



Asociación
Cuadernos
de economía

Cuadernos de economía

www.cude.es



In the Wake of Crisis: Investigating Causal Impact with Wavelet Analysis of Oil Prices on Inflation in G20 Countries

Haitham Khoj^{1*}, Mohammed Saeed²

¹ Associate Professor, King Abdulaziz University, Saudi Arabia.

ORCID iD: <https://orcid.org/0000-0002-7031-3657>, Email: hkhøj@kau.edu.sa

² Assistant Professor, King Abdulaziz University, Saudi Arabia.

ORCID iD: <https://orcid.org/0009-0005-9331-968X>, Email: msaeed@kau.edu.sa

*Corresponding Author Email: hkhøj@kau.edu.sa

Keywords:

Asymmetries, Causal Impact, G20 Countries, Global Disruptions, Inflation, Oil Prices, Wavelet Analysis.

Abstract: This study examines the nexus between oil prices and inflation in G20 economies, addressing the critical gaps by adopting a comparative approach across three pivotal oil price downturns in 2008, 2014, and 2020 (during the COVID-19 pandemic). This study utilised monthly time series data from January 2000 to December 2023 and the Bayesian Structural Time Series (BSTS) approach for causal impact analysis. This study found that during the global financial crisis (December 2007 to June 2014), advanced economies such as Australia and the UK displayed varying degrees of negative absolute causal impact, aligning with the deflationary impact of falling oil prices. In contrast, emerging economies faced significant negative causal impacts. From June 2014 to January 2020, diverse inflation impacts were observed across G20 economies after a significant oil price decline. Advanced economies such as Australia and emerging economies such as Brazil experienced negative impacts, while others showed negligible effects. In the subsequent period from January 2020 to December 2023, amid the COVID-19 pandemic and substantial oil price decline, G20 countries exhibited varied inflation outcomes. According to the results, there were absolute positive effects, which had a direct connection to high inflation rates. However, China was exceptional, as it had a significantly negative response. According to the wavelet coherence analysis, oil prices have an uneven and asymmetrical effect on inflation. This study's results will help policymakers understand how various economies respond to shocks related to oil prices. Notably, this study also highlights the need for policymakers to develop flexible and forward-looking policies. As a result, this study underscores the need for G20 countries to develop strategic interventions that can adapt to the varying ways oil prices influence inflation, to keep their economies stable.

Author Correspondence: hkhøj@kau.edu.sa

<https://doi.org/10.32826/cude.v48i136.1008>

0210-0266/© 2025 asociación Cuadernos de economía. Todos los derechos reservados

Introduction

The nexus between oil prices and inflation has long held centre stage in the macroeconomic discussion (Bernanke, 1983; Hamilton, 1996). It features well-structured bilateral interconnections between a range of economic and financial services, highlighting its central position in guiding the macro-policy and welfare of society (Farzanegan & Markwardt, 2009; Salisu et al., 2017). As a raw material important in industrialisation, oil produces energy, which is a crucial raw input in terms of transportation and the production of goods. Therefore, fluctuations in oil prices have a strong effect on the entire economy, affecting the purchasing power of consumers and, consequently, central bank policy (Lorusso & Pieroni, 2018; Segal, 2011). Therefore, it is vital to understand the causal link between oil price fluctuations and inflation. This will enable policymakers to provide effective responses, reduce economic instability, and protect the well-being of millions of people (Abdulrahman, 2023; Kan & Serin, 2022; Nazlioglu, Gormus, & Soytaş, 2019). In the 1970s, there was a significant surge in inflation, closely tethered to abrupt spikes in oil prices globally. The subsequent decades saw inflation diminish alongside downturns in oil prices (Barsky & Kilian, 2002; Nelson, 2005). Moreover, during the COVID-19 pandemic, in January 2020, global oil prices experienced a substantial decline. Surprisingly, despite this downturn in oil prices, there was an observed increase in inflation on a global scale. The apparent disparity in the trends of oil prices and the mixed findings in the related literature leave room for ongoing debate and prompt a need for an in-depth examination of the relationship between WOP and inflation (Álvarez et al., 2011; Bernanke, 1983; Hamilton, 1996, 2003, 2011; Hooker, 1996; Renou-Maissant, 2019; Sek, 2017; Wu & Ni, 2011).

This study builds on prior research by Escobari & Sharma (2020), Li & Guo (2022), Khan et al. (2019), and Mensi et al. (2023), specifically investigating the asymmetric effects of oil price shocks on inflation. In contrast to conventional methods, our approach focuses on causal inferences, utilising the BSTS technique to precisely measure the magnitude of the causal impact during episodes of decreasing oil prices. A distinctive feature of our methodology lies in its comparative nature, delving into responses across distinct oil price shock episodes, encompassing the years 2008, 2014, and 2020 (during the COVID-19 pandemic). This approach enables an examination of the inherently asymmetrical nature of the causal impact. However, recognising the limitations of scrutinising the causal link between oil prices and inflation, our research responds to the observed “asymmetric impact” phenomenon highlighted in the existing literature. It posits that upward oil price shocks exert more distinct inflationary pressures than the deflationary effects induced by downward shocks. To delve deeper, our study focuses explicitly on three recent oil price downturns: 2008, 2014, and 2020.

The nexus of oil prices and inflation for G20 economies holds paramount importance for several reasons. Firstly, the G20 economies constitute over 80% of global GDP (Taylan, Alkabaa, & Yilmaz, 2022) and are an important indicator of global economic health in terms of inflation. Secondly, oil remains a cornerstone of energy consumption across most G20 economies, which leads to its price fluctuations being a potent driver of inflationary pressures (Renou-Maissant, 2019). The sharp oil price downturns in 2008, 2014, and 2020 during the COVID-19 pandemic highlight the urgent need to better understand the extent of their casual impacts.

There is a clear asymmetry in how oil prices shocks affect

inflation. Developed economies struggled with deflationary pressures from falling oil prices, but emerging economies were strongly affected by negative causal effects during the downturns. Between January 2020 and December 2023, during the COVID-19 pandemic, declining oil prices had uneven inflation outcomes in different economies. By integrating partial wavelet coherence, wavelet coherence, and multivariate wavelet coherence analysis, this study reveals the robustness of these asymmetries and determines varying strengths in the relationship between oil prices and inflation. The wavelet coherence analysis also includes exchange rates, which show a strong influence, especially in advanced economies. The findings of this study lead to an important conclusion: policymakers should not rely on generic responses; instead, they need tailored and proactive strategies for each country's unique economic structure, its vulnerability to exchange rate movements, and its exposure to global shocks. Other studies have mainly focused on co-movements, but this study has quantified the magnitude of the causal impacts and reveals how asymmetric responses shape outcomes in different countries. Combining wavelet coherence analysis with the Bayesian Structural Times Series (BSTS) approach, this study gives precise estimates of the causal effects in major downturns, which addresses the traditional linear models' weaknesses (Hamilton, 2011; Hooker, 1996). By using this approach, this study contributes significantly to the growing literature that reveals the nonlinear and uneven nature of oil price shocks (Nasir, Huynh, & Yarovaya, 2020; Raheem, Bello, & Agboola, 2020). This study examines both advanced and emerging G20 economies, offering a comprehensive overview on how inflationary responses are different, reflecting the heterogeneous structures of the world's largest economies. The findings are significant because they provide policymakers with critical insights into the unique impact that oil price dynamics have on inflation in their respective contexts, enabling tailored and adaptive policy responses. Additionally, this research has practical applications for economists and financial analysts interested in understanding the complex interplay between global oil markets and macroeconomic variables. This study is crucial, as it provides valuable insights for policymakers aiming to understand the two different inflationary responses to oil price shocks, which allow us to formulate adaptive and proactive economic policies. Multinational corporations, especially within energy-intensive sectors, can also use these insights to better anticipate inflationary pressures during oil price swings, while governments can leverage the findings to use their fiscal and monetary policies to stabilise inflation and support economic resiliency during times of global disruption. The related literature is discussed in the next section. Section 3 covers the data and methodology. Section 4 presents the results, and Section 5 provides the conclusions.

Literature Review

Bernanke's (1983) hypothesis that rising oil prices result in deferred corporate investments and production declines, fuelling inflation, received corroboration in subsequent studies, such as those of Peter Ferderer (1996) and Farzanegan & Markwardt (2009). The latter highlighted the importance of comprehending the nonlinear dynamics between oil price volatility and macroeconomic variables, especially inflation. One of the central threads in the literature has been the investigation of asymmetric effects. Salisu et al. (2017) determined that oil price shocks tend to have differential short- and long-term consequences on inflation, with net oil-importing nations

being more severely affected. Similarly, [Sek \(2017\)](#) examined the role of oil prices in domestic inflation in Malaysia, revealing both symmetric and asymmetric effects across sectors.

These findings imply that the influence of oil price volatility on inflation is not monocultural and that the nature of the domestic economy controls such impacts through the mediation of its structure. A study of 72 economies, conducted by [Choi et al. \(2018\)](#), showed that a 10% increase in worldwide oil prices boosted household inflation by 0.4 points, with varying durations between nations. This nonconformist trend has been reported in research involving the heterogeneity of regions. As an example, [Bala & Chin \(2018\)](#) studied the African members of OPEC, namely, Angola, Libya, Nigeria, and Algeria, and discovered that falling oil prices had a more deflationary than inflationary impact in these countries. In the same manner, the study conducted by [Khan et al. \(2019\)](#) established that oil-price shocks in the Asian economies had different impacts on economic activity based on the appreciation or depreciation of prices.

[Li & Guo \(2022\)](#) expanded their research to the BRICS, in addition to up-and-coming economies, finding that there were strong asymmetries, especially in China, where the deflationary effects of falling oil prices surpassed the inflationary effect of price gains.

Additional support can be found in [Nusair & Olson \(2021\)](#), who reported that, in Southeast Asian economies, the negative implications of an increase in oil prices were more consequential than the positive implications of a decline in prices. These combined findings highlight how important regional economic forms are in the process of defining the oil-price-inflation nexus. Although literature unanimously attributes oil-price movement to inflation, more studies should be conducted to outline the entire scope of the effects and to determine how common asymmetry is. Furthermore, the causal significance of different oil-price shock events has not been studied in the literature, and most studies have focused on directional causality and co-movement ([Beckmann & Czudaj, 2013](#); [Nazlioglu et al., 2019](#); [Sek, 2017](#)).

As a result, the current study aimed to fill this gap by determining the causal influence of shock related to oil prices on inflation across G20 countries and highlighting possible asymmetries in the reactions. In short, although the importance of oil prices as determinants of inflation is largely acknowledged in the literature, there is wide disagreement about both the extent and asymmetry of such effects in various regions and economic circumstances. This study contributes to the ongoing debate by providing empirical evidence on the causal effects of oil prices shocks in the G20 economies. What makes this study unique is the focus on the crucial role of asymmetries and regional differences in how inflationary outcomes develop in different countries.

