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**Analysis of the Links among FDI, GDP, Oil
and Gas Prices in Developed, Developing and
Resource-Dependent Countries**

Actuarial and Financial Engineering

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Abstract

This thesis studies the possible causal relationships among foreign direct investment (FDI), oil and gas prices, and gross domestic product (GDP) growth in 3 different groups of countries for the period of 1971-2021. Many unsuccessful countries in the world cannot efficiently attract their resources for economic growth. Sometimes resource-rich countries cannot maximize the benefits of the trade of natural sources. For example, many oil-dependent countries still fail to diversify their economy, and state incomes fluctuate as oil prices change. Moreover, in this thesis, some developed and successful developing countries are studied in order to compare their experience with resource-dependent countries. The effects of oil/gas prices on GDP and FDI, also the relationship between GDP and FDI are studied in selected 5 resource-dependent countries, 5 developed countries, and 5 developing countries using the Granger causality test and vector autoregressive (VAR) model. In general, this thesis asserts that an increase in commodity prices can negatively affect resource-dependent countries.

CERCS research specialisation: P160 Statistics, operations research, programming, financial and actuarial mathematics.

Key Words: GDP, Granger Causality, FDI, Time Series Analysis, VAR.

**VÄLISMAISTE OTSEINVESTEEERINGUTE, SKT, NAFTA- JA
GAASIHINDADE VAHELISTE SEOSTE ANALÜÜS ARENENUD,
ARENGUMAADE JA RESSURSSIDEST SÕLTUVATES RIIKIDES**

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Lühikokkuvõte

See lõputöö uurib võimalikke põhjuslikke seoseid välismaiste otseinvesteeringute (FDI), naftahinna ja sisemajanduse koguprodukti (SKP) kasvu vahel kolmes erinevas riikide rühmas ajavahemikul 1971-2021. Maailmas on palju ressursirikkaid riike, kes ei suuda oma ressursse majanduskasvuks tõhusalt kaasata. Mõnikord ei suuda ressursirikkad riigid looduslike allikatega kauplemisest saadavat kasu maksimeerida. Näiteks ei suuda paljud naftast sõltuvad riigid endiselt oma majandust mitmekesistada ja riigi sissetulekud kõiguvad naftahinna muutudes. Lisaks uuritakse selles lõputöös mõningaid arenenud ja edukaid arengumaid, et võrrelda nende kogemusi ressurssidest sõltuvate riikidega. Nafta/gaasi hindade mõju SKT-le ja välismaistele otseinvesteeringutele, samuti SKT ja välismaiste otseinvesteeringute vahelist seost uuritakse valitud 5 ressurssist sõltuvas riigis, 5 arenenud riigis ja 5 arenguriigis, kasutades Grangeri põhjuslikkuse testi ja vektorautoregressiivset (VAR) mudelit. Üldiselt kinnitab see väitekirj, et toormehindade tõus võib ressurssidest sõltuvaid riike negatiivselt mõjutada.

CERCS teaduseriala: P160 Statistika, operatsioonianalüüs, programmeerimine, finants- ja kindlustusmatemaatika.

Märksõnad: SKT, Grangeri põhjuslikkus, välismaised otseinvesteeringud, aegridade analüüs, VAR.

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Introduction

As many studies show, FDI causes economic growth. However, some studies argue with this idea. In this thesis, it will be analyzed for the selected five developed and ten developing countries whether FDI causes GDP growth or not. Using the time series models like VAR, it is shown how FDI, oil/gas price and GDP are interrelated. Also, the results of the resource-dependent countries will be derived and compared with the successful economies.

One of the aims of this thesis is to study whether there is a strong link between oil prices and GDP. If yes, then oil dependency transfers commodity market volatility to the economy which can lead to economic difficulties. Also, we should understand whether there is a negative link between oil prices and FDI or not. If FDI causes economic growth and higher oil prices decrease the incentive for the FDI inflow-targeted economic strategy in oil-dependent countries, then one can assert that higher oil prices slow down economic growth. This is important to know that in the short-run higher oil prices could bring higher revenues and result in an increase in GDP growth rate. However, it should be proved that higher oil prices could lead to destructive results in resource-dependent countries in the long run. From a macroeconomic perspective, the short run can be up to two years, while the long run can be more than 5 years. Thus, using the time series models and relevant tests, the causality between oil/gas price and FDI, oil/gas price and GDP, FDI, and GDP will be studied. The thesis consists of three chapters. The first chapter is a literature review. This part collects literature about the factors affecting GDP and the applied methods. This is a summary of the previous studies on the topic. In the second chapter, the general theoretical background will be developed. As it is planned to use the VAR model, Granger causality, and the stationarity tests, in the second chapter these terms are discussed in more detail. The last chapter is devoted to the explanation of the datasets and empirical analysis. The last part of the third chapter shows the results of the empirical analysis.

1 Literature about relationship of FDI, GDP, oil and gas prices

There are many views that assert that FDI is important for GDP growth. In addition, there are studies proving the impact of oil and gas prices on economic growth. Mello in his study argues that FDI can cause economic growth in developing countries (De Mello Jr., 1997). This study surveys the literature about FDI and economic growth patterns. Mello's study in general refers to the Granger causality test equation that includes FDI inflow and GDP growth rate. Based on Mello's own work Granger causality test was conducted by using the data from Brazil, Mexico, Venezuela, Chile and Colombia for 1970-91. The findings show that both directions of the causality depend on the trade regime (import substitution, export promotion, etc.), economic openness and domestic policy variables. The study also refers to Kholdy's study about the causality between foreign investment and spillover efficiency. The term spillover efficiency means that FDI inflow could result in indirect benefits for the economy. It includes high technologies that are transferred from foreign companies to local ones. Here the paper re-examines the relationship between foreign direct investment and technological efficiency in Mexico, Brazil, Chile, Singapore and Zambia using Granger Causality tests and VAR model based on the annual data from 1970 to 1990 (Kholdy, 1995). Thus, based on Kholdy's study, Mello concludes that FDI-related growth depends on factor endowments, internal markets and advanced technology. In general, Mello's study concludes that FDI-related growth happens because of technological development, and then FDI will result in higher economic growth in technologically less developed countries (De Mello Jr., 1997).

Also, a better environment for investment in a country is essential for FDI-related economic growth. This idea is visible in the work about Croatia. The study tries to explain how FDI inflow influences economic growth and competitiveness in Croatia. Quarterly FDI inflows, exports, employment and real GDP data for the period

of 2002-2017 are used for the study. Logarithmic transformation, VAR model and Granger causality test are applied. The VAR model is constructed for the research where exogenous recession dummy variable, FDI inflow, exports (EXP), employment (EMP) and GDP are included. Based on the VAR model, while FDI inflow is a dependent variable, recession and employment level are statistically significant. While GDP is the dependent variable, again recession and employment level are statistically significant. GDP as an independent variable is statistically significant for export. In the case of the FDI and GDP, there is no strong relationship for the Croatian case. The study concludes that country-specific barriers slowed economic growth, despite the high investment (Skare and Cvek, 2020).

Mugableh also conducted a study examining the connections between foreign direct investment (FDI) inflows and various factors that influence them, such as the money supply, inflation, exchange rates, gross domestic product, and trade. This paper studies relationships between FDI inflows (as % of GDP) and their determinants for the period of 1977-2012 (annual data) in Malaysia. The cointegration test is conducted to study the cointegrated relationship among variables. The data are cointegrated. The unconditional error correction equation is modeled for the test purposes. In other words, the autoregressive distributed lag (ARDL) approach is used (a form of UECM). According to the study, this approach has the benefit that it could take differently integrated variables into account. A general equation in this study is as follows:

$$\begin{aligned} \Delta FDI_t = & \beta_0 + \beta_1 FDI_{t-1} + \beta_2 LCPI_{t-1} + \beta_3 ER_{t-1} + \beta_4 LGDP_{t-1} + \beta_5 LM3_{t-1} \\ & + \beta_6 LT_{t-1} + \sum_{a=1}^h \lambda_1 \Delta FDI_{t-a} + \sum_{b=0}^h \lambda_2 \Delta LCPI_{t-b} + \sum_{c=0}^h \lambda_3 \Delta ER_{t-c} \\ & + \sum_{d=0}^h \lambda_4 \Delta LGDP_{t-d} + \sum_{e=0}^h \lambda_5 \Delta LM3_{t-e} + \sum_{f=0}^h \lambda_6 \Delta LT_{t-f} + \epsilon_t. \end{aligned}$$

β_0 denotes an intercept, β_i $i = 1, 2, \dots, 6$ are coefficients of lagged values of variables, where $\beta_i = 0$, $i = 1, 2, \dots, 6$ means that there is no cointegration. LCPI is the natural logarithm of the consumer price index, ER stands for the exchange rate, LGDP is the natural logarithm of GDP, LM3 is the natural logarithm of M3 (broad) money supply and LT is the natural logarithm of trade. The white noise term is denoted with ϵ_t . Coefficient vectors λ_i , $i = 1, 2, \dots, 6$ represents the short-run coefficients of FDI inflows, logarithm of CPI, exchange rate, logarithm of GDP, logarithm of M3 and logarithm of trade. Also, h denotes the maximum lag length obtained based on AIC. The maximum lag order is equal to 1, 2, 2, 2, 0, and 0 respectively for the ΔFDI , $\Delta LCPI$, ΔER , $\Delta LGDP$, $\Delta LM3$, and ΔLT . Variables ΔLT_t , $\Delta LM3_t$, ΔFDI_{t-1} , and $\Delta LCPI_t$ are statistically insignificant, while $LCPI_{t-1}$, ER_{t-1} , $LGDP_{t-1}$, $LM3_{t-1}$, and LT_{t-1} are statistically significant with significance level 5%, 10%, 5%, 1% and 1% respectively. Variables $\Delta LCPI_{t-1}$, $\Delta LCPI_{t-2}$, ΔER_t , ΔER_{t-1} , ΔER_{t-2} , $\Delta LGDP_t$, $\Delta LGDP_{t-1}$, $\Delta LGDP_{t-2}$ are also statistically significant. Mugableh in his study concludes that exchange rates, gross domestic product, broadest money supply, and trade increase the flows of FDI into Malaysia. However, increases in the consumer price index decline FDI inflows (De Mello Jr., 1997).

In the case of China, FDI has a positive impact on domestic investment. Tang, E. Selvanathan and S. Selvanathan's study examined the causal link between foreign direct investment (FDI inflow), domestic investment (DI) and economic growth (as GDP) in China for the period 1988-2003 in local currency. The study uses quarterly data. The test for Granger causality and cointegration are applied, and the error correction model is constructed. The Johansen cointegration test shows that there is cointegrated relation among the three variables. According to the Granger causality test, the effects of FDI inflow and GDP on DI, also the effects of FDI inflow and DI on GDP are statistically significant. However, the effects of DI and GDP on FDI inflow are not statistically significant. The study about China shows

that there is one-directional causality from FDI inflow to DI and from FDI inflow to GDP, while the causal relationship between GDP and DI is bi-directional (Tang, Selvanathan, and Selvanathan, 2008).

Nevertheless, as mentioned in previous studies foreign investment should be supported by local regulations. In the case of resource-rich countries, some studies show that oil prices affect economic growth. The study of Jahangir and Dural uses the ordinary least square (OLS) regression method and the Granger causality test. The applied data is time series data from 1997 to 2015 (annually) for the Caspian Sea region (Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan) to research the impact and causality of crude oil and natural gas on economic growth. The following form of formula is used for the Granger causality test:

$$X_t = \sum_{i=1}^p \alpha_i X_{t-i} + \sum_{i=1}^p \beta_i Y_{t-i} + \epsilon_t,$$

$$Y_t = \sum_{i=1}^p \gamma_i Y_{t-i} + \sum_{i=1}^p \phi_i X_{t-i} + v_t.$$

In the equation, ϵ and v are the serially correlated random vectors with zero mean and finite variance. X, Y pairs are chosen as (GDP, crude oil reserve), (GDP, crude oil export), (GDP, crude oil production), (GDP, crude oil price), (GDP, natural gas reserve), (GDP, natural gas export), (GDP, natural gas production), and (GDP, natural gas price). According to the OLS method except for crude oil price (COP) and natural gas production (NGPRO), all independent variables (taking GDP as a dependent variable) are statistically insignificant. However, the Granger causality test shows that there is bi-directional causality between oil prices and GDP. Natural gas prices Granger causes to GDP. Here one-directional causality from natural gas price is observed. In addition, GDP causes oil export, while natural gas export Granger causes the GDP. The lags selected for the Granger causality test are 2 in the GDP-oil price and GDP-oil export pair, 3 in the GDP-gas price pair, and 5 in the GDP-gas export pair. The study of Jahangir and Dural concludes that oil

and natural gas prices have an impact on the economic growth, in the Caspian Sea region. While in the case of oil price, this impact is positive, in the case of natural gas prices the impact can be negative (Jahangir and Dural, 2018).

There is another research about the effects of oil prices. Udemba asserts that there is unidirectional causality between real oil price and trade (export + import as % of GDP), FDI inflow and GDP, GDP and trade in Nigeria (Udemba, 2019). The duration of the research data is from 1970 to 2018 (annually). In research, Granger causality test based on VARX model is used. Oil price is held as an exogenous variable because it is determined exogenously in international commodity markets. Logarithmic transformation for endogenous variables is applied. Granger causality test shows that unidirectional causalities between FDI and GDP, GDP and trade, oil price and trade are statistically significant (Udemba, 2019).

In Ghana, oil price is one of the important factors for economic growth. Mensah's research uses annual time series data for the period 1980–2013 for the analysis of the effects of oil prices (OILP) on exchange rate (EXR), energy consumption (ENGC) and GDP of Ghana. After conducting Johansen cointegration test, the null hypothesis is rejected. In other words, there is cointegration among variables. The study employs VEC model and conducts Granger causality test. All variables in the model are logarithmically transformed. When we assume logarithm of GDP as a dependent variable, then all independent variables are statistically significant. The study proves that there is long-term and short-term Granger causality from oil price to economic growth and from exchange rate to GDP. Furthermore, there are Granger causality from energy consumption to real exchange rate and from oil price and GDP to energy consumption. According to the study, an increase in oil price leads to an increase in the exchange rate, which can lead to the macroeconomic phenomenon that is called 'Dutch disease' (Mensah et al., 2016). A 'Dutch disease' occurs when high dependency on one economic sector negatively affects the development of other sectors. When oil price increases and causes to increase in exchange rate, a country loses its competitiveness in the international market

and becomes reluctant to develop other sectors except the energy sector. According to the impulse-response function, the study also mentions that a positive shock in oil price negatively affects GDP.

The relationship between FDI and GDP for Qatar is examined too. The objective of this investigation is to examine the relationship between foreign direct investment inflows, as a percentage of GDP and economic development, as indicated by the growth rate of real Gross Domestic Product (GDP) in Qatar. The study utilizes data collected on an annual basis from 1970 to 2010 to determine if there is a causal link between the two variables. Johansen cointegration test shows that there is cointegrated relation. The linear regression equations are used to test causality. The Granger causality test indicates there are both short and long-run bi-directional causality between FDI inflows and GDP growth. It is concluded that in the short run government spending stimulates the FDI inflow and in the long run, FDI increases the GDP in the case of Qatar (Alkhasawneh, 2013).

Chakraborty and Sintim-Aboagye's study is important for understanding the country-specific results of FDI and GDP. In the study, the authors used the data set of annual FDI net inflows (fdi) and GDP growth rates of the 22 emerging countries. The time period for the data set spans 1960 through 2016. All 22 countries were categorized as high central bank independence (10 countries) and low central bank independence (12 countries) groups. VEC model is preferred, because according to the cointegration test, the variables are cointegrated. The causality test shows that there is bidirectional causality between FDI inflows and GDP growth in a long run, but not in the short run. In general, the study shows countries with a high level of central bank independence (cbi) can reach to macroeconomic stability and show a strong bidirectional causal link between FDI and GDP. However, in countries with low cbi rates, this casual relation is one-directional (from GDP to FDI) (Sintim-Aboagye and Chakraborty, 2021).

M. Simionescu's study of FDI and GDP growth also reveals the bidirectional causality between both variables. The annual data is taken from 28 EU countries and

covers the period 2008-2014. Using the Bayesian random effect, Bayesian linear regression and panel VAR model the study concludes that in many EU countries real GDP growth rate positively affect FDI inflows (as % of GDP) and vice versa. No transformation for variables is considered in this study (Simionescu, 2016). Unlike the Simionescu's study, the research about the factors affecting the FDI of Ghana uses logarithmic transformation for FDI stock and real GDP. The analysis of the data in the study was conducted using Johansen's technique for cointegration and vector error correction model. The variables are cointegrated. The time span for research data is from 1990 to 2015 and frequency is quarterly. Based on this study, the impact of inflation rate, exchange rate, and interest rate on FDI in Ghana was negative and statistically significant in both the long and short terms. On the other hand, gross domestic product, electricity production, and telephone usage had a positive effect on FDI (Asiamah and Afful, 2019).

Another study with panel VAR model was conducted to capture the effect of GDP per capita growth, economic openness and FDI for the tourism receipts. Data is annual and covers the years from 2000 to 2015 for a sample of 19 Mediterranean countries. According to the article, there is one directional causality from GDP per capita growth to FDI (Perovic, Raicevic, and Delibasic, 2021). The similar research was conducted for the Norway by analysing the years between 1986-2009 in quarterly frequency. The aim of study is to model FDI inflow to Norway using co-integrating regressions with Fully Modified OLS (FMOLS) and the vector error correction model (VECM). The author uses these two models to be able to compare the robustness of results. Unlike OLS model, FMOLS is modified to take cointegrated relation into account. Because more than one cointegration relationship among variables is detected. FMOLS model considers the serial correlation effects and endogeneity in regression. The results of the Modified OLS analysis shows that in Norway, real GDP, GDP in the primary (agriculture), secondary (industry), and tertiary (service) sectors, exchange rate, and trade openness have a positive impact on inward FDI. Conversely, the analysis found that money supply,

interest rate, and unemployment have negative effects on FDI inflows in Norway. FDI inflow was used as a dependent variable and no transformation was applied. In case of the VECM model, real GDP, trade openness and exchange rate have positive impact on FDI inflow, while interest rate and unemployment negatively affect to it (Boateng et al., 2015). Analysis of FDI and GDP was conducted in the study about South Asia too. Using the VAR model for panel data consisting of 5 South Asian country (Bangladesh, India, Nepal, Pakistan, and Sri Lanka), the researchers considered 1998-2017 annual data. GDP growth rate and FDI inflow as % of GDP are considered for the VAR model. The Granger causality test shows that there is one directional causality from FDI to GDP growth and VAR model shows that there is positive relationship between FDI inflow as % of GDP and GDP growth (Nguyen, 2022).

Similar scientific articles are available about China, Vietnam, India, Mexico and Turkey. They are using VAR or linear regression model and Granger causality test to find factors affecting GDP and FDI. In case of China, 1981-2018 years are studied as annual data. For FDI inflow and real GDP variables logarithmic transformation was used. The results show that there is smaller short-term impact of FDI to GDP, while long term impact is stronger (Liu and Lee, 2020). In Vietnam positive effect of FDI inflow to real GDP was revealed based on the annual data from 1997-2018 (Nguyen, 2020). Similarly, the study in India based on annual data from 1971 to 2008 reveal Granger causality from the logarithm of FDI to the logarithm of GDP (Guru-Gharana, 2012). In research that conducted in Mexico quarterly data (1995-2020) was used. Logarithmic transformation for real FDI and GDP was applied. However, this study mostly concentrates on other variables that may affect FDI. Because the research tries to explain factors affecting FDI inflow (Elizalde Guzmán et al., 2022). Finally, study about Turkiye employs real annual data from 1980 to 2010. The FDI inflow was logarithmically transformed. According to the study, there is positive relationship between GDP growth and FDI inflow (Cambazoglu and Simay Karaalp, 2014).

In general, 20 scientific articles are reviewed: 16 of them analyzed GDP and FDI relations, where 14 of them found positive relation, 2 of them found no relation. In other words, 4 studies concluded that there is bi-directional relationship between FDI and GDP, 7 studies showed unidirectional relationship from FDI to GDP and 3 of studies showed unidirectional relationship from GDP to FDI. 3 of the observed literature analyzed the impact of oil prices on GDP. 1 relation is positive bi-directional, 1 of them is positive indirect from oil price to GDP and 1 is negative relationship from oil price to GDP. Only one research studies the impact of natural gas prices on GDP. This impact is unidirectional (from gas price to GDP) and negative. To sum up, as suggested in the literature, trade regime, economic openness, domestic policy variables (tax, duties etc.), technological development, economic recession, employment level, broadest money supply (M3), consumer price index, exchange rates, trade, domestic investment, oil prices, natural gas prices, natural gas export, central bank independence, exchange rate, energy consumption level, tourism receipts (TR) and FDI are directly or indirectly can affect the GDP of countries. It is visible that in open economic systems where governments support FDI inflow using domestic policy tools (monetary and fiscal policies), GDP increases. Furthermore, in resource-dependent countries increase in resource prices (oil, natural gas, etc.) increases cash inflows and GDP. However, it also increases exchange rate that can increase economic dependency on natural sources, which leads to the long-term economic fluctuations. If there is no barrier to investment and technological development, then FDI growth may increase the GDP. Moreover, technological development leads to higher labour productivity and less labour costs that may contribute to economic growth. Development of some aspects of the economy (trade, tourism, etc.) can enhance the whole economy too.

