University of Strathclyde Business School

Honours

Dissertation
2024/2025

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Title: The Effects of Oil Price Shocks on the UK Economy

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Abstract

This paper studies the effect of supply news shock driven oil price shocks on the UK macroeconomy, interpreting the results with particular reference to the welfare and finances consumers. Given the coming years of policy changes it will be imperative to better understand the dynamics of oil price relation to macroeconomic indicators. It answers the questions of does a shock in oil price inflation have negative impacts on the welfare of consumers? Are these negative impacts exacerbated by the central bank response? Finally, to increase the applicability of this report beyond the UK and other energy importers, the response of the Canadian economy to the same shock was studied. This allows for insight into the structural differences between energy importers and exporters. The approach used was a Structural Vectorised Autoregressive model augmented with an internal instrument to identify oil price inflation surprises, the structural shock of interest in this paper. The resulting impulse response functions were the main output of the analysis used to draw the paper's conclusions.

This paper finds the in the UK consumer welfare and finances are negatively impacted by oil price inflation shocks as unemployment rises, implying and increase in uncertainty and fall in job security. GDP growth, used as a proxy for income stays relatively constant while inflation rises, eroding the purchasing power. The central bank response of increasing interest rates to combat the high inflation serves to worsen the pressures on discretionary income by increasing the cost of credit and delaying the recovery GDP growth and inflation. This paper also find that there are structural differences between energy importers and exporters that cause them to differ in response when faces with the same oil price inflation shock. The exporter is relatively unresponsive to the upward shock in price due to the inverse movements of the imports and exports, resulting in little to no net change in the total trade balance. The importer's results also showed an element of persistence in the responses to the oil price inflation shock.

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Chapter 1: Introduction

Energy has been the quintessential essence of life and the heart of all modern economies since the inception of the digital age in the 1950s (Paige, 2024). Following this, energy consumption has seen exponential growth coinciding with the rapid development of old industries like manufacturing & heavy industry and the advent of revolutionary new industries such as computer science (Ritchie, Roser and Rosado, 2020). Giving rise to the development of the Internet in the 1970s, The World Wide Web in the 90s and Cloud Computing in the 2000s. Transforming the world from the collection of compartmentalised economies of the 20th century to the instantaneous communication global village of today.

In the UK this high energy demand has been met primarily by fossil fuel extraction, accounting for 78% of the energy on the market (Walker, 2024). The extraction of fossil fuels has generated significant externalities in the form of pollution sparking a global steer toward sustainable energy. What motivates this paper is that the UK is aiming to reduce consumption and reliance on oil and gas significantly over the coming decade (Burnett et al., 2024). In light of this, volatility in oil markets is expected to increase as both energy producers and consumers face increased scrutiny over, actions and change their behaviour according to policy news. It is crucial to understand the potential ramifications of the drive toward net zero's enormous macroeconomic policy undertaking on the economy. With particular concern for consumers considering the residential sector is a major consumer of according the UK Department of Energy Security, second only to the transport sector which consumers also have a stake in.

This report extends the existing body of literature on the topic by focusing on the UK, instead of the US that the vast majority of the literature in the space centres on. Using macroeconomic indicators to build an understanding of how the economy and consumer welfare changes when there are shocks to energy markets by measuring impacts to inflation, interest, unemployment and GDP. Using an alternative identification method to ascertain the implications of oil price shocks driven by oil supply news on the UK economy.

Given its importance in the coming years of policy changes, this report aims to investigate the impact of supply driven oil price shocks on the UK economy, with particular reference to what the macroeconomic indicators mean for consumers, using oil future price fluctuations around OPEC announcements as an instrument to answer the questions of; Is consumer welfare negatively impacted by shocks in oil markets? Are these impacts exacerbated by the central bank's response? Finally, for the applicability of findings beyond the UK economy this paper also studies whether there are differences in these structural relations between energy importing and exporting economies using the UK and Canada as case studies.

To assess this a structural vectorised autoregressive model was used with an Internal instrument shock identification approach. This paper analyses the output impulse response functions which describe the dynamic impact of the oil supply news shock on the variables considered. Given the nature of the research questions the null hypothesises will be that there is no statistically significant impact of oil price shocks on the macroeconomic indicators. In essence, policy shocks will have no structural effect on the economy.

This report finds that, with reference to the UK, the results show supply driven shocks to oil prices negatively impact the economy and consumer welfare by adding financial pressure. Income, proxied by GDP growth, stays relatively fixed or falls following a shock. While the trend in long run inflation increases with unemployment. The central bank responds on impact with an increase in interest rate that closely tracks Core inflation as expected. In the 3 months it stays high following the shock interest rates squeeze discretionary income with added pressure to the cost of credit as well as hinders the recovery of unemployment and GDP growth. Though this short-run squeeze may be justified in the long-run by subduing the depreciative effect of inflation on consumer's relatively fixed income. There are structural differences between energy importers and exporters that cause them to react differently to these shocks as it is found that the Canadian economy is relatively unresponsive to the shocks compare to the UK. Additionally, when the Canadian economy responds it is often in the opposite direction to the UK as seen with GDP growth, Unemployment and Interest rates.

This report is divided into the following six chapters. This first chapter has introduced the research area, the motivation behind the study and stated its contribution to the present body of energy economics literature. The research aims and hypotheses have also been outlined, including an introductory summary of the methodology and key findings. Chapter 2, the literature review, will provide a summary of the current body of research in the field of energy economics, touching on topics at the core of answering the report's questions, namely; The Asymmetric effects of oil price shocks, Channels of Transmission, The Central Bank Response and potential structural differences between importers and exporters. Chapter 3 will discuss the data collected, highlighting the variables and why they are necessary for the analysis and will explain the empirical model introduced in Chapter 1 in greater detail. Chapter 4 will present the empirical analysis findings, referencing the stated null hypotheses. Chapter 5 will draw on existing literature to consider whether findings are in line or contradictory to expectations and provide potential reasons for being as such. Finally, Chapter 6 will summarise the study, touching on the limitations of the study and providing suggestions for future research in the field.

Chapter 2: Literature Review

2.1 The Reallocation Effect

This paper aims to study the effect of a price shock in oil markets to the UK economy. Literature in the space has concluded that there are asymmetric effects of upward and downward price shocks on the economy. Meaning that, though oil price increases lead to economic downturns, price falls do not elicit an equal and opposite boom. Kilian Lutz touches on this asymmetry in his 2009 paper on the sensitivity of consumer spending to retail energy prices where he attributes this asymmetry to the Reallocation Effect. This is the shift of economic resources such as labour, capital and investment from less productive markets to more productive ones (Mohaddes and Pesaran, 2017). Although it is necessary for the long run growth of an economy, in the short run it can cause disruptions such as unemployment. In this context, the expected boon to output and fall in unemployment cause by negative shocks in oil price is counteracted by the reallocation effect's short run inefficiencies. And in the case of a positive shock in oil price the aforementioned forces move in the same direction, amplifying the response of the macroeconomic indicators. Meaning the Reallocation Effect's short-run frictional inefficiencies will exacerbate the fall in output from increased energy prices and unemployment.

2.2 Channels of Transmission & Ascertaining Consumer Welfare

Discretionary income is the remainder of an individual or household's income after essential deductions e.g. debt or taxes and spending on necessities such as food, housing and transport have been removed. It represents the level of income available for consumers to spend at their discretion on non-essentials such as entertainment, luxury goods, savings and investments (Karp, Cheng and Meyers, 2005). It represents the level of consumer financial freedom beyond meeting their basic needs. The higher the discretionary income level, it is assumed the higher the standard of living as more leisure and luxuries can be afforded to improve wellbeing (Bucknall, 2021). Thus, in this paper, impacts to discretionary income will be interpreted as impacts to welfare in the same direction.

Though households do not purchase primary energy, shocks in the market are transmitted to discretionary income through two major channels; Spending on essentials that contracts discretionary income and spending on non-essential energy related products that affect the purchasing power of said income. Essentials, such as transport and utilities, alone account for up to 47% of energy consumption (Desjardins, 2016). These goods are necessary for every-day functions therefore consumption is effectively fixed in the short run and can only be adjusted in the long run, thus making energy demand inelastic in the short-run (Edelstein, 2009). Non-Essentials spending is primarily affected by the inflation rate which, due to oil's status as a key input for production, is highly correlated with the price of oil. Inflation captures the depreciation of the purchasing power of discretionary income by increasing the general price level in the economy such that the same value of income will not be able to purchase the same quantity of goods in the market. This is especially true in the case of consumer durables e.g. cars and home appliances (Kilian, 2008).

Though literature also suggests that spending falls in this sector could be due to eroded consumer confidence as uncertainty about the future state of the economy causes them to delay the purchase of durables (Kilian 2009). This is an example of consumption smoothing, or precautionary Saving in other literature, where consumers increase saving. Consumers are said to have an aversion to falls in standard of living thus attempt to smooth consumption by saving in periods of high income to buffer consumption in periods of low income (Haddow and Hare, 2013). The severity of which is determined by whether consumers expect the shock to their income to be transitory or permanent (Kovacs, Rondinelli and Trucchi, 2019). Though this behaviour protects consumers against drastic changes in standard of living, it also worsens economic downturns due to the lack of spending and investments (Bloom, 2014).