Methodology and Data

Causal Impact - Bayesian Structural Time Series (BSTS)

The Bayesian Structural Time Series-based Causal Impact framework is a powerful model used to determine the causation between WOP and inflation. [Brodersen et al. \(2015\)](#) followed this causal impact framework and built state-space models. The basic process design of the BSTS model is as follows:

$$y_t = Z_t \alpha_t + X_t \beta + \epsilon_t \quad (1)$$

where y_t , α_t , Z_t , X_t , and β are observed inflation rate, hidden state vector, observation matrix, external

covariates, and vector of coefficients respectively. ϵ_t is the innovation vector and is assumed to be normally distributed with mean zero and variance σ^2 .

$$\epsilon_t \sim N(0, \sigma^2) \quad (2)$$

This study used the exchange rate (ER) as a covariate of interest to regulate the effects of exchange rate volatility on the effect of inflation. It has three major elements constituting the state-space representation, which are the observation equation, the state transition equation, and innovations. The state transition equation is the equation describing the time dependence of the latent state vector:

$$\alpha_{t+1} = T_t \alpha_t + R_t \eta_t \quad (3)$$

where T_t is the transition matrix, R_t is the input matrix, and η_t is the state innovation vector which is assumed to follow a normal distribution with mean zero and covariance matrix Q_t .

$$\eta_t \sim N(0, Q_t) \quad (4)$$

This study used the Bayesian Structural Time Series (BSTS) model on individual periods during the periods of 2008, 2014, and 2020, which were separate oil price downturns. This was achieved by making the model consistent with the observed empirical data in each downturn and obtaining samples to provide an estimate of the causal effect of the World Oil Price (WOP) on inflation. The BSTS approach included a counterfactual analysis that allowed differentiating the observed course of inflation and the counterfactual scenario, which would have occurred in the absence of oil price shocks ([Bednar, 2021](#); [Brodersen et al., 2015](#)). This counterfactual paradigm is the basis on which the cause of WOP on inflation in either downturn is established. Notably, the approach explains the varied economic conditions and reactions to the scenario of oil price shocks in the discussed episodes. Its inherent flexibility allows for the introduction of exogenous covariates, which makes it especially appropriate for our task to gauge the effect of WOP on inflation and at the same time to consider the role played by exchange rates. The Bayesian foundations offer a sound concept of uncertainty quantification thus facilitating a more effective inference of the estimated causal effects ([Brodersen et al., 2015](#)).

Prior Distributions and Prior Elicitation

Assigning prior distributions to the model parameters is a crucial step in implementing the Bayesian approach. Let β represent the vector of coefficients associated with the external covariates and its prior distribution is denoted as $p(\beta)$ which captures our beliefs about the plausible values of these coefficients. Similarly, prior distributions are assigned to the parameters of the state space model. The information or assumptions about the plausible values of the transition matrices, input matrices, and innovation variances are encoded by these priors ([Box & Tiao, 2011](#); [Brodersen et al., 2015](#)).

Inference

Inference in Bayesian analysis involves the principles by which the previous assumptions about the model parameters have been revised as a result of the empirical data. The parameters are then inferred by their posterior distribution, using the observed data, which include the inflation y_t :

$$p(\alpha_t, \beta | y_t) \propto p(y_t | \alpha_t, \beta) (\alpha_t, \beta) \quad (5)$$

Accordingly, the posterior distribution considers the updated data of latent states and coefficients, taking into account both the observed and predicted results.

Gibbs sampling or Metropolis-Hastings algorithms are commonly used to draw samples of the posterior distribution using Markov Chain Monte Carlo (MCMC) techniques ([Box & Tiao, 2011](#); [Brodersen et al., 2015](#)). Such

procedures provide estimations of the latent states and model parameters.

Evaluating Impact

The cause effect is gauged by evaluating the inflation outcome as observed historically against an ex post facto situation whereby oil prices are kept constant. This counterfactual is created by extrapolating in time an underlying econometric model to subsequently infer which inflationary path would have been dominant were oil prices to be fluctuating (Brodersen et al., 2015). The ensuing causal effect in terms of the difference in the resulting inflation and the counterfactual inflation is determined. Counterfactual analyses were conducted separately on the three downturns in oil prices that occurred in 2008, 2014, and 2020.

Wavelet Coherence Analysis

Wavelet coherence analysis was conducted to indicate comoments and the strength of the results. We describe wavelet transform coherence (WTC), partial wavelet coherence (PWC) and multivariate wavelet transform coherence (MWTC), based on previous research (Aloui et al., 2018; Jiang & Yoon, 2020; Tiwari et al., 2019).

Wavelet Transform Coherence (WTC)

WTC is utilized to assess the coherence between WOP and INF at various time-frequency locations. Let $X(t)$ and $Y(t)$ represent two time series, and $WTC_{XY}(\omega, t)$ denote the WTC $X(t)$ and $Y(t)$ at frequency ω and time t . The formula for WTC is given by:

$$WTC_{XY}(\omega, t) = \frac{|P_{XY}(\omega, t)|^2}{P_X(\omega, t)P_Y(\omega, t)} \quad (6)$$

where $P_{XY}(\omega, t)$ is the cross-wavelet power, and $P_X(\omega, t)$ and $P_Y(\omega, t)$ are the wavelet power spectra of $X(t)$ and $Y(t)$ respectively. WTC ranges from 0 to 1, with higher values indicating stronger coherence.

Partial Wavelet Coherence (PWC)

PWC extends WTC by considering the influence of a third variable, providing insights into the direct relationship between two variables after removing the effect of the third. Let $Z(t)$ be the third time series (exchange rate). The

PWC between $X(t)$ and $Y(t)$ given $Z(t)$ at frequency ω and time t is given by:

$$PWC_{XY.Z}(\omega, t) = \frac{|P_{XY.Z}(\omega, t)|^2}{P_{X.Z}(\omega, t)P_{Y.Z}(\omega, t)} \quad (7)$$

The terms $P_{XY.Z}(\omega, t)$, $P_{X.Z}(\omega, t)$, and $P_{Y.Z}(\omega, t)$ are cross-wavelet powers and wavelet power spectra involving the three variables. PWC allows for the identification of direct relationships between $X(t)$ and $Y(t)$ after accounting for the influence of $Z(t)$.

Multivariate Wavelet Transform Coherence (MWTC)

MWTC extends the analysis to multiple variables, allowing for the simultaneous examination of coherence among WOP, INF, and ER. Let $X(t)$, $Y(t)$, and $Z(t)$ represent the three time series. The MWTC between $X(t)$, $Y(t)$, and $Z(t)$ at frequency ω and time t is given by:

$$MWTC_{XYZ}(\omega, t) = \frac{|P_{XYZ}(\omega, t)|^2}{P_X(\omega, t)P_Y(\omega, t)P_Z(\omega, t)} \quad (8)$$

where $P_{XYZ}(\omega, t)$ is the cross-wavelet power, and $P_X(\omega, t)$, $P_Y(\omega, t)$ and $P_Z(\omega, t)$ are the wavelet power spectra of $X(t)$, $Y(t)$, and $Z(t)$ respectively. MWTC offers insights into coordinated behavior and interactions among the three variables.

The time-frequency representation generated through wavelet analysis provides visual insights into the evolution of coherence over time and frequency. It allows for the identification of periods and frequencies where the relationships between WOP, INF, and ER are particularly prominent or weak.

Data

Examining monthly data on West Texas Intermediate crude oil prices and inflation rates based on the Consumer Price Index (CPI) across G20 economies, we delve into the dynamics of both net oil exporters and importers. Our analysis also includes the exchange rate as a control variable with the oil-inflation connection, as highlighted by Cerra (2019), Cologni & Manera (2008) and Günay (2018). For G20 nations utilizing the Euro, we introduce the Real Effective Exchange Rate (REER) as a control variable, aiming for a more comprehensive perspective. Unfortunately, the inclusion of other monthly variables was hindered by inconsistent data availability.

Table 1: Descriptive Statistics and Unit Root Tests - Inflation and WOP.

	Mean	Max.	Min.	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	ADF	PP
Australia_INF	2.86	7.80	-0.30	1.48	1.24	4.45	98.72 ^a	-3.53 ^a	-2.80 ^c
Brazil_INF	0.51	3.02	-0.68	0.40	1.53	9.81	668.95 ^a	-8.45 ^a	-8.09 ^a
Canada_INF	0.18	1.43	-1.04	0.39	-0.01	3.38	1.77	-13.14 ^a	-12.75 ^a
China_INF	0.17	2.60	-1.39	0.61	0.36	3.61	10.76 ^a	-3.04 ^b	-12.97 ^a
France_INF	0.14	1.42	-1.00	0.34	0.10	3.89	10.03 ^b	-2.35	-17.11 ^a
Germany_INF	0.16	1.98	-1.03	0.39	0.41	5.37	75.72 ^a	-2.21	-18.01 ^a
India_INF	0.50	4.58	-1.60	0.72	0.65	6.46	162.46 ^a	-2.93 ^b	-12.37 ^a
Indonesia_INF	0.49	8.71	-0.46	0.70	6.01	66.64	50334.57 ^a	-13.19 ^a	-13.16 ^a
Italy_INF	0.17	3.42	-0.68	0.32	3.91	40.26	17391.34 ^a	-7.95 ^a	-15.40 ^a
Japan_INF	0.03	2.09	-0.80	0.30	0.98	9.74	589.19 ^a	-14.23 ^a	-14.16 ^a
Korea_INF	0.21	1.30	-0.74	0.37	0.12	2.93	0.72	-2.92 ^b	-12.52 ^a
KSA_INF	0.19	5.87	-1.05	0.54	5.64	53.21	31782.95 ^a	-14.82 ^a	-15.34 ^a
Mexico_INF	0.38	1.70	-1.01	0.36	-0.42	4.33	29.72 ^a	-3.80 ^a	-9.56 ^a
Russia_INF	0.79	7.61	-0.54	0.76	3.50	27.48	7215.26 ^a	-5.25 ^a	-5.42 ^a
South_Africa_INF	0.43	1.70	-1.14	0.44	0.34	3.81	13.17 ^a	-11.78 ^a	-12.18 ^a
Turkiye_INF	1.45	13.58	-1.44	1.87	2.81	14.27	1895.84 ^a	-3.48 ^a	-7.40 ^a
UK_INF	0.20	2.15	-0.70	0.34	0.51	7.39	244.34 ^a	-2.37	-15.87 ^a
USA_INF	0.21	1.37	-1.92	0.39	-0.55	6.16	133.94 ^a	-10.37 ^a	-8.65 ^a
WOP	63.14	133.96	16.98	25.71	0.27	2.23	10.64 ^a	-2.93 ^b	-2.62 ^c

Note: a, b, and c are the level of significance at 1%, 5% and 10% respectively

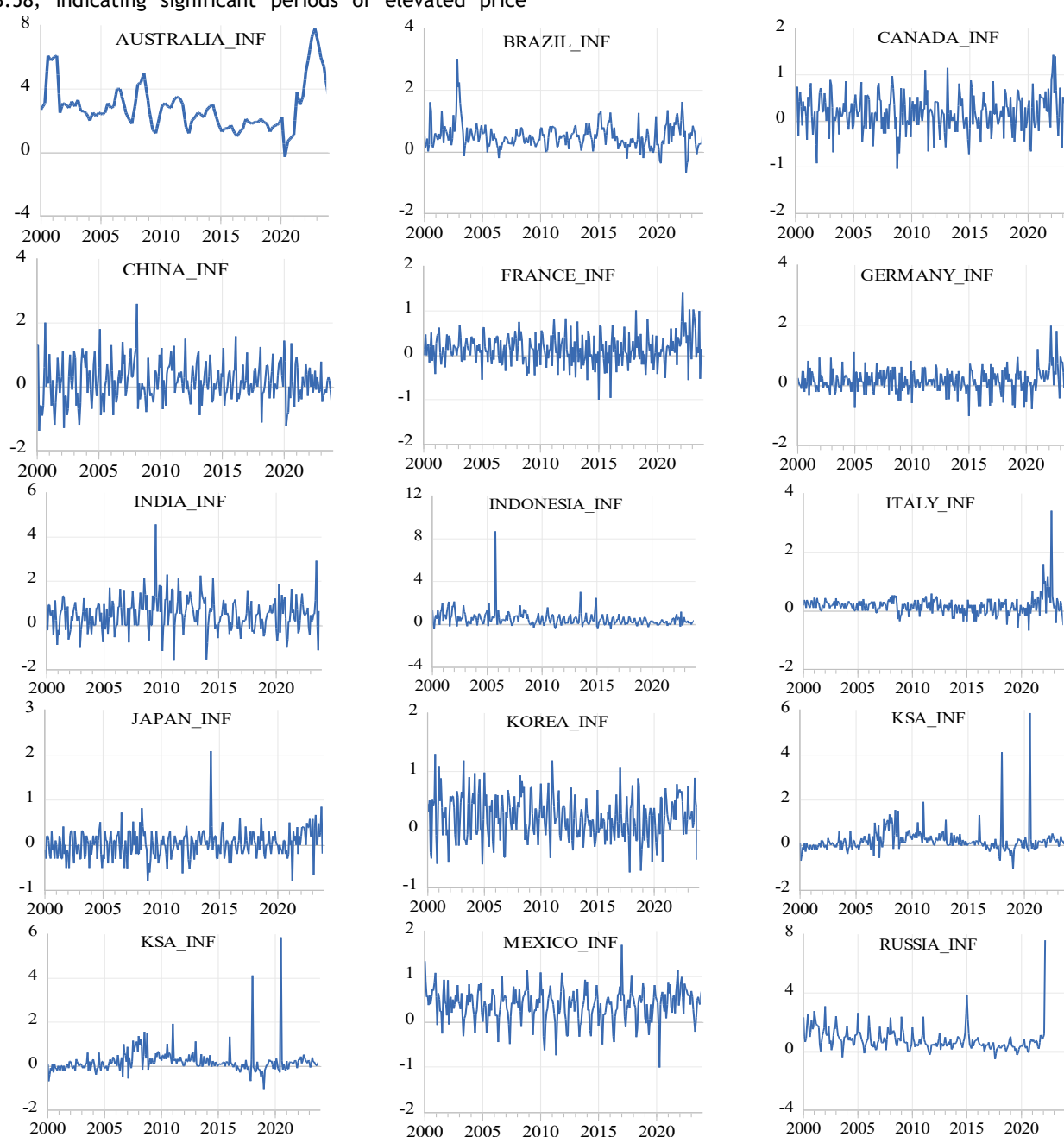
The sampled period spans from January 2000 to December 2023, capturing pivotal events such as the 2007 and 2014 oil price shocks and the disruptive circumstances of the