2 Theoretical background for Granger causality test and VAR model

In this part of the thesis, a theoretical background of the research is defined. The stationarity, unit root tests, vector autoregressive models, impulse-response function and Granger causality test are explained in this section. The theoretical overview is written based on the books of Box et al. (2016), Enders (2015), and Kirchgässner, Wolters, and Hassler (2013).

2.1 Stationarity and unit root

In order to define stationarity, we should understand the essence of stochastic processes. In time series if the next period value can be found using some mathematical function, then the time series is generated by a deterministic process. Because using some calculations beforehand we can find the next value. However, if the next value is based on probabilistic laws, then it is called that the time series is generated by a stochastic process. We cannot know the exact next value of the time series in the case of a stochastic process.

Definition. *A stochastic process is a random process which consists of a collection of random variable sequences.*

In random variable the sequence is time units. Thus, in a stochastic process variable for each time unit is random and cannot be known beforehand (Box et al., 2016, Chapter 2.1.1).

A stochastic process can be stationary and non-stationary. A stationary time series is one where the statistical properties of the series, such as the mean, variance, and autocovariance, are constant over time. This means that the statistical properties of the series do not change over time and are therefore predictable. In addition, there are two types of stationarity: weak stationarity and strong stationarity. If we assume

that realizations of stochastic process are from the same distribution for all time points, then it is called a strictly stationary process. In practice, strict stationarity is hardly applicable. Because of this, weak stationarity is used. A process is k -th order weakly stationary when for different time period all moments up to k is finite and equal for each random vector of a stochastic process. The k 'th moment of m random vectors is defined as $E(Z_1^{b_1} Z_2^{b_2} \dots Z_m^{b_m})$ where $\sum_{i=1}^m b_i = k$. All b 's are non-negative integers. Taking this into account, we can say that if mean, variance and covariance of a random process do not depend on time, then it is second order stationary. Because mean is 1st moment, while variance and covariance is second moment of the process. Generally, we refer to 2nd order stationarity when we talk about stationary data (Kirchgässner, Wolters, and Hassler, 2013, Chapter 1.3). There are some examples of stochastic processes:

1. White noise:

$$Z_t = \epsilon_t. \tag{1}$$

Here ϵ_t are independent and identically distributed random variables where $E(\epsilon_t) = 0$, $Var(\epsilon_t) = \sigma^2$, and $Cov(\epsilon_t, \epsilon_{t+j}) = 0$ for $j \neq 0$. This process is an example of weakly stationary process.

2. Random walk:

$$Z_t = Z_{t-1} + \epsilon_t, Z_0 = z_0. \tag{2}$$

Considering that the $z_0 = const.$, we can rewrite the formula (2) as:

$$Z_t = z_0 + \sum_{i=1}^t \epsilon_i. \tag{3}$$

From the last formula (3) it follows that mean is constant and both variance and covariance are time dependent.

3. Random walk with drift:

$$Z_t = a_0 + Z_{t-1} + \epsilon_t. \quad (4)$$

In this case (4), we have intercept term a_0 . This process is non-stationary because mean, variance and covariance of the process are time dependent.

Stationarity is an important concept in time series analysis because it allows for the use of various modeling techniques and statistical methods, such as ARMA or VAR models, that assume stationary data. ARMA model consists of two parts: autoregressive (AR) and moving average (MA) parts. The autoregressive process is such a process where time series depends on its own lagged values and white noise process:

$$Z_t = \sum_{i=1}^p \phi_i Z_{t-i} + \epsilon_t. \quad (5)$$

By considering the equation (5) it is important to define the lag operator. The lag operator B helps to show time series Z_t in compact form. In order to represent Z_{t-k} , $k = 1, 2, \dots, p$ in compact form, we use $B^k Z_t$. By using the lag operator we can rewrite the equation (5) as:

$$\left(1 - \sum_{i=1}^p \phi_i B^i\right) Z_t = \epsilon_t.$$

Thus, we can define a function as:

$$\phi(x) = 1 - \sum_{i=1}^p \phi_i x^i. \quad (6)$$

The polynomial (6) is important to test for the stationarity. When $p = 1$, then the equation (5) can be represented as:

$$Z_t = \phi_1 Z_{t-1} + \epsilon_t \Rightarrow Z_t = \sum_{i=0}^{\infty} \phi_1^i \epsilon_{t-i},$$

$$Var(Z_t) = \sigma^2 \sum_{i=0}^{\infty} \phi_1^{2i}.$$

In this case if $|\phi_1| < 1$, then variance is finite, and process is stationary. In other words, we know that $\phi(x) = 1 - \phi_1 x$ and root of $\phi(x)$ should be greater than 1. Otherwise, the process is not stationary. In AR(p) process, if all roots of the polynomial (6) are out of the unit circle (it means, modules of all roots are greater than 1), then the process is stationary.

A moving average (MA) process is in the following form:

$$Z_t = \epsilon_t - \sum_{i=1}^q \psi_i \epsilon_{t-i}. \quad (7)$$

So, MA process is the sum of ϵ_t and its lagged values. As number of parameters is finite it is always stationary.

Combination of AR and MA processes is called ARMA process and expressed in the following form:

$$Z_t = \sum_{i=1}^p \phi_i Z_{t-i} + \epsilon_t - \sum_{i=1}^q \psi_i \epsilon_{t-i}. \quad (8)$$

If modules of all roots of function $\phi(x)$ of AR side (6) are greater than one, then the process is second order weakly stationary. On the other hand, if at least one root of function $\phi(x)$ is one, then there is unit root (Kirchgässner, Wolters, and Hassler, 2013, Chapter 2).

If a time series is non-stationary, it may require more analysis before it can be modeled accurately. Because regression between non-stationary time series can result in spurious regression. In spurious regression R^2 may be high and model may seem well suited, but the model cannot be interpreted in logical manner. In other words, a regression may seem good due to the coincidence or the third factor that both of the variables have relationship with. In order to avoid from this problem, time series should be tested for stationarity before modeling. These tests are called unit root tests and check for the existence of unit root. In this thesis two main unit

root tests are employed:

- Augmented Dickey-Fuller Test (ADF)
- Phillips-Perron Test (PP)

The Augmented Dickey-Fuller (ADF) test is one of the common unit root tests that is used in time series analysis. The test is used to determine whether a series has a unit root, and thus whether the series is stationary or not.

The ADF test works by estimating a p-th order autoregression formula:

$$z_t = \sum_{i=1}^p a_i z_{t-i} + \epsilon_t. \quad (9)$$

By subtracting $a_p z_{t-p+1}$ from both sides of the equation (9) we get:

$$z_t = \sum_{i=1}^{p-2} a_i z_{t-i} + (a_{p-1} + a_p) z_{t-p+1} - a_p \Delta z_{t-p+1} + \epsilon_t.$$

After that subtracting $(a_{p-1} + a_p) z_{t-p+2}$ from both sides of the last equation we get:

$$z_t = \sum_{i=1}^{p-3} a_i z_{t-i} + (a_{p-2} + a_{p-1} + a_p) z_{t-p+2} - (a_{p-1} + a_p) \Delta z_{t-p+2} - a_p \Delta z_{t-p+1} + \epsilon_t.$$

So, we continue in this form until we get the formula (10):

$$\Delta z_t = \gamma z_{t-1} + \sum_{i=1}^{p-1} \psi_{i+1} \Delta z_{t-i} + \epsilon_t. \quad (10)$$

The equation (10) is AR process where Δz_{t-i} are lagged changes. In equation (10) $\gamma = -(1 - \sum_{i=1}^p a_i)$ and $\psi_i = -\sum_{j=i}^p a_j$. The null hypothesis is $\gamma = 0$. When null hypothesis is true, then $\sum_{i=1}^p a_i = 1$ and the polynomial $\phi(x)$ of AR process (9) $(1 - \sum_{i=1}^p a_i x^i)$ contains unit root. However, AR process may contain intercept term or trend term. In order to take these factors into account the following test

equations are considered:

$$\Delta z_t = \alpha_0 + \gamma z_{t-1} + \sum_{i=1}^{p-1} \psi_{i+1} \Delta z_{t-i} + \epsilon_t, \quad (11)$$

$$\Delta z_t = \alpha_0 + \gamma z_{t-1} + \alpha_2 t + \sum_{i=1}^{p-1} \psi_{i+1} \Delta z_{t-i} + \epsilon_t. \quad (12)$$

Here α_0 is intercept term (or drift), $\alpha_2 t$ stands for deterministic trend. In general, we have 3 models to test. The equation (10) is model without drift and trend. We calculate test statistic τ_1 to test the null hypothesis whether $\gamma = 0$ or not. In other words, we test whether there is unit root or not. It is calculated like t-statistic where estimate of γ is divided by the standard error of it, although, τ 's critical values are different from ordinary t-statistic. In the equation (11) drift term is added. In this case, we need to calculate the test statistic ϕ_1 . We test the null hypothesis whether there is unit root and no drift ($\alpha_0 = \gamma = 0$). If reject the null hypothesis, then we should consider model with drift. In that case, unit root test decision is based on τ_2 statistic. The third model (12) adds trend term. In that case, the test statistic is ϕ_2 . We are interested in the null hypothesis whether there is unit root, absence of drift and trend terms ($\alpha_0 = \gamma = \alpha_2 = 0$). If we fail to reject null hypothesis, then ϕ_3 statistic should be considered. By considering ϕ_3 we test the null hypothesis whether there is unit root and no trend ($\gamma = \alpha_2 = 0$). In case of "trend" model, τ_3 is used to check for unit root. To put simple, ϕ_2 compares simple model with "trend+drift" model, ϕ_3 compares "drift" model with "trend" model, ϕ_1 compares simple model with "drift" model. While checking models we start with the broadest model and continue testing (if failing to reject null hypothesis in broader models) until the narrowest model where we test only for unit root. In other words, if ϕ_2 is non-significant, then we look for the significance of ϕ_3 . If none of them is significant, then trend shouldn't be in the model. After that we test for ϕ_1 to check "drift" model. If fail to reject null hypothesis, then "none" model is selected. If after all τ_1 is insignificant, then the data contains unit root. The table

(1) shows the null hypothesis summary of the ADF test.

Table 1: Null hypothesis summary of ADF test

Model		Hypothesis	Test statistic
	$\gamma = 0$	there is unit root	τ_3
Trend	$\gamma = a_2 = 0$	there is unit root and no trend	ϕ_3
	$a_0 = \gamma = a_2 = 0$	there is unit root and no trend and drift	ϕ_2
Drift	$\gamma = 0$	there is unit root	τ_2
	$a_0 = \gamma = 0$	there is unit root and no drift	ϕ_1
None	$\gamma = 0$	there is unit root	τ_1

All test-statistics ϕ are calculated using standard F-test formula:

$$\phi = \frac{[SSR(restricted) - SSR(unrestricted)]/r}{SSR(unrestricted)/(T - k)}. \quad (13)$$

But their critical values are different from ordinary F-statistic critical values. In addition, critical values for ϕ_1 , ϕ_2 and ϕ_3 are different from each other. In the formula (13), SSR is sum of squared residuals based on the restricted and unrestricted models, r is restriction number, T is number of observations and k is number of parameters in unrestricted model (Enders, 2015, Chapter 4.5, 4.7).

The Phillips-Perron (PP) test is another commonly used unit root test in time series analysis. However, unlike ADF test statistics, the test statistic of PP test is adjusted to account for the fact that the series may exhibit serial correlation. In ADF test there is an assumption that residuals are uncorrelated. But in PP test the possibility of correlated residuals is taken into account. The null hypothesis of the PP test is the same as the ADF test: the presence of a unit root in the series. The alternative hypothesis is that the series is stationary.

The PP test is considered more robust than the ADF test because it uses a correction for serial correlation in the time series. Although, PP test is not always the best choice. Because when the model contains moving average part with negative autocorrelation, the possibility of rejection of true null hypothesis in PP test is

more than it is in ADF test. Because of these issues, it is important to use both tests and compare their results (Kirchgässner, Wolters, and Hassler, 2013, Chapter 5.3.2).

In general, stationarity is an important concept in time series analysis, as it allows for the use of various modeling techniques and statistical methods that assume stationary data. A non-stationary time series may require further analysis and transformation before it can be modeled accurately. If after conduction of stationarity tests non-stationarity is found, then taking difference of time series data maybe the solution. For example, if data is non-stationary the 1st difference of it could be stationary. In general, if we take k times difference of initial time series to make it stationary, then it is integrated of k -th order ($I(k)$). If initial time series is stationary, then it is integrated of order 0, in other words, it is $I(0)$. In macroeconomics and finance, it is common to use (if data is not stationary) data that is integrated of order 1. For example, if data related to GDP is non-stationary then we can use 1st difference of it (e.g. $GDP_t - GDP_{t-1}$). We can interpret it as a change in GDP.

2.2 Granger causality test

The Granger causality test is a statistical test used to find whether one time series can be used to predict another time series. The test is named after an econometrician Clive W. Granger, who introduced it in his paper "Investigating Causal Relations by Econometric Models and Cross-spectral Methods" in 1969 (Granger, 1969).

The Granger causality test is based on the idea that if a time series X Granger-causes another time series Z , then changes in X can be used to predict changes in Z better than using only lagged values of Z . In other words, if we can predict Z better using both X and lagged values of Z than using only the lagged values of Z ,

then X Granger-causes Z . The inequality (14) shows this relationship as follows:

$$\sigma^2(Z_{t+1}|I_t) < \sigma^2(Z_{t+1}|I_t - \bar{X}_t). \quad (14)$$

Here $\sigma^2(\cdot)$ is error variance and I_t is all available information set related to the time series Z and X up to time t . The set of all values of variable X up to time t is given with \bar{X}_t . The inequality shows that next value of Z could be forecasted better using the variable X . It shows that there is Granger causality between Z and X . If $\sigma^2(Z_{t+1}|I_t + X_{t+1}) < \sigma^2(Z_{t+1}|I_t)$, then it proves that X_{t+1} is important to forecast Z_{t+1} . In other words, there is instantaneous causality. We must estimate a model for each time series individually and compare its performance to a combined model that takes into account both time series in order to test for Granger causality. Let's assume that we are interested in whether X Granger-causes Z . We can write the autoregressive model for Z as:

$$Z_t = \alpha + \sum_{i=1}^p \beta_i Z_{t-i} + \epsilon_t. \quad (15)$$

Once we have estimated the model (15), we can construct a combined model that includes both X and Z :

$$Z_t = \eta + \sum_{i=1}^p \beta'_i Z_{t-i} + \sum_{i=n}^q \delta'_i X_{t-i} + \epsilon_t. \quad (16)$$

If $\delta'_i = 0$, $i = 0, 1, \dots, q$, then there is no causality between Z and X . In case of $n = 0$ then it can be asserted that there is instantaneous causality. Otherwise n starts from 1. If we interchange Z and X , then we can run the Granger causality test from Z to X . Similarly, we can write the model for X as:

$$X_t = \gamma + \sum_{i=1}^q \delta_i X_{t-i} + \epsilon_t. \quad (17)$$

So, it is possible to reconstruct the equation (16) as follows:

$$X_t = \eta' + \sum_{i=1}^p \lambda_i X_{t-i} + \sum_{i=n}^q \omega_i Z_{t-i} + \epsilon_t. \quad (18)$$

Thus, Granger causality test can be conducted based on the null hypothesis that there is no Granger causality between variables, in other words, ω_i and δ'_i ($i = 0, 1, 2, \dots, q$) are zero. We can compare the performance of the separate models and the combined model using the error variances as shown in inequality (14). If the combined model has an error variance that is significantly less than the separate models, then we can conclude that X Granger-causes Z . If there is a bi-directional causality such as X causes Z and Z causes X , then it is called a feedback relation. To test the significance of the Granger causality, we use an F-test. The alternative hypothesis is that X Granger-causes Z , meaning that at least one of the coefficients for X is not equal to zero. Also, the null hypothesis asserts that there is no causality between variables. The F-statistic for the test is calculated as:

$$F = \frac{[SSR(restricted) - SSR(unrestricted)]/q}{SSR(unrestricted)/(T - p - q - 1)}. \quad (19)$$

Where $SSR(restricted)$ is the sum of squared residuals from the restricted model (i.e., the separate models for X and Z), $SSR(unrestricted)$ is the residual sum of squares from the unrestricted model (i.e., the combined model), q is the number of lag coefficients for X in the combined model, T is the total number of observations, p is the number of lag coefficients for Z .

Under the null hypothesis of no Granger causality, the F-statistic follows an F-distribution with degrees of freedom $(q, T - p - q - 1)$. We can use this distribution to calculate a p-value for the test. Also, critical values for F statistic are considered. If the p-value is below a chosen significance level (e.g., 0.05), we reject the null hypothesis and conclude that there is evidence of Granger causality from X to Z . It's important to note that the Granger causality test is a statistical test and does

not necessarily imply a causal relationship in the strict sense. Rather, it tests for the ability of one time series to predict another time series, which is a necessary but not sufficient condition for causality.

When using the Granger causality test in practice, there are a few things to keep in mind. For example, the test presumes that the time series are stationary and linear, with no missing variables. Additionally, the choice of lag length for the models can affect the results of the test. When we add more lagged values, then it increases the probability of rejection of null hypothesis. These issues should be carefully considered when interpreting the results of the Granger causality test (Kirchgässner, Wolters, and Hassler, 2013, Chapter 3).

2.3 Vector Autoregressive model and impulse-response function

The Vector Autoregressive (VAR) model is multivariate time series model which is consist of system of autoregressive equations. Each variable in the system is modeled as a function of its own lagged values and the lagged values of all the other variables in the system. This means that each variable in the system is both an endogenous variable and an exogenous variable for the other variables in the system. However, we can use VARX model where some variables are only exogenous, not endogenous.

The VAR model equation can be represented as system of equations:

$$\begin{aligned}
Z_{t,1} &= \alpha_1 + \sum_{j=1}^q \sum_{i=1}^p \phi_{1j}(i) Z_{t-i,j} + \epsilon_{t,1}, \\
Z_{t,2} &= \alpha_2 + \sum_{j=1}^q \sum_{i=1}^p \phi_{2j}(i) Z_{t-i,j} + \epsilon_{t,2}, \\
&\dots \\
Z_{t,q} &= \alpha_q + \sum_{j=1}^q \sum_{i=1}^p \phi_{qj}(i) Z_{t-i,j} + \epsilon_{t,q}.
\end{aligned} \tag{20}$$

In the equation (20), q and p are the number of variables and the maximum lag length respectively (Enders, 2015, Chapter 5.5).

One of the main advantages of the VAR model is that it allows for the modeling of complex interrelationships between multiple variables in the system. For example, the VAR model can capture the feedback relations between different variables, such as output, inflation, and interest rates. This makes the VAR model a popular tool for macroeconomic analysis and forecasting.

In VAR stationarity is an important concept too. As it is in AR model, in VAR system if roots of polynomial $\phi(x)$ of each AR process is outside the unit circle, then the processes are stationary (Kirchgässner, Wolters, and Hassler, 2013, Chapter 4.1).

As mentioned above, the VAR model can be extended to include exogenous variables through the VARX model. The VARX model includes both endogenous and

exogenous variables, and can be represented as:

$$\begin{aligned}
Z_{t,1} &= \alpha_1 + \sum_{j=1}^q \sum_{i=1}^p \phi_{1j}(i) Z_{t-i,j} + \sum_{j=1}^m \sum_{i=0}^s \beta_{1,j}(i) X_{t-i,j} + \epsilon_{t,1}, \\
Z_{t,2} &= \alpha_2 + \sum_{j=1}^q \sum_{i=1}^p \phi_{2j}(i) Z_{t-i,j} + \sum_{j=1}^m \sum_{i=0}^s \beta_{2,j}(i) X_{t-i,j} + \epsilon_{t,2}, \\
&\dots \\
Z_{t,q} &= \alpha_q + \sum_{j=1}^q \sum_{i=1}^p \phi_{qj}(i) Z_{t-i,j} + \sum_{j=1}^m \sum_{i=0}^s \beta_{q,j}(i) X_{t-i,j} + \epsilon_{t,q}.
\end{aligned} \tag{21}$$

Here X_t up to X_{t-s} are exogenous variables, and β 's are coefficients of exogenous variables. In addition, m and s are number of exogenous variables and maximum lag length for exogenous variables respectively.

