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Abstract

Revealing the precise thresholds at which fluctuations in oil prices start to affect gross domestic product and its various components (consumption, investment, expenditure and exports) holds significant implications for policymakers in both oil-importing and oil-exporting countries. Existing studies assessing the effects of oil prices on economic activity typically assume constant or stable threshold values. However, recent evidence suggests that this restrictive assumption may not accurately capture the dynamic nature of these relationships. We address this issue by adopting a more realistic framework that allows for the possibility that oil prices will have a time-varying effect on economic activity. We also employ the innovative time-varying threshold regression kink model of Yang and Su (2018). Our analysis focuses on a sample of 20 top oil-importing and oil-exporting countries during the period 1995Q1 to 2023Q2. The findings of our investigation provide compelling evidence to support the existence of time-varying threshold levels in the relationship between oil prices and macroeconomic activity for most countries in our sample. Notably, our research unveils a substantial heterogeneity in the oil price thresholds across the investigated countries, thereby challenging the notion of a universal threshold applicable to all.

JEL-Codes: C500, Q400, Q430.

Keywords: oil price, GDP and its components, time-varying threshold, oil-importing countries, oil-exporting countries.

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1. Introduction

Recent global unrest has significantly affected international energy markets, especially oil prices (Chang et al., 2022; Jawadi and Sellami, 2022). Furthermore, the sharp rises in oil prices recorded on the world market have affected the economic performance of countries; even the most developed ones (see Hamilton, 1983; De Michelis et al., 2019; Deyshappriya et al., 2023). The notable escalation in oil prices over recent years holds considerable implications for economic activity and macroeconomic policy. The fear that they will continue to increase remains a prevailing concern. In particular, the high price values recorded in the world oil market raise alarms about potential slowdowns in the most developed countries. Given the extensive reliance of countries on oil and its status as the most traded commodity in the world, it has evolved into a key indicator of economic stability (Ghalayini, 2011). Additionally, it plays a pivotal role in the economic development of both oil-exporting and oil-importing countries (Charfeddine and Barkat, 2020; Baek and Young, 2021). Oil stands as a crucial element in the production processes of nearly all world economies, wielding a substantial impact on the economic activity levels. As a result, the dramatic fluctuations in the price of oil, by directly influencing the gross domestic product (GDP) rates, play a crucial role in shaping the economic activity and the wealth of nations. For these reasons, economists have focused their attention on the link between oil prices and GDP. In the context of oil-exporting countries, the surge in oil revenues translates into heightened savings, thereby stimulating investment and pushing up the GDP rate (Rotimi and Ngalawa, 2017; Sadeghi, 2017; Alekhina and Yoshino, 2018). Conversely, for oil-importing countries, a wealth transfer occurs from these countries to oil-exporting ones, leading to a drop in purchasing power for businesses and households in oil-importing nations, thereby adversely impacting growth (Gadea et al., 2016; Deyshappriya et al., 2023).

The relationship between the oil price and GDP, which represents an essential indicator of economic performance, has always been at the center of the attention of economists and analysts, particularly after the oil events that have been produced since the 70s. However, the results in this area are inconclusive and mixed (Tumala et al., 2022). While certain researchers assert the substantial impact of oil prices on GDP (see Ftiti et al., 2016; Balcilar et al., 2017; Baek and Young, 2021; Deyshappriya et al., 2023), others suggest a more muted influence (Ghalayini, 2011; Khan et al., 2019). This inconclusiveness and divergence in the mentioned studies may stem from three potential reasons: Firstly, as highlighted by Moghaddam and Lloyd-Ellis (2022), most prior studies do not differentiate oil-importing countries from oil-exporting countries or solely concentrate on one category while assessing the macroeconomic effects of oil price changes. This oversight may obscure significant heterogeneity across the two groups of countries, leading to potentially misleading conclusions. Unforeseen changes in oil prices can have widespread implications for economic activity in both oil-exporting and oil-importing countries, but the magnitude of the effects may vary significantly between these subgroups (Gershon et al., 2019). Indeed, rising oil prices should be seen as good news for the GDP in oil-exporting countries and bad news in oil-importing countries. The opposite should be expected when these prices fall (see Bhanumurthy et al., 2012; Kriskkumar and Naseem, 2019; Wu, 2020).

Secondly, a notable gap in previous empirical studies analyzing the nexus between oil price changes and macroeconomic activities is the predominant focus on the GDP as a unified entity, neglecting the differentiation between its core components such as investment, net exports, public expenditure, and consumption. This assumption implies a uniform impact of oil price changes on all GDP components, yet evidence suggests that the subcomponents of GDP may respond differently to such fluctuations (Al-Jabri et al., 2022). The four main components of GDP can present disparate pictures as they follow distinct trends, production processes, and growth trajectories, each intertwined with unique factors. Furthermore, the channels through which the price of oil influences GDP and its broader economic impact vary considerably (Deyshappriya et al., 2023). Consequently, relying on a singular GDP target might prove inappropriate, as it could unduly favor specific sectors of the economy over others.