COVID-19 pandemic in 2020. Data is sourced from the International Financial Statistics for Inflation (CPI and exchange rates) and WOP data from St. Louis (2023).

Table 1 offers a comprehensive glimpse into the inflation rates and WOP of G20 nations. In terms of descriptive statistics, the mean inflation rates vary notably, with Australia exhibiting a relatively higher mean of 2.86, while Japan records a significantly lower mean of 0.03. The standard deviations reveal the volatility of inflation, with Indonesia displaying higher fluctuations compared to the more stable inflation environment in the UK. The unit root test results of the ADF and PP statistics Table 1 provide the stationarity of inflation and oil price series. The higher negative ADF and PP statistics indicate evidence against a unit root. Specific countries like Brazil, Canada, India, and others exhibit strong evidence against a unit root, pointing to stable inflation dynamics. Conversely, the UK and Germany showcase evidence against a unit root with less pronounced statistics, suggesting relatively consistent economic conditions. These unit root test results collectively lay the foundation for robust econometric analyses.

Figure 1 illustrates WOP and inflation rates for various G20 countries. Turkey stands out with the highest value at 13.58, indicating significant periods of elevated price

increases. Australia, Brazil, and India also experience relatively high inflation rates. On the other end of the spectrum, Japan maintains the lowest maximum inflation at 2.09, reflecting a more restrained inflationary environment. Examining the downward movement of inflation values, several countries, including Canada, France, and Japan, report negative inflation. Turkey registers the lowest minimum inflation at -1.44, reflecting potential economic downturns during 2011. Notably, the global COVID-19 pandemic has contributed to a general increase in inflation rates across most countries. This trend aligns with the economic disruptions and increased government spending witnessed during the pandemic. Additionally, the WOP exhibits fluctuations, with a maximum value of 133.96 and a minimum value of 16.98. The decline in WOP during COVID-19 is likely influenced by reduced global demand amid lockdowns and travel restrictions. These observations highlight the interconnectedness of global economic factors, influencing inflation rates and energy markets across G20 nations.



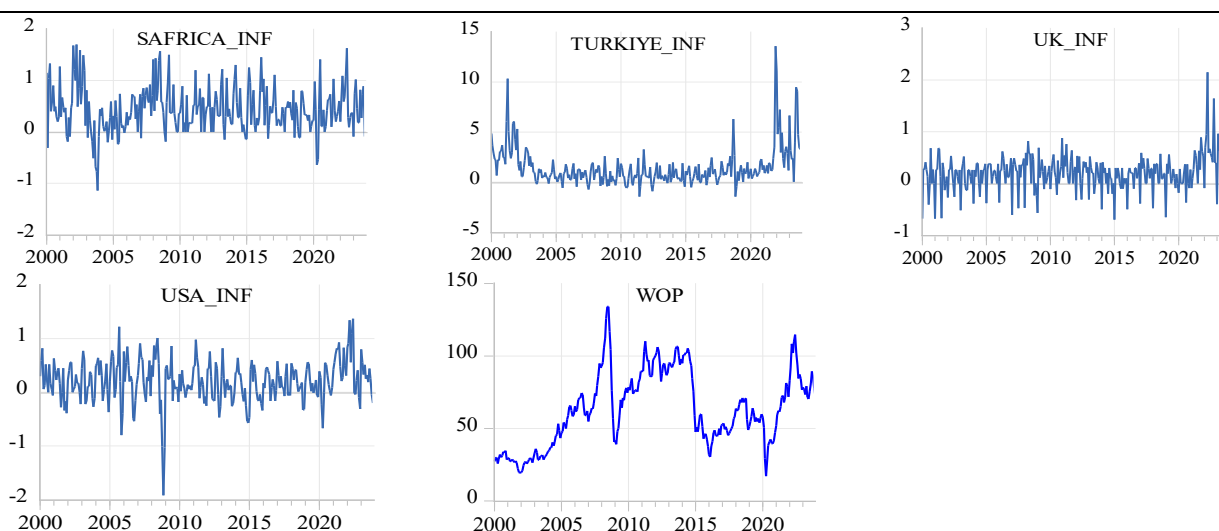


Figure 1: Inflation and WOP.

Results

Table 2 to Table 4 present the outcomes of the causal impact analysis, delineating the causal effects of three different periods of WOP downturns. Figure 2 provides a visual representation of the consistent causal impact across all G20 countries. Additionally, Figures 2 to 5 showcase the results of WTC, PWC, and MWTC analyses.

Causal Impact of Oil Prices on Inflation

Causal Impact of WOP on Inflation from 2007 to June 2014

During the period from December 2007 to June 2014, marked by the global financial crisis and a significant downturn in WOP. The causal impact of WOP on inflation during this period is reported in Table 2. The findings reveal a spectrum of economic responses to the relationship between oil price dynamics and the global financial crisis.

Countries like Australia witnessed a slight negative absolute effect, suggesting a modest decrease in inflation following the oil price downturn. In contrast, Brazil exhibited a substantial positive absolute effect. This disparity accentuates the varied economic responses of nations to the WOP downturn responses of inflation (Barsky & Kilian, 2002). Canada, along with China, France, and Germany, demonstrated negative absolute effects, aligning with the

conventional understanding that higher oil prices contribute to reduced economic activity and lower inflation (Hamilton, 1996). India displayed a marginal positive absolute effect, highlighting the resilience of its economy during the specified period, while Indonesia showed a significant negative absolute effect. Italy, Japan, and South Korea exhibited negative absolute effects of varying magnitudes. Russia, unexpectedly, displayed a negative significant absolute effect of WOP on inflation, possibly due to unique geopolitical and economic factors in the region.

Mexico indicated a positive absolute effect, suggesting increased inflation, while South Africa displayed a substantial negative absolute effect, revealing a considerable decrease in inflation (Salisu et al., 2017). Turkiye exhibited a remarkably negative absolute effect, emphasizing the severity of the impact on inflation during this period. The UK and the USA both demonstrated negative absolute effects, indicating reduced inflation. Relative effects, expressed as percentage changes in inflation, further accentuate asymmetries among countries. Brazil's substantial 200.00% relative effect reflects a significant percentage increase in inflation while Russia and Turkiye exhibit large negative relative effects, indicating substantial percentage decreases, possibly due to specific economic challenges.

Table 2: Posterior Estimates - Causal Impact of Oil Prices on Inflation During Dec. 2007 - Jun. 2014.

Country	Actual	Prediction	95% CI	Absolute effect	95% CI	Relative effect	p
Australia	2.80	3.00	[2.6, 3.5]	-0.20	[-0.71, 0.19]	-6.67%	0.149
Brazil	0.48	0.16	[-0.051, 0.37]	0.32	[0.11, 0.53]	200.00%	0.002
Canada	0.15	0.33	[0.12, 0.54]	-0.18	[-0.39, 0.03]	-54.55%	0.053
China	0.22	1.40	[0.3, 2.4]	-1.18	[-2.2, -0.077]	-84.29%	0.020
France	0.11	0.22	[0.071, 0.38]	-0.11	[-0.27, 0.039]	-50.00%	0.072
Germany	0.11	0.22	[0.018, 0.43]	-0.11	[-0.32, 0.096]	-50.00%	0.156
India	0.78	0.77	[0.17, 1.4]	0.01	[-0.58, 0.61]	1.30%	0.494
Indonesia	0.47	0.95	[0.46, 1.4]	-0.48	[-0.95, 0.011]	-50.53%	0.028
Italy	0.15	0.20	[0.14, 0.27]	-0.05	[-0.12, 0.014]	-25.00%	0.059
Japan	0.03	0.10	[-0.091, 0.29]	-0.07	[-0.27, 0.12]	-74.00%	0.218
South Korea	0.23	0.45	[0.054, 0.86]	-0.22	[-0.63, 0.17]	-48.89%	0.152
KSA	0.38	0.55	[0.36, 0.72]	-0.17	[-0.34, 0.023]	-30.91%	0.044
Mexico	0.34	0.21	[0.033, 0.4]	0.13	[-0.062, 0.31]	61.90%	0.099
Russia	0.68	-0.09	[-0.61, 0.44]	0.77	[0.24, 1.3]	-831.18%	0.001
South Africa	0.50	0.93	[0.66, 1.2]	-0.43	[-0.69, -0.16]	-46.24%	0.001
Turkiye	0.66	-0.53	[-1.3, 0.23]	1.19	[0.43, 2]	-224.53%	0.003
UK	0.21	0.44	[0.2, 0.69]	-0.23	[-0.47, 0.011]	-52.27%	0.036
USA	0.16	0.33	[0.16, 0.51]	-0.17	[-0.34, 0.0082]	-51.52%	0.035

Note: p is Bayesian posterior tail-area probability for the significance of causal impact

Causal Impact of WOP on Inflation June 2014 - January 2020

The causal impact of WOP on inflation from June 2014 to January 2020 is reported in Table 3 and Figure 2. The Causal Impact findings reveal diverse impacts on inflation across countries. Noteworthy trends emerged as we examined the absolute effects which show distinctive patterns in this regard.

Australia witnessed a substantial negative absolute causal impact of WOP on inflation, aligning with established literature recognizing the deflationary impact of falling oil prices on advanced economies (Hamilton, 1996, 2003). Emerging economies such as Brazil, Indonesia, and South Africa displayed a significant negative absolute causal impact. The findings are consistent with studies recognizing the deflationary consequences of oil price downturns during this period in emerging markets (Barsky & Kilian, 2002).

Canada, India, and KSA exhibited a modest negative absolute causal impact, meanwhile, China, France, Germany, and the USA showed negligible absolute causal impact, suggesting a limited impact on inflation possibly

influenced by their diverse economic structures. Italy and South Korea experienced a significant negative absolute effect, aligning with research that recognizes the deflationary impact of reduced oil prices on certain European economies. Japan's positive absolute effect indicates a minor increase in inflation, reflecting the varied impact of oil price changes on different economies. Mexico's negligible absolute effect suggests a limited impact on inflation, possibly influenced by diverse economic factors shaping the Mexican economy. The absolute causal impact of WOP on inflation in Russia and Turkiye was remarkably high which reflects the vulnerability of emerging economies to external shocks.