Finally, it is important to mention impulse response function. Impulse response function measure the dynamic response of each variable in the system to a shock in one of the other variables. Impulse response function can be used to analyze the transmission of shocks and policy interventions through the system, and to assess the effectiveness of different policy interventions.

To compute the impulse response function for a VAR model, we first need to specify the shock or intervention of interest. This is typically done by setting the value of one of the variables to a known value, while keeping the other variables unchanged. For example, if we are interested in the response of GDP to an investment policy shock, we could set the FDI to a known value, while keeping the other variables unchanged.

It is known that the stationary AR process can be represented as an infinite MA process. So, in order to define impulse response function initial step is to represent the VAR model in vector moving average (VMA) form:

$$\begin{bmatrix} x_t \\ z_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \epsilon_{x,t-i} \\ \epsilon_{z,t-i} \end{bmatrix}. \tag{22}$$

If we consider VAR model that consists of two variables, then its MA representation will be as in equation (22). In this equation μ_1 and μ_2 are unconditional means for x_t and z_t respectively. The coefficients ϕ represent the effect of changes in error term to respective time series for periods of i . Thus, by examining the values of $\phi(i)$ for each i will give us an impulse response functions. For example, in order to capture the impact of $\epsilon_{z,t-2}$ on x_t we use $\phi_{12}(2)$. So, plotting $\phi_{12}(i)$, $i = 0, 1, \dots, n$ will show the impact of unit change in $\epsilon_{z,t}, \epsilon_{z,t-1}, \dots, \epsilon_{z,t-n}$ on x_t . Alternatively, $\phi_{11}(i)$ and $\phi_{12}(i)$ can be interpreted as i period effect of unit change in $\epsilon_{x,t}$ and $\epsilon_{z,t}$ on x_{t+i} .

Generally, impulse responses are based on estimated coefficients, because of this calculation of confidence interval is important for its precision. Using the corresponding t-statistic we can find standard deviation and based on two standard deviations we can calculate the 95% confidence interval of the coefficient (Enders, 2015, Chapter 5.7). The following figure (1) shows one example of impulse response function that analyzes the response of FDI to the shocks from GDP.

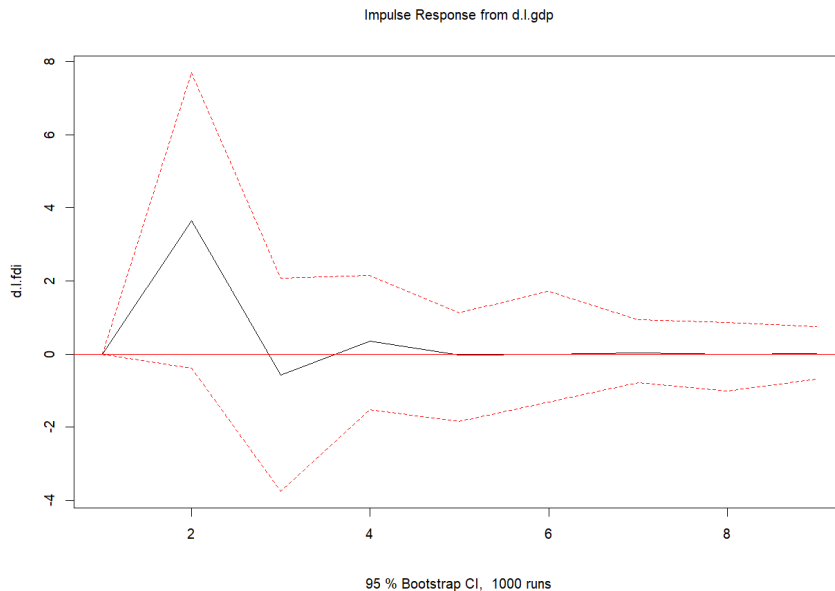


Figure 1: Impulse response function of GDP-FDI

Thus, based on the shocks of error term of each variable we can examine the reaction of other variables. The visualization of an impulse response graph (with confidence intervals) visually represents significant changes of one variable to the shock from other variables.

3 Empirical analysis of the links among FDI, GDP, oil and gas prices

3.1 Data sets and methodology

In order to find the relationship among FDI, GDP, oil prices, and gas prices 3 groups of countries are selected. Each of these groups contains 5 countries with common backgrounds:

- France, Germany, Japan, the UK, and the USA
- Brazil, China, India, Mexico, and Turkey
- Algeria, Gabon, Oman, Saudi Arabia, and The Republic of Congo.

The first group of countries are developed countries. The second group consists of developing countries that have reached high economic growth rates and share the global economy with developed countries. Finally, the last group of countries are resource-dependent countries. Their economy mostly depends on the revenues of natural resources, especially of oil.

The selected countries in the group of developed countries are among the countries with the highest gross domestic products (in USD) for 2021. It means that they are among the biggest economies in the world. Those five developed countries' GDP accounts for 60 % (\$ 40,336,336) of the OECD total GDP (\$67,210,885) in 2021. Moreover, the five above-mentioned developing countries' total GDP is about 45,273,570 million US dollars or 67.4 % of the OECD total GDP in 2021 (taking into account that China, India and Brazil are not OECD member countries) (OECD Data, [2023b](#)). The same result is also applicable in the case of the FDI flows. While in developing countries FDI inflows are higher, in developed countries FDI outflows are dominant (OECD Data, [2023a](#)). These countries' total results regarding the GDP and FDI will give a much-generalized overview of the link between

the FDI and GDP. Furthermore, we are interested in the effects of the oil and gas prices too. According to the World Bank data, five resource-dependent (mainly oil-dependent) countries are selected (Algeria, Gabon, Saudi Arabia, Oman and The Congo Republic). Their oil rent is a higher portion of their GDP. Oil rents are the difference between the value of crude oil production at regional prices and the total costs of production. While the world average for oil price rents was 1.3 % in 2021, in Algeria it was 14.5 %, in Congo 34.4 %, in Gabon 15.6 %, in Oman 23.5 %, and in Saudi Arabia it was 23.7 % (World Bank Data, 2023b). The main problem in oil-dependent countries is the lack of economic diversification. They are vulnerable to oil price changes (Donkor, Mensah, and Sarpong-Kumankoma, 2022).

In the literature review of the thesis, the relation between GDP and FDI is mentioned. We already know the importance of FDI for GDP growth. But it is needed to analyze the importance of GDP in three different groups of countries and compare them. Oil and gas prices are also vital for all these countries. Some of them get revenues from these natural resources, while others suffer from high energy costs because of increases in oil/gas prices.

The data about oil and gas prices, GDP, and FDI is taken from the World Bank Data (2023c) and World Bank Data (2023a). The data frequency for all variables is annual. The time range of collected time series data is from 1971 to 2021, containing 51 time points. Oil price data consist of the annual average prices for Brent oil in international markets. Also, the gas prices are considered as an annual average of natural gas sold from Netherlands TTF (Title Transfer Facility). TTF is a virtual trading facility. Based on the supply and demand of natural gas, the prices for the EU are mostly determined in TTF. The measurement unit for natural gas is a million British thermal units (MMBTU), while for oil it is a barrel. In the World Bank database, prices of oil and gas are defined in real (2010's) US dollars. Data about GDP is also in real terms based on 2015's US dollar for all countries. However, FDI data is not in real terms. Thus, the real FDI inflows based on the GDP deflator were calculated. As the FDI inflows are defined in the US dollars,

GDP deflator of the USA is used to calculate the real FDI inflows. The following formula is employed for real FDI inflow calculation:

$$real\ FDI\ inflow = \frac{NFDI}{GDPDC/100}. \quad (23)$$

Here NFDI stands for the nominal FDI inflows and GDPDC is a current GDP deflator in the US. For example, if we have nominal FDI for 2010 and GDP deflator for 2010, then we can calculate the real FDI and take 2015 as a base year. As real GDP's base year in the World Bank database is 2015, for FDI inflow 2015 is taken as a base year too. Another problem with FDI inflow data is negativity. The figure (2),(3), and (4) show the FDI inflows of three groups of countries.

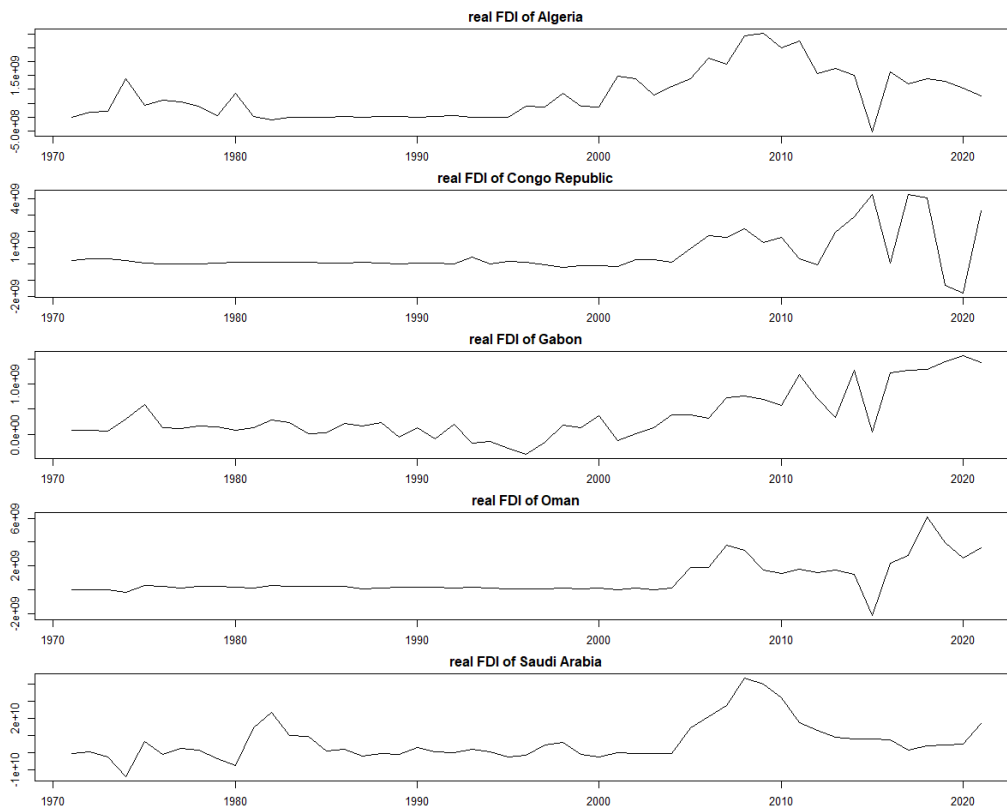


Figure 2: Real FDI of selected resource-dependent countries

The fluctuations in FDI are obvious. We need to apply the natural logarithmic

transformation to decrease the effect of large fluctuations. However, except the US, Mexico, Brazil, France, and Turkiye all countries have negative FDI inflows for some points in time. This happens because of disinvestments. FDI inflow consists of two parts: investments that are made to the country by foreigners and disinvestments that are withdrawal of invested money from the economy. When disinvestments are higher than the investments then net FDI inflow is negative. Also in China zeros exist in data until 1978. Because China opened its economy for foreign investments starting from 1978. These issues create problem for logarithmic transformation. In order to solve this problem, a constant was added to the FDI inflow data.

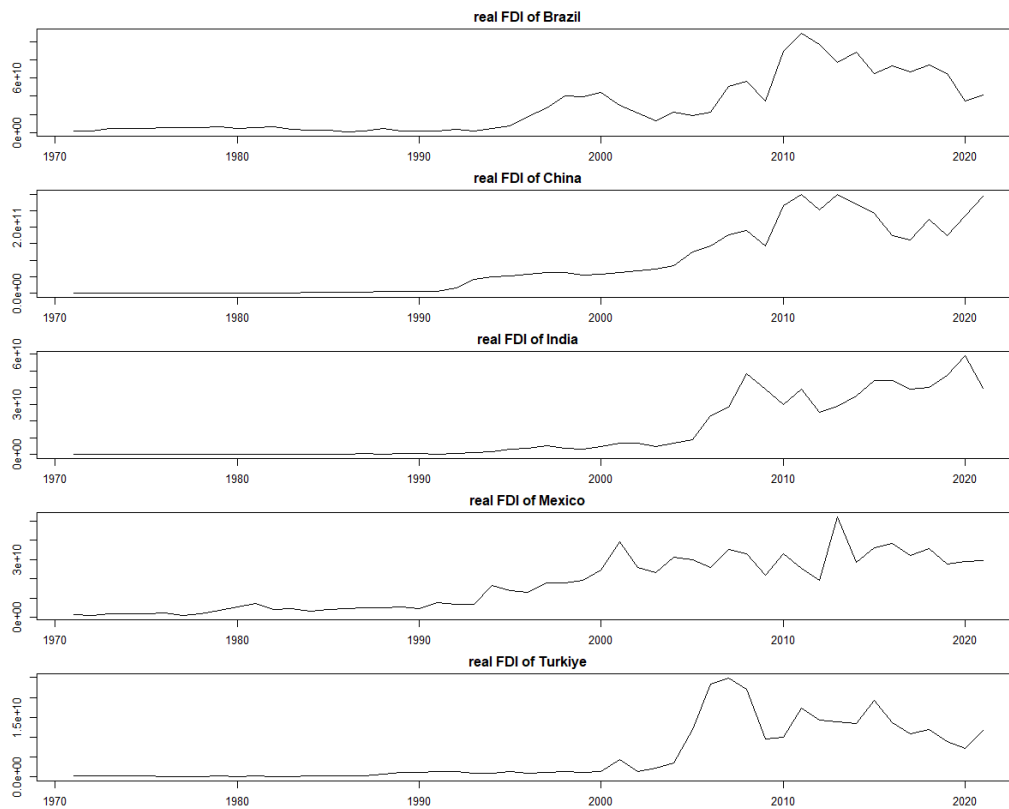


Figure 3: Real FDI of selected developing countries

Also, there is a common pattern of FDI inflows for each group of countries. In resource-dependent countries, we can see high fluctuation and more negative values.

This may happen because of the unstable economy. When there is uncertainty about the economic condition of a country, investors start to withdraw their money. On the other hand, in developing countries, there is an increasing trend in FDI inflow. However, in developed countries, we can see stable fluctuations. Because as investors of these countries invest in other countries, in developed countries FDI outflow becomes more dominant than inflows.

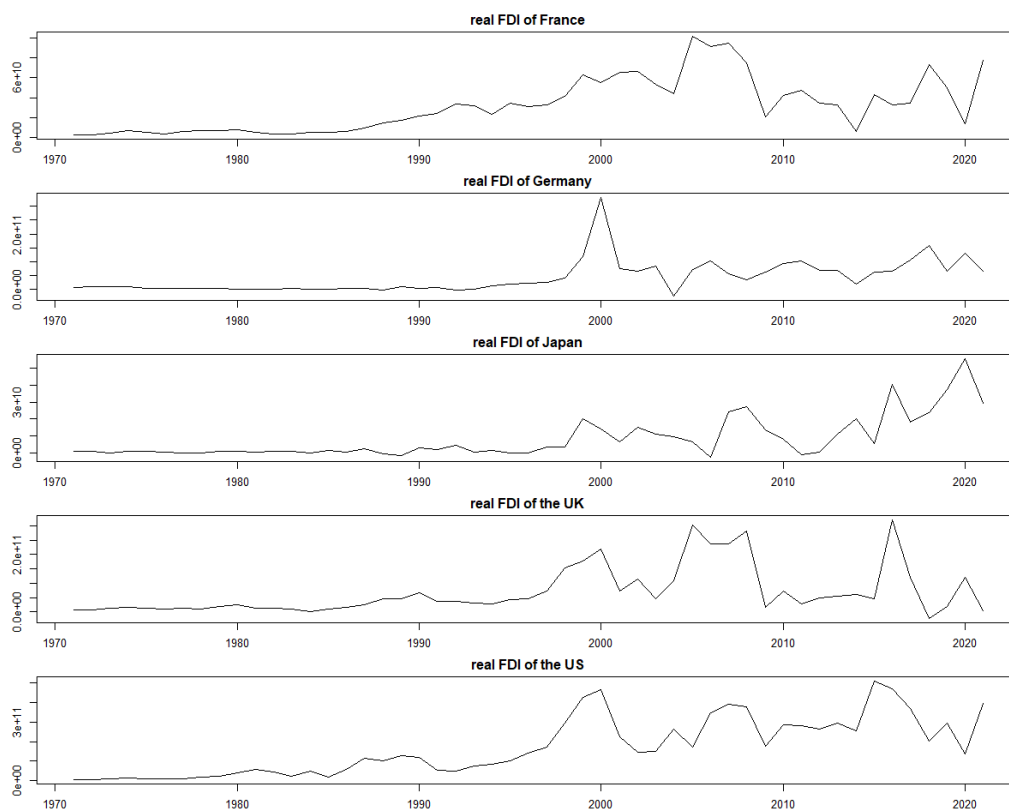


Figure 4: Real FDI of selected developed countries

The figure (5) represents oil and gas prices for 1971-2021. We can see that they are highly correlated. Because gas and oil demand is mostly based on the same purposes. So, their prices move together. High fluctuations are also visible in the case of oil and gas prices. It is important to consider natural logarithms of prices for analysis.

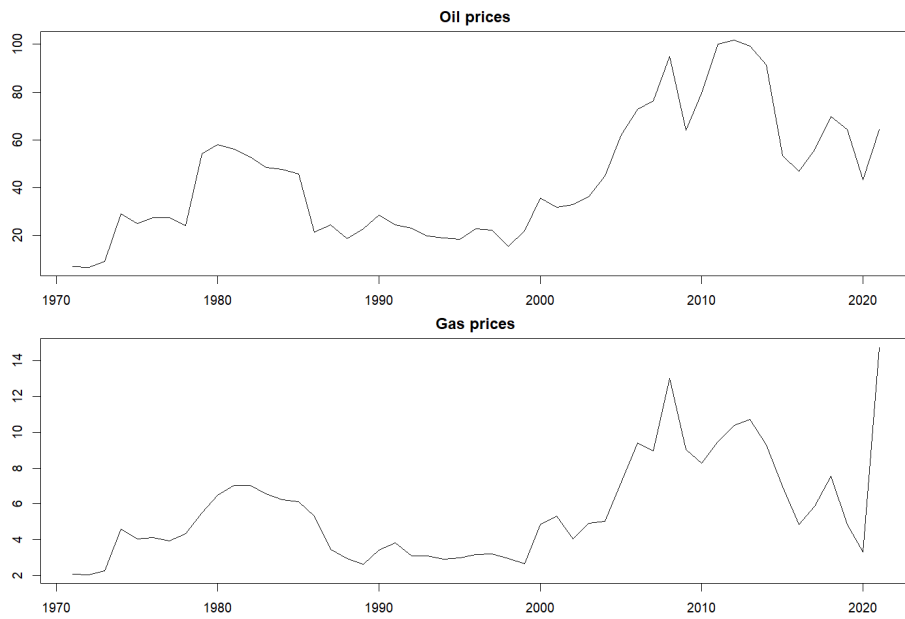


Figure 5: Graph of the average annual Brent oil and natural gas prices between 1971 and 2021 in real (2010) US dollars

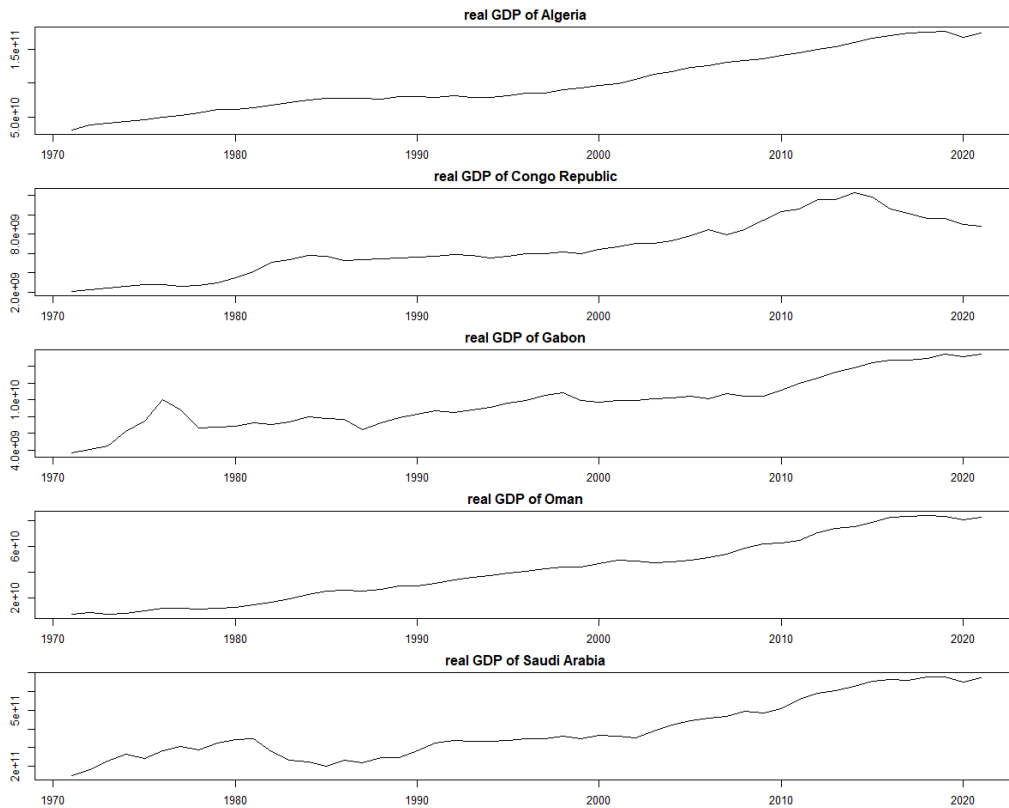


Figure 6: Real GDP of selected resource-dependent countries

The real GDP of different groups of countries is present in figure (6),(7), and (8). We can see upward-sloping lines for all three groups of countries. Here, the logarithmic transformation is important to be applied too. Again, in the case of resource-dependent countries, fluctuations are a bit more than others. It is related to the dependence on oil and gas prices. It is obvious that the volatility of natural resource prices is transferred to the economic growth of resource-dependent countries.

