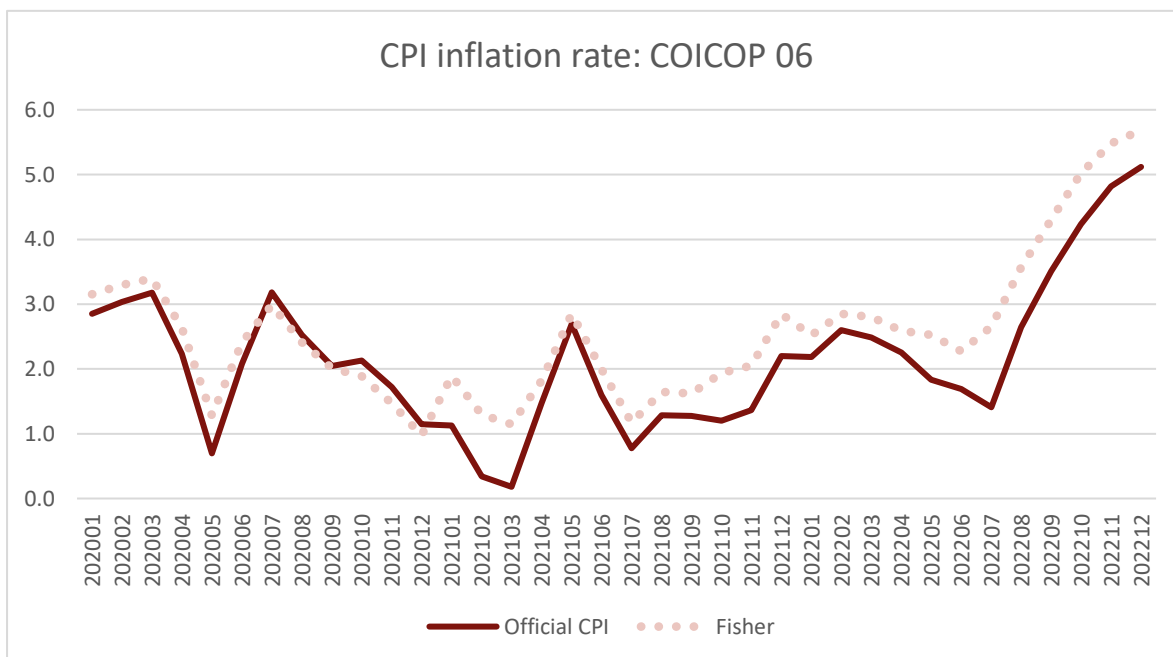
Source: Author calculation

Figure E. CPI inflation rate: COICOP 05 Furniture, Household Equipment and Maintenance