The UK displayed a negligible absolute effect, suggesting a limited impact on inflation, potentially influenced by the diverse economic factors shaping the UK economy. Relative effects highlight percentage changes in inflation which show asymmetries among G20 economies. The heterogeneity in findings shows the importance of considering country-specific factors when analyzing the impact of oil price changes on inflation.

Table 3: Posterior Estimates - Causal Impact of Oil Prices on Inflation During Jun. 2014 - Jan. 2020.

Country	Actual	Prediction	95% CI	Absolute effect	95% CI	Relative effect	p
Australia	1.70	2.50	[2.2, 2.9]	-0.80	[-1.2, -0.5]	-32%	0.001
Brazil	0.45	1.00	[0.83, 1.2]	-0.55	[-0.75, -0.38]	-55%	0.001
Canada	0.12	0.18	[0.043, 0.3]	-0.06	[-0.18, 0.081]	-33%	0.208
China	0.21	0.12	[-0.18, 0.39]	0.09	[-0.18, 0.39]	75%	0.261
France	0.07	0.08	[-0.033, 0.2]	-0.02	[-0.14, 0.097]	-23%	0.387
Germany	0.08	0.09	[-0.039, 0.22]	-0.01	[-0.13, 0.12]	-8%	0.456
India	0.38	0.45	[0.02, 0.9]	-0.07	[-0.52, 0.36]	-16%	0.387
Indonesia	0.33	0.90	[0.39, 1.4]	-0.57	[-1.1, -0.057]	-63%	0.020
Italy	0.04	0.17	[0.099, 0.24]	-0.13	[-0.2, -0.057]	-75%	0.001
Japan	0.04	0.02	[-0.088, 0.11]	0.02	[-0.075, 0.13]	131%	0.358
South Korea	0.09	0.21	[0.082, 0.34]	-0.12	[-0.25, 0.008]	-57%	0.035
KSA	0.05	0.09	[-0.031, 0.22]	-0.04	[-0.17, 0.082]	-46%	0.263
Mexico	0.34	0.36	[0.077, 0.67]	-0.02	[-0.33, 0.27]	-6%	0.476
Russia	0.50	-0.06	[-1, 0.88]	0.56	[-0.38, 1.5]	881%	0.130
South Africa	0.39	0.97	[0.73, 1.2]	-0.58	[-0.85, -0.34]	-60%	0.001
Turkiye	0.92	-0.10	[-1.6, 1.4]	1.02	[-0.44, 2.5]	1048%	0.088
UK	0.12	0.13	[0.0027, 0.24]	-0.01	[-0.12, 0.12]	-8%	0.488
USA	0.12	0.19	[0.049, 0.32]	-0.07	[-0.21, 0.069]	-37%	0.161

Note: p is Bayesian posterior tail-area probability for the significance of causal impact

Causal Impact of WOP on Inflation January 2020 - December 2023

Over the span from January 2020 to December 2023, characterized by the dual impact of the COVID-19 pandemic and a substantial decline in oil prices, the Causal Impact findings in Table 4 offer a thematic perspective on inflation outcomes across countries, with a particular focus on their absolute effects.

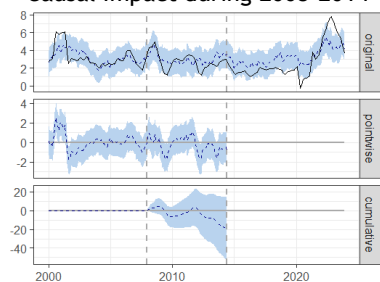
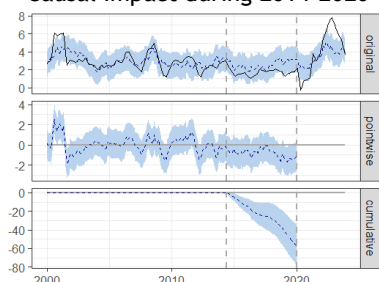
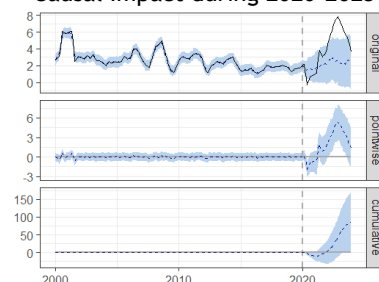
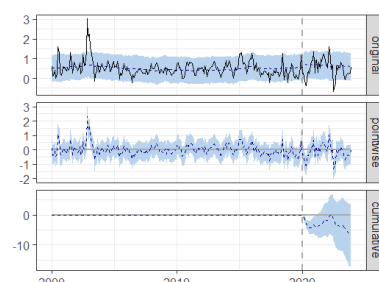
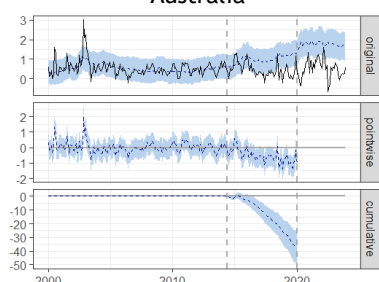
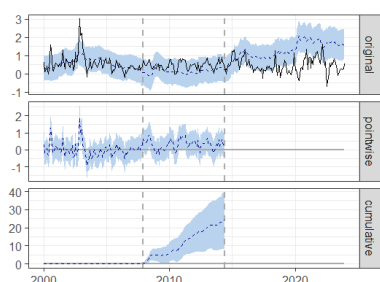
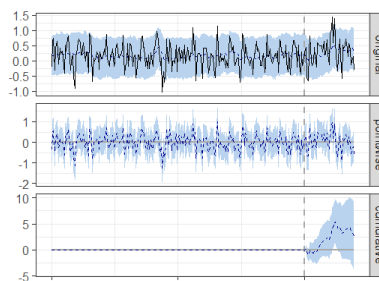
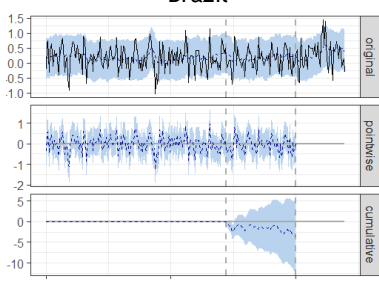
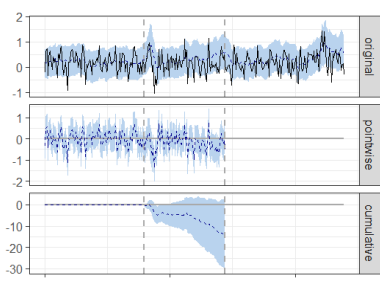
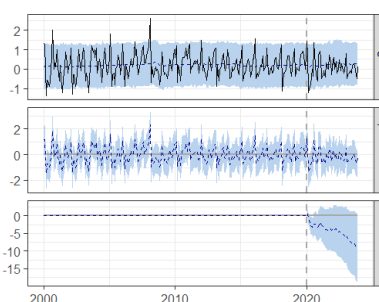
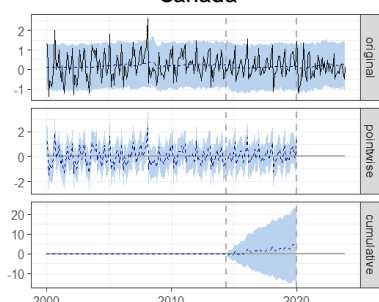
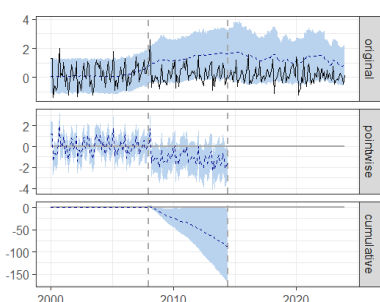
Several G20 countries, including Australia, France, Germany, India, Italy, Saudi Arabia (KSA), Mexico, Russia, Turkey, the UK, and the USA, exhibited positive absolute effects, signifying a noteworthy rise in inflation. The magnitude of these increases varied, reflecting the distinctive economic structures, policy approaches, and challenges faced by each nation. South Korea, Mexico, and Turkey exhibited moderate positive absolute causal impact. Canada, Japan, the UK, and the USA showed small positive absolute effects due to the oil price downturn in 2020. This suggests that economic structure, policy responses, and the repercussions of the COVID-19 pandemic may be the major contributing factors of the rise in inflation even in

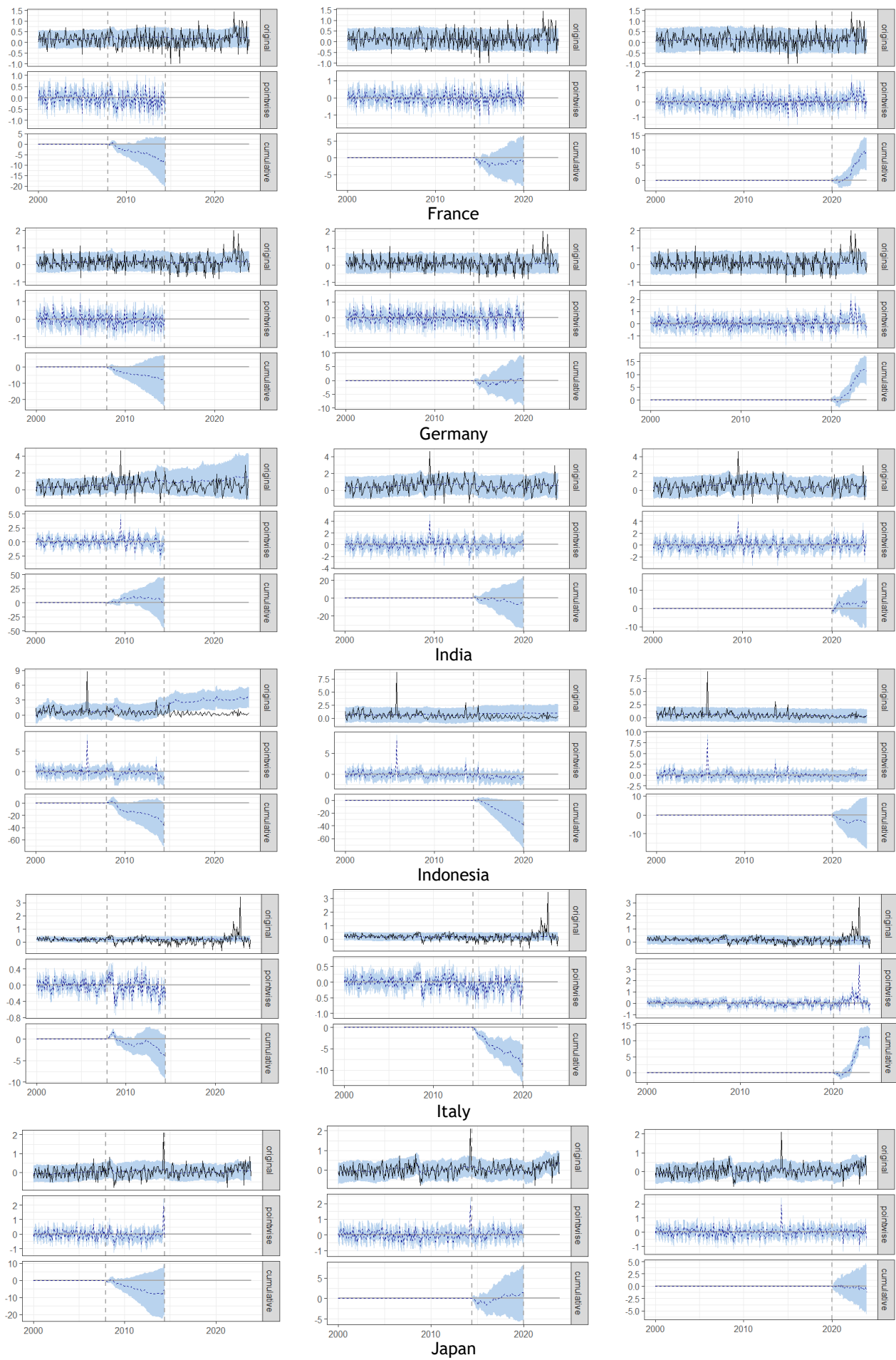
the presence of low oil prices. China stood out with a substantial negative absolute causal impact, emphasizing a significant decrease in inflation. The deflationary pressures experienced by China during the pandemic, affecting both domestic demand and global trade, played a pivotal role in this regard. South Africa displayed a moderate negative absolute causal impact on inflation. Japan's negligible absolute effect suggests the limited impact on inflation, reflecting persistent challenges faced by the Japanese economy, including deflationary pressures and a cautious approach to monetary policy.