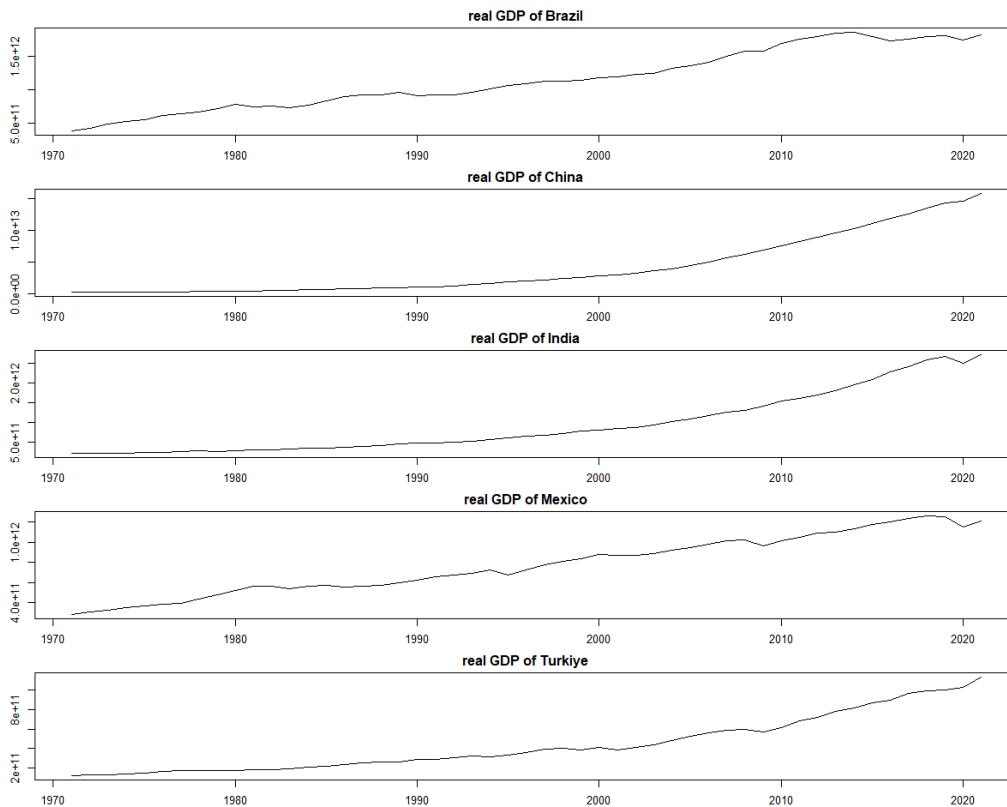


Figure 7: Real GDP of selected developing countries

In developing countries, especially in China and India, the real GDP growth is higher. Developing countries show more economic growth than other countries do. This tendency is partly because of the high FDI inflows to the developing countries. However, economic growth in developed countries is small. Because these countries' economies are operating at full technological capacity. Unlike developed countries, in developing countries, there is room for technological development and

this development leads to higher economic growth. However, high economic growth in resource-dependent countries is related to the increasing prices of natural resources. As prices of oil and gas show an upward trend, the GDP of these countries should grow faster.

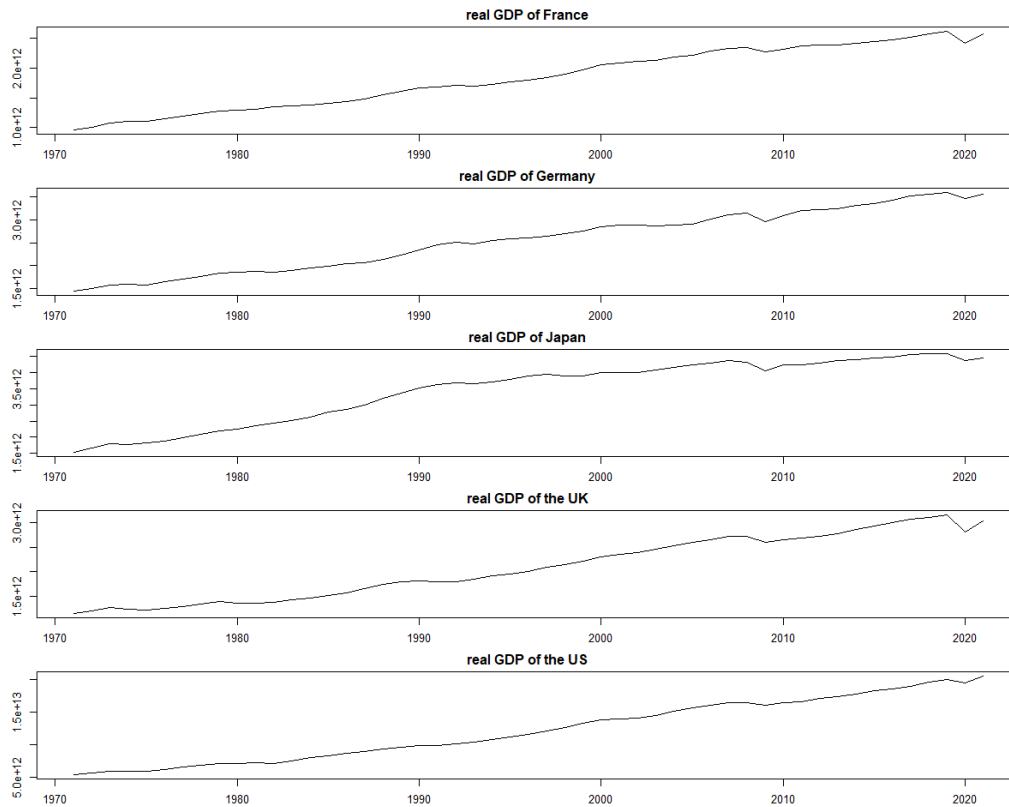


Figure 8: Real GDP of selected developed countries

In order to understand the relationship among variables for each country, we construct a multivariate time series model VARX. In this model, endogenous variables are GDP and FDI inflow and exogenous variables are oil and gas prices. The model is important to understand the general view of the relationship. But in order to build a reliable model we need data to be stationary.

3.2 Unit root tests and their results

We use two unit root tests as discussed above. They are the Augmented Dickey-Fuller test and the Phillip-Perron test. The null hypothesis for both tests is that the time series are non-stationary. We need to be able to reject the null hypothesis. The PP test results are shown in the table (2). First of all-natural logarithm of data is tested for unit root using R function `PP.test()` from the `stats` package. If it is failed to reject the null hypothesis then the first difference of logarithm of data is used. According to the table (2), the logarithm of real GDP (`l.gdp`) is non-stationary in 12 countries and we consider 1st difference of it (`d.l.gdp`) for modeling. In Algeria, Gabon and Brazil logarithm of real GDP are stationary based on the PP test. The logarithms of oil and gas prices are integrated of order 1 as well (`d.l.oil` and `d.l.gas`). However, in the case of the logarithm of FDI (`l.fdi`), the situation is different. Except for France, the US, Turkiye, Mexico, Brazil, and China in all countries `l.fdi` is stationary. However, in the US, France, Mexico and Turkiye `l.fdi` is stationary with 10% of significance. As we consider only 5% significance level, in these cases the first difference of the logarithm of FDI is taken. In addition, R output for p-values in many cases shows 0.01. However, in `PP.test()` function if the p-value is less than 0.01, the R output doesn't show the exact p-value and replaces it with 0.01.

Table 2: Phillips-Perron Unit Root Test Results

Country	Time series	P-value	1st difference of the time series	P-value	Order of differencing
	l.oil	0.3106	d.l.oil	0.01 (**)	I(1)
	l.gas	0.3172	d.l.gas	0.01 (**)	I(1)
Algeria	l.gdp	0.01 (**)			I(0)
Congo, Rep.	l.gdp	0.7570	d.l.gdp	0.01 (**)	I(1)
Gabon	l.gdp	0.0209 (*)			I(0)
Saudi Arabia	l.gdp	0.2303	d.l.gdp	0.01 (**)	I(1)
Oman	l.gdp	0.9349	d.l.gdp	0.01 (**)	I(1)
France	l.gdp	0.7352	d.l.gdp	0.01 (**)	I(1)
Germany	l.gdp	0.7922	d.l.gdp	0.01 (**)	I(1)
Japan	l.gdp	0.8849	d.l.gdp	0.01 (**)	I(1)
United Kingdom	l.gdp	0.7565	d.l.gdp	0.01 (**)	I(1)
United States	l.gdp	0.9017	d.l.gdp	0.01 (**)	I(1)
Mexico	l.gdp	0.3096	d.l.gdp	0.01 (**)	I(1)
Turkiye	l.gdp	0.2452	d.l.gdp	0.01 (**)	I(1)
Brazil	l.gdp	0.0449 (*)			I(0)
China	l.gdp	0.4058	d.l.gdp	0.01 (**)	I(1)
India	l.gdp	0.1488	d.l.gdp	0.01 (**)	I(1)
Algeria	l.fdi	0.01 (**)			I(0)
Congo, Rep.	l.fdi	0.01 (**)			I(0)
Gabon	l.fdi	0.01 (**)			I(0)
Saudi Arabia	l.fdi	0.01 (**)			I(0)
Oman	l.fdi	0.01 (**)			I(0)
France	l.fdi	0.0827 (!)	d.l.fdi	0.01 (**)	I(1)
Germany	l.fdi	0.01 (**)			I(0)
Japan	l.fdi	0.01 (**)			I(0)
United Kingdom	l.fdi	0.01 (**)			I(0)
United States	l.fdi	0.0797 (!)	d.l.fdi	0.01 (**)	I(1)
Mexico	l.fdi	0.0832 (!)	d.l.fdi	0.01 (**)	I(1)
Turkiye	l.fdi	0.0717 (!)	d.l.fdi	0.01 (**)	I(1)
Brazil	l.fdi	0.4724	d.l.fdi	0.01 (**)	I(1)
China	l.fdi	0.7585	d.l.fdi	0.01 (**)	I(1)
India	l.fdi	0.01 (**)			I(0)

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

A similar situation happens in `ur.df()` ADF test. It gives only critical values and test statistic values. The table (1) from the second section of the thesis shows the summary of the hypotheses that are tested.

As it is mentioned in the table we test three different models. Initially, the broadest model - the trend model is tested. If ϕ_2 and ϕ_3 are not statistically significant (e.g. p-value is greater than 0.05) then we switch to the drift model. Otherwise, the trend model should be accepted. The same comparison is conducted between the "drift" and "none" models. After finding the suitable model, the statistical significance of respective τ will give us information about stationarity.

The table (3) shows p values for τ in selected models. In general, the variables that show non-stationarity in the PP test are non-stationary in the case of the ADF test too. Although, the logarithm of GDP is stationary in the case of Gabon, France and Japan. Only in Gabon, the logarithm of GDP is stationary based on both the PP test and the ADF test. Thus, for simplicity, we use only the first difference of the logarithm of GDP in modeling and testing for all countries. In addition, the variables or their first differences for all countries are trend stationary, except the first difference of logarithm of GDP in Algeria, Congo Republic and China. In these three countries, `d.l.gdp` is drift stationary. As it was in the PP test, in the ADF test the p-values are not exact values for p. Here, those value e.g. 0.05 shows that we can reject the null hypothesis at 5% significance level.

To sum up all test results, all variables are first-order integrated ($I(1)$), except the logarithm of FDI in all resource-dependent countries, Germany, Japan, the United Kingdom, and India.

Table 3: Augmented Dickey-Fuller Unit Root Test Results

Country	Variable	p-value of tau_1 in none	p-value of tau_2 in drift	p-value of tau_3 in trend	Order of differencing
	d.l.oil			0.01 (**)	I(1)
	d.l.gas			0.01 (**)	I(1)
Algeria	d.l.gdp		0.05 (*)		I(1)
Congo Republic	d.l.gdp		0.05 (*)		I(1)
Gabon	l.gdp			0.01 (**)	I(0)
Oman	d.l.gdp			0.01 (**)	I(1)
Saudi Arabia	d.l.gdp			0.01 (**)	I(1)
France	l.gdp			0.05 (*)	I(0)
Germany	d.l.gdp			0.01 (**)	I(1)
Japan	l.gdp			0.05 (*)	I(0)
United States	d.l.gdp			0.01 (**)	I(1)
United Kingdom	d.l.gdp			0.01 (**)	I(1)
Brazil	d.l.gdp			0.01 (**)	I(1)
China	d.l.gdp		0.05 (*)		I(1)
Mexico	d.l.gdp			0.01 (**)	I(1)
India	d.l.gdp			0.01 (**)	I(1)
Turkiye	d.l.gdp			0.01 (**)	I(1)
Algeria	l.fdi			0.01 (**)	I(0)
Congo Republic	l.fdi			0.05 (**)	I(0)
Gabon	l.fdi			0.01 (**)	I(0)
Oman	l.fdi			0.01 (**)	I(0)
Saudi Arabia	l.fdi			0.01 (**)	I(0)
France	d.l.fdi			0.01 (**)	I(1)
Germany	l.fdi			0.01 (**)	I(0)
Japan	l.fdi			0.01 (**)	I(0)
United States	d.l.fdi			0.01 (**)	I(1)
United Kingdom	l.fdi			0.01 (**)	I(0)
Brazil	d.l.fdi			0.01 (**)	I(1)
China	d.l.fdi			0.01 (**)	I(1)
Mexico	d.l.fdi			0.01 (**)	I(1)
India	l.fdi			0.01 (**)	I(0)
Turkiye	d.l.fdi			0.01 (**)	I(1)

3.3 VARX model and impulse-response analysis

After taking all stationary data we can build a VAR model with exogenous variables. Because in an ordinary VAR model, all values are considered endogenous, where all these variables can be dependent variables. However, in our model both oil and gas prices are determined internationally and we are not interested to model the effect of different countries on oil and gas prices. So, we assume both resource prices as exogenous variables, in other words, they are only explanatory variables. The equation (25) shows the considered model:

$$\begin{aligned}
 l.fdi_t &= \alpha_0 + \alpha_1 t + \sum_{i=1}^p \phi_{1i} l.fdi_{t-i} + \sum_{i=1}^p \phi_{2i} d.l.gdp_{t-i} + \\
 &\quad + \sum_{l=0}^s \beta_{1l} d.l.oil_{t-l} + \sum_{l=0}^s \gamma_{1l} d.l.gas_{t-l} + \epsilon_{t,1}, \\
 d.l.gdp_t &= \alpha_2 + \alpha_3 t + \sum_{i=1}^p \phi_{3i} d.l.gdp_{t-i} + \sum_{i=1}^p \phi_{4i} l.fdi_{t-i} + \\
 &\quad + \sum_{l=0}^s \beta_{2l} d.l.oil_{t-l} + \sum_{l=0}^s \gamma_{2l} d.l.gas_{t-l} + \epsilon_{t,2}.
 \end{aligned} \tag{24}$$

This model is applied to the countries where the logarithms of FDI inflows are stationary. Here $\alpha_1 t$ and $\alpha_3 t$ are trend terms, while α_0 and α_2 are intercepts. As we use the logarithm of FDI inflow it can show some trend. In the case of model for countries where $l.fdi$ is 1st order integrated then we don't need to use trend term.

Instead, we include only a constant term in the model:

$$\begin{aligned}
d.l.fdi_t &= a_0 + \sum_{i=1}^p \phi_{1i} d.l.fdi_{t-i} + \sum_{i=1}^p \phi_{2i} d.l.gdp_{t-i} + \\
&\quad + \sum_{l=0}^s \beta_{1l} d.l.oil_{t-l} + \sum_{l=0}^s \gamma_{1l} d.l.gas_{t-l} + \epsilon_{t,1}, \\
d.l.gdp_t &= a_1 + \sum_{i=1}^p \phi_{3i} d.l.gdp_{t-i} + \sum_{i=1}^p \phi_{4i} d.l.fdi_{t-i} + \\
&\quad + \sum_{l=0}^s \beta_{2l} d.l.oil_{t-l} + \sum_{l=0}^s \gamma_{2l} d.l.gas_{t-l} + \epsilon_{t,2}.
\end{aligned} \tag{25}$$

In this VARX model, a_0 and a_1 are constant (intercept) terms. In both models, p is the maximum lag of endogenous variables while s is the maximum lag of exogenous variables. The optimal maximum lag of endogenous variables is found using the Akaike information criterion (AIC). While, for exogenous variables, the lag length is fixed and equal to 1. Because the most suitable package for VARX modeling in R, `vars` package doesn't support automatic lag inclusion for exogenous variables. In order to include lagged values manually, `lag()` function is used from `stats` package. However, the result generates "N/A" values at the beginning of the output. When we omit "N/A", some information is lost and the length of the series decreases. So, only one lag is considered in order not to lose too much information. Also, there is `VARselect()` function that automatically selects optimal lag length for endogenous variables. As it is available for only endogenous variables, oil and gas data are included one by one with GDP and FDI as endogenous variables to the function and optimal lag length is generated for Granger causality test. In many cases, the output shows that 1 is the optimal lag for oil prices based on AIC and Schwarz criterion (SC).

The generated output of the VARX model is too large. Because of this, they are included in Appendix 2. From the R output of VARX models, it is clear that the coefficient of determination (R^2) is small in many cases. To sum up, all models based on the R^2 , the VARX models for GDP in Gabon, Germany, India, Turkiye,

the US, France, Mexico and Brazil do not fit well. Also, FDI models fit well only in Congo Republic, Saudi Arabia, India, and China.

The summary of VARX models is represented in table (4), (5), and (6). The tables consist of two parts. In the first part dependent variable is GDP growth (d.l.gdp) and the left column lists the independent variables. In the second part, we can see the model where FDI (l.fdi or d.l.fdi) is a dependent variable. Each cell of the table contains information about the statistically significant coefficients. The cells contain information about the sign of the coefficient, statistically significant lag of the variables and significance codes. For example, in the table (4), "(+)(1)(**)" in the first row and first column means that, while d.l.gdp is a dependent variable first lag of d.l.gdp is statistically significant with 99% confidence and positively affect to the d.l.gdp. In general, we can reject the null hypothesis that the coefficient is 0 with 99.9% confidence (***), with 99% confidence (**), with 95% confidence (*) and with 90% confidence (!). However, only at least a 95% confidence interval should be considered to claim that coefficients are significantly different from 0. The table (4) shows the summary of the VARX model for resource-dependent countries. According to the table, the significance of coefficient estimates of VARX in resource-dependent countries shows that FDI does not affect GDP growth. Only in Saudi Arabia coefficient of FDI is significant as an explanatory variable in the GDP model. However, in 1st lagged value of the logarithm of FDI, it is negative and in 2nd lagged value, it is positive. Also, in the case of Algeria gas prices positively affect GDP growth with a 10% significance level. Unexpectedly, we can see a statistically significant negative coefficient of the first lag of oil prices in the GDP model of Algeria. In Gabon and Saudi Arabia, oil prices positively affect GDP growth with a 10% significance level. In the FDI model, oil and gas prices have a positive effect. Except for Congo and Gabon, in all resource-dependent countries, either oil or gas prices have a positive effect on FDI with a 10% significance level. In Congo oil price and FDI relationship is negative. But only in Congo coefficients of both oil and gas prices is statistically significant with 95% confidence.

