Erasmus University Rotterdam

Erasmus School of Economics

Bachelor Thesis Economics and Business Economics

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The relevance of oil price shocks on oil-importing and oil-exporting countries

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Date final version: 13-07-2021

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Abstract

The main purpose of this thesis is to analyse the impact of crude oil price shocks on oil-exporters and oil-importers' GDP growth per capita. Oil-exporters can be defined as countries that produce significantly more oil than they consume, while oil-importers depict the opposite scenario. Firstly, variables that influence GDP such as a country's exports and savings will be added to the empirical analysis in order to provide as many explanatory variables that impact GDP growth as possible. Secondly, oil prices will be deconstructed into oil price increases and oil price decreases as a means to analyse which oil shock is more detrimental for a country's economy. Thirdly, a fixed-effects multivariate panel data regression will be run for both oil-importers and oil-exporters in an attempt to estimate the causal effect of oil price shocks on a country's GDP growth per capita. Overall, the findings suggest that both oil-importers and oil-exporters face negative and asymmetric effects caused by oil price shocks, where oil price decreases are worse than oil price increases for both samples. It is important to note however that oil-exporters were more negatively affected as compared to oil-importers, for both oil price increases and decreases.

I. Introduction

The 2008 financial crisis, seen as one of the worst recessions since the 1930 Great Depression, damaged many industries across the world. It was caused by a bubble burst in the US real estate market and provoked enormous distress in the worldwide economy. For example, housing prices in the US fell drastically while unemployment rose to around 25% that year (Cassidy, 2018). The oil industry was also worse-off after the 2008 financial crisis, as crude oil prices rose by 150% between 2005 and 2008 (McMahon, 2021). Over the years, oil has arguably become one of the most important factors of production since the 20th Century, as goods ranging from plastic bags to cars all include some form of oil. Also, with the rise of globalisation, countries around the world import and consume more oil, meaning that it is used to a very large extent everywhere. However, with the rise of climate change, policymakers have actively tried to limit oil consumption and production around the world, since oil is environmentally harmful. The unpredictable volatility behind oil prices has also incentivised some countries such as Sweden to switch to a more sustainable source of energy. Nevertheless, a change in oil price has a significant impact on the world economy and on oil importers and exporters. For example, Rasche and Tatom (1981) suggest that the bigger the increase in oil price, the more inflationary pressure there is, and the more need there is to finance ordinary business activities. Similarly, Carruth, Hooker and Oswald (1998) developed an efficiency-wage model and showed that changes in oil prices significantly affect unemployment rates. Therefore, this leads us to the following research question:

To what extent do oil crises impact an oil-exporting or oil-importing country's annual GDP growth per capita?

Oil-exporting countries can be defined as countries that produce more crude oil than they consume, while oil-importing countries can be defined as countries that consume more crude oil than they produce. To answer this research question, three hypotheses will be tested on two financial crises: the 2014 oil price crisis and the 2008 financial crisis that both caused a drastic change in oil prices. The 2014 crisis resulted in oil price decreases, whereas the 2008 financial crisis resulted in oil price increases. As a result, this paper will analyse different effects of oil price increases and decreases.

This paper is scientifically relevant as most literature on oil crises does not differentiate between oil-importing and oil-exporting countries. Also, literature on oil shocks is outdated and this is thus problematic since more countries are switching to renewable energy instead of oil. As such, this paper will offer less biased results since two samples will be used in order to analyse the impact of oil crises on oil-importing and oil-exporting economies. Regarding the social relevance, non-economics readers will be able to understand the mechanism behind oil crises and how they impact a country's GDP growth per capita.

Regarding the structure of the paper, the theoretical framework will: a) briefly mention the history of oil, b) define certain concepts relevant for this paper through a literature review, and c) show the oil consumption and imports of countries used in the oil-exporting and oil-importing samples by means of tables. Then, the data and methodology used for our hypothesis testing will be explained, where the emphasis will be put on the empirical results. At last, this paper will offer some limitations in the way in which the data and methodology was collected and executed, while suggestions for further research will also be evoked.

II. Theoretical Framework

a) Changes in oil prices on a micro and macro level

Increases and decreases in oil prices are both characteristics of external shocks. However, both do not necessarily have the same effects on a micro and macro level. For example, an increase in oil prices may lead to a lower average propensity to consume for households. This is because higher oil prices increase costs of production, and those costs are then passed on to households under the form of higher final prices of goods. From a macroeconomic perspective, basic economic theory suggests that an oil price increase generally increases inflation and hinders economic growth. The more dependent an economy is on oil consumption and production, the more negatively affected it should be by an oil price increase. Similarly, an oil price decrease, in theory, should lead to a reduction in costs of production such as transportation and fuel costs. As a result, lower prices will increase households' average propensity to consume as they will benefit from higher disposable income, enabling them to spend more on other goods. This will create inflationary pressures linked with higher economic growth.

The ambiguity behind whether oil price increases are arguably better than oil price decreases is socially and academically relevant as oil is omnipresent in almost most industrial sectors globally, meaning that a change in oil prices can have drastic impacts within industries. However, the intertwinement of oil usage within industries has created a certain form of oil dependency that is stronger for economies such as the US and China. As a result, understanding oil price fluctuations to a larger extent will benefit policy makers and businesses around the world in times of crises. The fact that oil demand is highly price-inelastic also helps non-economics readers understand how important oil is in today's society (Krichene, 2002). If a good is price-inelastic, a change in the price of that good will result in a change in demand for that good. Necessity goods such as life-saving medicine, electricity and oil fall under that category for example.

b) Literature review

A lot of literature exists on the asymmetric response of crude oil prices on GDP growth. Hamilton (1983) found a strong correlation between changes in oil prices and GDP growth. However, those results cannot be fully statistically interpretated, as his sample only consisted of oil price increases, neglecting the impact oil price decreases have on GDP growth. More concisely, a vast amount of empirical evidence suggests that gasoline prices do respond asymmetrically to oil price decreases and increases (Borenstein, Cameron & Gilbert, 1997). This is consolidated by Manera, Galeotti & Lanza (2003) who depicted widespread discrepancies in the period of adjustment of gasoline prices to changes in crude oil prices. Also, a paper from Mork, Olsen & Mysen (1994) created a sample of 7 OECD countries and found that oil price increases are negative on GDP for most countries while oil price decreases were mostly positive on GDP. This suggests that most countries faced asymmetric effects of oil on GDP apart from Norway, who produces a lot of oil compared to the size of its economy.