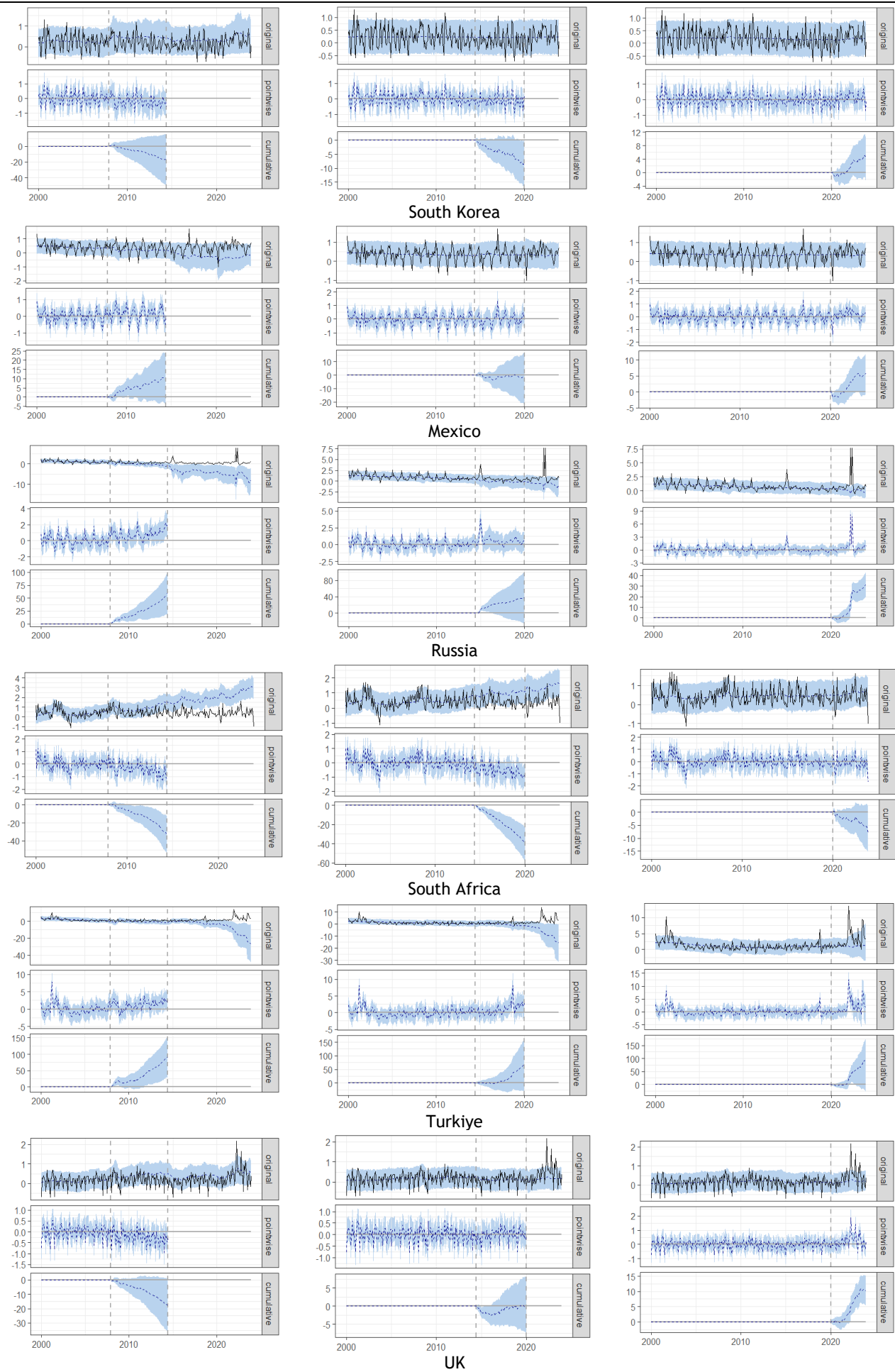
These findings illuminate notable asymmetries in inflation outcomes. The COVID-19 pandemic likely played a significant role in shaping relationships between WOP and inflation. The initial oil price decline in early 2020 might have dampened inflationary pressures in some countries (e.g., France, Germany), while the subsequent price rise throughout the period could have exacerbated inflation in others (e.g., Australia, Turkiye). Country-specific factors may also contribute to these asymmetries. For example, reliance on oil imports, monetary and fiscal policies, and the structure of the economy.

Table 4: Posterior Estimates - Causal Impact of Oil Prices on Inflation During Jan. 2020 - Dec. 2023.

Country	Actual	Prediction	95% CI	Absolute effect	95% CI	Relative effect	p
Australia	4.00	2.20	[0.36, 4]	1.80	[-0.004, 3.7]	82%	0.028
Brazil	0.51	0.65	[0.43, 0.86]	-0.14	[-0.35, 0.08]	-22%	0.120
Canada	0.31	0.26	[0.13, 0.4]	0.05	[-0.091, 0.18]	19%	0.259
China	0.04	0.23	[0.042, 0.44]	-0.19	[-0.4, -0.003]	-83%	0.023
France	0.27	0.08	[-0.033, 0.19]	0.19	[0.074, 0.3]	255%	0.001
Germany	0.35	0.11	[-0.021, 0.24]	0.24	[0.11, 0.37]	218%	0.002
India	0.50	0.42	[0.14, 0.7]	0.08	[-0.2, 0.36]	19%	0.289
Indonesia	0.24	0.32	[0.022, 0.62]	-0.08	[-0.38, 0.22]	-25%	0.307
Italy	0.32	0.10	[0.022, 0.17]	0.23	[0.15, 0.3]	237%	0.001
Japan	0.13	0.15	[0.048, 0.26]	-0.02	[-0.14, 0.08]	-13%	0.329
South Korea	0.25	0.16	[0.02, 0.3]	0.09	[-0.05, 0.23]	56%	0.103
KSA	0.24	0.05	[-0.1, 0.21]	0.19	[0.03, 0.35]	362%	0.008
Mexico	0.47	0.34	[0.21, 0.48]	0.13	[-0.018, 0.26]	38%	0.038
Russia	0.84	0.16	[-0.11, 0.43]	0.68	[0.41, 0.95]	425%	0.001
South Africa	0.42	0.59	[0.4, 0.78]	-0.17	[-0.35, 0.021]	-29%	0.041
Turkiye	3.10	1.10	[-0.68, 3.7]	2.00	[-0.57, 3.8]	182%	0.063
UK	0.40	0.18	[0.069, 0.28]	0.22	[0.12, 0.33]	122%	0.002
USA	0.37	0.34	[0.14, 0.53]	0.03	[-0.16, 0.23]	9%	0.375

Causal Impact during 2008-2014**Causal Impact during 2014-2020****Causal Impact during 2020-2023****Australia****Brazil****Canada****China**





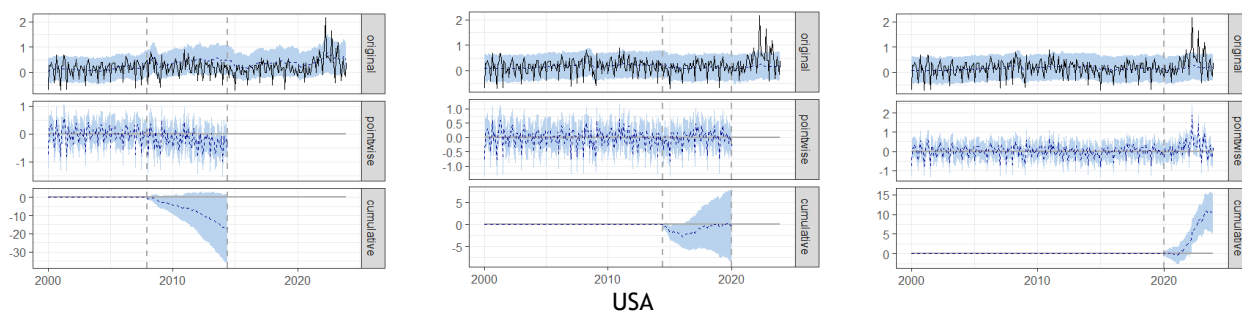


Figure 2: Causal Impact of WOP on Inflation.

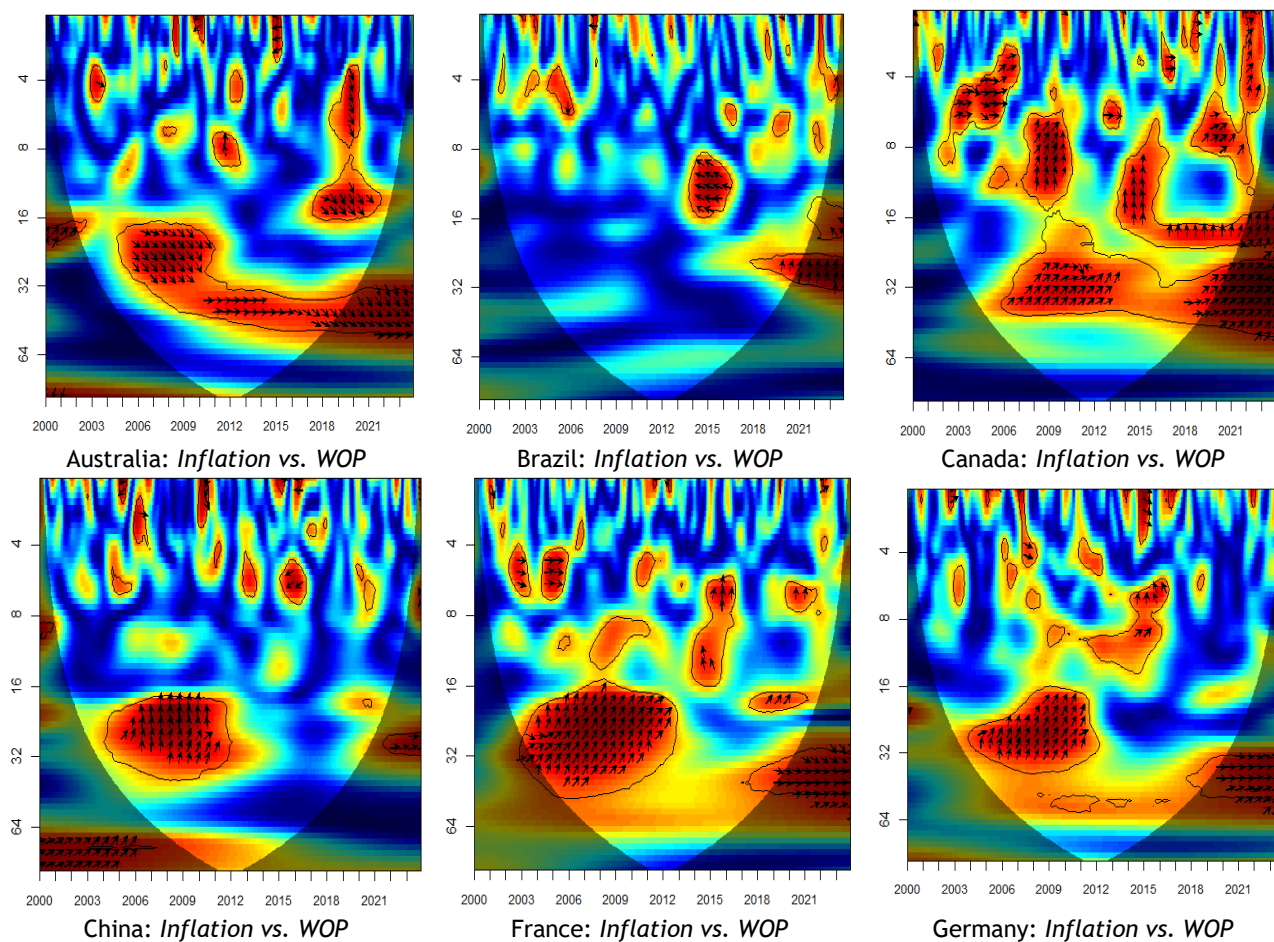
Wavelet Coherence Analysis

The figures from 3 to 5 depict the estimated wavelet coherence and the relative phasing of the two series spanning from January 2000 to December 2023. The visual representation describes the dynamics between oil price fluctuations and inflation across different time scales. A discernible black contour in wavelet coherence plots demarcates the 5% significance level. Warm colors like red highlight periods of robust co-movements and cooler shades like blue denote weaker associations. This visual distinction aids in swiftly identifying periods and frequencies where the nexus between oil prices and inflation is most prominent.