Table 4: VARX model summary for the resource-dependent countries

	Algeria	Congo	Gabon	Oman	Saudi Arabia
dep.var = GDP					
GDP	(+)(1)(**)			(+)(1)(*)	(+)(1)(*) (-)(4)(!)
FDI					(-)(1)(**) (+)(2)(**) (-)(5)(!)
Oil	(-)(1)(*)		(+)(1)(!)		(+)(1)(!)
Gas	(+)(0)(!)				
constant				(+)(*)	
trend		(-)(*)		(-)(*)	
dep.var = FDI					
GDP					(+)(2)(*) (+)(5)(!)
FDI		(+)(1)(***) (-)(3)(*) (+)(4)(***) (-)(5)(***)			(+)(1)(***) (+)(4)(!)
Oil	(+)(0)(!)	(-)(1)(*)		(+)(0)(!)	
Gas		(+)(0)(*)			(+)(0)(!)
constant	(+)(***)	(+)(*)	(+)(***)	(+)(***)	
trend					

In the case of the FDI model of Gabon, we can't see any statistically significant coefficient of oil/gas prices.

Generally, table (6) shows that in developed countries oil price change decreases the economic growth. However, in Japan and France gas prices have a positive impact on GDP growth. Also, there is no common pattern of FDI in the GDP model. It is important to note that, the model where FDI inflow (l.fdi or d.l.fdi) is a dependent variable, doesn't give any important information in developed countries.

Table 5: VARX model summary for the developing countries

	Brazil	China	India	Mexico	Turkiye
dep.var = GDP					
GDP		(+)(1)(***) (-)(2)(*) (+)(3)(!)			
FDI		(-)(2)(!) (+)(3)(*) (+)(5)(!)	(+)(2)(***)		
Oil		(-)(1)(!)		(+)(0)(*)	
Gas		(+)(1)(*)			
constant	(+)(**)	(+)(!)		(+)(**)	(+)(***)
trend			(-)(!)		
dep.var = FDI					
GDP		(-)(3)(***) (+)(4)(*) (-)(5)(**)	(-)(2)(!)	(+)(1)(*)	
FDI		(+)(1)(***) (-)(2)(**)		(-)(1)(***)	(-)(1)(**)
Oil	(+)(0)(!)	(+)(0)(*)		(-)(1)(!)	
Gas					
constant		(+)(*)	(+)(***)		
trend			(+)(***)		

In the summary table of the developing countries (5), the FDI of China and India has a significant positive effect on GDP growth. In China, 1st lag of difference of logarithm of oil prices shows negative relation with GDP growth with 10% significance level. In Mexico, there is a significant instantaneous effect of oil prices on GDP growth. In the FDI model for developing countries sometimes negative coefficient of lagged values of FDI is significant. In China, oil prices positively affect to FDI. The relationship between GDP and FDI in the VARX model of developing countries, where FDI (l.fdi or d.l.fdi) is a dependent variable, is statistically significant. However, it is hard to identify the common patterns of relationship. For example, in China 3rd and 5th lags of GDP, in India 2nd lag of GDP have negative

impact on FDI, while the 4th lag of GDP in China and 1st lag of GDP in Mexico have positive impact on FDI. To sum up, in the case of each of the three groups of countries common pattern of relationship among variables is hard to identify.

Table 6: VARX model summary for the developed countries

	France	Germany	Japan	UK	USA
dep.var = GDP					
GDP			(+)(1)(**)	(+)(1)(***)	(+)(1)(*)
FDI			(+)(2)(!)	(-)(1)(!)	
			(+)(3)(*)	(+)(2)(***)	
			(-)(4)(**)	(-)(3)(*)	
Oil	(-)(1)(*)			(-)(1)(*)	(-)(1)(*)
Gas	(+)(0)(*)		(+)(0)(*)		
constant	(+)(***)				(+)(***)
trend			(-)(*)		
dep.var = FDI					
GDP	(+)(1)(!)				
FDI	(-)(1)(*)				(-)(1)(!)
Oil					
Gas	(+)(0)(*)				
constant		(+)(***)	(+)(**)	(+)(*)	
trend					

An impulse response analysis is important to visualize the relationship among variables in the model. Although, `irf()` function from `vars` library doesn't consider the impulse response function between exogenous and endogenous variables. So, exogenous variables are included as endogenous variables to the `VAR()` function and the output used in `irf()` function. The graph (9) is an example of the plotted impulse-response function. All other impulse-response functions are added to Appendix 3. The figure (9) shows the responses of the logarithm of FDI to the impulses from differences of logarithms of GDP, oil prices, and gas prices in Algeria. Also, responses of GDP growth to the impulse from 3 other variables are plotted. There

is no significant pattern in the case of Algeria, Congo Republic, Oman, France, Germany, and Brazil. As we see in impulse response functions, there is either a non-significant response or unstable fluctuations. It means that the relationship between variables is changing within the short or long term.

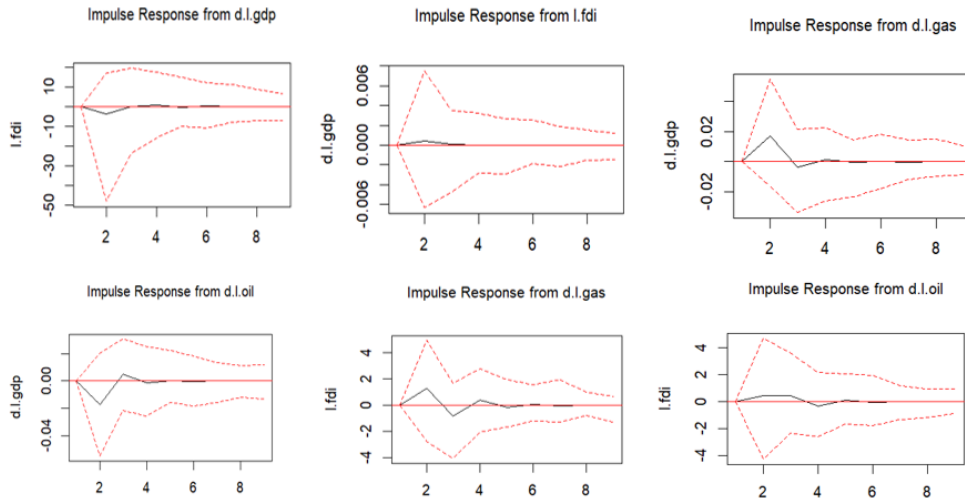


Figure 9: Impulse-response functions of Algeria

Such kind of patterns is common for many analyzed countries. These impulse-response relations confirm the interpretation of VARX model coefficient estimates. In Gabon and Saudi Arabia, GDP growth shows a positive response to the shock in oil prices. In Gabon, there is a negative response to the gas price shocks. In Saudi Arabia, we can see negative and then positive responses from GDP growth to the shocks of the logarithm of FDI. In Japan and the UK, there is a positive impact of FDI on GDP growth with some delay. In the UK gas prices have a positive impact on GDP growth, while in the US this impact is negative. Also, in the US, oil prices negatively affect both FDI inflow growth and GDP growth. Unlike in the VARX model, there is a positive impact of oil prices on GDP growth in China. However, the effect of gas prices on GDP and FDI in both India and China fluctuates. While in China there is a positive effect of FDI inflows on GDP growth, in Mexico GDP growth has a positive impact on FDI inflows. As in the US, in Turkiye shocks in

gas prices negatively affect GDP growth. All of the above-mentioned impacts last at most 2 years and do not cause a permanent impact. In the long run, they are not significantly different from zero.

3.4 Granger causality test results

The VAR and VARX model helps us to specify the relationship between variables. However, these models do not clarify the direction of the relationship. In order to understand the direction of causality, the Granger causality test is conducted. In the context of the VAR and VARX models, the Granger causality test determines whether the lagged values of one variable help to predict the current and future values of another variable. If the inclusion of lagged values of one variable (endogenous or exogenous) improves the predictive power of the model for another variable, then between the two variables Granger causality exists.

The Granger causality procedure for the VAR model is similar to the AR model. It can be tested using a variety of statistical tests, such as the F-test. This test compares the performance of two nested VAR models: one model that includes both variables and another model that only includes one variable. If the inclusion of values of one variable improves the predictive power of the model, then Granger causality is said to exist between the two variables (Kirchgässner, Wolters, and Hassler, 2013, Chapter 4.2).

In the empirical analysis, two different functions of R are applied for causality testing. The VARX output in R is tested for Granger causality with `causality()` test. But this test also considers only endogenous variables. In order to test for the Granger causality between exogenous and endogenous variables `grangertest()` function is used from `lmtest` package. Using this test a pairwise Granger causality between each exogenous and endogenous variable is tested. The optimal lag order is selected using the `VARselect()` function. Two information criterias: AIC and SC are compared for lag selection. In general, the maximum allowed lag length is

determined as 5 lags. The null hypothesis is no causality between variables. The table (7), (8) and (9) shows the results of Granger causality test. The tables are divided based on the null hypotheses that are tested. In the table (7), we test whether the logarithm of FDI or the difference of logarithm of FDI Granger causes GDP growth and vice versa. Columns of the table show optimal lags, F-statistics and p-values based on the lags selected using AIC and SC. There is Granger causality from FDI to GDP growth in Saudi Arabia, Japan, the UK and India. However, in China, the null hypothesis is rejected with only a 10% significance level. Causality from GDP growth to FDI exists only in the case of China and Mexico. The table (8) shows the results of Granger causality from the 1st difference of logarithm of oil prices to GDP growth and to FDI. According to the SC, there is causality from oil prices to GDP growth with a 10% significance level in the Congo Republic and Gabon. In Oman, this causality exists with a 5% significance level. In the case of the US and the UK, Granger causality from oil prices to GDP growth exists too. Causality from oil prices to FDI exists only in Mexico and India. Moreover, gas prices Granger causes to the FDI in France, India and Turkiye. By considering the optimal lags based on SC we can interpret that gas prices Granger causes to GDP growth in the US and Turkiye with 5% significance level. The lack of causality from oil and gas prices to GDP growth in many countries is surprising. Because energy costs should affect the economic growth in all three groups of countries. In oil and gas-producing countries commodity prices should increase state revenues, while in other countries they may increase energy costs and decrease economic growth.

Table 7: Granger causality from FDI to GDP and from GDP to FDI

H0: logarithm of FDI (or FDI growth) does not Granger cause GDP growth								
	L	AIC	L	SC	F-AIC	p-AIC	F-SC	p-SC
Algeria	1	1	0.0458	0.8310	0.0458	0.8310		
Congo Republic	5	1	0.4965	0.7775	0.1217	0.7281		
Gabon	2	1	0.0258	0.9746	0.0111	0.9165		
Oman	1	1	1.6113	0.2080	1.6113	0.2080		
Saudi Arabia	5	2	4.8977	0.0009 ***	3.9327	0.0238 *		
France	1	1	0.3127	0.5776	0.3127	0.5776		
Germany	1	1	0.3581	0.5513	0.3581	0.5513		
Japan	4	1	6.1919	0.0003 ***	0.9252	0.339		
United States	1	1	2.0637	0.1547	2.0637	0.1547		
United Kingdom	3	2	23.932	0 ***	22.897	0 ***		
Brazil	1	1	0.0468	0.8294	0.0468	0.8294		
China	5	3	2.1127	0.0767 !	1.0999	0.3551		
Mexico	1	1	2.2849	0.1345	2.2849	0.1345		
India	2	2	7.406	0.0012 **	7.406	0.0012 **		
Turkiye	1	1	0	0.9946	0	0.9946		
H0: GDP growth does not Granger cause logarithm of FDI (or FDI growth)								
	L	AIC	L	SC	F-AIC	p-AIC	F-SC	p-SC
Algeria	1	1	0.8866	0.3492	0.8866	0.3492		
Congo Republic	5	1	0.6425	0.6682	0.0289	0.8654		
Gabon	2	1	0.0263	0.974	0.0237	0.878		
Oman	1	1	1.8311	0.1798	1.8311	0.1798		
Saudi Arabia	5	2	2.3018	0.05679 !	1.5438	0.2204		
France	1	1	3.0487	0.0846 !	3.0487	0.0846 !		
Germany	1	1	1.5782	0.2127	1.5782	0.2127		
Japan	4	1	0.1261	0.9725	0.6307	0.4295		
United States	1	1	2.6164	0.1096	2.6164	0.1096		
United Kingdom	3	2	0.0978	0.961	0.1152	0.8914		
Brazil	1	1	0.097	0.7563	0.097	0.7563		
China	5	3	6.9168	0 ***	5.5857	0.0017 **		
Mexico	1	1	6.5199	0.0125 *	6.5199	0.0125 *		
India	2	2	2.9334	0.0594 !	2.9334	0.0594 !		
Turkiye	1	1	1.3625	0.2465	1.3625	0.2465		

Table 8: Granger causality from oil prices to GDP and to FDI

H0: Oil price growth does not Granger cause GDP growth								
	L	AIC	L	SC	F-AIC	p-AIC	F-SC	p-SC
Algeria	1		1		0.1628	0.6884	0.1628	0.6884
Congo Republic	1		1		3.4771	0.0686 !	3.4771	0.0686 !
Gabon	4		1		1.4751	0.2295	2.8388	0.0988 !
Oman	5		1		1.8179	0.1356	4.8841	0.0321 *
Saudi Arabia	1		1		0.0321	0.8586	0.0321	0.8586
France	1		1		1.4402	0.2363	1.4402	0.2363
Germany	1		1		2.0916	0.1549	2.0916	0.1549
Japan	1		1		1.6046	0.2116	1.6046	0.2116
United States	1		1		8.3868	0.0058 **	8.3868	0.0058 **
United Kingdom	1		1		5.7561	0.0205 *	5.7561	0.0205 *
Brazil	1		1		0.0196	0.8893	0.0196	0.8893
China	1		1		0.1301	0.72	0.1301	0.72
Mexico	1		1		0.0702	0.7922	0.0702	0.7922
India	1		1		0.1113	0.7402	0.1113	0.7402
Turkiye	1		1		1.0243	0.3168	1.0243	0.3168
H0: Oil price growth does not Granger cause logarithm of FDI (or FDI growth)								
	L	AIC	L	SC	F-AIC	p-AIC	F-SC	p-SC
Algeria	1		1		0.6083	0.4394	0.6083	0.4394
Congo Republic	5		5		1.1208	0.368	1.1208	0.368
Gabon	1		1		0.0626	0.8036	0.0626	0.8036
Oman	1		1		0.1944	0.6613	0.1944	0.6613
Saudi Arabia	2		1		0.5673	0.5712	0.8735	0.3549
France	1		1		0.822	0.3693	0.822	0.3693
Germany	1		1		0.0407	0.841	0.0407	0.841
Japan	1		1		1.4507	0.2346	1.4507	0.2346
United States	1		1		3.0452	0.0877 !	3.0452	0.0877 !
United Kingdom	1		1		0.2512	0.6186	0.2512	0.6186
Brazil	1		1		1.4853	0.2292	1.4853	0.2292
China	1		1		0.0664	0.7978	0.0664	0.7978
Mexico	3		1		3.5395	0.023 *	0.0249	0.8752
India	3		1		5.0208	0.0048 **	0.3794	0.541
Turkiye	1		1		0.5524	0.4611	0.5524	0.4611

Table 9: Granger causality from gas prices to GDP and to FDI

H0: Gas price growth does not Granger cause GDP growth								
	L	AIC	L	SC	F-AIC	p-AIC	F-SC	p-SC
Algeria	2		1		0.4212	0.659	0.1829	0.6709
Congo Republic	2		1		1.6366	0.2065	2.7275	0.1054
Gabon	4		2		0.8626	0.4954	0.6049	0.5507
Oman	2		1		1.0342	0.3642	3.3427	0.074 !
Saudi Arabia	2		1		1.0197	0.3692	2.2331	0.1419
France	2		1		2.1856	0.1247	0.3494	0.5574
Germany	2		1		0.8555	0.4322	2.1147	0.1527
Japan	2		1		1.6126	0.2112	2.4633	0.1234
United States	2		1		2.1467	0.1292	5.2597	0.0264 *
United Kingdom	2		1		1.9815	0.1502	1.4481	0.235
Brazil	1		1		0.0125	0.9115	0.0125	0.9115
China	2		1		0.9519	0.394	1.2708	0.2655
Mexico	1		1		0.0048	0.9448	0.0048	0.9448
India	1		1		0.2082	0.6503	0.2082	0.6503
Turkiye	2		1		3.0101	0.0598 !	5.1053	0.0286 *
H0: Gas price growth does not Granger cause logarithm of FDI (or FDI growth)								
	L	AIC	L	SC	F-AIC	p-AIC	F-SC	p-SC
Algeria	2		1		0.5274	0.5939	0.8992	0.3479
Congo Republic	5		5		1.1821	0.3383	1.1821	0.3383
Gabon	1		1		0.0236	0.8785	0.0236	0.8785
Oman	1		1		0.4155	0.5224	0.4155	0.5224
Saudi Arabia	2		1		0.111	0.8952	0.0823	0.7756
France	3		1		4.2759	0.0104 *	1.2722	0.2652
Germany	2		1		1.1626	0.3223	0.8088	0.3732
Japan	2		1		1.3425	0.2719	2.7577	0.1036
United States	2		1		1.2484	0.2972	2.1888	0.1458
United Kingdom	3		3		1.526	0.2225	1.526	0.2225
Brazil	1		1		0.1172	0.7337	0.1172	0.7337
China	2		1		0.0262	0.9741	0.0354	0.8516
Mexico	2		1		0.6753	0.5143	0.4082	0.5261
India	3		1		3.2338	0.0322 *	0.2005	0.6564
Turkiye	2		1		5.8887	0.0055 **	0.7924	0.378

Conclusions

This thesis discussed the relationship among FDI, GDP, and oil/gas prices in three different groups of countries. Overall, 15 countries are studied. Based on the result of the VARX model, impulse response functions and Granger causality test, we can assert that FDI is a very important factor for China, India, Saudi Arabia, the UK and Japan. However, the importance of FDI cannot be generalized for any of the groups of countries. Moreover, as FDI affects GDP, GDP growth may also affect the FDI inflows in developing countries. In our model, we saw that in Saudi Arabia there is a significant positive coefficient of GDP when FDI inflow (l.fdi) is a dependent variable. Also, there is Granger causality with a 10% significance level. It means that sometimes high economic development could attract more investors and increase the volume of the FDI inflows. Unlike Saudi Arabia, in China, we see both negative and positive relationships between GDP and FDI. One of the reasons for that may be the different economic system of China. Because the rising economy could lead to a huge amount of direct local investments. In that situation, the government does not apply an FDI-targeted economic strategy and FDI could negatively affect local investments. In the case of oil and gas prices, there is a negative relationship between oil prices and the GDP growth of developed countries. Because these countries are mostly the buyers of oil. Thus, higher prices lead to a decrease in economic growth due to the high energy costs. Based on the impulse-response functions we can conclude that in developing countries gas prices negatively affect economic growth. But oil prices in resource-dependent countries may positively affect GDP and FDI inflows. In addition, the modeling of FDI doesn't show a clear picture in developed countries. Moreover, it should be mentioned that our model is based on short and middle-term analysis. Maybe there is a different relationship among variables in the long term. This is not captured by this thesis. Because in the VARX model, the maximum lag length for the oil and gas prices is 1. Also, the maximum lag for endogenous variables is 5 years.