However, Godby, Lintner, Stengos & Wandschneider (2000) actively rejected this perspective, by using the Canadian gasoline market and a threshold regression model. They found no significant evidence of asymmetric adjustments in the gasoline market. Bachmeier & Griffin (2003) also did not find any solid asymmetry evidence between crude oil prices and gasoline prices. As a result, the question of how gas asymmetry in relation to changes in oil prices arises is a relevant topic. Bettendorf, van der Geest & Varkevisser (2003) analysed the Dutch gasoline market and found that conclusions on asymmetry are correlated to the date that the oil sample has been picked and observed. Thus, some time periods will depict stronger asymmetric effects compared to other. Similarly, (Borenstein, Cameron & Gilbert, 1997) depicted three different explanations as to why gasoline prices respond asymmetrically. As such, asymmetry arises because of: a) production and inventory adjustment cost, b) oligopolistic coordination theory, and c) the search theory. In example, according to the search theory, increases in retail gasoline price generate incentives to search for a lower retail price and vice-versa. The production and inventory adjustment refers to the fact that oil price asymmetry is caused by oil production and oil usage rates, where the higher the oil production rate the higher the oil price asymmetry. The oligopolistic coordination theory at last refers to the intertwinement between oil oligopolistic countries such as Saudi Arabia that respond to increasing oil price fluctuations in a similar manner in order to keep their market share and influence. According to Radchenko (2005), the oligopolistic coordination theory is the best scenario in explaining price asymmetry, where the relationship between the degree of asymmetry and oil price fluctuations are depicted in Figure 1. Therefore, an increase in oil price fluctuations can lead to a decrease and an increase in gasoline price asymmetry.

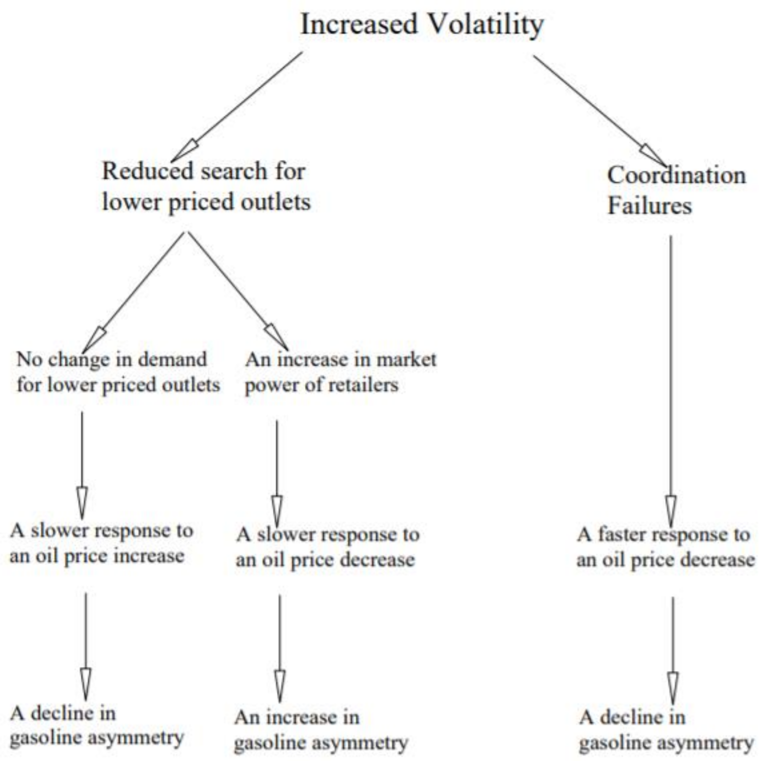

Figure 1: Mechanism of increased oil price fluctuations on gasoline price asymmetry. Reprinted from "Oil price volatility and the asymmetric response of gasoline prices to oil price increases and decreases "by Radchenko, S., 2005, *Energy Economics, 27*(5), 708-730.

Overall, literature about oil price fluctuations and its impact on GDP growth is ambiguous. While some papers such as Borenstein, Cameron & Gilbert (1997) suggest that oil price increases and decreases are asymmetric, other literature such as Bachmeier & Griffin (2003) depict no evidence between oil price fluctuations and asymmetry. The problem however with most literature is that the samples used in the papers do not take into account the effects of oil price fluctuations on oil-exporting and oil-importing countries. Large oil-exporters will clearly face different impacts of an oil crisis as compared to oil-importers. Mork, Olson & Mysen (1994) found that oil price increases are likely to have a negative impact on an economy, unless the economy relies on oil to a large extent, which is the case for most oil-exporting countries. Similarly, Herrera, Lagalo & Wada (2015) found that amongst oil-importing countries, increases in oil prices have a more negative impact on GDP growth. As such, there are also discrepancies between oil-importing and oil-exporting countries, where Norway benefited from an oil price increase while the UK was negatively affected (Herrera, Lagalo & Wada, 2015). This concern is highly relevant for this paper, as the emphasis is put on oil-exporting and oil-importing countries.

Wang, Wu & Yang (2013) analysed oil price shocks and stock market activity and found that the impact of any oil price shock- whether it be an increase or a decrease in crude oil prices- depends on the importance of oil to the given economy as well as the economy's position in the oil market. Similarly (Aziz, 2009) found that increases in oil prices positively and statistically significantly affect the real exchange rate of net oil-importing countries. An increase in a country's exchange rate means that the national currency is stronger on the currency market. A stronger currency benefits importers, as external imports become cheaper for local consumers. As a result, this benefits oil-importing countries, since imports of oil prices will be cheaper. Huang and Guo (2007) represented similar findings by analysing an oil importer such as China. According to them, oil price shocks lead to a relatively small currency appreciation.

To add, Yang, Cai & Hamori (2017) depicted a negative relationship between crude oil prices and exchange rates for oil-exporting countries. As such, an increase in crude oil prices will cause a currency depreciation for oil-exporters. A currency depreciation benefits exporters, as the exports of the oil-exporting economy will become more competitive and cheaper, meaning that oil-exporting countries will be able to sell more oil. Hasanov et al. (2017) found that oil prices have a significant effect on real effective exchange rate appreciation, where their sample consisted of three oil exporters. Currency appreciation caused by changes in oil prices therefore harms exports of non-oil goods and services, where rising domestic prices, significant budget deficits and public spending prevail. At last, Vohra (2017) analysed the impact of oil prices on the Gulf Cooperation Council (GCC) and showed that decreasing and volatile oil prices are driving forces behind increased budget deficits. Changing oil prices therefore significantly hurt oil exporters.

c) Historical and empirical evidence of oil price volatility

The invention of cars in the late 19th and early 20th Century marked the introduction of the internal combustion engine (ICE), a heat engine that operates with the combustion of fuel with an oxidiser. As a result, demand for fuel was already on the rise at that time as car production and popularity was emerging. Throughout the 20th Century, oil was used as a production input in many industries ranging from plastic to food. That trend saw an exponential increase in the beginning of the 21st Century, where even goods such as cosmetics and pencils contain oil. As a result, only a few industries and services do not use any form of oil in their production today and thus, it should not be a surprise to anyone that the crude oil market is one of the largest commodity markets in the world. In the mid-20th Century, the oil industry grew considerably over the years, where oil demand had approximately increased by 10% between 1950 and 1973. In general, oil-produced goods also faced an important surge in demand, where Americans for example purchased as near as two hundred million cars since World War II (Smith, 1975). The mid-20th Century also marked the introduction of the *Organisation of the Petroleum Exporting Countries* (OPEC), an intergovernmental agreement that ensures the stabilisation of oil markets in order to provide an ethical and efficient supply of petroleum to consumers and producers.