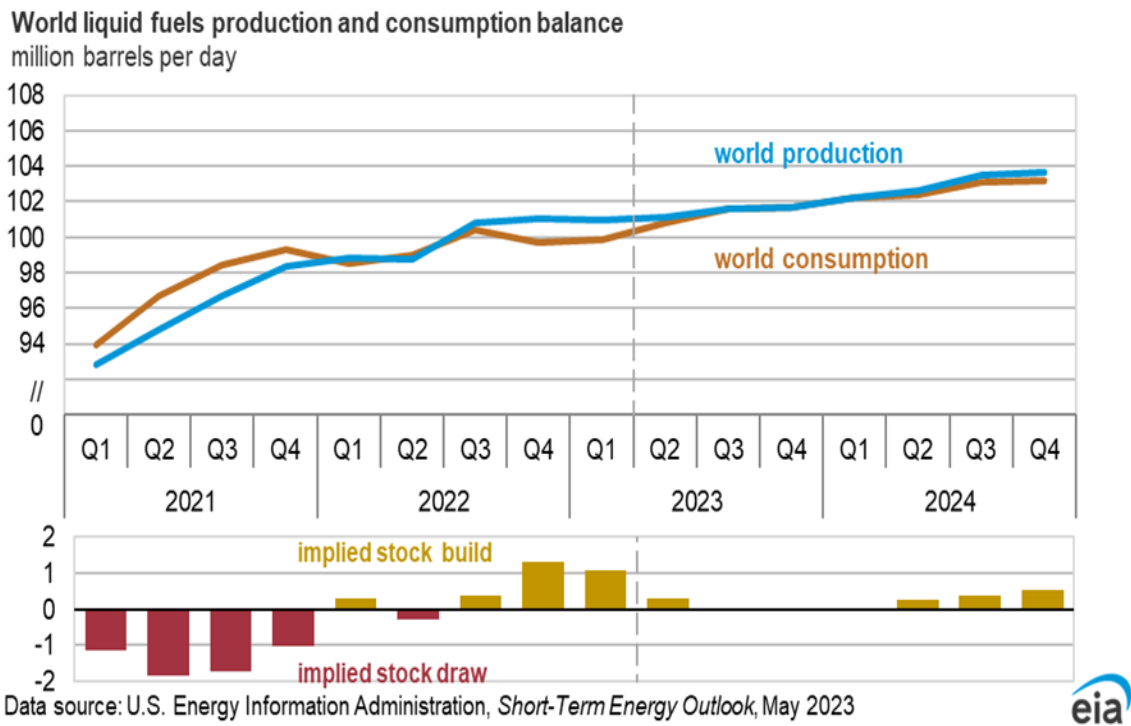
Source: Author calculation

Figure F. CPI inflation rate: COICOP 06 Health



Source: Author calculation

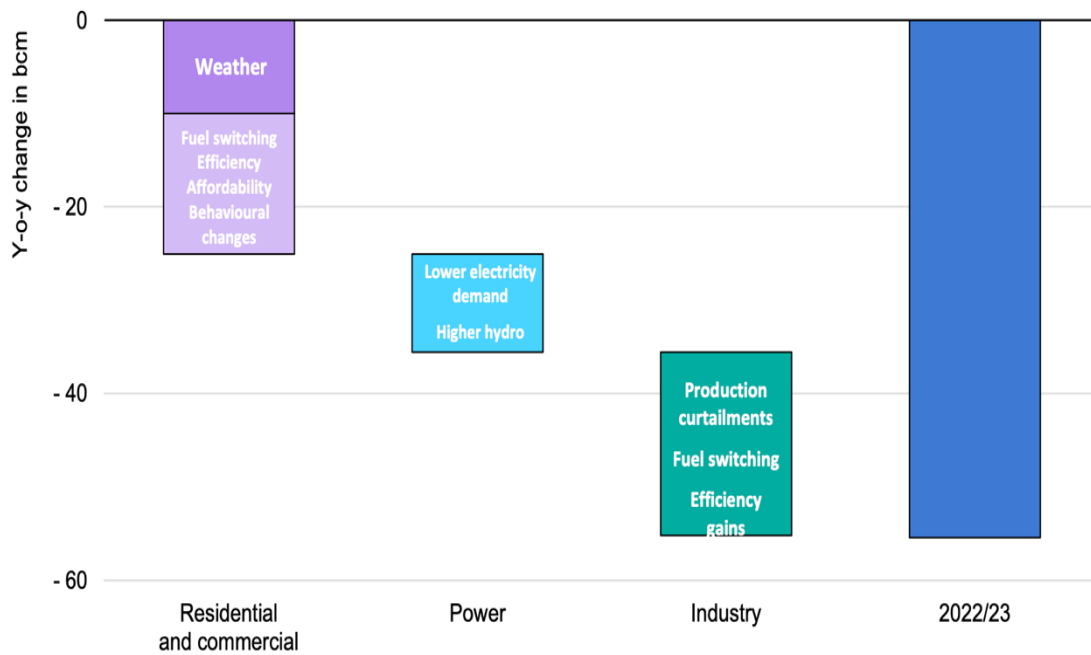
Figure G. Global Oil Market



Source: U.S. Energy Information Administration

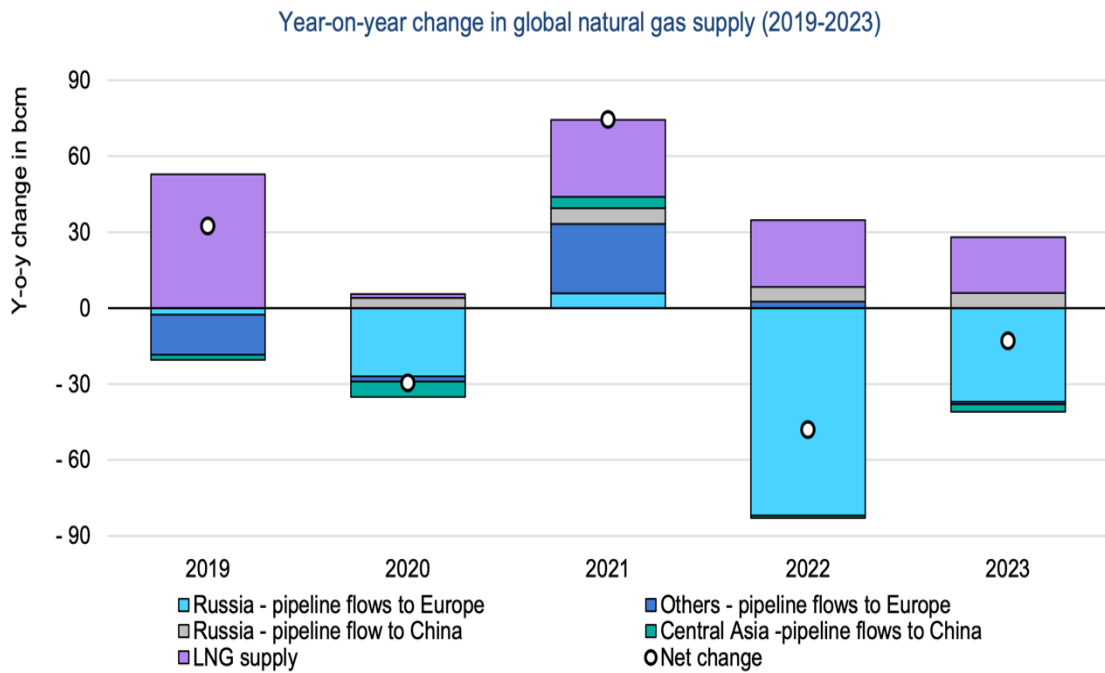
Figure H. Gas Demand by sector, OECD Europe