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Appendix 1. R source codes and outputs

Data formatting

```
library(tseries)
library(vars)
library(urca)
library(dplyr)
library(lmtest)

data1 <- read.csv("/.../Oil_gas_data.csv",
                 header=TRUE, skip=4, sep="," ,dec=".",na.strings = "")
data2 <- read.csv("/.../GDP_FDI_data.csv",
                 header=TRUE,sep="," ,dec=".",na.strings = "..")

# Oil and Gas price
Brent <- data1$Crude.oil..Brent.....bbl.
NG_EU <- data1$Natural.gas..Europe.....mmbtu.
oil <- ts(Brent[12:62],start= 1971,frequency=1)
gas <- ts(NG_EU[12:62],start = 1971,frequency=1)

#Function of real GDP and FDI per country
info <- function(country){
  y <- filter(data2,Country.Name == country)
  gdp_real <- filter(y,Series.Name == "GDP (constant 2015 US$)")
  gdp_real1 <- c(t(gdp_real))
  gdp_real2 <- as.numeric(gdp_real1[6:56])
  fdi_real_const <- filter(y,Series.Name ==
                           "real FDI corrected (base year 2015)")
```

```

fdi_real1_const <- c(t(fdi_real_const))
fdi_real2_const <- as.numeric(fdi_real1_const[6:56])
gdp.real <- ts(gdp_real2,start = 1971, end= 2021, frequency = 1)
fdi.const <- ts(fdi_real2_const,start = 1971, end= 2021,
               frequency = 1)
return(cbind(gdp.real,fdi.const))
}
w <- info("Algeria")
gdp.real <- w[,1]
fdi.const <- w[,2]

```

PP and ADF test for data of Algeria

```

### Phillips Perron test
PP.test(diff(log(gdp.real)))
### Output
Phillips-Perron Unit Root Test
data: diff(log(gdp.real))
Dickey-Fuller = -7.9791, Truncation lag parameter = 3, p-value = 0.01

### GDP (in real $) ADF test for trend model
adf_gdp.r <- ur.df(diff(log(gdp.real)),type="trend",
                  selectlags = "BIC")
summary(adf_gdp.r)
### Output
#####
# Augmented Dickey-Fuller Test Unit Root Test #
#####

```

Test regression trend

Call:

```
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.064643	-0.009913	0.000549	0.015268	0.040568

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)	
(Intercept)	0.0230773	0.0110574	2.087	0.042710	*
z.lag.1	-0.5437234	0.1538272	-3.535	0.000974	***
tt	-0.0002953	0.0002853	-1.035	0.306283	
z.diff.lag	-0.1681382	0.1010020	-1.665	0.103079	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02462 on 44 degrees of freedom

Multiple R-squared: 0.3655, Adjusted R-squared: 0.3223

F-statistic: 8.45 on 3 and 44 DF, p-value: 0.0001517

Value of test-statistic is: -3.5346 4.3582 6.3811

Critical values for test statistics:

	1pct	5pct	10pct
tau3	-4.15	-3.50	-3.18
phi2	7.02	5.13	4.31
phi3	9.31	6.73	5.61

VARX model for Algeria

```
### VARX model
endo <- cbind(diff(log(gdp.real)),(log(fdi.const))[2:51])
exo <- cbind(diff(log(oil)),diff(log(gas)),
             stats::lag(diff(log(oil)),k=-1),stats::lag(diff(log(gas)),k=-1))
colnames(endo) <- c("d.l.gdp","l.fdi")
colnames(exo) <- c("d.l.oil","d.l.gas","d.l.oil.l1","d.l.gas.l1")
vrx <- VAR(endo[2:50,], lag.max=5, exogen = na.omit(exo), type='both',
          ic="AIC")
summary(vrx)
```

Output

VAR Estimation Results:

=====

Endogenous variables: d.l.gdp, l.fdi

Deterministic variables: both

Sample size: 48

Log Likelihood: 4.232

Roots of the characteristic polynomial:

0.4318 0.1188

Call:

```
vars::VAR(y = endo[2:50, ], type = "both", exogen = na.omit(exo),
          lag.max = 5, ic = "AIC")
```

Estimation results for equation d.l.gdp:

=====

```
d.l.gdp = d.l.gdp.l1 + l.fdi.l1 + const + trend + d.l.oil +
d.l.gas + d.l.oil.l1 + d.l.gas.l1
```

	Estimate	Std. Error	t value	Pr(> t)	
d.l.gdp.l1	0.4403670	0.1504499	2.927	0.00562	**
l.fdi.l1	0.0002845	0.0013291	0.214	0.83159	
const	0.0212224	0.0293778	0.722	0.47425	
trend	-0.0004041	0.0002630	-1.537	0.13226	
d.l.oil	0.0092058	0.0152035	0.606	0.54826	
d.l.gas	0.0268631	0.0152520	1.761	0.08583	.
d.l.oil.l1	-0.0358420	0.0175043	-2.048	0.04720	*
d.l.gas.l1	0.0273720	0.0203440	1.345	0.18606	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02342 on 40 degrees of freedom

Multiple R-Squared: 0.3941, Adjusted R-squared: 0.2881

F-statistic: 3.717 on 7 and 40 DF, p-value: 0.003455

Estimation results for equation l.fdi:

=====

l.fdi = d.l.gdp.l1 + l.fdi.l1 + const + trend + d.l.oil +
d.l.gas + d.l.oil.l1 + d.l.gas.l1

	Estimate	Std. Error	t value	Pr(> t)	
d.l.gdp.l1	-1.675e+01	1.779e+01	-0.942	0.352	
l.fdi.l1	-1.273e-01	1.572e-01	-0.810	0.423	
const	2.342e+01	3.474e+00	6.741	4.31e-08	***
trend	-2.875e-05	3.109e-02	-0.001	0.999	
d.l.oil	3.359e+00	1.798e+00	1.868	0.069	.
d.l.gas	-5.512e-01	1.803e+00	-0.306	0.761	

```
d.l.oil.l1  1.174e+00  2.070e+00  0.567  0.574
d.l.gas.l1  1.408e+00  2.406e+00  0.585  0.562
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.769 on 40 degrees of freedom

Multiple R-Squared: 0.1385, Adjusted R-squared: -0.01228

F-statistic: 0.9185 on 7 and 40 DF, p-value: 0.5025

Covariance matrix of residuals:

```
          d.l.gdp    1.fdi
d.l.gdp  0.0005484 -0.008164
1.fdi    -0.0081643  7.667652
```

Correlation matrix of residuals:

```
          d.l.gdp    1.fdi
d.l.gdp  1.0000 -0.1259
1.fdi    -0.1259  1.0000
```

Impulse-response function

```
endo <- cbind(diff(log(gdp.real)),(log(fdi.const))[2:51])
```

```
exo1 <- cbind(diff(log(oil)),diff(log(gas)))
```

```
ts <- cbind(endo,exo1)
```

```
colnames(ts) <- c("d.l.gdp","1.fdi","d.l.oil","d.l.gas")
```

```
vr1 <- vars::VAR(ts,lag.max=5,type="both",ic="AIC")
```

```
impulse <- function(model, range){
```

```
  a=irf(model, impulse = "d.l.gdp", response = "1.fdi",
```

```

        n.ahead = range, ortho = FALSE, runs = 1000)
b=irf(model, impulse = "l.fdi", response = "d.l.gdp",
        n.ahead = range, ortho = FALSE, runs = 1000)
c=irf(model, impulse = "d.l.gas", response = "d.l.gdp",
        n.ahead = range, ortho = FALSE, runs = 1000)
d=irf(model, impulse = "d.l.oil", response = "d.l.gdp",
        n.ahead = range, ortho = FALSE, runs = 1000)
e=irf(model, impulse = "d.l.gas", response = "l.fdi",
        n.ahead = range, ortho = FALSE, runs = 1000)
f=irf(model, impulse = "d.l.oil", response = "l.fdi",
        n.ahead = range, ortho = FALSE, runs = 1000)
plot(a)
plot(b)
plot(c)
plot(d)
plot(e)
plot(f)
}

```

```
impulse(vr1,range=8)
```

Granger causality test for data of Algeria

```
### Granger causality test of endogenous variables
```

```
causality(vrx,cause = 'd.l.gdp')$Granger
```

```
### Output
```

```
Granger causality H0: d.l.gdp do not Granger-cause l.fdi
```

```
data: VAR object vrx
```

F-Test = 0.88658, df1 = 1, df2 = 80, p-value = 0.3492

Granger causality test from exogenous variables

```
grangertest(diff(log(oil)),diff(log(gdp.real)),order=1)
```

Output

Granger causality test

Model 1: $\text{diff}(\log(\text{gdp.real})) \sim \text{Lags}(\text{diff}(\log(\text{gdp.real})), 1:1) +$

$\text{Lags}(\text{diff}(\log(\text{oil})), 1:1)$

Model 2: $\text{diff}(\log(\text{gdp.real})) \sim \text{Lags}(\text{diff}(\log(\text{gdp.real})), 1:1)$

	Res.Df	Df	F	Pr(>F)
1		46		
2	47	-1	0.1628	0.6884

Appendix 2. VARX model results

Algeria

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	-16.7500	17.7900	-0.9420	0.3520
l.fdi.l1	-0.1273	0.1572	-0.8100	0.4230
const	23.4200	3.4740	6.7410	0.0000 ***
trend	0.0000	0.0311	-0.0010	0.9990
d.l.oil	3.3590	1.7980	1.8680	0.0690 !
d.l.gas	-0.5512	1.8030	-0.3060	0.7610
d.l.oil.l1	1.1740	2.0700	0.5670	0.5740
d.l.gas.l1	1.4080	2.4060	0.5850	0.5620

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.769 on 40 degrees of freedom
Multiple R-Squared: 0.1385, Adjusted R-squared: -0.01228
F-statistic: 0.9185 on 7 and 40 DF, p-value: 0.5025

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.4404	0.1504	2.9270	0.0056 **
l.fdi.l1	0.0003	0.0013	0.2140	0.8316
const	0.0212	0.0294	0.7220	0.4743
trend	-0.0004	0.0003	-1.5370	0.1323
d.l.oil	0.0092	0.0152	0.6060	0.5483
d.l.gas	0.0269	0.0153	1.7610	0.0858 !
d.l.oil.l1	-0.0358	0.0175	-2.0480	0.0472 *
d.l.gas.l1	0.0274	0.0203	1.3450	0.1861

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02342 on 40 degrees of freedom
Multiple R-Squared: 0.3941, Adjusted R-squared: 0.2881
F-statistic: 3.717 on 7 and 40 DF, p-value: 0.003455

Congo Republic

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	5.8378	5.0149	1.1640	0.2542
l.fdi.l1	0.8296	0.2136	3.8830	0.0006 ***
d.l.gdp.l2	-0.4743	4.9721	-0.0950	0.9247
l.fdi.l2	-1.5151	1.1769	-1.2870	0.2085
d.l.gdp.l3	-0.4834	5.2491	-0.0920	0.9273
l.fdi.l3	-3.0389	1.2225	-2.4860	0.0192 *
d.l.gdp.l4	4.3805	5.1382	0.8530	0.4012
l.fdi.l4	7.1803	1.2703	5.6530	0.0000 ***
d.l.gdp.l5	2.8611	5.0066	0.5710	0.5722
l.fdi.l5	-6.4373	1.3618	-4.7270	0.0001 ***
const	83.7612	32.6773	2.5630	0.0160 *
trend	0.0487	0.0333	1.4620	0.1550
d.l.oil	-2.3983	1.5550	-1.5420	0.1342
d.l.gas	5.9335	2.4620	2.4100	0.0228 *
d.l.oil.l1	-4.3022	1.9352	-2.2230	0.0345 *
d.l.gas.l1	1.6512	1.7661	0.9350	0.3578

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.66 on 28 degrees of freedom
Multiple R-Squared: 0.7919, Adjusted R-squared: 0.6804
F-statistic: 7.103 on 15 and 28 DF, p-value: 4.79e-06

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.2305	0.1708	1.3490	0.1881
l.fdi.l1	-0.0014	0.0073	-0.1960	0.8464
d.l.gdp.l2	0.1534	0.1694	0.9060	0.3727
l.fdi.l2	0.0309	0.0401	0.7710	0.4470
d.l.gdp.l3	-0.0203	0.1788	-0.1140	0.9103
l.fdi.l3	-0.0049	0.0416	-0.1170	0.9075
d.l.gdp.l4	0.0236	0.1750	0.1350	0.8939
l.fdi.l4	0.0459	0.0433	1.0610	0.2976
d.l.gdp.l5	-0.1757	0.1705	-1.0300	0.3116
l.fdi.l5	-0.0095	0.0464	-0.2050	0.8389
const	-1.2170	1.1131	-1.0930	0.2836
trend	-0.0027	0.0011	-2.3910	0.0238 *
d.l.oil	0.0587	0.0530	1.1080	0.2772
d.l.gas	-0.0017	0.0839	-0.0200	0.9844
d.l.oil.l1	0.0576	0.0659	0.8740	0.3895
d.l.gas.l1	0.0292	0.0602	0.4860	0.6307

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.05655 on 28 degrees of freedom
Multiple R-Squared: 0.521, Adjusted R-squared: 0.2644
F-statistic: 2.031 on 15 and 28 DF, p-value: 0.05122

Gabon

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	-1.1306	4.9629	-0.2280	0.8210
l.fdi.l1	0.1335	0.1633	0.8180	0.4188
d.l.gdp.l2	0.2115	5.0303	0.0420	0.9667
l.fdi.l2	0.0529	0.1680	0.3150	0.7546
const	15.5683	4.2857	3.6330	0.0008 ***
trend	0.0260	0.0332	0.7810	0.4396
d.l.oil	-1.1812	2.1838	-0.5410	0.5918
d.l.gas	0.2659	1.8760	0.1420	0.8881
d.l.oil.l1	0.7093	2.0840	0.3400	0.7355
d.l.gas.l1	-0.5328	2.5512	-0.2090	0.8357

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.922 on 37 degrees of freedom
Multiple R-Squared: 0.05886, Adjusted R-squared: -0.1701
F-statistic: 0.2571 on 9 and 37 DF, p-value: 0.9822

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.2182	0.1459	1.4950	0.1434
l.fdi.l1	-0.0008	0.0048	-0.1560	0.8767
d.l.gdp.l2	-0.0723	0.1479	-0.4890	0.6280
l.fdi.l2	-0.0007	0.0049	-0.1410	0.8888
const	0.0340	0.1260	0.2700	0.7890
trend	0.0003	0.0010	0.3060	0.7615
d.l.oil	0.0071	0.0642	0.1110	0.9122
d.l.gas	-0.0110	0.0552	-0.2000	0.8428
d.l.oil.l1	0.1087	0.0613	1.7740	0.0843 !
d.l.gas.l1	-0.0903	0.0750	-1.2030	0.2365

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.08592 on 37 degrees of freedom
Multiple R-Squared: 0.1578, Adjusted R-squared: -0.04702
F-statistic: 0.7704 on 9 and 37 DF, p-value: 0.6439

Oman

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	10.9277	8.0756	1.3530	0.1836
l.fdi.l1	-0.0845	0.1555	-0.5440	0.5896
const	22.2926	3.5692	6.2460	0.0000 ***
trend	0.0084	0.0341	0.2470	0.8062
d.l.oil	3.4100	1.9640	1.7360	0.0902 !
d.l.gas	0.3208	1.7926	0.1790	0.8589
d.l.oil.l1	0.3610	2.0261	0.1780	0.8595
d.l.gas.l1	0.8701	2.5085	0.3470	0.7305

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.868 on 40 degrees of freedom
Multiple R-Squared: 0.1304, Adjusted R-squared: -0.02174
F-statistic: 0.8571 on 7 and 40 DF, p-value: 0.548

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.3380	0.1328	2.5440	0.0149 *
l.fdi.l1	-0.0032	0.0026	-1.2690	0.2117
const	0.1352	0.0587	2.3030	0.0265 *
trend	-0.0013	0.0006	-2.3560	0.0234 *
d.l.oil	0.0141	0.0323	0.4380	0.6641
d.l.gas	0.0294	0.0295	0.9970	0.3246
d.l.oil.l1	0.0384	0.0333	1.1530	0.2557
d.l.gas.l1	0.0258	0.0413	0.6250	0.5357

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.04717 on 40 degrees of freedom
Multiple R-Squared: 0.423, Adjusted R-squared: 0.322
F-statistic: 4.189 on 7 and 40 DF, p-value: 0.001522

France

Estimation results for equation d.l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	9.0525	5.1846	1.7460	0.0883 !
d.l.fdi.l1	-0.4063	0.1603	-2.5350	0.0152 *
const	-0.0956	0.1186	-0.8060	0.4248
d.l.oil	-0.3367	0.3903	-0.8630	0.3932
d.l.gas	1.0435	0.4085	2.5540	0.0145 *
d.l.oil.l1	-0.6875	0.4267	-1.6110	0.1148
d.l.gas.l1	0.0516	0.4765	0.1080	0.9143

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5467 on 41 degrees of freedom
Multiple R-Squared: 0.323, Adjusted R-squared: 0.2239
F-statistic: 3.26 on 6 and 41 DF, p-value: 0.01031

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.0925	0.1839	0.5030	0.6178
d.l.fdi.l1	0.0032	0.0057	0.5590	0.5791
const	0.0159	0.0042	3.7870	0.0005 ***
d.l.oil	0.0049	0.0138	0.3540	0.7251
d.l.gas	0.0367	0.0145	2.5300	0.0153 *
d.l.oil.l1	-0.0316	0.0151	-2.0870	0.0432 *
d.l.gas.l1	0.0191	0.0169	1.1320	0.2641

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01939 on 41 degrees of freedom
Multiple R-Squared: 0.3264, Adjusted R-squared: 0.2278
F-statistic: 3.311 on 6 and 41 DF, p-value: 0.009472

Saudi Arabia

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	-0.4782	0.9249	-0.5170	0.6092
l.fdi.l1	0.8268	0.1683	4.9130	0.0000 ***
d.l.gdp.l2	1.9110	0.7075	2.7010	0.0116 *
l.fdi.l2	-0.1874	0.2367	-0.7920	0.4350
d.l.gdp.l3	-0.7540	0.7444	-1.0130	0.3198
l.fdi.l3	0.0628	0.2020	0.3110	0.7583
d.l.gdp.l4	-0.1963	0.7156	-0.2740	0.7859
l.fdi.l4	0.0332	0.0188	1.7650	0.0884 !
d.l.gdp.l5	1.2440	0.6662	1.8670	0.0724 !
l.fdi.l5	0.0329	0.0208	1.5860	0.1239
const	5.4750	3.2890	1.6650	0.1071
trend	0.0001	0.0049	0.0170	0.9865
d.l.oil	-0.0856	0.2633	-0.3250	0.7474
d.l.gas	0.3535	0.2035	1.7370	0.0934 !
d.l.oil.l1	-0.2676	0.2476	-1.0810	0.2890
d.l.gas.l1	0.4666	0.2981	1.5650	0.1287

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.297 on 28 degrees of freedom
Multiple R-Squared: 0.7356, Adjusted R-squared: 0.5939
F-statistic: 5.192 on 15 and 28 DF, p-value: 8.879e-05

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.4119	0.1795	2.2950	0.0295 *
l.fdi.l1	-0.1149	0.0327	-3.5200	0.0015 **
d.l.gdp.l2	0.1589	0.1373	1.1580	0.2568
l.fdi.l2	0.1655	0.0459	3.6040	0.0012 **
d.l.gdp.l3	-0.0194	0.1445	-0.1340	0.8943
l.fdi.l3	-0.0516	0.0392	-1.3150	0.1990
d.l.gdp.l4	-0.2545	0.1389	-1.8330	0.0775 !
l.fdi.l4	0.0010	0.0036	0.2620	0.7952
d.l.gdp.l5	-0.0293	0.1293	-0.2270	0.8223
l.fdi.l5	-0.0070	0.0040	-1.7330	0.0941 !
const	0.1511	0.6382	0.2370	0.8145
trend	0.0009	0.0009	0.9670	0.3420
d.l.oil	-0.0614	0.0511	-1.2010	0.2396
d.l.gas	0.0558	0.0395	1.4120	0.1690
d.l.oil.l1	0.0890	0.0480	1.8520	0.0745 !
d.l.gas.l1	-0.0586	0.0578	-1.0130	0.3198

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.05764 on 28 degrees of freedom
Multiple R-Squared: 0.6157, Adjusted R-squared: 0.4098
F-statistic: 2.99 on 15 and 28 DF, p-value: 0.005963

United Kingdom

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	-13.8082	34.4958	-0.4000	0.6910
l.fdi.l1	0.0103	0.1978	0.0520	0.9590
d.l.gdp.l2	14.9409	35.8594	0.4170	0.6800
l.fdi.l2	-0.0224	0.1987	-0.1130	0.9110
d.l.gdp.l3	1.5647	30.9519	0.0510	0.9600
l.fdi.l3	0.0507	0.4080	0.1240	0.9020
const	24.4825	9.8496	2.4860	0.0180 *
trend	-0.0353	0.0460	-0.7660	0.4490
d.l.oil	-0.2224	3.3390	-0.0670	0.9470
d.l.gas	-1.3309	5.3466	-0.2490	0.8050
d.l.oil.l1	0.7765	4.2615	0.1820	0.8560
d.l.gas.l1	-2.9440	3.9041	-0.7540	0.4560

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.838 on 34 degrees of freedom
Multiple R-Squared: 0.05473, Adjusted R-squared: -0.2511
F-statistic: 0.179 on 11 and 34 DF, p-value: 0.9979

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.5099	0.1289	3.9560	0.0004 ***
l.fdi.l1	-0.0014	0.0007	-1.8300	0.0761 !
d.l.gdp.l2	-0.1588	0.1340	-1.1850	0.2442
l.fdi.l2	0.0058	0.0007	7.8150	0.0000 ***
d.l.gdp.l3	-0.0999	0.1156	-0.8640	0.3937
l.fdi.l3	-0.0032	0.0015	-2.0770	0.0454 *
const	-0.0094	0.0368	-0.2560	0.7995
trend	-0.0002	0.0002	-1.4390	0.1594
d.l.oil	-0.0054	0.0125	-0.4360	0.6659
d.l.gas	0.0283	0.0200	1.4190	0.1651
d.l.oil.l1	-0.0398	0.0159	-2.5000	0.0174 *
d.l.gas.l1	-0.0178	0.0146	-1.2170	0.2320