The Philips Curve Relation is a core macroeconomic framework describing the inverse relationship between inflation and unemployment. It states that in the short run there is an inverse relationship between the two, meaning as inflation rises unemployment falls due to the wage-price spiral. This is where price increases illicit a higher wage as workers

bargain for higher pay to keep up with the price levels in the economy. These higher wages serve as an incentive to work and increases the working population (Lorenzoni and Werning, 2023). In the long run, the Philips Curve becomes vertical as further increases in inflation will not reduce unemployment below its natural level (here). However, this relationship breaks down in the case of inflation caused by aggregate supply contraction (cost-push Inflation). Here the relation is inverted as inflation rises with unemployment as goods become scarce and producers lay off staff. This paper will interpret shocks to unemployment as changes to uncertainty in the same direction and job security in the opposite.

As previously stated, in the case of a positive oil price shock a cost-push inflationary response is elicited, causing unemployment to rise. A component of this will be frictional due to the Reallocation effects (Davis and Haltiwanger, 2001). Literature posits that another component will be permanent due to the changes in relevant industries and structure of the economy. Considering large policy decisions e.g. to end the sale and production of all new petroleum vehicles by 2030. A higher proportion of job loss will be permanent as entire industries shutdown. Aberdeen researchers estimate up to 95,000 jobs at risk from a mismanaged energy transition (Fraser, 2023). Given this, it is expected that the model built on historic data will underestimate the future effects to unemployment as without appropriate education to reskill workers, future policy will effectively make workers in non-renewable fields irrelevant.

2.3 Central Bank Response

Under the current paradigm of inflation targeting the Bank of England has aimed to target inflation measured by the Consumer Price Index (CPI) at 2% (Bank of England, 2024). cCPI measure of inflation is generated by taking 180,000 prices on a basket of 700 goods and services and calculating the percentage change in the average price. This measure differs from Core inflation by including volatile items such as food and energy such that it provides a more accurate representation of how inflation affects economic actors, whereas Core captures the general trend in inflation and is less susceptible to noise.

Central Banks first assess whether to respond based on whether a shock influences the long run output level and inflation rate of the economy i.e. whether shocks have permanent or transitory effects. Since this report focuses on cost-push, a supply-side inflationary pressure, which is commonly interpreted as impermeant in economics literature, (Killian 2008), the central bank may choose to 'Look through' (Hofmann, Manea and Mojon, 2024) the crisis and take no monetary action.

If it is concluded that action is required, in the short-run, Central Bank response is determined by the Taylor Rule. Introduced by John Taylor in his 1993 paper, it suggests that short term nominal rates should be set as a function of the inflation rate and the output gap, with a higher inflation rate or larger output gap leading to higher interest rates. When there is excessive inflation in an economy e.g. near the natural rate of unemployment where employment levels are unresponsive to further increases in inflation, an increase in interest rates will reduce inflation toward the targeted natural rate by contracting aggregate demand and consequentially, the output and price level in the economy.

This paper studies Central Bank responses with interest rates as it impacts consumers through the cost of credit e.g. mortgage payments, another necessary payment that adds pressure to discretionary income and by proxy, welfare.

2.4 Oil Importers and Exporters

For the purposes of comparison required in this paper the UK and Canadian economies are comparable for the following reasons. Both are developed nations with GDPs of $3.6 and $2.2 trillion respectively (IEA, 2022). They share similar economic structures with the service sector being a key driver of economic activity with an 80% share of Gross Value Added in the UK (Brien, 2020) and 70% in Canada (Statista, n.d.). Yet relative to the UK, Canada is considered a net energy exporter. In 2023 the Canadian economy produced 3,425,950 GWh of crude oil while only consuming 1,002,935 GWh (IEA, 2022). Meanwhile in the same year the UK imported 33,000 GWh of electricity and exported just 9,000 GWh (RSM, 2024). On the global scale, Canada is an energy supplier whereas net importing economies such as the UK are considered energy consumers. With the economies

playing opposing forces in the market for oil, economic theory suggests that they would have differing reactions to a shock in said oil price across the response variables considered in this report (Lin and Bai, 2021). The ability to cover domestic requirements for oil without relying on imports means that domestic oil prices are less influenced by the international price (Cardinale, 2023), providing a sense of energy security and non-reliance on the global market. Banna concludes in his 2023 paper on energy security and economic stability that economies with high energy security risk see reduced GDP growth rates. This shows that energy security policy is invaluable to the stability of an economy (Banna et al., 2023). Another potential difference would be in the effect of an oil price shock on GDP through the channel of the Trade Balance. Importers will see a worsening in their Trade Balance as their costs rise, whereas exporters see the opposite due to the increase in revenues. These differences in effect on GDP may be reflected as differences in responses in other macroeconomic indicators, making the conclusions and policy recommendations of this paper different depending on the status of the economy. This paper discusses what structural differences may arise between economies that can meet their domestic energy requirements and nations that rely on imports to do so.

Chapter 3: Data Discussion & Methodology

This section discusses the data used in the formation of the report's findings touching on their sources, importance, interpretation within the paper and any transformations required.

3.1 Data Discussion

The data for this report was collected from a variety of sources ranging from Federal Reserve Economic Data (FRED) Database to Känzig's and Christiane Baumeister's respective replication repositories. The dataset built from these sources was a monthly time series of oil related variables and macroeconomic indicators for the UK and Canada spanning from January 1980 to December 2016 with no missing values resulting in 4440 observations. Summary statistics can be found in Figures1.1 – 1.7.

3.1.1 The Instrument

A robust, high frequency instrument of surprises in oil future contract prices following Organisation for the Petroleum Exporting Countries (OPEC) announcements developed by Känzig in his 2021 paper was selected. Känzig undertook instrument relevance tests finding significantly higher price volatility on days identified than that of sample days. Endogeneity was tested with the correlations with several shock series from literature to ensure other shocks are not picked up in the series. Känzig also undertook autocorrelation and forecast-ability tests, further lending credence to the validity and appropriateness of this identification instrument. The series was created by measuring the price change in oil futures in a 1-day window around OPEC announcements to ensure all other variables are held constant in the period to maintain endogeneity. By using future prices the forward-looking tendencies of oil price reactions is factored in through the expectations. Figure 2 shows how the instrument denoted by Principal Component (PC) maps the common factor of all the surprises across the yield curve of Oil futures following an announcement from OPEC. Further demonstrating the relevance of the instrument. Figure 1.9 shows this PC plot over the full sample period with 0 in the months with no announcement.

Figure 2: Cumulative Suprises Across the Yield Curve of Oil Futures Contract Prices

Note: This figure was generated by cumulating the surprises in oil futures prices for each contract maturity, then normalising the resulting series by subtracting the mean. The longer the contract maturity the darker the line

The first series is Oil Price Inflation. The target response variable that denotes how oil price changes following a shock. This paper is concerned with upward surprises in the series to investigate how an increase in oil price affects the macroeconomic indicators. This series was logged and first differenced to obtain stationarity.

3.1.2 The Global Series

The variables in the Global Series are prefixed with 'World'. Oil Production was considered as it is a standard variable used in Oil related VARs that allows for an understanding of how the global scene reacts to a shock in the price of oil. In this report it serves to show the direction of OPEC's intended supply action. Oil Inventories is also a standard variable used in analysis as such that allows for an insight into how much oil is held in reserves globally. Industrial production is yet another standard variable to be included in such models that captures the world's production response to shocks in the system. In this report it serves as a benchmark that allows for a comparison between the UK and Canada's differing responses as energy importers and exporters respectively relative to a benchmark.

These series were logged and first differenced to obtain stationarity required for the analysis.

3.1.3 Country Specific Series

The country specific variables are prefixed with 'UK' and 'CAN' for the United Kingdom and Canada data respectively, constituting the bulk of the analysis of this report. The first of which is CPI inflation that captures how the price levels in the economies respond to shocks in the system. It differs from the also included CORE in that it includes volatile items such as food and energy, allowing for it to capture inflation in a way more representative to the experience of economic actors such as consumers which is more appropriate for this report. CORE still holds value in that ignoring the volatile items, it represents the long run trend in inflation which central banks may look to more when determining their monetary policy response. These inflation measures are also used as a

proxy for the purchasing power of a fixed income within an economy to develop an understanding of how discretionary income is squeezed. These series were de-seasonalised for the analysis. Interest Rate series were included to capture the response of the central bank to shocks in the system. This variable allows for an understanding of how central banks reacts which is invaluable to both hypothesis 1 and 2 of this report as it pertains to the pressure added to discretionary income as detailed in the literature review. Unemployment data was included, depicting how the employment level in the economy changed following the oil price shock. In this analysis it serves to check the integrity of the Philip's Curve Relation and a proxy for job security and uncertainty within the economy. GDP Growth was included using Industrial production for each country to gain an understanding of how the economic growth is affected, as well as used as a proxy for income in the economy. This series was logged and first differenced to obtain stationarity for this analysis.