Arrows serve as essential indicators, following the principles outlined by Aloui et al. (2018), Torrence & Compo (1998), Tiwari et al. (2019), and Jiang & Yoon (2020). Those pointing right ($\rightarrow$) show a positive correlation between WOP and inflation, left-pointing

arrows ($\leftarrow$) indicate a negative correlation. The arrow types and angles ($\nearrow$, $\swarrow$, $\nwarrow$, $\searrow$) reveal the temporal sequence of causality relationships (WOP leads or lags Inflation). Notably, upward ($\uparrow$) and downward ($\downarrow$) arrows indicate that whether WOP leads or lags. This detailed visualization through wavelet coherence and arrows facilitates the interpretation of the relationships.

Figure 3 illustrates the dynamics of bivariate wavelet coherence between WOP and inflation across different countries. The majority of nations exhibit a robust and positive relationship which illustrates the influential role of oil prices in shaping inflationary dynamics. Russia, however, emerges as an exception to this trend and indicates a comparatively weaker correlation in this net oil-exporting country. In the cases of India and Indonesia, a discernible relationship between WOP and inflation is present. However, it appears less prominent than in other nations. This suggests varying degrees of strength across G20 economies.



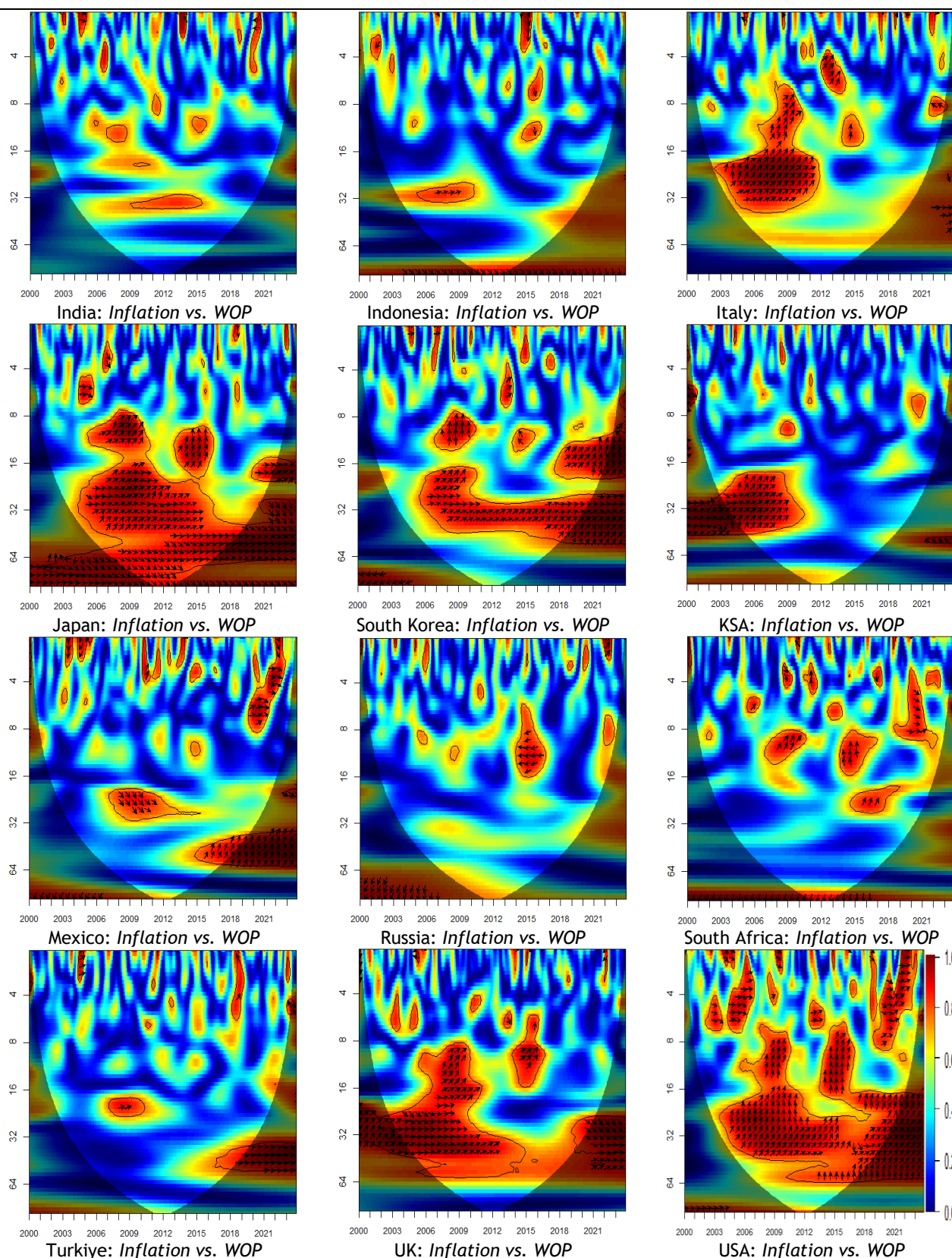


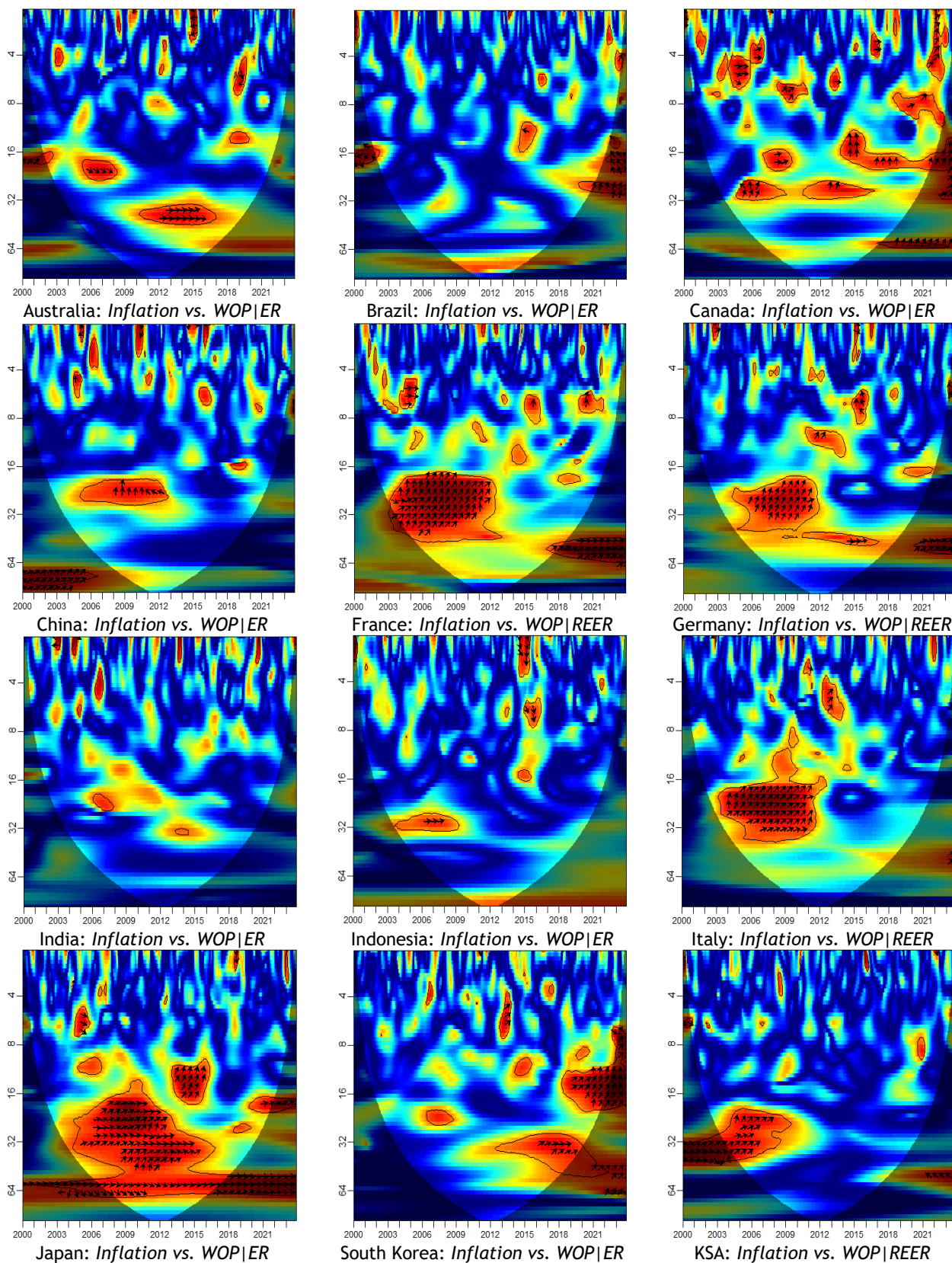
Figure 3: Wavelet Transform Coherence.

A closer examination of the short and medium-run reveals the enduring nature of the WOP-inflation relationship. Significantly, during the financial crises of 2007-08, a compelling link between WOP and inflation emerges across almost all countries, particularly on intermediate and long-term scales. Brazil, however, deviates from this trend, displaying a weaker long-term connection during this tumultuous period. The directional information derived from

the arrows in the analysis adds depth to our understanding. For the majority of countries, WOP emerges as a causal factor for inflation, highlighting the substantial impact of oil price fluctuations. Conversely, in Russia, the directional arrows suggest a weaker causal link from WOP to inflation, setting it apart from the observed patterns in other nations. Analyzing the events, such as the 2014 decline in oil prices and the subsequent decrease in WOP in 2020 highlights their

substantial impact on inflation dynamics across most countries. Intriguingly, in the case of KSA, the strength of this relationship appears less prominent compared to other G20 nations, signaling a unique economic response in this specific context as a net oil exporting country. These findings highlight the multifaceted nature of the correlation between WOP and inflation resulting from the distinctive economic and geopolitical contexts of each economy. The study also utilizes PWC which isolates the direct

relationship between two variables (inflation and WOP) by removing the indirect influence of a third variable (exchange rate) which can potentially affect both (Torrence & Compo, 1998). This visualization technique Figure 4 allows to identify frequency-specific co-movements between inflation and WOP and a better understanding of their dynamic interactions across different timescales (Torrence & Compo, 1998).