Regarding the demand side of oil, countries such as the US, Saudi Arabia and India dominate the field as they represent some of the largest oil consumer globally. These trends are characteristics of the present and previous periods of industrialisation, where oil demand has only seen a constant increase over the years. Also, the way in which oil prices affect countries' economic growth consolidates its importance. Berument, Ceylan & Dogan (2010) analysed the impact of changes in oil prices on countries in the Middle East North Africa (MENA) region - known as large net oil exporters or importers- and found that oil price increases are statistically significant and have a significant effect on most oil importing countries from that region.

In a competitive market, scarcity is measured by a price indicator. As such, oil price increases since 1970 do not show any link to increased scarcity, but rather those increases are characteristics of market control (Adelman, 1993). More intuitively, large-cost oil producers actively try to sell all quantities that they can produce given their endowments, while low-cost producers put emphasis on the production quantities that can match market demand, rather than exploiting all of their resources. For example, OPEC member countries represent low-cost producers that act as last resort oil suppliers. As a result, one can define OPEC members as a cartel actively trying to fix prices and output in order to maximise wealth and profits. As such, the main conclusion behind rising oil prices since 1960 is due to the formation of the OPEC cartel, leading monopoly of the oil industry (Cremer & Weitzman, 1976).

The 20th Century was characterised by three external supply shocks that affected worldwide demand and supply of oil: the 1973 Arab oil crisis, the 1979 Iranian revolution and the 1991 Gulf war and Soviet Union (USSR) collapse. To begin with, the 1973 Arab oil crisis was an embargo to hinder oil exports to the US, which caused world oil prices to increase drastically from $25.97 per barrel in 1973 to $46.35 per barrel in 1974 (Amadeo, 2020). The 1979 Iranian revolution generated a drop in oil production, where crude oil prices doubled to approximately $40 per barrel within a year (Downey, 2020). This crisis was significant as OPEC's market share decreased drastically due to the supply shock, while external businesses slowly shifted to alternative energy sources. At last, the 1991 Gulf war, where Iranian President Saddam Hussein invaded Kuwait – a large oil producer- created a large oil supply decrease. Also, with the collapse of the USSR in 1991, who was one of the biggest oil producers at that time, oil supply levels decreased even more. As a result, both external shocks caused crude oil prices to increase significantly.

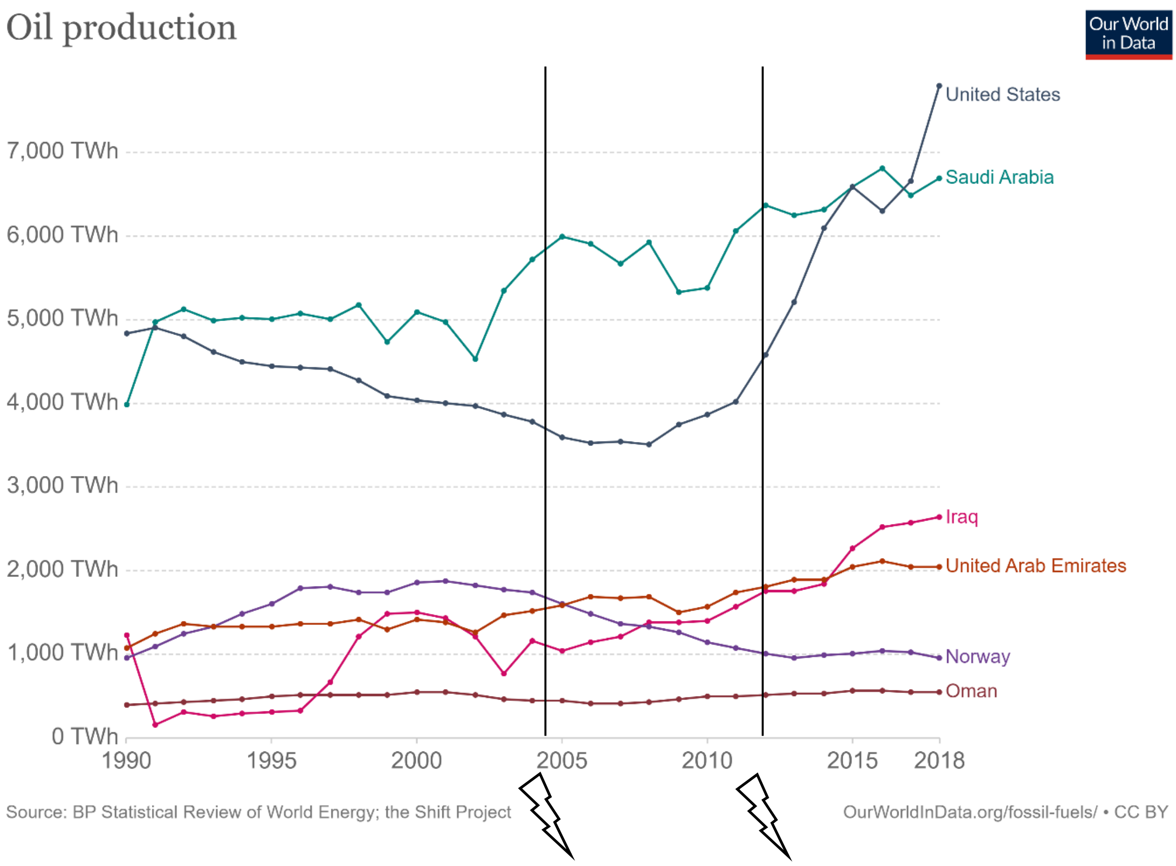

Figure 2: Main oil producing countries between 1990 and 2018. Reprinted from "Our World in Data", by Our World in Data, 2019, Retrieved from *https://ourworldindata.org/grapher/oil-production-by-country?time=1990..2019*

Figure 2 represents crude oil production between 1990 and 2018. While some countries faced increased in oil production over the years, others such as Norway and Oman decreased their production levels. Regarding the 2008 financial crisis, the figure shows that most countries reacted to that crisis by decreasing their oil production, with the exception of Iraq who actually increased its production. The 2014 oil crisis had an opposite effects, where most countries increased their oil production.

d) Oil-importing countries

Table 1: Oil consumption and oil imports for oil-importing countries, in 2016

Country	Oil consumption (2016)	Oil imports (2016)	% Of Oil imports (2016)	Oil consumption World rank (2016)
Finland	210030	226517	108%	54
France	1705568	1091365	65%	13
Germany	2383393	1835271	77%	10
Iceland	19090	0	0%	139
Ireland	152404	64377	42%	66
New Zealand	166913	76740	46%	60
Sweden	322109	396510	123%	43
Switzerland	228194	58719	26%	52

Where all columns refer to the year 2016, and where the 4th column represents oil imports as a percentage of oil consumption.