3.2 The Econometric Model & Analysis Method

This study employs a Structural Vector Autoregressive (SVAR) model with internal instrument identification to examine the structural impact to the UK of oil price shocks, the structural shock of interest. A standard VAR model being a generalisation of an Autoregressive (AR) model only identifies correlation between lags of itself and other variables in the system. While this is effective in capturing dynamic relationships, it does not provide a means to disentangle contemporaneous interactions to find a direction of effect and establish causality. i.e.

The Identification problem with VARs

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \phi_{1,1} & \phi_{1,2} \\ \phi_{2,1} & \phi_{2,2} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \cdots + \begin{bmatrix} \varepsilon_{x,t} \\ \varepsilon_{y,t} \end{bmatrix}, \qquad \begin{bmatrix} \varepsilon_{x,t} \\ \varepsilon_{y,t} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_x^2 & \sigma_{xy}^2 \\ \sigma_{yx}^2 & \sigma_y^2 \end{bmatrix} \right)$$

Since the reduced form residuals are the covariances between the errors of the system, there is no way to make a causal inference as the matrix is symmetric, $\sigma_{yx}^2 = \sigma_{xy}^2$ and there is no way to disentangle them. The structural shocks to the errors of the model are said to be exogenous and uncorrelated to other structural shocks such that:

$$\begin{bmatrix} Oil\ Price\ Inflation \\ Any\ other\ Strutural\ Shock \end{bmatrix} = \begin{bmatrix} w_{x,t} \\ w_{y,t} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \right)$$

If it is assumed the reduced form residuals are a linear combination of the structural shocks, then:

$$\begin{bmatrix}\varepsilon_{x,t}\\ \varepsilon_{y,t}\end{bmatrix} = \begin{bmatrix}b_{1,1} & b_{1,2}\\ b_{2,1} & b_{2,2}\end{bmatrix}\begin{bmatrix}w_{x,t}\\ w_{y,t}\end{bmatrix} = \begin{bmatrix}b_{1,1}w_{x,t} + b_{1,2}w_{y,t}\\ b_{2,1}w_{x,t} + b_{2,2}w_{y,t}\end{bmatrix}$$

The reduced form errors ε are estimated from the data, then the impact matrix b is used to obtain the structural shocks w. By substituting the structural shock relation into the VAR formula, the structural form of the VAR is derived:

$$\begin{bmatrix}x_t\\ y_t\end{bmatrix} = \begin{bmatrix}\phi_{1,1} & \phi_{1,2}\\ \phi_{2,1} & \phi_{2,2}\end{bmatrix}\begin{bmatrix}x_{t-1}\\ y_{t-1}\end{bmatrix} + \cdots + \begin{bmatrix}b_{1,1} & b_{1,2}\\ b_{2,1} & b_{2,2}\end{bmatrix}\begin{bmatrix}w_{x,t}\\ w_{y,t}\end{bmatrix}, \qquad \begin{bmatrix}w_{x,t}\\ w_{y,t}\end{bmatrix} \sim N\left(\begin{bmatrix}0\\ 0\end{bmatrix}, \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}\right)$$

But impact matrix b is not unique as there is an infinite set of parameters to satisfy the equation. By incorporating structural restrictions based on economic theory or in the case of this paper, an internal instrument, it collapses the set of possible values in b and allows for the identification of the oil price shock. Thus the SVAR model improves the interpretability of the results over a VAR by explicitly identifying the exogenous oil price shocks.

By inserting a relevant and exogenous instrument in the first position, in this case the Principal Component of the surprises in oil future prices in a 1-day window around an OPEC announcement. Then apply Cholesky Decomposition we can identify the structural shock of interest, returning the impact vector associated with the instrument $c_1 = (1, \dots, c_{1,n})$.

$$\begin{bmatrix}z_t\\ \dots\\ y_t\end{bmatrix} = \begin{bmatrix}a_1\\ \dots\\ a_m\end{bmatrix} + \begin{bmatrix}0 & \cdots & 0\\ \vdots & \ddots & \vdots\\ 0 & \cdots & \phi_{m,n}\end{bmatrix}\begin{bmatrix}x_{t-1}\\ \dots\\ y_{t-1}\end{bmatrix} + \cdots + \begin{bmatrix}\varepsilon_{x,t}\\ \dots\\ \varepsilon_{z,t}\end{bmatrix}, \qquad \begin{bmatrix}\varepsilon_{x,t}\\ \dots\\ \varepsilon_{z,t}\end{bmatrix} \sim N\left(\begin{bmatrix}0\\ \dots\\ 0\end{bmatrix}, \begin{bmatrix}1 & \cdots & c_{1n}\\ \vdots & \mathrm{S} & \\ c_{m1} & & \end{bmatrix}\right)$$

$$\gamma_t = a + \sum_{n=1}^{N} \phi y_{t-n} + u_t$$

The primary output analysed to generate the findings are the system's impulse response functions (IRFs). These measure the dynamic impact of a one-time shock to one variable on itself and other variables in the system over time. Assuming that no exogenous factors are correlated with the surprise in oil price identified by the instrument, the output impulse responses may be interpreted as the causal impact of oil price shocks on the

endogenous variables in the system. More broadly, they represent the expected change in the response variables from a one-time surprise in oil prices.

In accordance with the explanation above, a SVAR model was estimated with a varying la lengths, inserting the instrument in the first position. Then the impact vector was extracted and IRF generated from the results with estimation window of 18 months. A window length selected based on the literature and time taken for variables to stabilise. To generate the 1 standard deviation confidence intervals bootstrapping was used with 1000 resamples with replacement. This was repeated for both the UK and Canada datasets.

3.3 Robustness Checks

In addition to the relevance, endogeneity and granger causality tests carried out by Känzig, Lag Length Sensitivity tests were run to ascertain the robustness of the report findings The results of which are shown in Figure 3.1-3.4. The Akaike Information Criterion (AIC) specified optimal lags of 12, 3 and 4 were considered. Due to constraints of the data with only 440 observations per series, there is not enough variation to estimate so many lags, resulting in an unstable model and IRFs. There is minimal difference between that of 3 and 4 lags, the model being robust across both lag lengths, but due to the detail offered by 4, it was chosen as the final model specification.

Chapter 4: Findings

4.1 Summary

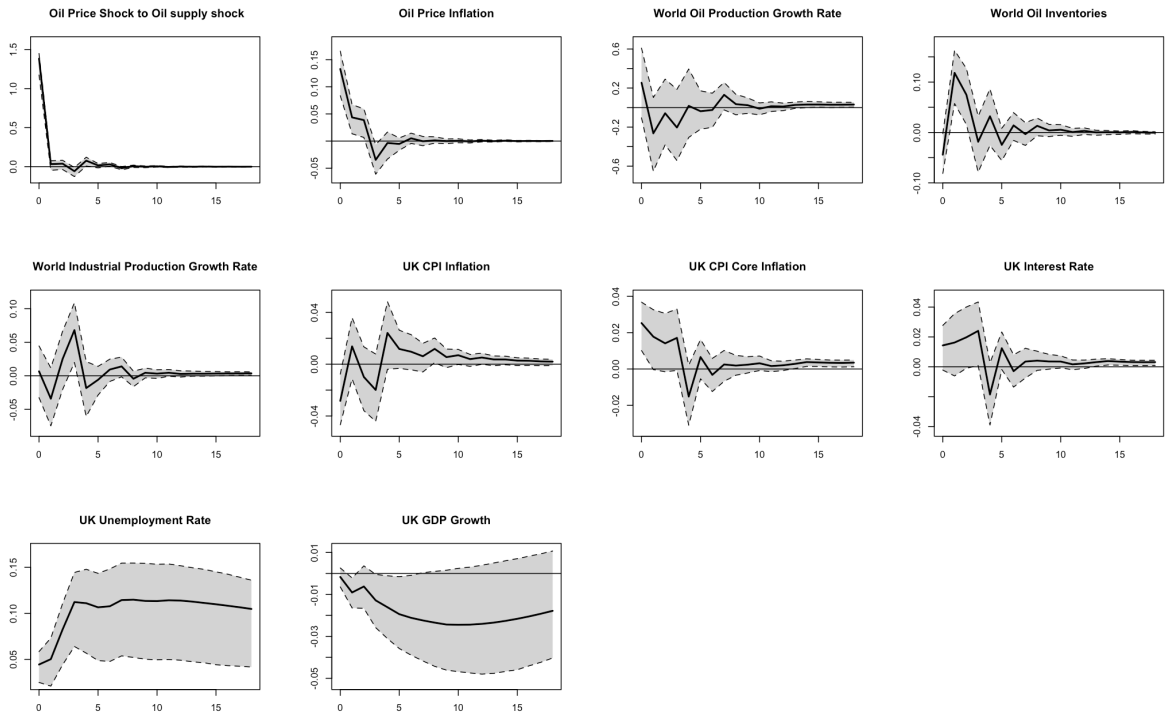
4.1.1 World

The instrument identified a significant 1.68% annualised shock to Oil Price Inflation demonstrating an increase in the growth rate of oil price stabilising in month 6 following the shock. World Oil Production's growth rate sees a statistically insignificant increase of 2.4% annualised on impact yet remains stable over the IRF estimation window. World Oil Inventories sees a significant fall of 1.2% annualised on impact and climbed for 2 months following a shock, oscillating around the baseline before stabilising in month 4 following

the shock. World Industrial production growth rate sees a near zero increase on impact, yet statistically insignificant and remains relatively stable around the baseline.