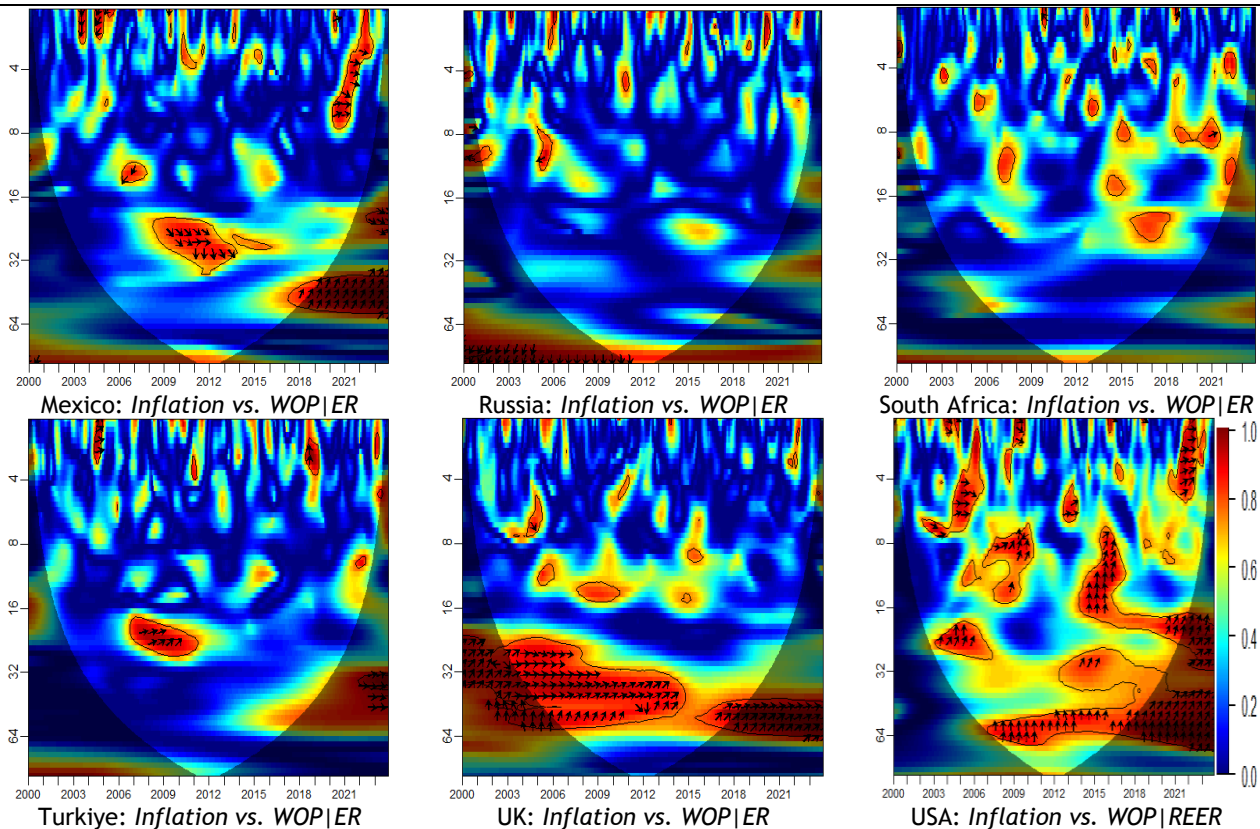


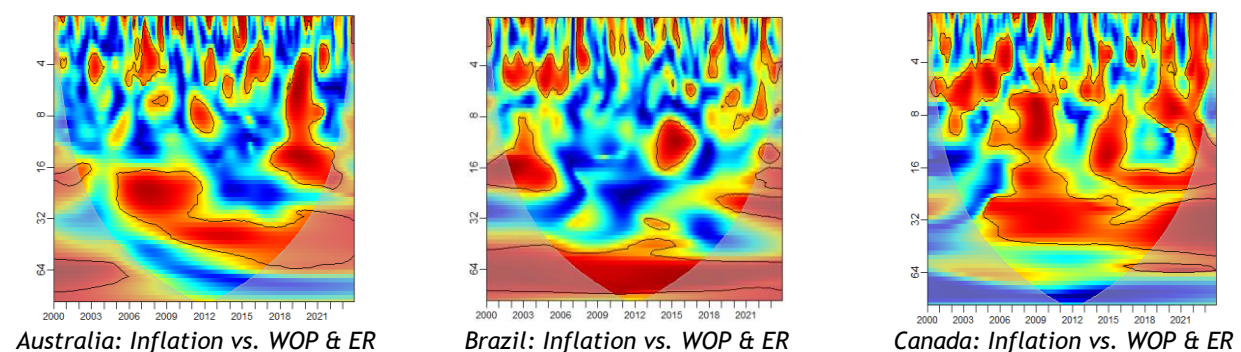
Figure 4: Partial Wavelet Coherence.

In Figure 4, we observe distinct patterns indicating the correlation between WOP and inflation across various time frequencies in different countries. Small red and yellow clouds within the time-frequency range of less than 8 months signify a strong short-term correlation between WOP and inflation, with this association particularly prominent in North American countries like Canada and the USA. Similarly, during the medium-run time-frequency (8 to 32 months), a consistent correlation is noted, with heightened prominence in Canada, France, Germany, Italy, Japan, the UK, and the USA. In the long run, a high correlation is observed in most countries, except for India. Notably, during significant declines in WOP in 2008, 2014, and COVID-19, a consistent correlation is maintained from the short to the long run. The WOP correlation in 2008 is prominently observed across all countries, with a more pronounced effect during the decline in WOP associated with COVID-19 in all G20 countries, except for Russia, where the relationship is significant but comparatively less robust than in other G20 nations.

Figure 5 The purpose of a MWTC heat map, particularly in analyzing the relationship between inflation (dependent), oil prices (independent), and an additional variable like exchange rates, is to offer a holistic perspective on the

interconnections across various time-frequency scales. MWTC heat maps enable the simultaneous examination of the coherence between inflation and oil prices while considering the impact of exchange rates. This visualization aids in identifying common regions of coherence, elucidating how these economic variables interact at specific time and frequency domains.

The MWTC results depicted in Figure 5 align almost with the patterns observed in the PWC analysis. However, the incorporation of the exchange rate as an additional variable intensifies the observed relationships between WOP and inflation. This enhancement suggests that the relationship between WOP and inflation is much stronger when considering the influence of exchange rates. This emphasizes the importance of including ER for a better understanding of the economic dynamics. Furthermore, the MWTC figures highlight that this strengthened relationship, particularly in the presence of exchange rate effects, is relatively more robust in advanced developed countries. Countries such as Canada, Japan, Germany, France, the UK, and the USA exhibit more prominent correlations between WOP and inflation. This observation aligns with existing literature (Wen, Zhang, & Gong, 2021).



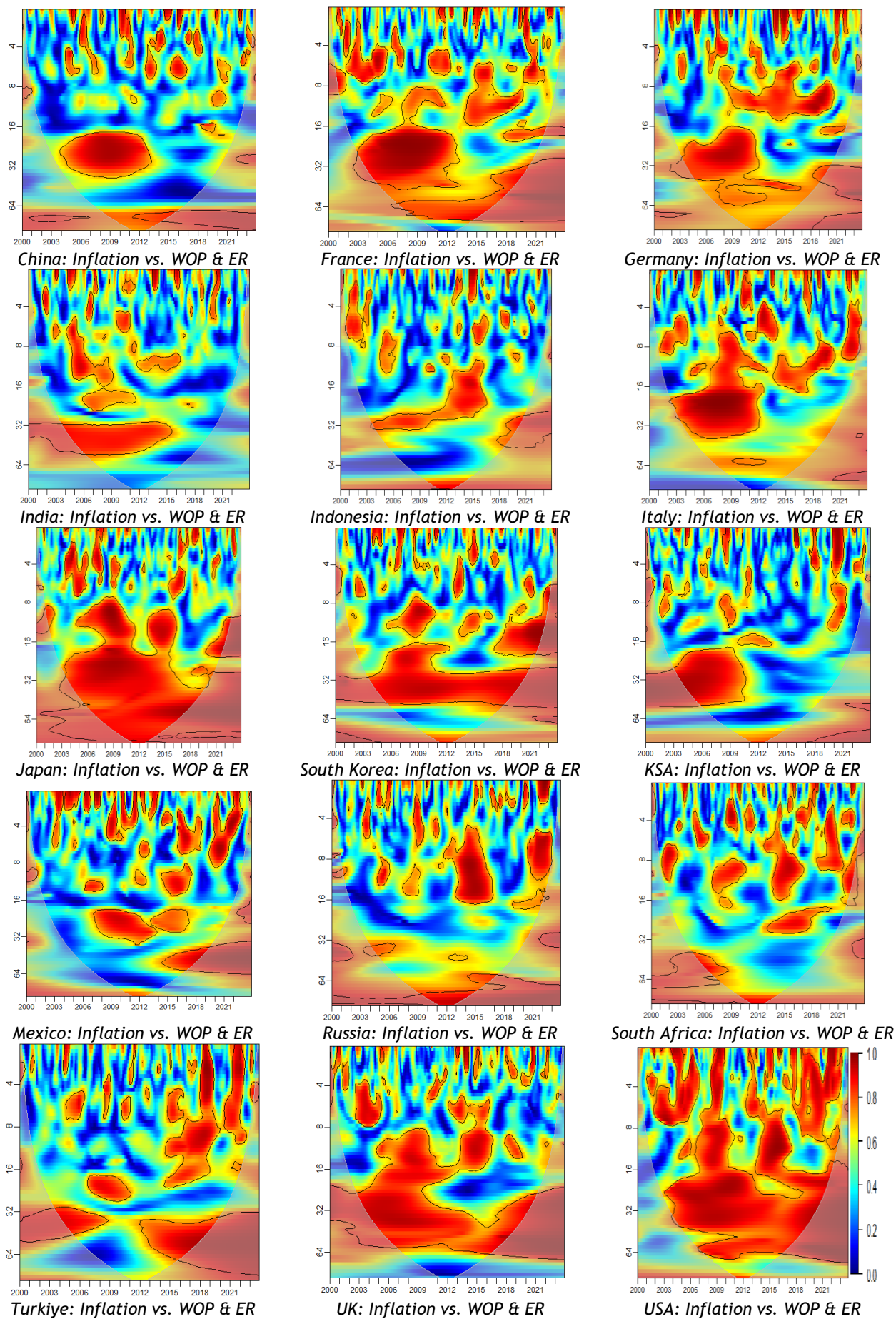


Figure 5: Multivariate Wavelet Transform Coherence.

Conclusion

This study investigated the causal impact of oil price dynamics on inflation for G20 economies during global oil disruptions spanning key episodes in 2008, 2014, and 2020 (COVID-19).

The findings from the period of December 2007 to June 2014 highlight a spectrum of economic responses to the relationship between oil price dynamics and the global financial crisis. Notable asymmetries in absolute and relative effects highlight unique economic conditions and policy landscapes across G20 countries. Advanced economies like Australia and the UK displayed varying degrees of negative absolute effects, aligning with the deflationary impact of falling oil prices. Emerging economies exhibited significant negative impacts, emphasizing the challenges faced during the oil price downturn. The observed heterogeneity in the impact on inflation emphasizes the importance of considering individual economic structures and policy landscapes, contributing valuable insights for policymakers. In the period from June 2014 to January 2020, marked by a significant oil price decline, our Causal Impact analysis Table 3 reveals diverse inflationary impacts. Australia, an advanced economy, experienced a substantial negative causal impact, aligning with the deflationary consequences of falling oil prices. Similarly, emerging economies like Brazil, Indonesia, and South Africa displayed significant negative impacts. Canada, India, and KSA showed modest negative impacts, while China, France, Germany, and the USA demonstrated negligible impacts, possibly due to their diverse economic structures. Italy and South Korea experienced substantial negative effects on inflation. Japan saw a minor increase, Mexico showed a negligible impact, and Russia and Türkiye faced remarkably high absolute causal impacts, emphasizing emerging economies' vulnerability to external shocks. The UK demonstrated a negligible effect, highlighting the need to consider country-specific factors. The subsequent period from January 2020 to December 2023 is characterized by the dual impact of the COVID-19 pandemic and a substantial decline in oil prices. Positive absolute effects in several economies indicated a noteworthy rise in inflation. China stood out with a substantial negative absolute causal impact. These findings signify the existence of asymmetric responses to inflation during the downturn of WOP.