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01434 on 34 degrees of freedom
Multiple R-Squared: 0.8103, Adjusted R-squared: 0.7489
F-statistic: 13.2 on 11 and 34 DF, p-value: 2.824e-09

Germany

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	33.2198	26.4431	1.2560	0.2160
l.fdi.l1	-0.0464	0.1546	-0.3000	0.7660
const	24.1011	3.8716	6.2250	0.0000 ***
trend	0.0286	0.0386	0.7420	0.4620
d.l.oil	-1.3824	2.1676	-0.6380	0.5270
d.l.gas	1.1354	2.1771	0.5220	0.6050
d.l.oil.l1	0.4290	2.4376	0.1760	0.8610
d.l.gas.l1	-2.5043	3.0081	-0.8330	0.4100

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.456 on 40 degrees of freedom
Multiple R-Squared: 0.07365, Adjusted R-squared: -0.08846
F-statistic: 0.4543 on 7 and 40 DF, p-value: 0.8613

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.1134	0.1520	0.7460	0.4600
l.fdi.l1	0.0005	0.0009	0.5980	0.5530
const	0.0110	0.0223	0.4940	0.6240
trend	-0.0004	0.0002	-1.6280	0.1110
d.l.oil	0.0066	0.0125	0.5290	0.5990
d.l.gas	0.0137	0.0125	1.0930	0.2810
d.l.oil.l1	-0.0135	0.0140	-0.9620	0.3420
d.l.gas.l1	-0.0076	0.0173	-0.4420	0.6610

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01987 on 40 degrees of freedom
Multiple R-Squared: 0.1951, Adjusted R-squared: 0.05424
F-statistic: 1.385 on 7 and 40 DF, p-value: 0.2383

Japan

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	-20.1264	40.8818	-0.4920	0.6260
l.fdi.l1	-0.1143	0.1771	-0.6450	0.5235
d.l.gdp.l2	-2.7345	32.4369	-0.0840	0.9334
l.fdi.l2	-0.1106	0.1747	-0.6330	0.5314
d.l.gdp.l3	-6.9317	29.8756	-0.2320	0.8181
l.fdi.l3	-0.1137	0.2016	-0.5640	0.5767
d.l.gdp.l4	10.3899	27.1873	0.3820	0.7050
l.fdi.l4	0.0828	0.2251	0.3680	0.7155
const	27.8928	9.4936	2.9380	0.0062 **
trend	0.0171	0.0757	0.2260	0.8225
d.l.oil	0.2698	2.6126	0.1030	0.9184
d.l.gas	-1.5781	2.4854	-0.6350	0.5301
d.l.oil.l1	-0.0052	2.9387	-0.0020	0.9986
d.l.gas.l1	-4.1736	3.4042	-1.2260	0.2294

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.537 on 31 degrees of freedom
Multiple R-Squared: 0.142, Adjusted R-squared: -0.2179
F-statistic: 0.3945 on 13 and 31 DF, p-value: 0.961

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.5294	0.1596	3.3180	0.0023 **
l.fdi.l1	-0.0006	0.0007	-0.8740	0.3891
d.l.gdp.l2	0.1262	0.1266	0.9970	0.3267
l.fdi.l2	0.0013	0.0007	1.8950	0.0674 !
d.l.gdp.l3	-0.0857	0.1166	-0.7350	0.4681
l.fdi.l3	0.0017	0.0008	2.1010	0.0439 *
d.l.gdp.l4	-0.0765	0.1061	-0.7210	0.4766
l.fdi.l4	-0.0030	0.0009	-3.4410	0.0017 **
const	0.0417	0.0371	1.1240	0.2696
trend	-0.0007	0.0003	-2.2400	0.0324 *
d.l.oil	0.0081	0.0102	0.7910	0.4349
d.l.gas	0.0252	0.0097	2.6010	0.0141 *
d.l.oil.l1	-0.0170	0.0115	-1.4810	0.1487
d.l.gas.l1	-0.0111	0.0133	-0.8340	0.4107

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01381 on 31 degrees of freedom
Multiple R-Squared: 0.7812, Adjusted R-squared: 0.6894
F-statistic: 8.512 on 13 and 31 DF, p-value: 5.72e-07

USA

Estimation results for equation d.l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	6.0532	3.7422	1.6180	0.1130
d.l.fdi.l1	-0.2977	0.1647	-1.8080	0.0780 !
const	-0.0510	0.1152	-0.4430	0.6600
d.l.oil	-0.0322	0.3104	-0.1040	0.9180
d.l.gas	0.4119	0.3086	1.3350	0.1890
d.l.oil.l1	-0.4939	0.3334	-1.4820	0.1460
d.l.gas.l1	0.0277	0.4153	0.0670	0.9470

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4758 on 41 degrees of freedom
Multiple R-Squared: 0.2234, Adjusted R-squared: 0.1098
F-statistic: 1.966 on 6 and 41 DF, p-value: 0.09295

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.2992	0.1476	2.0280	0.0491 *
d.l.fdi.l1	-0.0093	0.0065	-1.4370	0.1584
const	0.0192	0.0045	4.2380	0.0001 ***
d.l.oil	-0.0044	0.0122	-0.3630	0.7184
d.l.gas	0.0163	0.0122	1.3410	0.1873
d.l.oil.l1	-0.0269	0.0131	-2.0430	0.0475 *
d.l.gas.l1	-0.0016	0.0164	-0.0980	0.9228

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01876 on 41 degrees of freedom
Multiple R-Squared: 0.2749, Adjusted R-squared: 0.1688
F-statistic: 2.591 on 6 and 41 DF, p-value: 0.03198

Brazil

Estimation results for equation d.l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.6607	2.1218	0.3110	0.7571
d.l.fdi.l1	-0.0610	0.1546	-0.3940	0.6955
const	0.0275	0.0929	0.2970	0.7683
d.l.oil	0.5577	0.3141	1.7750	0.0833 !
d.l.gas	-0.2405	0.3115	-0.7720	0.4446
d.l.oil.l1	-0.3761	0.3790	-0.9920	0.3268
d.l.gas.l1	0.1822	0.4519	0.4030	0.6890

Signif. codes: 0 '****' 0.001 '***' 0.01 '**' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4984 on 41 degrees of freedom
 Multiple R-Squared: 0.136, Adjusted R-squared: 0.009586
 F-statistic: 1.076 on 6 and 41 DF, p-value: 0.3927

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.2214	0.1445	1.5320	0.1332
d.l.fdi.l1	0.0023	0.0105	0.2160	0.8299
const	0.0193	0.0063	3.0470	0.0040 **
d.l.oil	0.0256	0.0214	1.1950	0.2388
d.l.gas	0.0177	0.0212	0.8350	0.4083
d.l.oil.l1	-0.0050	0.0258	-0.1940	0.8474
d.l.gas.l1	0.0127	0.0308	0.4130	0.6820

Signif. codes: 0 '****' 0.001 '***' 0.01 '**' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03395 on 41 degrees of freedom
 Multiple R-Squared: 0.2045, Adjusted R-squared: 0.0881
 F-statistic: 1.757 on 6 and 41 DF, p-value: 0.1323

China

Estimation results for equation d.l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	6.3215	8.6587	0.7300	0.4712
d.l.fdi.l1	0.7754	0.1638	4.7350	0.0001 ***
d.l.gdp.l2	0.7333	8.6772	0.0850	0.9332
d.l.fdi.l2	-0.5237	0.1771	-2.9580	0.0061 **
d.l.gdp.l3	-32.4093	7.8582	-4.1240	0.0003 ***
d.l.fdi.l3	0.1646	0.1423	1.1570	0.2568
d.l.gdp.l4	23.8531	8.8823	2.6850	0.0119 *
d.l.fdi.l4	-0.0309	0.1355	-0.2280	0.8214
d.l.gdp.l5	-25.2588	8.2831	-3.0490	0.0049 **
d.l.fdi.l5	-0.0707	0.1183	-0.5970	0.5549
const	2.7082	1.0288	2.6320	0.0134 *
d.l.oil	1.8183	0.8217	2.2130	0.0349 *
d.l.gas	-0.7435	0.7387	-1.0070	0.3225
d.l.oil.l1	0.1095	0.9699	0.1130	0.9109
d.l.gas.l1	-0.4056	1.0026	-0.4050	0.6888

Signif. codes: 0 '****' 0.001 '***' 0.01 '**' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.095 on 29 degrees of freedom
 Multiple R-Squared: 0.7411, Adjusted R-squared: 0.6162
 F-statistic: 5.93 on 14 and 29 DF, p-value: 2.707e-05

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.7875	0.1546	5.0940	0.0000 ***
d.l.fdi.l1	0.0025	0.0029	0.8650	0.3939
d.l.gdp.l2	-0.4257	0.1549	-2.7480	0.0102 *
d.l.fdi.l2	-0.0063	0.0032	-1.9780	0.0575 !
d.l.gdp.l3	0.2675	0.1403	1.9070	0.0665 !
d.l.fdi.l3	0.0058	0.0025	2.2990	0.0289 *
d.l.gdp.l4	-0.0141	0.1586	-0.0890	0.9297
d.l.fdi.l4	-0.0014	0.0024	-0.5970	0.5550
d.l.gdp.l5	-0.0472	0.1479	-0.3190	0.7517
d.l.fdi.l5	0.0041	0.0021	1.9210	0.0646 !
const	0.0351	0.0184	1.9120	0.0659 !
d.l.oil	-0.0041	0.0147	-0.2820	0.7799
d.l.gas	0.0221	0.0132	1.6780	0.1041
d.l.oil.l1	-0.0294	0.0173	-1.6990	0.0999 !
d.l.gas.l1	0.0378	0.0179	2.1130	0.0434 *

Signif. codes: 0 '****' 0.001 '***' 0.01 '**' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01955 on 29 degrees of freedom
 Multiple R-Squared: 0.6263, Adjusted R-squared: 0.446
 F-statistic: 3.472 on 14 and 29 DF, p-value: 0.002244

India

Estimation results for equation l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	18.3000	13.3500	1.3710	0.1787
l.fdi.l1	-0.0004	0.1571	-0.0020	0.9981
d.l.gdp.l2	-31.0300	16.0300	-1.9350	0.0606 !
l.fdi.l2	-0.1438	0.1677	-0.8570	0.3968
const	18.8000	3.8820	4.8420	0.0000 ***
trend	0.2463	0.0544	4.5250	0.0001 ***
d.l.oil	-0.2996	1.9570	-0.1530	0.8792
d.l.gas	0.5299	1.7190	0.3080	0.7597
d.l.oil.l1	0.6885	1.7430	0.3950	0.6952
d.l.gas.l1	1.3490	2.1160	0.6370	0.5278

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.418 on 37 degrees of freedom
Multiple R-Squared: 0.6348, Adjusted R-squared: 0.546
F-statistic: 7.146 on 9 and 37 DF, p-value: 6.368e-06

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	-0.0992	0.1556	-0.6380	0.5276
l.fdi.l1	0.0001	0.0018	0.0410	0.9679
d.l.gdp.l2	-0.0173	0.1869	-0.0930	0.9268
l.fdi.l2	0.0075	0.0020	3.8440	0.0005 ***
const	-0.0709	0.0452	-1.5670	0.1256
trend	-0.0012	0.0006	-1.8160	0.0775 !
d.l.oil	0.0123	0.0228	0.5410	0.5920
d.l.gas	0.0101	0.0200	0.5060	0.6159
d.l.oil.l1	-0.0139	0.0203	-0.6850	0.4974
d.l.gas.l1	0.0240	0.0247	0.9740	0.3364

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02818 on 37 degrees of freedom
Multiple R-Squared: 0.3333, Adjusted R-squared: 0.1711
F-statistic: 2.055 on 9 and 37 DF, p-value: 0.06013

Mexico

Estimation results for equation d.l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	3.9705	1.5550	2.5530	0.0145 *
d.l.fdi.l1	-0.5231	0.1382	-3.7860	0.0005 ***
const	-0.0134	0.0616	-0.2170	0.8289
d.l.oil	0.0945	0.2098	0.4500	0.6548
d.l.gas	0.2378	0.2055	1.1570	0.2538
d.l.oil.l1	-0.4221	0.2373	-1.7790	0.0827 !
d.l.gas.l1	0.3145	0.2872	1.0950	0.2799

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3286 on 41 degrees of freedom
Multiple R-Squared: 0.31, Adjusted R-squared: 0.2091
F-statistic: 3.071 on 6 and 41 DF, p-value: 0.01417

Estimation results for equation d.l.gdp:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.2544	0.1567	1.6230	0.1122
d.l.fdi.l1	-0.0211	0.0139	-1.5120	0.1383
const	0.0189	0.0062	3.0440	0.0041 **
d.l.oil	0.0464	0.0211	2.1920	0.0341 *
d.l.gas	0.0211	0.0207	1.0190	0.3142
d.l.oil.l1	-0.0029	0.0239	-0.1220	0.9034
d.l.gas.l1	0.0132	0.0290	0.4570	0.6502

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03312 on 41 degrees of freedom
Multiple R-Squared: 0.3007, Adjusted R-squared: 0.1984
F-statistic: 2.939 on 6 and 41 DF, p-value: 0.0177

Turkiye

Estimation results for equation d.l.fdi:

	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	2.8293	2.4239	1.1670	0.2499
d.l.fdi.l1	-0.3912	0.1426	-2.7430	0.0090 **
const	-0.0329	0.1420	-0.2320	0.8180
d.l.oil	-0.0586	0.4079	-0.1440	0.8865
d.l.gas	0.4740	0.4039	1.1740	0.2473
d.l.oil.l1	-0.1148	0.4517	-0.2540	0.8006
d.l.gas.l1	0.4451	0.5815	0.7650	0.4484

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6561 on 41 degrees of freedom
Multiple R-Squared: 0.2152, Adjusted R-squared: 0.1004
F-statistic: 1.874 on 6 and 41 DF, p-value: 0.1087

Estimation results for equation d.l.gdp:

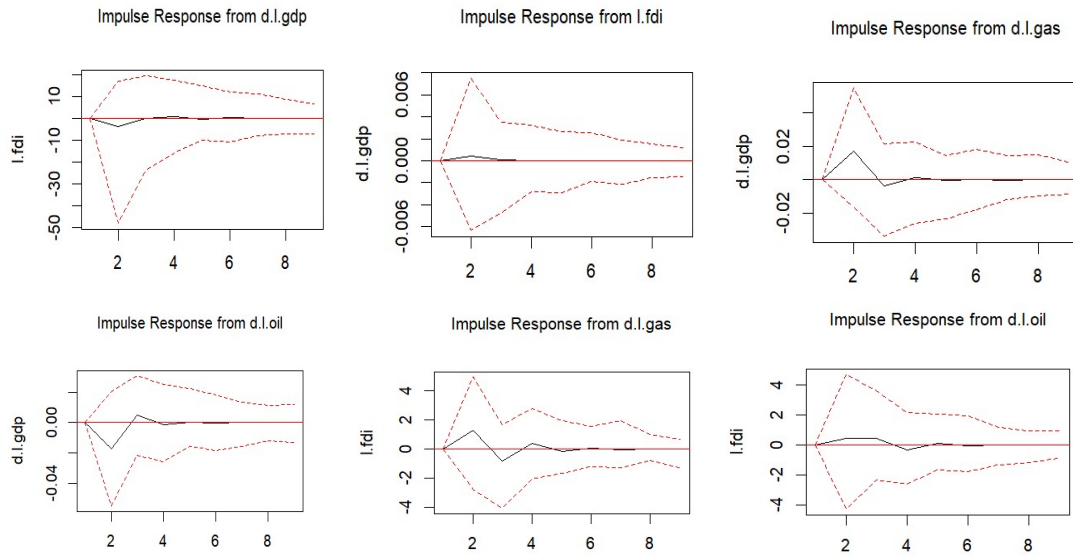
	Estimate	Std. Error	t value	Pr(> t)
d.l.gdp.l1	0.0422	0.1507	0.2800	0.7810
d.l.fdi.l1	0.0001	0.0089	0.0070	0.9950
const	0.0415	0.0088	4.7000	0.0000 ***
d.l.oil	0.0052	0.0254	0.2040	0.8390
d.l.gas	0.0240	0.0251	0.9560	0.3450
d.l.oil.l1	0.0063	0.0281	0.2260	0.8220
d.l.gas.l1	-0.0576	0.0362	-1.5940	0.1190

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

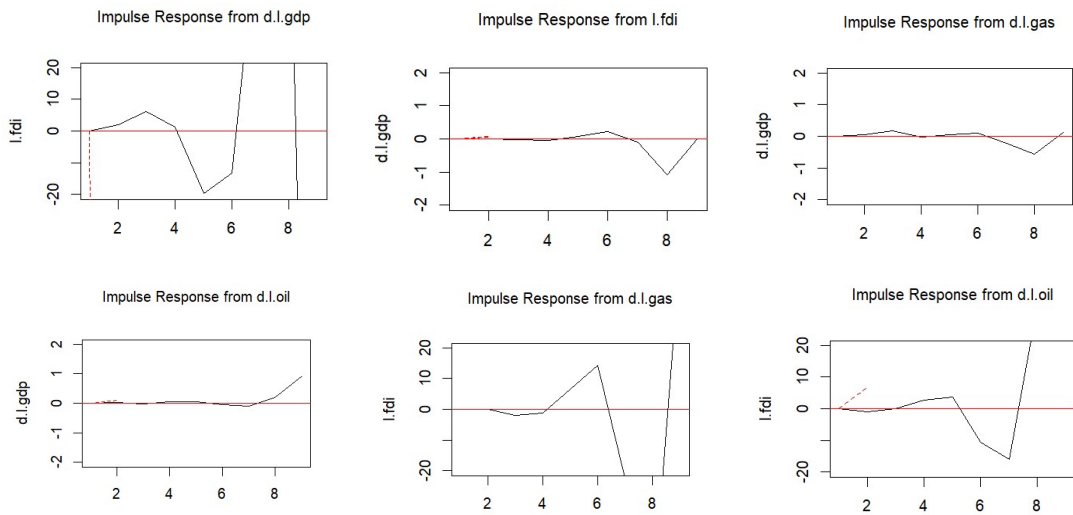
Residual standard error: 0.04079 on 41 degrees of freedom
Multiple R-Squared: 0.151, Adjusted R-squared: 0.02674
F-statistic: 1.215 on 6 and 41 DF, p-value: 0.3182

Appendix 3. Impulse response functions

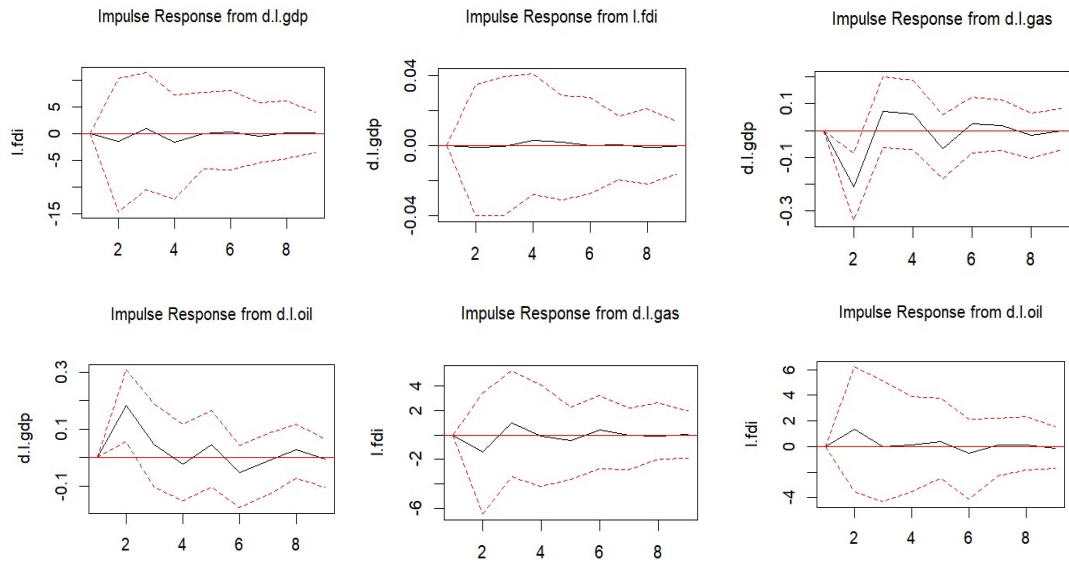
Algeria.