4.1.2 United Kingdom

Figure 4.1: IRFs of the UK 4 Lag Model



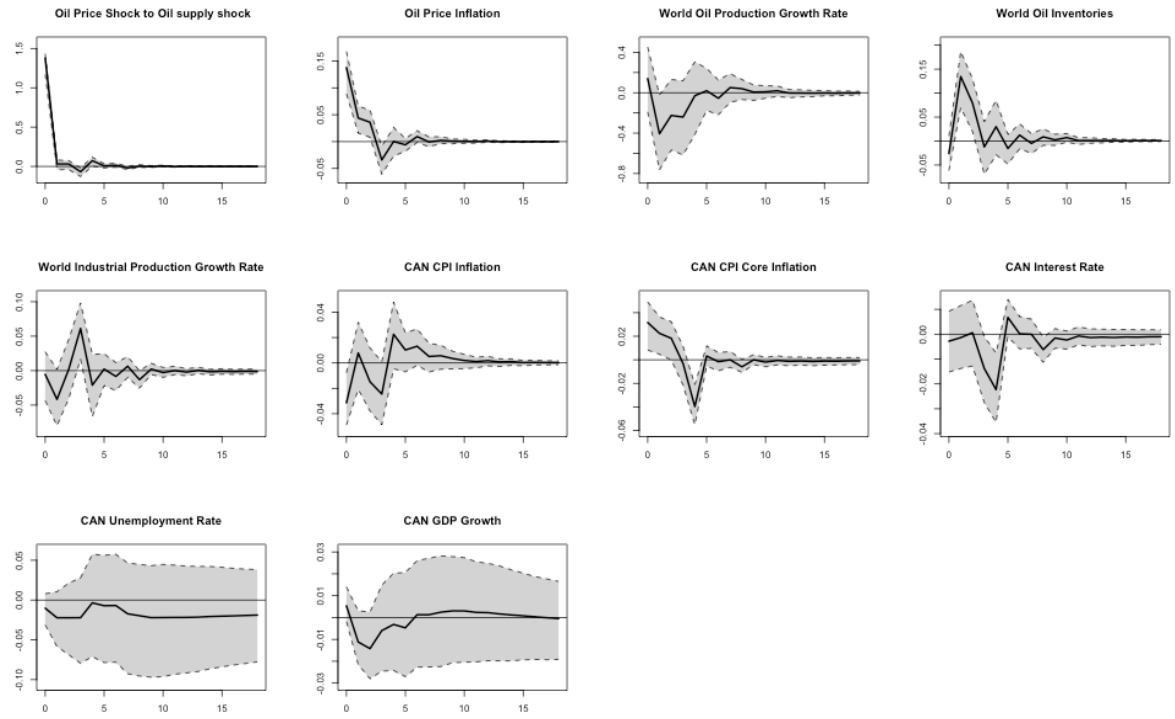
Note: Since these series were multiplied by 100 putting the figures in percentages shown in Figure 1.10, the results will multiplied the displayed value by 12 to obtain annualised rates of change.

CPI sees a significant fall of 0.36% on impact, rising to stable levels within 2 months of impact. It does not return to baseline over the IRF estimation window, staying persistently high. CORE inflation rises significantly to 0.42% on impact and stays high for 3 month before returning to stable levels, yet above the baseline zero similar to CPI. Interest rates rise to 0.18% on impact, though due to wide confidence bans is insignificant. Staying elevated for 3 months before falling to stable levels after 3 months. Unemployment rises to 0.6% on impact, continuing this increasing trend for 3 months to 1.32% before plateauing. It stays persistently high and doesn't stabilise in the IRF estimation window. GDP growth rate falls though insignificantly on impact and continues to fall over the IRF estimation window. The wide and growing confidence bands suggests there are

persistent errors in the model, suggesting a need for 2nd differencing to reduce the risk of type 2 error where we fail to reject the null hypothesis when it is in fact false. The UK being an energy importer sees a fall in GDP growth relative to the benchmark World Industrial Production Growth rate which stayed relatively constant.

4.1.3 Canada

Figure 4.2: IRFs of the Canada 4 Lag Model



Note: Since these series were multiplied by 100 putting the figures in percentages shown in Figure 1.10, the results will multiplied the displayed value by 12 to obtain annualised rates of change.

Canada sees a significant CPI fall of 0.36% on impact, rising then stabilising at baseline over following 5 months. CORE significantly rises to 0.42% on impact stabilising after 7 months and returning to baseline. Interest rates fall insignificantly on impact to 0.18%. Yet remain relatively unchanged over the IRF estimation window. The only significant period being 4 months post-shock where interest rates hit a minimum of 0.48%. Unemployment rates see fall to 0.12% and stay persistently low following the shock. Yet due to the confidence bands width, there is no statistically significant change. GDP growth sees an increase of 0.12% on impact albeit insignificant. It remains relatively stable and unresponsive throughout the IRF estimation window. Canada being an energy

exporter sees a similar trend in GDP growth to the benchmark World Industrial Production Growth rate.

4.2 Pressures to Consumer Finances

The UK sees GDP growth rate to be unchanged on impact but fall consistently over the estimation window. However, when considering statistical significance, it is relatively unchanged, only showing a significant response 5 months after the shock with a fall of 0.24% annualised. The conservative interpretation of no change in income will be taken for this parameter.

Unemployment rises by an annualised 0.6% on impact and continues to rise over the following 3 months to 1.32% where it plateaus. This stark rise with no sign of returning to baseline suggests the null hypothesis of no change is rejected thus the economy sees a fall in job security and a rise in uncertainty.

Core inflation rises significantly yet briefly by 0.42% annualised on impact, losing significance after just 2 months. It oscillates around the baseline but does not stabilise to 0 as it gains significance at an albeit low positive value in month 13 after impact. In these significant periods it erodes the purchasing power of consumer's relatively fixed income, adding financial pressure to consumers' discretionary income.

CPI inflation sees a significant fall of 0.36% annualised on impact but loses significance almost immediately as it rises and oscillates around the baseline. This result puts in question the validity of the above argument of inflationary pressures harming consumer welfare as the null hypothesis is only rejected briefly.

Considering the above, this paper still concludes that consumer welfare is negatively impacted by positive shocks to oil prices as in the short run unemployment significantly rises by a large magnitude while GDP growth stays constant. Though CPI falls implying an increase in purchasing power, this is a relatively small change compared to that of unemployment. Core inflation's results also suggest that the long-run trend in inflation is positive following an oil price shock.

4.3 Does the Central Bank add to Consumer's Financial Pressures?

The UK's interest rate sees an annualised rise of 0.18% on impact albeit insignificant. Then rises to a significant level on 0.24% in the 3rd month following the shock. The response stabilises but not the baseline of 0, gaining significance at a low value in month 13 post-shock. In these significant periods the Central bank response adds financial pressure to consumers through the channel of squeezing discretionary income by increasing the cost of debt. This paper concludes that the central bank response exacerbates the pressures of an oil price increase in the short run.

4.4 Differences Between Energy Importers and Exporters

Canada's GDP growth sees a small and insignificant increase on impact of less than 0.12% annualised but remains relatively unresponsive over the estimation window. Following a trend more akin to World Industrial production than that of the UK, the resident energy importer. Suggesting that the null hypothesis of no response holds. The unemployment rate response is also insignificant yet also shows a trend opposite to that of its energy importing counterpart seeing a fall of less than 0.12% annualised. The fall seen on impact persists through the window further implying there are structural differences between the importers and exporters generating these heterogenous effects.

The interest rate also exhibits no statistically significant change until month 4 post-shock where it falls to 0.24% annualised before increasing and stabilising at the baseline. Core inflation increases significantly on impact to 0.36% before falling to -0.36% in the 4th month after the shock. Yet unlike the UK, it then stabilises at the baseline of 0. CPI inflation similar to that of the UK also exhibits an unexpected and significant fall on impact of 0.36% that quickly loses significance. But in this case it stabilises to 0.

This paper concludes that there are structural differences between energy importing and exporting economies that cause each to react differently to shocks in the price of oil. Particularly in the response of the unemployment rate and central bank.