Table 1 represents the countries in our oil-importing sample. We can see that Germany is the biggest oil-consumer in our sample, while Iceland represents the country that relies the least on oil in our sample. In terms of oil-imports, Sweden imported the most oil in 2016: 123% of its oil consumption. It is important to note that Iceland does not export nor import any oil as of 2016. The reason as to why Iceland was still chosen as an oil-importing[1] country is because it consumes the most oil per capita in our sample.

e) Oil-exporting countries

Table 2: Oil consumption and oil exports for oil-exporting countries, in 2016

Country	Oil production (2016)	Oil exports (2016)	% Of Oil exports (2016)	Oil consumption rank (2016)
Algeria	1259000	633661	37%	18
Canada	4264000	1858572	40%	5
Iran	4251000	1896823	43%	6
Iraq	4613000	3576636	80%	4
Oman	979000	887500	87%	21

[1] **Recall that oil-importing countries in this paper refer to countries that consume more oil than they produce**

Russian Federation	10759000	5098477	45%	2
Saudi Arabia	10425000	7333556	59%	3
United Arab Emirates	3216000	2487580	66%	8

Where all columns refer to the year 2016, and where the 4th column represents oil exports as a percentage of oil consumption.

Table 2 depicts our oil-exporting countries, where the Russian Federation is the largest oil-consumer in our sample. Oman is our biggest oil-exporter, where the country exported 87% of its oil consumption in 2016. Algeria imports the least oil, where it imported 37% of its oil consumption in 2016.

III. Data

We will use empirical evidence and data on 16 countries to narrow the research: eight oil-exporting countries and eight oil-importing countries. In this paper, oil-exporting countries can be defined as countries that are ranked amongst the highest in oil production and that also therefore export large amounts of oil. In contrast, oil-importing countries can be defined as countries that consume considerably more oil than they produce, and that therefore import oil instead in order to satisfy their consumption needs. Oil-exporting countries therefore rely on oil to a significant extent, while oil-importing countries do not.

For example, large oil exporters such as Saudi Arabia and China will be used in the oil-exporting sample, while countries that do not produce much but import most of its oil such as Ireland and France will be used in the other sample. As such, this paper will compare the effects of an oil demand and supply shock on the GDP growth of oil-exporting countries as compared to oil-importing countries. That way, we will be able to analyse whether changes in oil prices affect importers and exporters the same way, and also whether oil price increases are worse for a country's GDP growth compared to oil price decreases.

More precisely, the oil-exporting sample will consist of Algeria, Canada, Iran, Iraq, Oman, Russian Federation, Saudi Arabia and the United Arab Emirates. These countries have been chosen because they represent some of the largest oil-consumers and oil-producers in the world, where countries such as Saudi Arabia and the Russian Federation export more than half of their oil production around the world. By picking such a sample, the estimated impact will be as close to its actual value as possible, since the world's biggest oil-exporters are chosen. In contrast, the oil-importing sample will consist of Finland, France, Germany, Iceland, Ireland, New Zealand, Sweden and Switzerland. These countries have been chosen because they all import oil. Differences in terms of consumption, production and oil importation/exportation are quite significant between both samples. As a result, this will consolidate the estimated results and their validity when we will interpret them. We will also refer to two crises: the 2008 financial crisis and the 2014 oil crisis. The former caused crude oil prices to increase between 2006 and 2008, while the latter triggered crude oil prices to decrease between 2014 and 2016.

To continue, the data used in our empirical section will range between 1990 and 2018 and will be retrieved on *The World Bank*, as well as on *Worldometer*, *Our World in Data* and

CEIC Data. We will also use governmental data from the US for example to make sure that our data is as reliable as possible. Regarding crude oil prices since 1990, data will be retrieved from the *Inflationdata* website. It is important to note however that due to a lack of resources, the database used for this paper has been created by means of a mix between sources. This is because for example, oil production and oil consumption rates per country per year retrieved on *Worldometer* were not available after 2016, while *The World Bank* did not even have databases on that topic. Additionally, missing information on oil production and oil consumption after 2016 has been retrieved on *CEIC Data*, a source that offers similar values to the database available at *Worldometer*. The issue however is that for the years before 2016, both databases do not offer exactly the same values, where some discrepancies arise depending on the chosen year and country. As a result, this represents the data's main limitation.

The following variables will be used in our sample: *GDP growth per capita per country, oil production and oil consumption per capita per country, global crude oil prices, imports and exports per country (% of GDP), savings and government spending (% of GDP, unemployment per country (% of total labour force) and Population per country*. We will also create two dummy variables: *Crisis_2008* which will represent crude oil price increases depicted between 2006 and 2008, and *Crisis_2014* which will show crude oil price decreases between 2014 and 2016. While performing a panel data unit root test[2], some variables in our database were reported as being non-stationary. To correct for non-stationary variables, some variables will be transformed into logarithms, while others will be changed into differences. The differences will be generated by subtracting the variable in year t by the same variable in year t-1. For example, the first difference of variable Crisis_2008 will depict the periods [t-(t-1)] while the second difference of variable Crisis_2008 will show the periods [t-(t-2)] and so on. Additionally, we will create lags for *oil production per capita per country* and for *Crisis_2008* and *Crisis_2014*. That way, these lagged dependent variables provide robust estimates of the effects of our independent variable, namely, *annual per capita GDP growth per country* (Wilkins, 2017).

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[2] **See Appendix a) and b) for the findings of the panel data unit root tests**

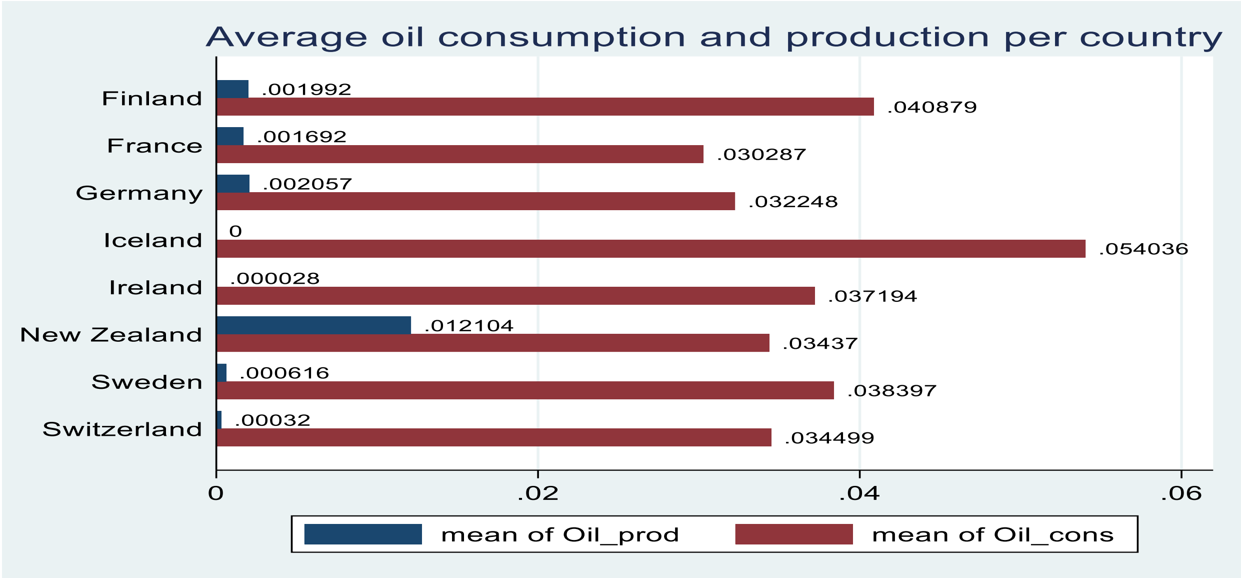

Figure 3: Oil production and consumption oil-importing sample

Figure 3 shows that Iceland is the largest country in our oil-importing sample in terms of oil consumption per capita, where the mean is estimated at 0.054036 barrels/day. In terms of oil production per capita, New Zealand is the largest country, where the mean is estimated at 0.012104 barrels/day.