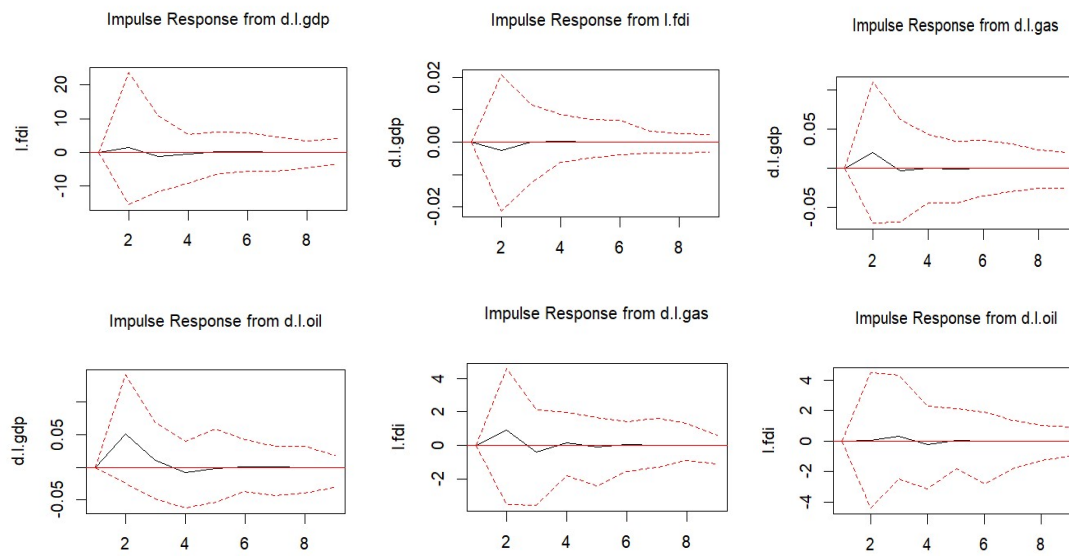
Congo, Rep.



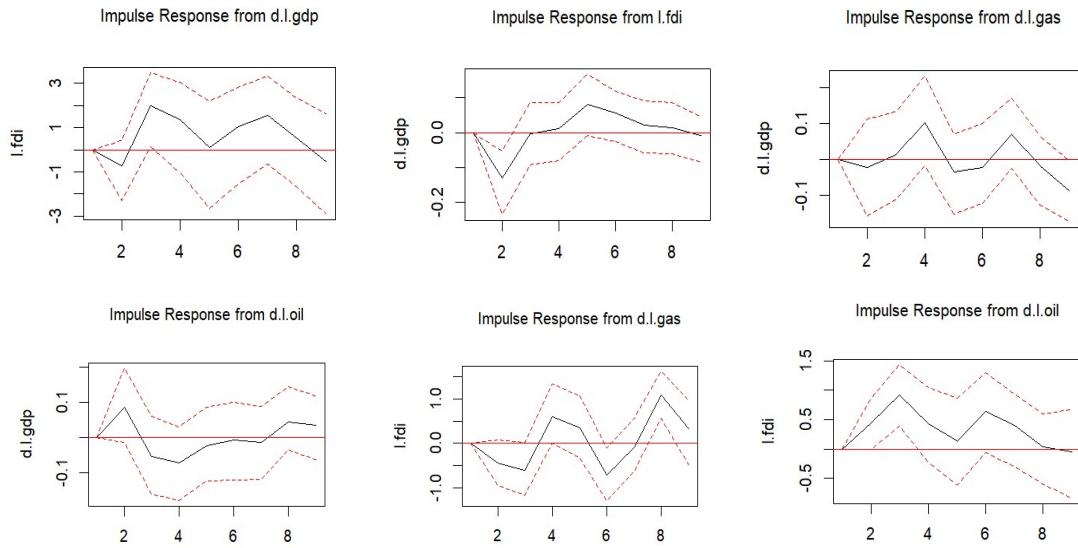
Gabon.



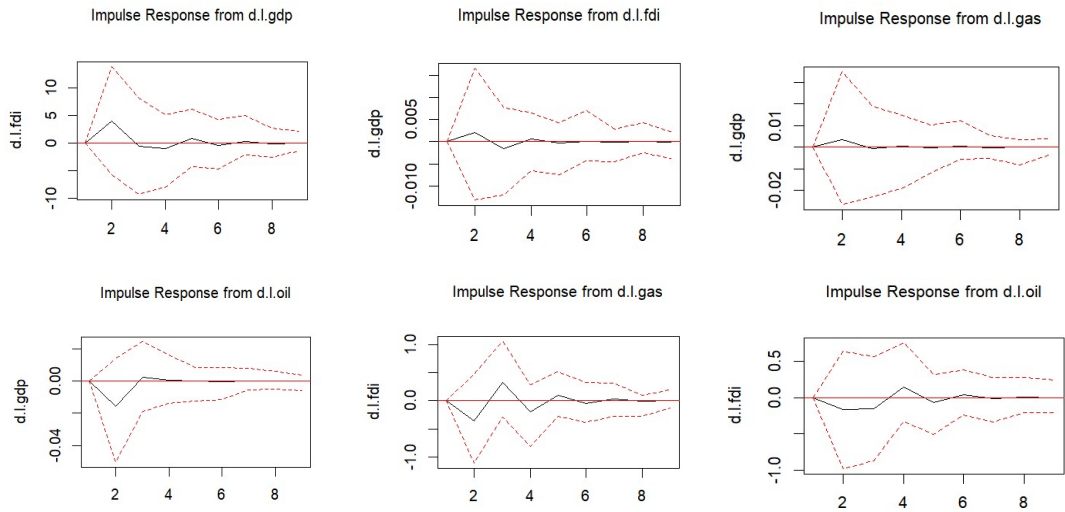
Oman.



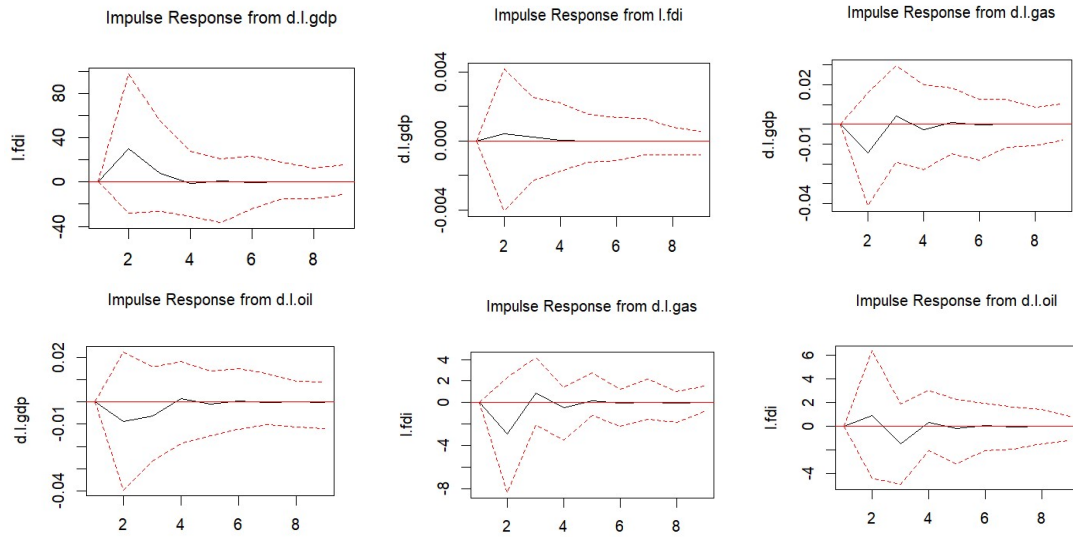
Saudi Arabia.



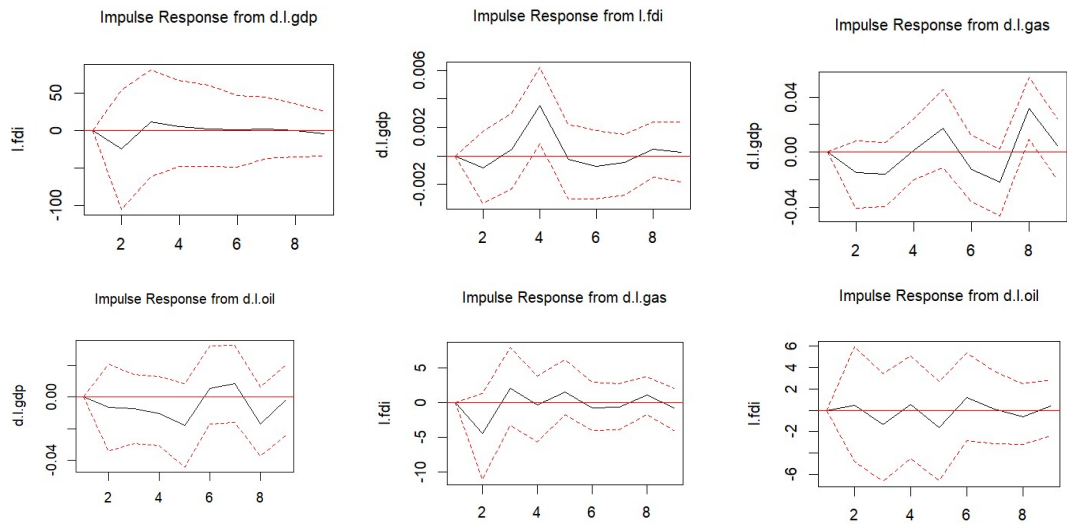
France.



Germany.



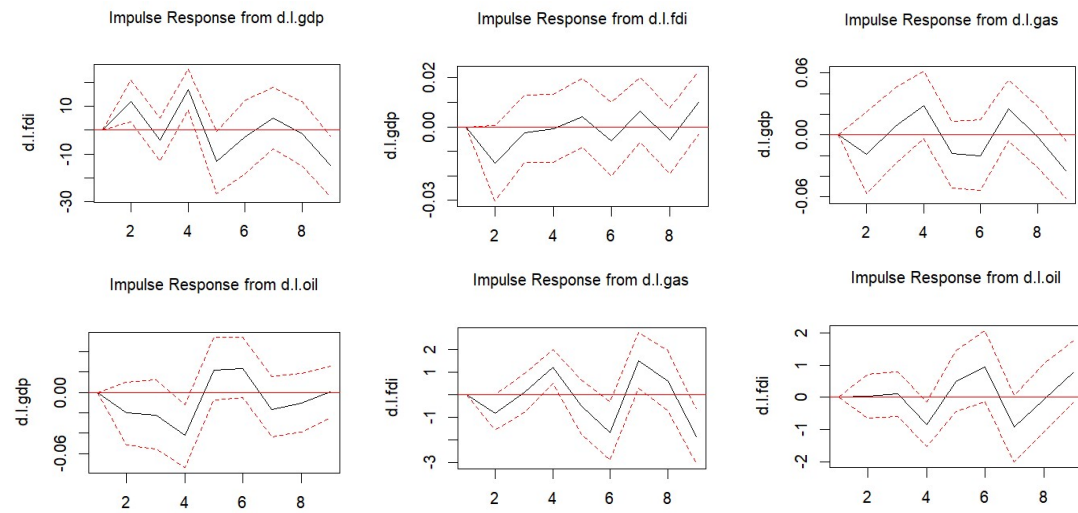
Japan.



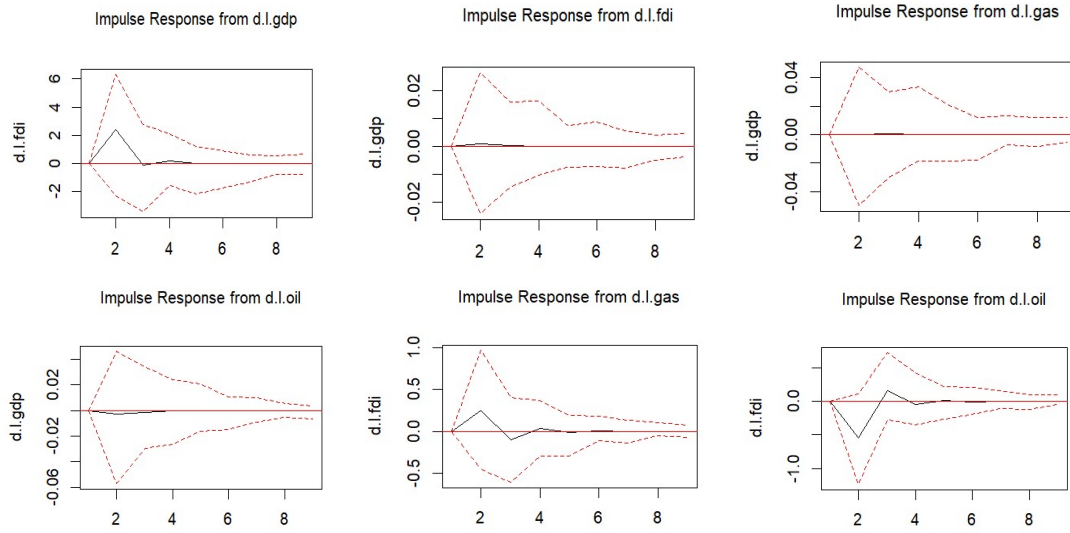
United Kingdom.



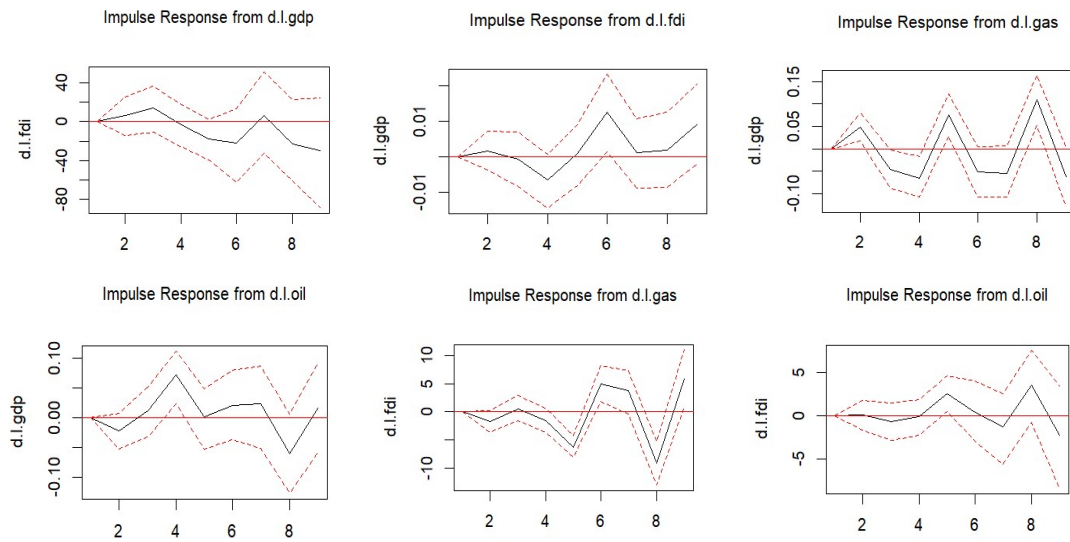
United States.



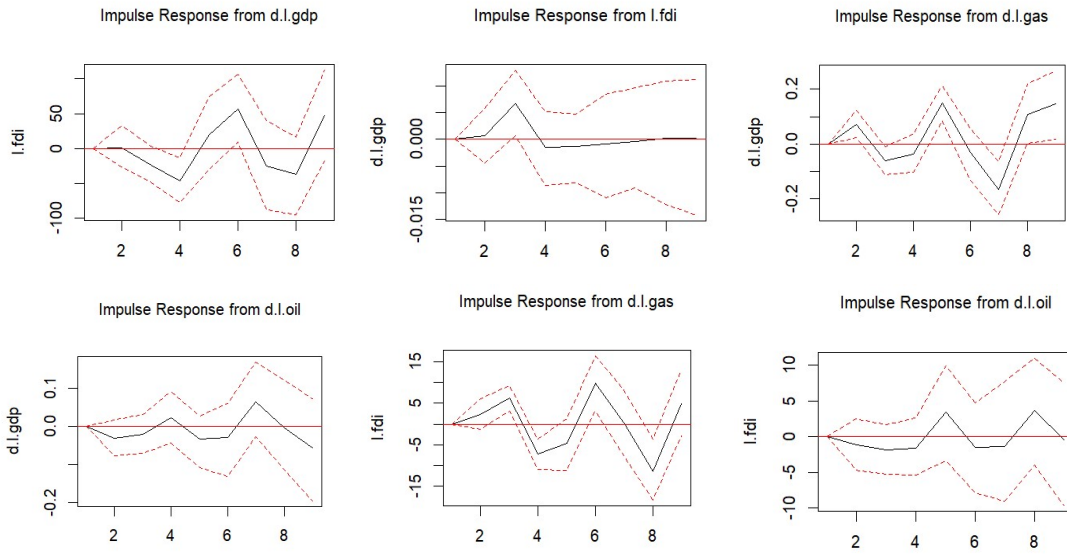
Brazil.



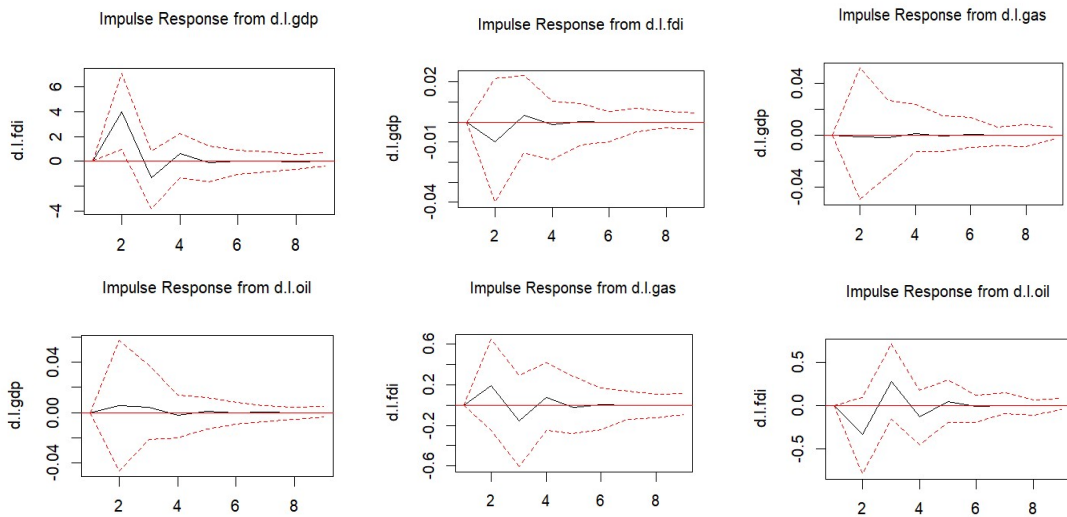
China.



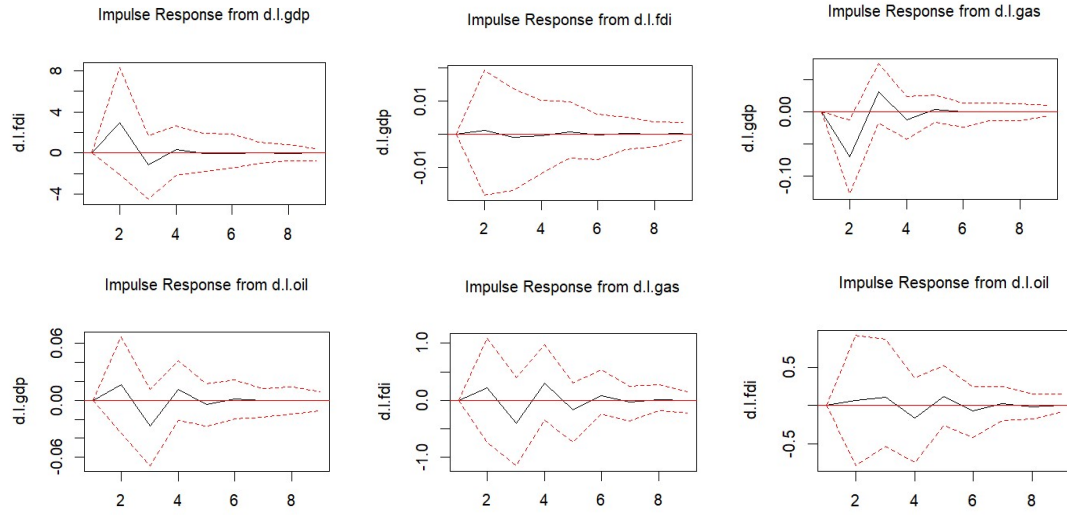
India.



Mexico.



Turkiye.



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