Chapter 5: Discussion + Policy Recommendations

5.1 World

Economic theory, through the relation of supply and demand, suggests that the increase in oil price identified is attributable to a negative shock in oil supply news from OPEC announcements (Bromberg, 2024). Though the data shows there is no significant response from World Oil production despite OPEC controlling up to 40% of the global oil supply (EIA, 2025). Announcements and policy action made by OPEC should be able to significantly impact global production measures as seen with the 2016 agreement to curtail production to bolster prices (OPEC, 2024). Though unanticipated, this result coincides with Banna's conclusion and policy recommendation of stabilising the energy supply (Banna et al., 2023).

The on-impact increase in production may be attributed to non-OPEC producers e.g. US or Russia capitalising on the high price from the shock. This opportunistic capitalisation argument is supported by the significant fall in World Oil Inventories on impact suggesting inventories may be sold off during the peak of oil price inflation to generate maximum revenues. The inventories rebound to a significant 1.42% annualised indicating a rebuy after the oil price inflation falls. World Industrial Production's insignificant fall is as expected due to the ubiquity and necessity of oil and energy in production as discussed in the Literature Review's inelasticity argument. It is unlikely demand for oil will change in the short-run thus industrial production is unresponsive.

As posited in the literature review supply side shocks are said to be transitory yet the data is contrary to this in the case of the UK parameters. The shocks do not stabilise to the baseline of 0 in the estimation window suggesting that there is a permanent component of these shocks. Both inflation measures, interest rates and unemployment stabilise above the baseline, albeit at small positive values in the case of all but unemployment. Canada's results replicate this behaviour in the case of interest rates and unemployment that stay persistently low. One explanation for this is that once an oil price shock enters the system it affects the price of many goods and wages, 22triggering the aforementioned wage spiral that takes much longer than the 18 months estimated to stabilise. These are called second-round effects of oil price's inflationary pressures in

Holm-Hadulla and Hubrich's 2017 working paper. Alternatively, Kilian posits that changes to aggregate demand have more persistent effects on the macroeconomy than that of supply side shocks (Kilian, 2009). There could be a change in aggregate demand for oil not captured in the dynamics of the model that results in the persistence seen. It is difficult to conclude which interpretation best fits the data without further research and decomposition of types of oil price shocks.

5.2 Fall in CPI on Impact

The significant fall in CPI on impact seen in both the UK and Canadian economies was an unanticipated result. Literature suggests that oil price inflation would constitute a Cost-Push inflationary pressure through the cost of production increasing within the economies (Ahmed et al., 2023). An alternative interpretation that more closely explains this paper's observations is that; the on-impact the upward inflationary pressure exemplified in the significant positive response of Core inflation may be counteracted by reduced aggregate demand as consumers engage in precautionary saving. Yet without a variable to track the domestic savings rate this interpretation can neither be proven or disproven by this report. Another less likely explanation is that the on-impact monetary policy response of increasing interest rates contracts aggregate demand in the same period. This is less likely as there is a transmission period between a policy coming into effect and when it impacts economic actor's behaviour ranging from 18-24months (Mann, 2023).

5.3 The Breakdown of the Philips Curve Relation: Stagflation and Implications for Central Banks

In the UK results, the rise in Core Inflation alongside that of the unemployment rate is contrary to the Philip's Curve relation. The relation states that as inflation rises, unemployment falls as the economy approaches full employment. Resulting in an inverse, downward sloping curve. Or in the long-run unemployment becomes unresponsive to changes in inflation such that the relation is no longer inverse but vertical centred on the natural rate of unemployment (Anderson, 2024). In the case of Cost-Push inflation. This presents a dilemma for traditional Central Bank policy as opposite policy

responses are required for managing high inflation and high unemployment. As shown in Figure 4.1, prioritising increases in interest rates to counteract the high inflation will ultimately worsen unemployment by slowing down the recovery of GDP growth (Nelson and Nikolov, 2002). In the first 3months of high interest rates, core inflation consistently fell, whereas unemployment consistently and sharply rose. Prioritising a fall in interest to stimulate spending and lower unemployment will worsen inflation by stimulating aggregate demand. In this case Central Banks may choose to not respond and '*Look through*' the stagflationary period because as previously stated it is seen to be transitory. Yet a rise in interest rate closely tracking the response of core inflation appears to be the Bank of England's preferred policy. As expected, the unemployment rate worsened over the same period.

5.4 Reallocation Effect

The most responsive variable is the rate of unemployment in the case of the UK, the energy importer. As discussed, the Reallocation effect is likely at play with the initial increase and continued growth within the first 3 months before plateauing. The lack of stabilisation around the baseline suggests that it takes longer than the 18-month IRF estimation window for the frictionally unemployed to find new work. This is unlikely as Böheim finds that the median unemployment period in the UK is 5 months (Böheim and Taylor, 2000). Though the applicability of this finding can be questioned as the study was carried out for the 1990s. Another interpretation is that there is a persistent or permeant component of unemployment caused by shocks to oil price. Literature touches on this with the lay-offs that involve reskilling posited by the Aberdeen researchers discussed in the literature review. This interpretation more closely explains the data as we see a steady decline in the unemployment rate that can be interpreted as unemployed people taking various periods of time to reskill and return to work.

5.5 Short-run Consumer Finance Squeeze

The results show that discretionary income is put under increased pressure, particularly in the first 3 months following an oil price shock as expected given thee literature review findings. Unemployment increases, the primary contributing factor, can be interpreted

as a fall in job security and rise in uncertainty because of the high and immediate responsiveness of unemployment to aggregate uncertainty found in the International Monetary Fund's (IMF) working paper on uncertainty and employment (Choi and Loungani, 2015). Coibion finds that high uncertainty reduces household spending significantly by up to 2.4%, lending credence to the precautionary savings argument and contributing to the delayed recovery of GDP growth seen in the UK economy.

As shown the central bank response worsens pressures to discretionary income in the short-run. This is done through 2 channels, squeezing discretionary income and increasing unemployment rates by increasing the cost of debt, spending is further slowed, delaying the recovery of GDP growth. This is supported by this paper's findings as although this interest rates fall after 3 months, GDP growth does not reverse its downward trend until 9 months post shock. Though curtailing the effect of prolonged inflation may mean the response has ambiguous effect on welfare in the long run.

Importer and Exporter Differences

The literature review describes that difference in GDP growth rate may arises through the trade balance. In oil exporting economies like Canada the trade balance is expected to improve as the price of the commodity sold to the global market increases while demand stays relatively fixed. While with importers the converse is true, and the trade balance worsens. Generally, the data does not support this hypothesis as there is no significant change in Canada's GDP growth. Rafiq's findings explain the data more accurately in that global demand contracts for non-oil related goods due to the increase in oil price, having a net negative or neutral effect on the net trade balance (Rafiq, Sgro and Apergis, 2016). Meaning that for economies with a well-diversified trade balance the expected GDP growth boon from increases in oil price is counteracted by the fall in demand for other exports (Gnimassoun, Joëts and Razafindrabe, 2017). They additionally find that oil supply shocks had no significant impact on Canada's trade balance due to the transitory nature of said shocks, but demand shock had significant positive and lasting effects. The UK sees a significant fall 5 months after impact which the Trade Balance hypothesis fall is likely a component of. With reference to the literature review these differences can be attributable to the economies differing abilities to meet domestic energy requirements.

Policy Implications

This paper recommends the following for policy makers: For energy importing economies, strong monetary policy on impact of an oil price shock can have benefits as the short run squeeze to discretionary income may be justified to manage the long-run depreciative effect of inflation on said income. As without monetary intervention high inflation can persist for up to 2 years following a shock (Lse et al., 2024). For energy exporting economies monetary action is not requited as the inflationary pressure caused by the shock identified is relatively short lived.

Policy makers should aim to increase the production of energy in the economy to meet the domestic energy requirements. Doing so provides a level of energy security that protects the macroeconomic indicators from shocks in international energy markets. Exemplified by the difference in responses between the UK and Canadian economies discussed in this paper.

Chapter 6: Conclusion

6.1 Limitations

Though IRFs show various impacts, in many cases, wide and persistent confidence bands resulted in imprecise, fuzzy conclusions.

Due to structural changes over the sample period of 1980-2016 such as the Global Financial crash of 2008 and technological advancements the relationship between model parameters can undergo structural changes. Using a constant parameter model as seen in this paper, these changes in dynamics are not captured in the model and can result in inaccurate estimates (Sarris, 1973).

6.2 Further Research Suggestions

Drawing on the aforementioned limitations of this study, Alternative approaches to analyse this question such as subsampling the data, Time Varying Parameter (TVP) or Bayesian Vectorised Autoregressive (BVAR) models as seen in the literature of Ahmed et al's and Lin's respective papers could have been used to improve the validity of the

findings. Additionally future research on this topic would benefit from, a larger sample size and increasing the bootstrapping resamples from 1000 to improve on the clarity of the conclusions drawn.