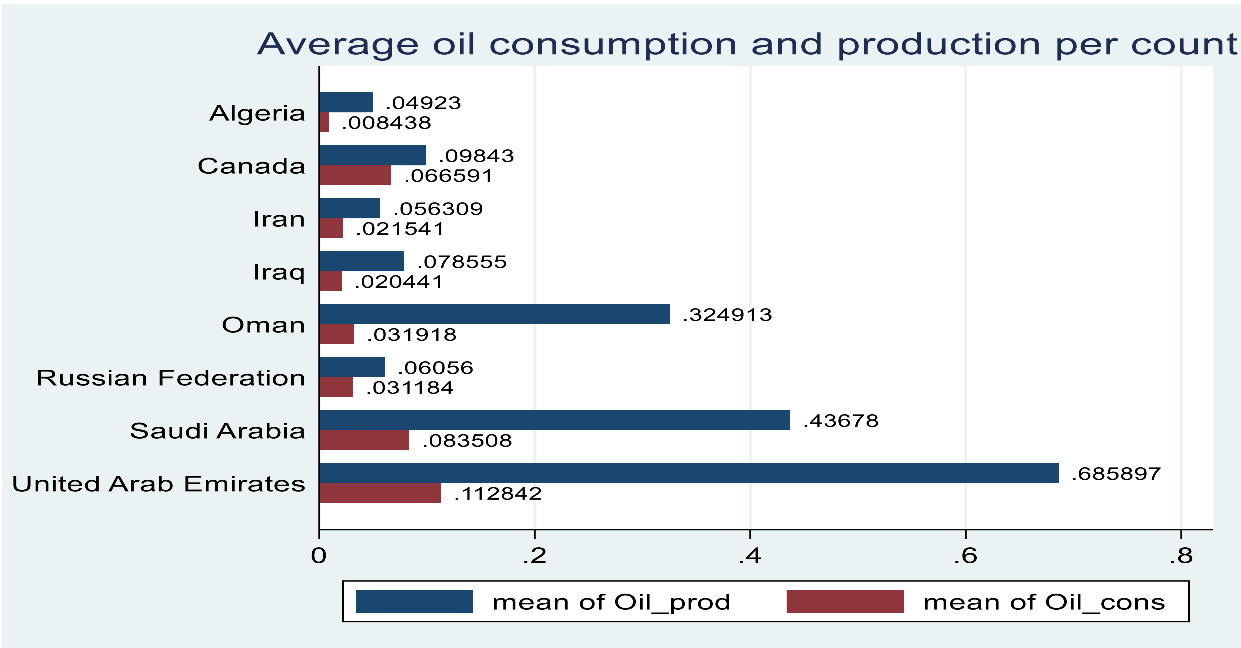

Figure 4: Oil production and consumption oil-exporting sample

We can see from Figure 4 that the United Arab Emirates is the largest oil consumer per capita, where the mean is estimated at 0.112842 barrels/day. In terms of oil production per capita, the United Arab Emirates also represents the largest oil producer, where the mean is estimated at 0.685897 barrels/day. By comparing both Figure 3 and Figure 4, we can understand the differences between both samples to a larger extent, where the distribution of oil production varies by a significant amount between oil-exporting and oil-importing countries.

IV. Methodology

In order to compute the causal effect of an oil shock on GDP growth, we will use panel data in order to gather data on an aggregate level, across countries and over time. The use of panel data allows to control for unobserved variables (Baltagi, 2008). As such, we will run fixed-effects multivariate panel data regression models for both samples: oil-exporting and oil-importing. In our case, the fixed-effects method is preferred over the random-effects method as it assumes that unobserved individual or aggregate characteristics may positively or negatively influence dependent or independent variables in our models. For example, a country's degree of trade openness or a country's geographical location might influence GDP growth. As such, fixed-effects will omit the effects of time-invariant unobserved and observed characteristics.

To continue, three model will be generated for the oil-importing sample with data ranging from 1990 to 2018. Three models will also be created for the oil-exporting sample, within the same time period. The first models from both samples will show a basic multivariate regression with incomplete and non-stationary variables. The second models from both samples will solve for non-stationary variables, but will still contain some missing variables that also influence GDP growth per capita. The third models from both samples will only contain stationary variables, and as many explanatory variables that influence GDP growth per capita as possible. To continue, all six models will include one dummy variable that will represent the 2008 oil price crisis and another dummy variable that will represent the 2014 financial crisis. This is because the 2008 financial crisis was characterised by rising oil prices, while the 2014 oil crisis showed significant decreases in oil prices. Therefore, we will be able to estimate the causal effect of both an increase in oil prices and a decrease in oil prices on GDP growth per capita, for both oil-importing and oil-exporting samples. Regarding whether homoscedasticity is respected in our panel data models, our regressions will be run with a variance robust to heteroscedasticity, in order to guarantee that the variances of our residuals are constant over time.

Actual standard errors, t-test statistics, and p-values of each variable coefficient will be as close to their actual value. Also, we need to ensure that our panel data is stationary, meaning that it has a constant mean and a constant variance over time. As a result, each variable in our models will be tested for stationarity by means of a Levin-Lin-Chu unit root test, where the null-hypothesis refers to having non-stationary data (Levin, Lin & Chu, 2002). All of the variables used in second and third models of both samples are stationary, since their reported p-values are below the 5% significance level[3], meaning that we can reject the null-hypothesis. It is also important to note that when a test for serial correlation of our models' standard errors was performed, autocorrelation was depicted in some models. As a result, the standard errors from our fixed-effects panel data models will be clustered on a country level, with the variable *CountryID*. That way, our models will produce standard errors that are robust to heteroscedasticity and autocorrelation.

To continue, our hypotheses used will be as follows:

1) a) *H_0: Oil price increases (Crisis_2008) have no effect on GDP growth, given the sample period.*

   b) *H_a: Oil price increases (Crisis_2008) do affect GDP growth, given the sample period.*

2) a) *H_0: Oil price decreases (Crisis_2014) have no effect on real GDP growth, given the sample period.*

   b) *H_a: Oil price decreases (Crisis_2014) do affect GDP growth, given the sample period.*

3) a) *H_0: Oil price increases (Crisis_2008) and oil price decreases (Crisis_2014) have symmetric effects.*

   b) *H_a: Oil price increases (Crisis_2008) and oil price decreases (Crisis_2014) have asymmetric effects.*

The following regression for N observations and T time periods will be performed to test the hypotheses:

$$LogGDP_{it} = \beta 1 * GDP_{it} + \beta 2 * Oil_{prod_{it}} + \beta 3 * Oil_{cons_{it}} + \beta 4 * Oil_{prices_{it}} + \beta 5 * Imports_{it} + \beta 6 * Exports_{it} + \beta 7 * Savings_{it} + \beta 8 * Unemployment_{it} + \beta 9 * Gov_{spending_{it}} + \beta 10 * Population_{it} + \beta 11 * Crisis_{it} + |\mu_{it}| \quad ; for\ t = 1, \dots, T\ and\ i = 1, \dots, N$$