Estimated y-o-y change in gas demand by sector, OECD Europe,
2021/22 heating season vs 2022/23 heating season



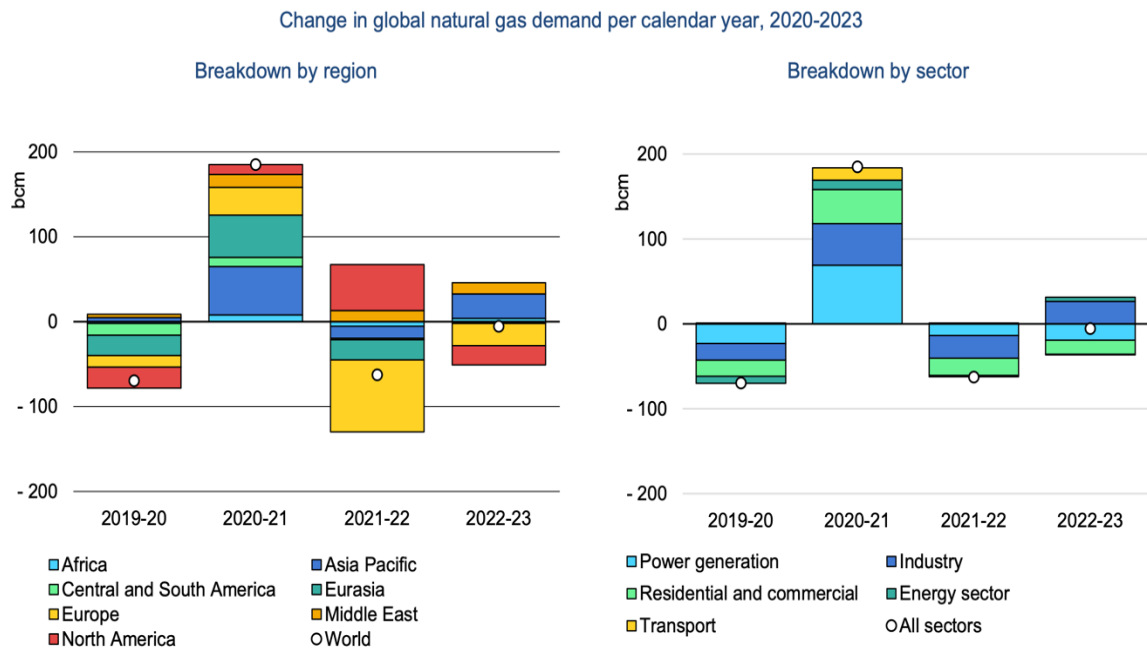
Source: IEA (2023b)

Figure I. Global Gas Supply



Source: IEA (2023b)

Figure J. Global Gas Demand



Source: IEA (2023b)

Figure K. CPI Official Weights and HHFCE Share

COICOP Divisions	CPI Official Weights		HHFCE Share from Consumer Trends			
	2022	2023	2022 Q1	2022 Q2	2022 Q3	2022 Q4
01 Food and non-alcoholic beverages	116	119	101	101	103	103
02 Alcoholic beverages and tobacco	50	42	40	39	38	38
03 Clothing and footwear	60	58	61	59	57	57
04 Housing, water, electricity, gas and other fuels	138	141	117	124	124	131
05 Furniture, household equipment and maintenance	76	68	67	64	63	60
06 Health	21	24	22	22	22	22
07 Transport	139	137	151	153	153	156
08 Communication	25	23	24	23	23	21
09 Recreation and culture	134	138	118	114	115	113
10 Education	33	29	29	28	29	28
11 Restaurants and hotels	114	138	136	139	138	131
12 Miscellaneous goods and services	94	83	135	134	136	141

Source: ONS

Figure L. CPI Official Weights and HHFCE Share: COICOP 04.5 and COICOP 07.2

COICOP Groups/Classes	CPI Official Weights		HHFCE Share from Consumer Trends			
	2022	2023	2022 Q1	2022 Q2	2022 Q3	2022 Q4
04.5 Electricity, gas and other fuels	36	49	30	40	40	48
04.5.1 Electricity	20	27	18	22	23	23
04.5.2 Gas	14	20	11	16	15	23
04.5.3 Liquid fuels	1	1	1	1	2	1
04.5.4 Solid fuels	1	1	0	0	0	0
07.2 Operation of personal transport equipment	72	67	63	65	65	67
07.2.1 Spare parts and accessories	4	5	5	5	4	4
07.2.2 Fuels and lubricants	31	31	32	34	33	36
07.2.3 Maintenance and repairs	21	16	14	15	16	16
07.2.4 Other services	16	15	12	12	11	11

Source: ONS