Kilian Lutz suggests since oil price shocks elicit different responses depending on the underlying cause, results as seen this paper will be misleading (Kilian, 2009). For example the central bank may not always be expected to increase interest rates on impact because a price increase caused by a war will require action whereas a temporary supply chain disruption may not. Future research may benefit from a more low-level study into the response for different causes of oil price shock. This will be particularly relevant for the coming decade of energy reforms with cuts in oil production and the rise of renewables as a clean substitute.

Research may also benefit from a historical decomposition of the macroeconomic response to the oil price shocks identified by the instrument. With this, the error in the response can be calculated to gain an understanding of which types of oil price shock the instrument tends to identify e.g. oil price shocks caused by temporary or persistent oil supply movements.

6.2 Conclusion

As made evident by this paper's findings shocks to the price of oil have a number of effects on both energy exporting and importing economies. Due to the security provided by being able to meet domestic energy requirements, energy exporters see relatively positive impacts of an increase in the price of oil due to the structure of their trade balance. GDP growth rises or continues at the pre-shock level, unemployment falls or also remains unimpacted and there is no lasting effect on inflation or interest rates. Though smaller than anticipated from the literature, this reaction is greatly preferred to that of energy importers that see a fall in GDP growth, and a significant rise in unemployment and interest rates. Inflation follows a similar trend between importers and exporters yet in the importer's case it remains persistent in the economy. In the case of the UK consumers face increased pressures on their finances in the short run due to high inflation and unemployment while income stays relatively fixed. Heightened interest

rates from the central bank response serve to worsen this financial squeeze in the short-run. As. Due to the inversion of the Philip's curve relation central banks face a trade-off between addressing high inflation and high unemployment. The UK response of rate hikes adds pressure to consumer finances and slows the recovery of GDP growth, and unemployment. Yet this may be justified given the benefit of subduing the long-run depreciative effect of inflation on the welfare of consumers.

It is recommended that economies push to be able to meet domestic energy requirements to build energy security. With this, production is less sensitive to fluctuations in global energy markets and the economy's welfare is shielded against the downturns resulting from price hikes. The UK has already taken steps toward this through the rapid and planned development of the renewable energy sector in the 21st century.

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Appendices

Figure 1.1: Variable Summary Statistics

Variable	Minimum	Maximum	Mean	Standard Deviation
Instrument	-9.818919	9.373943	0.017652454	1.3471675
OilInf	-2.884768	2.051271	0.004050413	0.5686299
OilProd	-39.418748	36.866433	-0.07555573	8.0990279
OilInv	-7.082559	4.526549	0.062569273	1.2497396
IP	-2.315487	3.798441	0.25387454	0.9750347
UKInf	-3.265213	2.235065	0.205599274	0.5857147
UKInfCore	-0.7	3.409992	0.296464459	0.4493391
UKIr	-1.28866	3.900105	0.2890249	0.542298
UKUR	0.25	17	6.53036036	4.5170316
UKGDPGr	4.7	11.9	7.663288288	2.2052941
CANInf	-3.265213	2.235065	0.205599274	0.5857147
CANInfCore	-1.037165	2.628285	0.254944885	0.3968456
CANIr	-1.004762	2.417759	0.249227456	0.3461556
CANUR	0.5	21.03	5.989977477	4.4400204
CANGDPGr	6	13.1	8.417567568	1.668012

Figure 1.2 Augmented Dickey-Fuller Test Results

Variable	ADF Test Statistic	P-value	Null Hypothesis
Instrument	-7.647145	0.01	Reject
OilInf	-8.136399	0.01	Reject
OilProd	-8.042964	0.01	Reject
OilInv	-9.384478	0.01	Reject
IP	-5.276013	0.01	Reject
UKInf	-5.506466	0.01	Reject
UKInfCore	-6.371539	0.01	Reject
UKIr	-6.222447	0.01	Reject
UKUR	-3.464536	0.046	Reject
UKGDPGr	-3.022828	0.15	Fail to Reject
CANInf	-5.506466	0.01	Reject
CANInfCore	-6.327969	0.01	Reject
CANIr	-4.490186	0.01	Reject
CANUR	-3.219082	0.08	Fail to Reject
CANGDPGr	-3.824972	0.02	Reject

Note: This unit root test was carried out using the 5% critical value of -2.86. After transformations all test statistics were more negative than the critical value suggesting there is no unit root. Though due to high p-values, the null was not rejected in some cases, suggesting a need for cointegration tests to ensure there is no Spurious Regression Problem.

Figure 1.3: Covariance Matrix (UK)

	Instrument	OilInf	OilProd	OilInv	IP	UKInf	UKInfCore	UKIr	UKUR	UKGDPGr
Instrument	1.815	0.170	0.367	-0.023	0.018	-0.053	0.035	0.021	0.031	-0.049
OilInf	0.170	0.323	0.148	-0.016	0.035	0.003	0.031	0.025	0.037	0.004
OilProd	0.367	0.148	65.594	-0.013	-1.188	0.953	0.307	0.367	1.452	-1.290
OilInv	-0.023	-0.016	-0.013	1.562	-0.011	0.030	-0.067	-0.050	-0.187	-0.170
IP	0.018	0.035	-1.188	-0.011	0.951	0.009	0.051	0.042	0.931	0.355
UKInf	-0.053	0.003	0.953	0.030	0.009	0.343	-0.020	-0.008	0.160	-0.090
UKInfCore	0.035	0.031	0.307	-0.067	0.051	-0.020	0.202	0.223	0.856	0.165
UKIr	0.021	0.025	0.367	-0.050	0.042	-0.008	0.223	0.294	0.953	0.197
UKUR	0.031	0.037	1.452	-0.187	0.931	0.160	0.856	0.953	20.404	4.510
UKGDPGr	-0.049	0.004	-1.290	-0.170	0.355	-0.090	0.165	0.197	4.510	4.863

Figure 1.4: Covariance Matrix (Canada)

	Instrument	OilInf	OilProd	OilInv	IP	CANInf	CANInfCore	CANIr	CANUR	CANGDPGr
Instrument	1.815	0.170	0.367	-0.023	0.018	-0.053	0.041	0.000	0.025	-0.025
OilInf	0.170	0.323	0.148	-0.016	0.035	0.003	0.056	0.004	0.098	0.013
OilProd	0.367	0.148	65.594	-0.013	-1.188	0.953	0.203	0.168	0.987	-1.185
OilInv	-0.023	-0.016	-0.013	1.562	-0.011	0.030	-0.043	-0.018	-0.381	-0.094
IP	0.018	0.035	-1.188	-0.011	0.951	0.009	0.068	0.066	1.063	0.220
CANInf	-0.053	0.003	0.953	0.030	0.009	0.343	-0.007	-0.008	0.048	-0.097
CANInfCore	0.041	0.056	0.203	-0.043	0.068	-0.007	0.157	0.103	0.790	0.036
CANIr	0.000	0.004	0.168	-0.018	0.066	-0.008	0.103	0.120	0.796	0.059
CANUR	0.025	0.098	0.987	-0.381	1.063	0.048	0.790	0.796	19.714	2.733
CANGDPGr	-0.025	0.013	-1.185	-0.094	0.220	-0.097	0.036	0.059	2.733	2.782

Figure 1.5: Correlation Matrix (UK)

	Instrument	OilInf	OilProd	OilInv	IP	UKInf	UKInfCore	UKIr	UKUR	UKGDPGr
Instrument	1.000	0.222	0.034	-0.013	0.014	-0.067	0.057	0.028	0.005	-0.016
OilInf	0.222	1.000	0.032	-0.022	0.063	0.010	0.122	0.080	0.015	0.003
OilProd	0.034	0.032	1.000	-0.001	-0.150	0.201	0.084	0.084	0.040	-0.072
OilInv	-0.013	-0.022	-0.001	1.000	-0.009	0.041	-0.119	-0.074	-0.033	-0.062
IP	0.014	0.063	-0.150	-0.009	1.000	0.016	0.115	0.079	0.211	0.165
UKInf	-0.067	0.010	0.201	0.041	0.016	1.000	-0.075	-0.026	0.060	-0.070
UKInfCore	0.057	0.122	0.084	-0.119	0.115	-0.075	1.000	0.914	0.422	0.166
UKIr	0.028	0.080	0.084	-0.074	0.079	-0.026	0.914	1.000	0.389	0.165
UKUR	0.005	0.015	0.040	-0.033	0.211	0.060	0.422	0.389	1.000	0.453
UKGDPGr	-0.016	0.003	-0.072	-0.062	0.165	-0.070	0.166	0.165	0.453	1.000

Figure 1.6: Correlation Matrix (Canada)