[3] **See Appendix a) and b)**

Where:

a) GDP_{it} represents GDP growth rate per capita in the given country i in the year t.
b) $LogGDP_{it}$ represents the logarithm of the GDP growth rate per capita in the given country i in the year t.
c) $Oil_{prod_{it}}$ represents oil production per capita in country i in the year t.
d) $Oil_{cons_{it}}$ represents oil consumption per capita in country i in the year t.
e) $Oil_{prices_{it}}$ represents global crude oil prices per country i per year t.
f) $Imports_{it}$ represents imports of goods and services (% of GDP) per country i per year t.
g) $Exports_{it}$ represents exports of goods and services (% of GDP) per country i per year t.
h) $Savings_{it}$ represents gross savings (% of GDP) per country i per year t.
i) $Unemployment_{it}$ represents unemployment rate (% of total labour force) per country i per year t.
j) $Gov_{spending_{it}}$ represents government spending (% of GDP) per country i per year t.
k) $Population_{it}$ represents population per country i per year t.
l) $Crisis_{it}$ represents a dummy variable for the 2008 and 2014 financial crises.
m) μ_{it} represents the error term.

V. Results

a) Table results oil-importing sample[4]

Table 3: Fixed effects multivariable regressions on oil-importing sample

	(1) LogGDP	(2) LogGDP	(3) LogGDP
GDP	0.0806***	0.0849***	0.0923***
	(9.16)	(10.27)	(7.05)
Oil_prod	-18.05**		
	(-5.27)		
Oil_cons	4.529		
	(1.72)		
Oil_prices	-0.00152*		
	(-2.42)		
Crisis_2008	0.0687	0.0203	-0.0810*
	(1.02)	(0.34)	(-2.46)
Crisis_2014	-0.114	-0.141*	-0.180**
	(-2.19)	(-2.84)	(-3.58)
Exports		-0.00112	-0.00205
		(-0.29)	(-0.54)
Imports		-0.00233	-0.000103
		(-0.40)	(-0.02)
Savings		0.00342*	0.00103
		(2.53)	(0.45)
difl_Oil_prices			-0.00162
			(-1.00)
Lag2_Oil_prod			-68.40***
			(-15.64)
Lag3_Oil_prod			59.75***
			(19.32)
Lag1_Crisis_2008			0.175**

[4] See Appendix c) for further information on the variables depicted in Table 3

			(3.67)
_cons	0.0337	0.146	0.158
	(0.26)	(2.15)	(2.01)
N	232	232	232

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

b) Table results oil-exporting sample[5]

Table 4: Fixed effects multivariable regressions on oil-exporting sample

	(1) LogGDP	(2) LogGDP	(3) LogGDP
GDP	0.0306**	0.0308***	
	(3.92)	(3.98)	
Oil_prod	-0.118	-0.0947	-0.188
	(-1.05)	(-0.80)	(-1.01)
Oil_cons	-0.971	-0.529	-1.129
	(-2.04)	(-1.10)	(-2.14)
Oil_prices	0.000586		
	(0.88)		
Crisis_2008	0.0206	0.0253	0.0850
	(0.32)	(0.33)	(0.89)
Crisis_2014	-0.197	-0.178	-0.159
	(-1.40)	(-1.32)	(-1.24)
Exports		0.00294*	0.000404
		(2.09)	(0.12)
Imports		-0.00310	-0.00238
		(-1.49)	(-0.65)
difl_Oil_prod			6.033*
			(2.89)
Lag4_Oil_prod			-0.286**
			(-4.54)

[5] See appendix d) for further information on the variables depicted in Table 4

dif2_Population			0.000000706*
			(2.44)
Lag2_Crisis_2008			-0.108*
			(-2.48)
Lag2_Crisis_2014			-0.264**
			(-4.20)
_cons	0.281**	0.266**	0.542**
	(5.08)	(2.72)	(4.87)
N	232	232	232

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

c) Interpretation

Table 3 refers to our oil-importing sample, where three fixed-effects multivariate regressions were run. According to column (1), which represents the first model of our oil-importing sample, oil production and GDP growth per capita are negatively correlated. An increase by one additional unit of per capita oil production in barrels/day (*Oil_prod*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 18.05 units, ceteris paribus. To continue, oil prices and GDP growth per capita are also negatively correlated, as an increase by one additional unit of global crude oil prices in barrels/day (*Oil_prices*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 0.00152 units, ceteris paribus. The issue however with our first model represented in Table 3 column (1) is that variables such as *Oil_prod* and *Oil_prices* are non-stationary. As a result, both variables appear to have a causal relationship with other variables from our first model, but in reality, this is not true.

With the problems omnipresent in our first model, we need to run another model that does not have any non-stationary variables and that consists of more explanatory variables that can affect GDP growth per capita. This is important as the variables present in the model found in column (1) capture every other variables that impact GDP growth per capita, but that are not part of the model. As a result, Table 3 column (2) represents our second model, where non-stationary variables have been removed and where other explanatory variables that influence GDP growth and are stationary have been added instead. By doing that, our second model will offer less-biased coefficients, as more coefficients will capture their impact on GDP growth per capita. Savings are positively correlated with a country's GDP growth per capita, where an increase by one additional unit of savings as a % of GDP (*Savings*) is associated with an increase in GDP growth per capita (*LogGDP*) by 0.00342 units, ceteris paribus. Crude oil price decreases are negatively correlated with GDP growth per capita, where an increase by one additional unit of oil price decreases (*Crisis_2014*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 0.141 units, ceteris paribus. The problem however with our second model is that it does not contain a lot more explanatory variables that impact GDP growth per capita as compared to the first model. This is because most variables present in our oil-importing sample are non-stationary and thus need statistical transformations.

Our third model represented in column (3) Table 3 only consists of stationary variables, and has many more explanatory variables that have been transformed into lagged variables and differences in order to become stationary, as compared to the two previous models. As a result, according to the model found in column (3), oil price decreases are negatively associated with GDP growth per capita, where an increase by one additional unit of oil price decreases (*Crisis_2014*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 0.180 units, ceteris paribus. Oil price increases are also associated with a negative effect on GDP growth per capita, where an increase by one additional unit of oil price increases (*Crisis*_2008) decreases GDP growth per capita (*LogGDP*) by 0.0810 units, all else equal. At last, oil production and GDP growth per capita are also negatively associated, where an extra unit of per capita oil production in barrels/day (*Lag2_Oil_prod*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 68.40 units, ceteris paribus.

To continue, Table 4 refers to our oil-exporting sample, where three fixed-effects multivariate regressions were also run. Like in Table 3 column (1), Table 4 column (1) contains a degree of non-stationary variables that offer a false causal effect on other variables, where only *Oil_prices* and *Oil_Cons* are non-stationary. As such, an increase in per capita oil production in barrels/day (*Oil_prod*) is associated with a decrease in GDP country per capita (*LogGDP*) by 0.118 units, all else equal. Similarly, an increase in per capita oil consumption in barrels/day (*Oil*_cons) by one additional unit is associated with a decrease in GDP growth per capita (*LogGDP*) by 0.971 units, ceteris paribus.