The WTC, PWC and MWTC provided dynamic relationships between oil prices and inflation across different time scales. The visualizations highlighted varying degrees of strength in the WOP-inflation relationship, with notable exceptions such as Russia. The incorporation of exchange rates in MWTC analysis intensified the observed relationships, particularly in advanced developed countries.

Considering the asymmetries revealed in our analysis, policymakers are suggested to tailor strategies to address the diverse responses of G20 economies to oil price dynamics. Advanced economies grappling with deflationary pressures post-oil price declines should implement targeted fiscal stimulus and accommodative monetary policies to counter adverse impacts effectively. Conversely, emerging economies facing significant negative impacts should prioritize structural reforms and economic diversification to bolster resilience. Recognizing the amplified relationship between oil prices and inflation in the presence of exchange rate effects, policymakers should integrate exchange rate considerations into decision-making processes for more comprehensive policy planning. Furthermore, fostering energy transition initiatives and investments in renewable energy can enhance economic resilience, particularly for economies heavily reliant on oil. In essence, the formulation

of a proactive and adaptive policy framework should be taken keeping in view the unique economic conditions of each country.

References

- Abdulrahman, B. (2023). Effects of Fuel Prices on Economic Activity: Evidence From Sudan. *International Journal of Advanced and Applied Sciences*, 10(6), 164-179. doi: <https://doi.org/10.21833/ijaas.2023.06.020>
- Aloui, C., Hkiri, B., Hammoudeh, S., & Shahbaz, M. (2018). A Multiple and Partial Wavelet Analysis of the Oil Price, Inflation, Exchange Rate, and Economic Growth Nexus in Saudi Arabia. *Emerging Markets Finance and Trade*, 54(4), 935-956. doi: <https://doi.org/10.1080/1540496X.2017.1423469>
- Álvarez, L. J., Hurtado, S., Sánchez, I., & Thomas, C. (2011). The impact of oil price changes on Spanish and euro area consumer price inflation. *Economic Modelling*, 28(1), 422-431. doi: <https://doi.org/10.1016/j.econmod.2010.08.006>
- Bala, U., & Chin, L. (2018). Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries. *Energies*, 11(11), 3017. doi: <https://doi.org/10.3390/en11113017>
- Barsky, R. B., & Kilian, L. (2002). Oil and the Macroeconomy Since the 1970s. *Journal of Economic Perspectives*, 18(4), 115-134. doi: <https://doi.org/10.1257/0895330042632708>
- Beckmann, J., & Czudaj, R. (2013). Is there a homogeneous causality pattern between oil prices and currencies of oil importers and exporters? *Energy Economics*, 40, 665-678. doi: <https://doi.org/10.1016/j.eneco.2013.08.007>
- Bednar, O. (2021). The Causal Impact of the Rapid Czech Interest Rate Hike on the Czech Exchange Rate Assessed by the Bayesian Structural Time Series Model. *International Journal of Economic Sciences*, 10(2), 1-17. doi: <https://doi.org/10.52950/ES.2021.10.2.001>
- Bernanke, B. S. (1983). Irreversibility, Uncertainty, and Cyclical Investment*. *The Quarterly Journal of Economics*, 98(1), 85-106. doi: <https://doi.org/10.2307/1885568>
- Box, G. E. P., & Tiao, G. C. (2011). *Bayesian Inference in Statistical Analysis*. John Wiley & Sons. doi: <https://doi.org/10.1002/9781118033197>
- Brodersen, K. H., Gallusser, F., Koehler, J., Remy, N., & Scott, S. L. (2015). Inferring Causal Impact Using Bayesian Structural Time-Series Models. *The Annals of Applied Statistics*, 9(1), 247-274. doi: <https://doi.org/10.1214/14-AOAS788>
- Cerra, V. (2019). How can a strong currency or drop in oil prices raise inflation and the black-market premium? *Economic Modelling*, 76, 1-13. doi: <https://doi.org/10.1016/j.econmod.2017.05.015>
- Choi, S., Furceri, D., Loungani, P., Mishra, S., & Poplawski-Ribeiro, M. (2018). Oil prices and inflation dynamics: Evidence from advanced and developing economies. *Journal of International Money and Finance*, 82, 71-96. doi: <https://doi.org/10.1016/j.jimonfin.2017.12.004>
- Cologni, A., & Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. *Energy Economics*, 30(3), 856-888. doi: <https://doi.org/10.1016/j.eneco.2006.11.001>
- Escobari, D., & Sharma, S. (2020). Explaining the nonlinear response of stock markets to oil price shocks.

- Energy*, 213, 118778. doi: <https://doi.org/10.1016/j.energy.2020.118778>
- Farzanegan, M. R., & Markwardt, G. (2009). The effects of oil price shocks on the Iranian economy. *Energy Economics*, 31(1), 134-151. doi: <https://doi.org/10.1016/j.eneco.2008.09.003>
- Günay, M. (2018). Forecasting industrial production and inflation in Turkey with factor models. *Central Bank Review*, 18(4), 149-161. doi: <https://doi.org/10.1016/j.cbrev.2018.11.003>
- Hamilton, J. D. (1996). This is what happened to the oil price-macro economy relationship. *Journal of Monetary Economics*, 38(2), 215-220. doi: [https://doi.org/10.1016/S0304-3932\(96\)01282-2](https://doi.org/10.1016/S0304-3932(96)01282-2)
- Hamilton, J. D. (2003). What is an oil shock? *Journal of Econometrics*, 113(2), 363-398. doi: [https://doi.org/10.1016/S0304-4076\(02\)00207-5](https://doi.org/10.1016/S0304-4076(02)00207-5)
- Hamilton, J. D. (2011). Nonlinearities and the Macroeconomic Effects of Oil Prices. *Macroeconomic Dynamics*, 15(S3), 364-378. doi: <https://doi.org/10.1017/S1365100511000307>
- Hooker, M. A. (1996). What happened to the oil price-macro economy relationship? *Journal of Monetary Economics*, 38(2), 195-213. doi: [https://doi.org/10.1016/S0304-3932\(96\)01281-0](https://doi.org/10.1016/S0304-3932(96)01281-0)
- Jiang, Z., & Yoon, S.-M. (2020). Dynamic co-movement between oil and stock markets in oil-importing and oil-exporting countries: Two types of wavelet analysis. *Energy Economics*, 90, 104835. doi: <https://doi.org/10.1016/j.eneco.2020.104835>
- Kan, E., & Serin, Z. V. (2022). Analysis of Cointegration and Causality Relations Between Gold Prices and Selected Financial Indicators: Empirical Evidence From Turkey. *International Journal of Advanced and Applied Sciences*, 9(3), 1-9. doi: <https://doi.org/10.21833/ijaas.2022.03.001>
- Khan, M. A., Husnain, M. I. U., Abbas, Q., & Shah, S. Z. A. (2019). Asymmetric effects of oil price shocks on Asian economies: a nonlinear analysis. *Empirical Economics*, 57(4), 1319-1350. doi: <https://doi.org/10.1007/s00181-018-1487-7>
- Li, Y., & Guo, J. (2022). The asymmetric impacts of oil price and shocks on inflation in BRICS: a multiple threshold nonlinear ARDL model. *Applied Economics*, 54(12), 1377-1395. doi: <https://doi.org/10.1080/00036846.2021.1976386>
- Lorusso, M., & Pieroni, L. (2018). Causes and consequences of oil price shocks on the UK economy. *Economic Modelling*, 72, 223-236. doi: <https://doi.org/10.1016/j.econmod.2018.01.018>
- Mensi, W., Rehman, M. U., Hammoudeh, S., Vo, X. V., & Kim, W. J. (2023). How macroeconomic factors drive the linkages between inflation and oil markets in global economies? A multiscale analysis. *International Economics*, 173, 212-232. doi: <https://doi.org/10.1016/j.inteco.2022.12.003>
- Nasir, M. A., Huynh, T. L. D., & Yarovaya, L. (2020). Inflation targeting & implications of oil shocks for inflation expectations in oil-importing and exporting economies: Evidence from three Nordic Kingdoms. *International Review of Financial Analysis*, 72, 101558. doi: <https://doi.org/10.1016/j.irfa.2020.101558>
- Nazlioglu, S., Gormus, A., & Soytaş, U. (2019). Oil Prices and Monetary Policy in Emerging Markets: Structural Shifts in Causal Linkages. *Emerging Markets Finance and Trade*, 55(1), 105-117. doi: <https://doi.org/10.1080/1540496X.2018.1434072>
- Nelson, E. (2005). The Great Inflation of the Seventies: What Really Happened? *Topics in Macroeconomics*, 5(1), 20121003. doi: <https://doi.org/10.2202/1534-6013.1297>
- Nusair, S. A., & Olson, D. (2021). Asymmetric oil price and Asian economies: A nonlinear ARDL approach. *Energy*, 219, 119594. doi: <https://doi.org/10.1016/j.energy.2020.119594>
- Peter Ferderer, J. (1996). Oil price volatility and the macroeconomy. *Journal of Macroeconomics*, 18(1), 1-26. doi: [https://doi.org/10.1016/S0164-0704\(96\)80001-2](https://doi.org/10.1016/S0164-0704(96)80001-2)
- Raheem, I. D., Bello, A. K., & Agboola, Y. H. (2020). A new insight into oil price-inflation nexus. *Resources Policy*, 68, 101804. doi: <https://doi.org/10.1016/j.resourpol.2020.101804>
- Renou-Maissant, P. (2019). Is Oil Price Still Driving Inflation? *The Energy Journal*, 40(6), 199-220. doi: <https://doi.org/10.5547/01956574.40.6.pren>
- Salisu, A. A., Isah, K. O., Oyewole, O. J., & Akanni, L. O. (2017). Modelling oil price-inflation nexus: The role of asymmetries. *Energy*, 125, 97-106. doi: <https://doi.org/10.1016/j.energy.2017.02.128>
- Segal, P. (2011). Oil price shocks and the macroeconomy. *Oxford Review of Economic Policy*, 27(1), 169-185. doi: <https://doi.org/10.1093/oxrep/grr001>
- Sek, S. K. (2017). Impact of oil price changes on domestic price inflation at disaggregated levels: Evidence from linear and nonlinear ARDL modeling. *Energy*, 130, 204-217. doi: <https://doi.org/10.1016/j.energy.2017.03.152>
- Taylan, O., Alkabaa, A. S., & Yilmaz, M. T. (2022). Impact of COVID-19 on G20 countries: analysis of economic recession using data mining approaches. *Financial Innovation*, 8(1), 81. doi: <https://doi.org/10.1186/s40854-022-00385-y>
- Tiwari, A. K., Cunado, J., Hatemi-J, A., & Gupta, R. (2019). Oil price-inflation pass-through in the United States over 1871 to 2018: A wavelet coherency analysis. *Structural Change and Economic Dynamics*, 50, 51-55. doi: <https://doi.org/10.1016/j.strueco.2019.05.002>
- Torrence, C., & Compo, G. P. (1998). A Practical Guide to Wavelet Analysis. *Bulletin of the American Meteorological Society*, 79(1), 61-78. doi: [https://doi.org/10.1175/1520-0477\(1998\)079<0061:APGTWA>2.0.CO;2](https://doi.org/10.1175/1520-0477(1998)079<0061:APGTWA>2.0.CO;2)
- Wen, F., Zhang, K., & Gong, X. (2021). The effects of oil price shocks on inflation in the G7 countries. *The North American Journal of Economics and Finance*, 57, 101391. doi: <https://doi.org/10.1016/j.najef.2021.101391>
- Wu, M.-H., & Ni, Y.-S. (2011). The effects of oil prices on inflation, interest rates and money. *Energy*, 36(7), 4158-4164. doi: <https://doi.org/10.1016/j.energy.2011.04.028>