	Instrument	OilInf	OilProd	OilInv	IP	CANInf	CANInfCore	CANIr	CANUR	CANGDPGr
Instrument	1.000	0.222	0.034	-0.013	0.014	-0.067	0.076	-0.001	0.004	-0.011
OilInf	0.222	1.000	0.032	-0.022	0.063	0.010	0.250	0.020	0.039	0.014
OilProd	0.034	0.032	1.000	-0.001	-0.150	0.201	0.063	0.060	0.027	-0.088
OilInv	-0.013	-0.022	-0.001	1.000	-0.009	0.041	-0.086	-0.042	-0.069	-0.045
IP	0.014	0.063	-0.150	-0.009	1.000	0.016	0.177	0.196	0.246	0.136
CANInf	-0.067	0.010	0.201	0.041	0.016	1.000	-0.032	-0.040	0.019	-0.100
CANInfCore	0.076	0.250	0.063	-0.086	0.177	-0.032	1.000	0.753	0.449	0.055
CANIr	-0.001	0.020	0.060	-0.042	0.196	-0.040	0.753	1.000	0.518	0.102
CANUR	0.004	0.039	0.027	-0.069	0.246	0.019	0.449	0.518	1.000	0.369
CANGDPGr	-0.011	0.014	-0.088	-0.045	0.136	-0.100	0.055	0.102	0.369	1.000

Figure 1.7: UK Time Series Plots

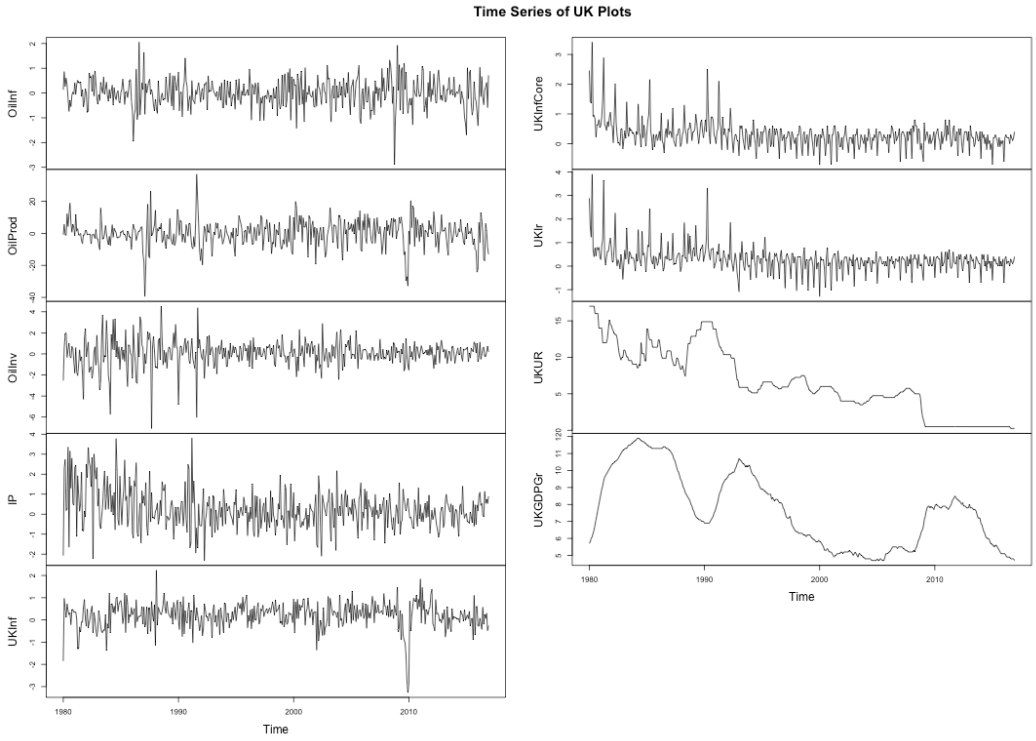
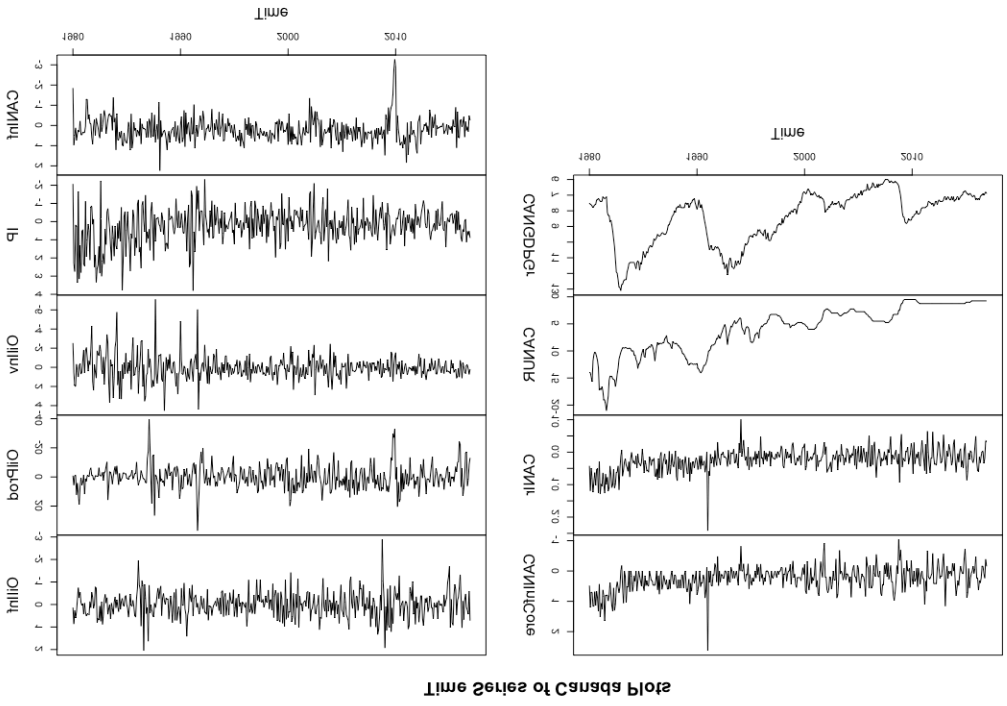
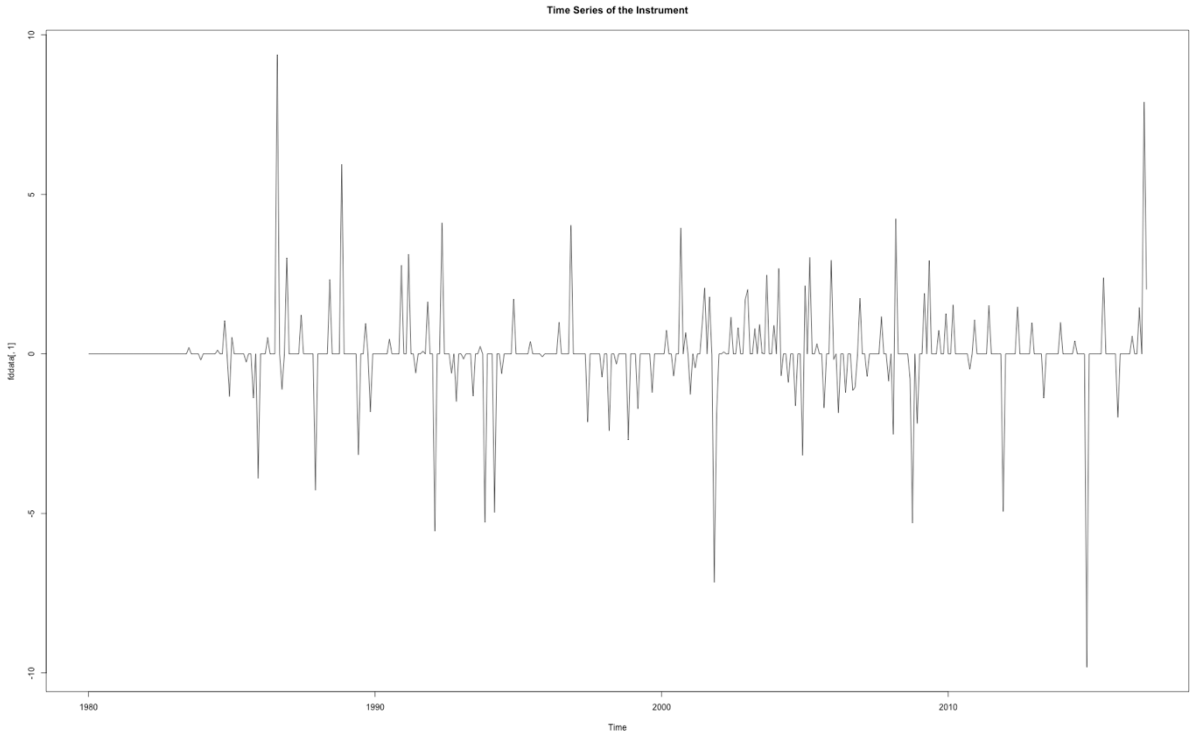


Figure 1.8: Canada Time Series Plots



Note: This was carried out as a visual check of the data and resulted in finding the inflation measures required de-seasonalisation.