Column (2) Table 4 is an improved version of the first model found in column (1) Table 4 since it only has stationary variables. Exports are positively correlated with GDP growth per capita, where an increase by one additional unit of exports as a % of GDP (*Exports*) is associated with an increase in GDP growth per capita (*LogGDP*) by 0.00294 units, all else equal.

At last, column (3) provides the best estimates as our third model only consists of stationary variables and other variables that were previously non-stationary but have been transformed into lagged variables and differences in order to become stationary. The lagged transformations of *Crisis_2008* and *Crisis_2014* offer statistical significance as compared to their simple form. One additional unit of oil price increases (*Lag2_Crisis_2008*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 0.108 units, all else equal. Similarly, one additional unit of oil price decreases (*Lag2_Crisis_2014*) is associated with a decrease in GDP growth per capita (*LogGDP*) by 0.264 units, all else equal.

d) Concluding remarks of results section

Our findings depicted in Table 3 show that oil price decreases (*Crisis_2014*) are worse for a country's GDP growth per capita than oil price increases (*Crisis_2008*). As such, the findings above suggest that for oil-importing countries, oil price decreases are worse than oil price increases. Countries that do not produce any oil and import most of their oil consumption should therefore be more worried about oil price decreases as compared to oil price increases. Although oil price increases are also negatively correlated to GDP growth, its impact on oil-importers is not that significant and thus, policymakers in oil-importing countries can afford to take their time in order to implement effective policies. Our models also show that savings do increase GDP growth per capita, suggesting that oil-importing countries should put emphasis on increasing its savings. At last, those countries should not engage in oil production, as our results show that oil production is negatively associated with GDP growth per capita.

Regarding the literature, our conclusion for oil-importing countries is ambiguous. Aziz (2009) found a positive and significant effect of oil prices on a country's exchange rate, where increases in oil prices is assumed to cause a currency depreciation for oil-importers. Herrera, Lagalo & Wada's (2015) point of view is also proven to be incorrect, as they showed that oil price increases negatively affect a country's GDP growth more than oil price decreases, amongst oil-importing countries. However, Huang and Guo's finding can be consolidated by our paper, as they suggested that oil price shocks trigger a minor currency appreciation. Oil shocks will thus cause exports to become cheaper, while imports will rise in price. In a scenario where aggregate demand is assumed to be elastic, increases in imports will cause a fall in aggregate demand, where a country's GDP growth per capita will fall.

When taking into account the results found in Table 4, the second lag of oil price increases (*Lag2_Crisis_2008*) suggests that oil price increases negatively affect GDP growth per capita, for oil-exporters. The second lag of oil price decreases (*Lag2_Crisis*_2014) also depicts a negative correlation with GDP growth per capita, where the effect is actually stronger as compared to oil price increases. Policymakers in oil-exporting countries should therefore worry when crude oil prices decrease, since its impact is more severe than what oil price increases generate. At last, oil production (*diff1_Oil_prod*) seems to increase GDP growth per capita, meaning that oil-exporters should increase their oil production in order to experience higher GDP growth per capita.

Since both oil price decreases and oil price increases negatively impact GDP growth per capita, our results from Table 4 suggest that a change in oil prices will cause a currency appreciation in oil-exporting countries, where exports become more expensive. This is in line with Hasanov et al. (2017) and Vohra (2017), who suggested that oil price changes generate a currency appreciation where increased government spending and budget deficits hurt oil exporting economies.

VI. Conclusion

This paper actively tried to answer the following research question:

To what extent do oil crises impact an oil-exporting or oil-importing country's annual GDP growth?

By means of a fixed-effects multivariate panel data regression analysis, we have shown that oil crises impact both oil-importers and oil-exporters' GDP growth per capita to a very large extent. Overall, oil price increases and oil price decreases are negatively associated with GDP growth per capita: oil price decreases deteriorate a country's GDP growth more than oil price increases for both oil-importers and oil-exporters. More concisely, we have found that oil price shocks negatively impact more oil-exporting countries than oil-importing countries. Compared to literature, our findings on oil-importers are ambiguous: Herrera, Lagala & Wada (2015) found that oil price increases negatively affect a country's GDP growth more than oil price decreases, while Aziz (2009) showed that oil price increases positively affect a country's exchange rate. However, Huang and Guo's (2007) findings are in line with those found in this paper, as they showed that oil price shocks generate a currency appreciation in oil-importing countries, where a fall in GDP growth per capita prevails. The results we found when it comes to oil exporting countries are similar to what Hasanov et al. (2017) and Vohra (2017) suggest, where oil price changes consolidate exchange rate appreciations for oil exporting countries.

Regarding the limitations, this paper does not offer a lot of statistical significance, meaning that most of our results cannot be interpreted. For example, when taking into account Table 4, only the lagged oil price increases/decreases found in column (3) are statistically significant. The problem with this however is that lagged variables do not depict the actual causal effect of independent variables on dependent ones, as they take into account different time frames. For example, variables such as *Lag2_Crisis_2008* and *Lag2_Crisis_2014* represent the second lags of crude oil price increases and decreases, respectively. The former takes into account the years 2008 till 2010, while the latter takes into account the years 2016 till 2018. As a result, financial oil crises are not really represented, as the 2008 financial crisis which caused increases in crude oil prices occurred between 2006 and 2008, while the 2014 oil crisis happened between 2014 and 2016. Therefore, those lags show crude oil prices for periods where oil price increases and/or oil price decreases did not completely occur, meaning that the wrong causal effect is interpreted.

To continue, our country selection for our two samples could have been improved in many ways. Our oil-importing sample does not represent most of the biggest oil-importers around the World. As such, countries such as Japan, India and Italy are not depicted in sample. Worse, the US, who is a leading oil-importer and oil-exporter around the globe, is also not used in neither sample. Similarly, the database used for both oil-exporting and oil-importing samples has been created from various sources. The database on *Worldometer* only showed oil production and oil consumption per country till 2016, meaning that information on the years 2017 and 2018 had to be retrieved from another source, namely, *CEIC* Data. Although the numbers were similar between databases, they were not identical. As a result, authors can have different causal effects of oil price shocks on GDP growth depending on the countries and databases they use.

This paper suggests that policymakers and investors should take a closer look at the impact of oil crises on a country's GDP growth. We have seen that a country's energy usage can considerably dictate the impacts of a crisis. For example, the fact that Saudi Arabia relies on oil to a very large extent means that Saudi policymakers should not be as concerned with oil price increases as compared to oil price increases, since oil-exporters are better-off with oil price increases than with oil price decreases. As a result, the use of policies can be limited and regulated, in an attempt to protect an economy from certain policies such as the fiscal one that causes a change in government spending and in household taxes.