Figure 1.9: Time Series Plot of The Instrument



Note: This shows the average surprise it future contract price across the yield curve following an OPEC announcement. The 0 values represent days with no OPEC announcement .

Figure 1.10: Series Transformations

Variable	Transformation
Instrument	100*log + FD
OilInf	100*log + FD
OilProd	100*log
OilInv	100*log
IP	100*log
Inf	deseasonalised
InfCore	deseasonalised
Ir	N/A
UR	N/A
GDPGr	100*log + FD

Note: FD: First Differenced, Log: log base 100, 100*: multiplied by 100

Figure 3.1: IRFs of UK 3 Lag Model

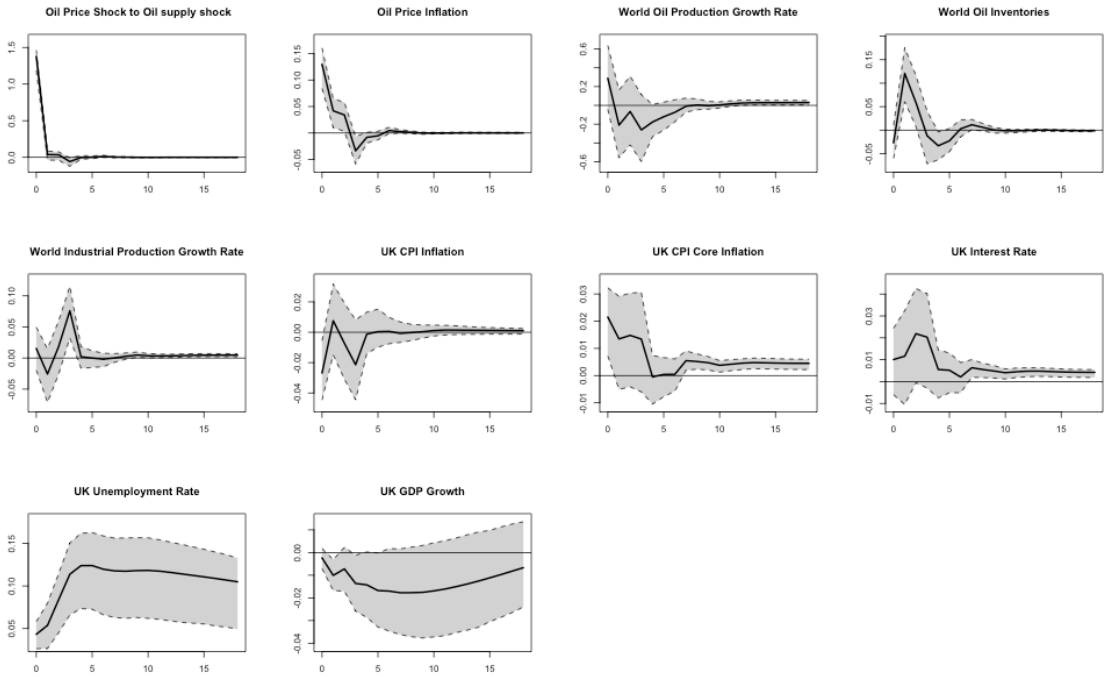


Figure 3.2: IRFs of Canda 3 Lag Model

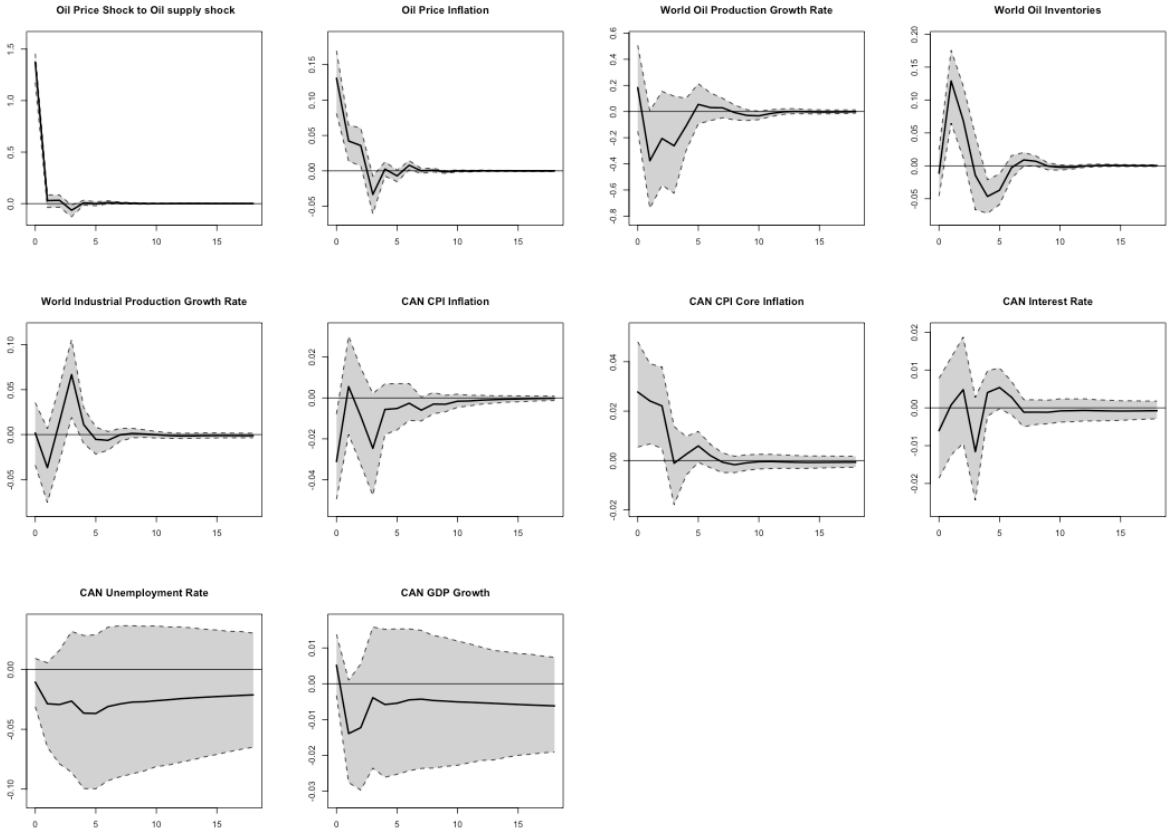


Figure 3.3: IRFs of UK 12 Lag Model

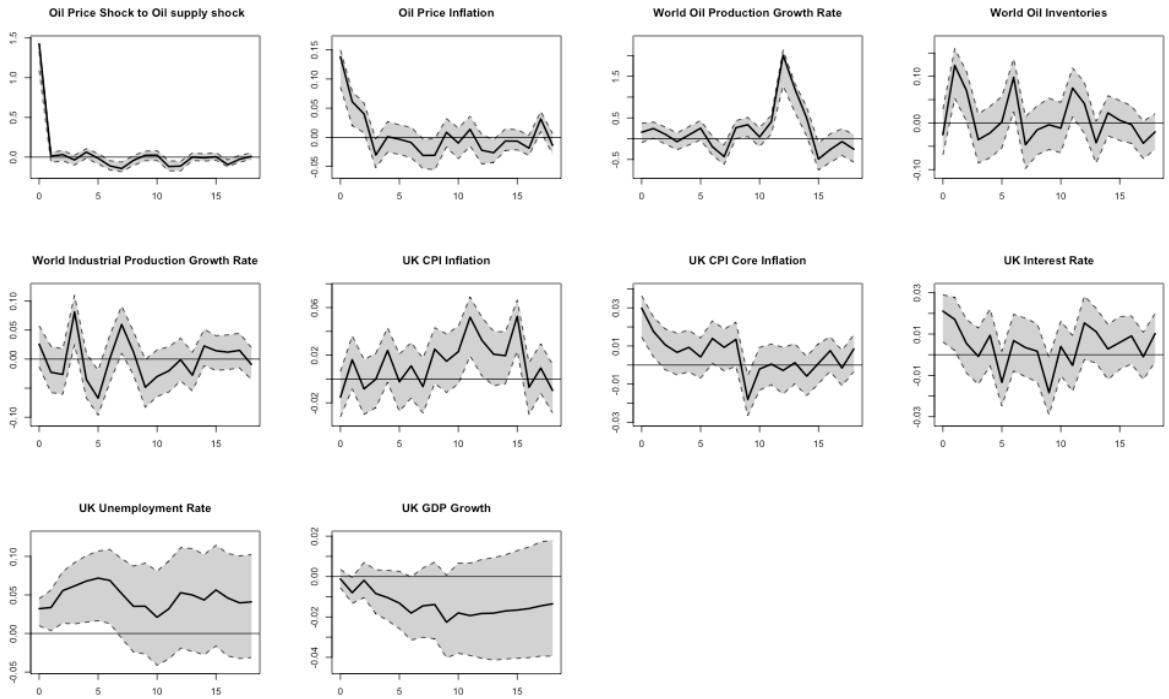


Figure 3.4: IRFs of Canada 12 Lag Model