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VIII. Appendix

a) Test for stationary variables oil-independent sample

Levin-Lin-Chu unit-root test

Ho: Panels contain unit roots   Number of panels = 9

Ha: Panels are stationary   Number of periods = 29

AR parameter: Common   Asymptotics: N/T -> 0

Panel means: Included

Time trend: Not included

ADF regressions: 1 lag

LR variance: Bartlett kernel, 9.00 lags average (chosen by LLC)

Table 5: unit root test for oil-independent sample

Variables	T-statistic (adjusted)	P-value
GDP	-8.1145	0
LogGDP	-4.9286	0
Oil_prod	-0.4523	0.3255
Oil_cons	2.7184	0.9967
Population	0.0193	0.5077
Oil_prices	-0.6373	0.262
Exports	-2.3613	0.0091
Imports	-1.9397	0.0262
Savings	-1.7363	0.0413
Unemployment	0.7903	0.7853
Gov_spending	-1.3547	0.0878
Crisis_2008	-4.2632	0
Crisis_2014	-4.2632	0
Lag1_Oil_prod	1.979	0.9761
Lag2_Oil_prod	-3.2636	0.0006
Lag3_Oil_prod	-1.8377	0.0331
Lag4_Oil_prod	-0.8145	0.2077
Lag1_Oil_cons	17.9547	1
Lag2_Oil_cons	-32.9151	0
Lag3_Oil_cons	-7.9403	0
Lag4_Oil_cons	-5.2661	0

Lag1_Oil_prices	0.0462	0.5184
Lag2_Oil_prices	-2.3343	0.0098
Lag3_Oil_prices	-2.166	0.0152
Lag4_Oil_prices	-0.9537	0.1701
Lag1_Population	33.7964	1
Lag2_Population	1.20E+02	0
Lag1_Unemployment	-7.6624	0
Lag1_Gov_spending	10.1896	1
Lag2_Gov_spending	-27.5429	0
Lag_1_Crisis_2008	-4.2632	0
Lag_1_Crisis_2014	-4.8790	0

b) Test for stationary variables oil-exporting sample

Levin-Lin-Chu unit-root test

Ho: Panels contain unit roots Number of panels = 9

Ha: Panels are stationary Number of periods = 29

AR parameter: Common Asymptotics: N/T -> 0

Panel means: Included

Time trend: Not included

ADF regressions: 1 lag

LR variance: Bartlett kernel, 9.00 lags average (chosen by LLC)

Table 6: unit root test for oil-dependent sample

Variables	T-statistic (adjusted)	P-value
GDP	-4.6939	0
LogGDP	-4.5726	0
Oil_prod	-1.7238	0.0424
Oil_cons	-22.93	0
Population	10.0699	1
Oil_prices	-0.6373	0.262
Exports	-1.8367	0.0331
Imports	-2.3936	0.0083

Savings	-1.3473	0.0889
Unemployment	7.1431	1
Gov_spending	-0.3738	0.3543
Crisis_2008	-4.2632	0
Crisis_2014	-4.2632	0
Lag1_Oil_prod	5.7915	1
Lag2_Oil_prod	-14.77	0
Lag3_Oil_prod	-6.424	0
Lag4_Oil_prod	-4.6205	0
Lag1_Oil_cons	6.1081	1
Lag2_Oil_cons	-17.2254	0
Lag3_Oil_cons	-6.7794	0
Lag4_Oil_cons	-4.8268	0
Lag1_Oil_prices	0.0462	0.5184
Lag2_Oil_prices	-2.3343	0.0098
Lag3_Oil_prices	-2.166	0.0152
Lag4_Oil_prices	-0.9537	0.1701
Lag1_Population	19.4767	1
Lag2_Population	-2.44E+01	0
Lag1_Savings	0.7024	0.7588
Lag2_Savings	-3.2495	0.0006
Lag1_Unemployment	-12.9204	0
Lag1_Gov_spending	4.1448	1
Lag2_Gov_spending	-0.3603	0.3593
Lag3_Gov_spending	1.6194	0.9473
Lag4_Gov_spending	1.7554	0.9604

c) Variable description Table 3

a) GDP_{it} represents GDP growth rate per capita in the given country i in the year t.

b) $LogGDP_{it}$ represents the logarithm of the GDP growth rate per capita in the given country i in the year t.

c) $Oil_{prod\,it}$ represents oil production per capita in country i in the year t.

d) $Oil_{cons\,it}$ represents oil consumption per capita in country i in the year t.

e) $Oil_{prices_{it}}$ represents crude oil prices per country i per year t.

f) $Crisis\_2008_{it}$ represents the 2008 financial crisis, where crude oil prices increased between 2006 and 2008.

g) $Crisis\_2014_{it}$ represents the 2014 oil crisis, where crude oil prices decreased between 2014 and 2016.

h) $Exports_{it}$ represents exports of goods and services (% of GDP) per country i per year t.

i) $Imports_{it}$ represents imports of goods and services (% of GDP) per country i per year t.

j) $Savings_{it}$ represents gross savings (% of GDP) per country i per year t.

k) $dif1\_Oil\_prod_{it}$ represents the first difference of ${Oil_{prod}}_{it}$.

l) $dif1\_Oil\_cons_{it}$ represents the first difference of ${Oil_{cons}}_{it}$.

m) $dif2\_Population_{it}$ represents the second difference of $Population_{it}$.

n) $dif1\_Oil\_prices_{it}$ represents the first difference of ${Oil_{prices}}_{it}$.

o) $dif1\_Unemployment_{it}$ represents the first difference of $Unemployment_{it}$.

p) $dif1\_Gov\_spending_{it}$ represents the first difference of ${Gov_{spending}}_{it}$.

q) $Lag2\_Oil\_prod_{it}$ represents the second lag of ${Oil_{prod}}_{it}$.

r) $Lag3\_Oil\_prod_{it}$ represents the third lag of ${Oil_{prod}}_{it}$.

d) Variable description Table 4

a) GDP_{it} represents GDP growth rate per capita in the given country i in the year t.

b) $LogGDP_{it}$ represents the logarithm of the GDP growth rate per capita in the given country i in the year t.

c) ${Oil_{prod}}_{it}$ represents oil production per capita in country i in the year t.

d) ${Oil_{cons}}_{it}$ represents oil consumption per capita in country i in the year t.

e) ${Oil_{prices}}_{it}$ represents crude oil prices per country i per year t.

f) $Crisis\_2008_{it}$ represents the 2008 financial crisis, where crude oil prices increased between 2006 and 2008.

g) $Crisis\_2014_{it}$ represents the 2014 oil crisis, where crude oil prices decreased between 2014 and 2016.

h) $Exports_{it}$ represents exports of goods and services (% of GDP) per country i per year t.

i) $Imports_{it}$ represents imports of goods and services (% of GDP) per country i per year t.

j) $dif1\_Oil\_prod_{it}$ represents the first difference of $Oil_{prod_{it}}$.

k) $Lag4\_Oil\_prod_{it}$ represents the fourth lag of $Oil_{prod_{it}}$.

l) $dif2\_Population_{it}$ represents the second difference of $Population_{it}$.

m) $Lag2\_Crisis\_2008_{it}$ represents the second lag of $Crisis\_2008_{it}$.

n) $Lag2\_Crisis\_2014_{it}$ represents the second lag of $Crisis\_2014_{it}$.