Thirdly, much of the earlier research has typically assumed that the relationship between oil price and GDP is linear. However, several recent studies provide evidence suggesting that this relationship is unlikely to be linear and it may be subject to threshold effect (Kilian and Vigfusson, 2013; Çatık and Önder, 2013; Alimi and Aflouk, 2017; Jawadi and Ftiti, 2019). Such a threshold effect is expected to hold because as pointed out by Jimenez-Rodriguez (2009) and Karaki (2017), the overall effect of the oil prices on economic activity hinges on the magnitude of the oil prices themselves. In essence, there might be a certain level of oil price threshold that must be reached before it can exert a significant effect on economic activity.

Fourthly, previous investigations into the oil-price threshold effect on economic activity have predominantly assumed that the values of these thresholds remain constant over time (eg.,; Alimi and Aflouk, 2017; Jawadi and Ftiti, 2019). However, this assumption, as highlighted by Baumeister and Peersman (2013), among others, may be overly restrictive and unrealistic. The joint dynamics of most macroeconomic variables evolve, suggesting that the associated assessing reference (threshold) is unlikely to remain constant (Yang and Su, 2018). It is wellestablished that thresholds are case-specific and may exhibit variations over time (Bentour, 2020). Relying on such a restrictive assumption could yield unreliable threshold estimates. Indeed, Yang and Su (2018) demonstrated that neglecting the potential time-varying nature of a threshold can lead to significantly biased estimates. To the best of our knowledge, Dueker et al. (2013) were pioneers in employing a varying threshold. They introduced a smooth transition autoregressive (STAR) model with a time-varying/state-dependent threshold, applying it to analyze the dynamics of U.S. short-term interest rates. Building on this, Yang and Su (2018) proposed an advanced time-varying threshold model, extending the constant-threshold regression kink model of Hansen (2017) by introducing a time-varying, state-dependent threshold. In this paper, we will use this model to investigate whether there is an oil-price threshold effect on economic activity, and we highlight if this threshold is time-varying and state-dependent.

Given the limited empirical studies examining potential nonlinear threshold effects in the connection between oil prices and economic activity, our paper aims to fill this gap in the literature. We specifically investigate the possible presence of time-varying threshold kink effects in the responses of GDP and its key components (consumption, investment, expenditure, and exports) to fluctuations in oil prices. The exploration is conducted for a sample of 20 top oil-importing and -exporting countries. The time-varying threshold effect of oil price on GDP is likely contingent on various factors. Bergmann's (2019) work, for instance, underscores the significance of energy shares as a critical moderator, suggesting a potentially nonlinear impact on the relationship between oil prices and economic activity. He found robust evidence supporting the existence of non-linear moderator effects, particularly with a decrease in the oil-to-energy share, which diminishes the causal effect of oil prices on economic growth. In addition to energy shares, other factors may influence the time-varying threshold effect of oil prices on GDP. Variables such as the level of GDP in each country, its growth trajectory, and exchange rates can also play pivotal roles in shaping this relationship (Deyshappriya et al., 2023).

This paper tackles the following research inquiries: i) Does a time-varying threshold effect characterize the responses of GDP components to fluctuations in oil prices? ii) If such an effect exists, is there a uniform threshold oil price level applicable across all countries, or does it vary on a country-specific basis? iii) Do GDP components react differently to oil price fluctuations? To address these questions, we adopt an innovative approach utilizing Yang and Su's (2018) model, an extension of Hansen's regression kink model. This model introduces a state-dependent threshold, treated as a function of informative covariates. This paper's analysis is of high importance from a policy perspective as it can help investors and policymakers in deciding appropriately what kind of policy to implement to hedge economic growth from oil price shocks and in making short- and long-term investment decisions.

Our contribution to the oil price-economic activity literature is threefold. First, the current paper assesses the effects of oil prices not only on overall GDP but also on its different components. This adds to existing literature that has considered the total or just one component of GDP or has not systematically examined the possible nonlinear relationship between oil prices and macroeconomic activities. To the best of the authors' knowledge, no previous empirical research has comprehensively investigated the response of all GDP components to oil price changes within an integrated framework. Thus, our study endeavors to bridge this gap by considering all GDP components in a multivariate setting. This approach allows us to investigate how each component of GDP responds to oil price fluctuations. Second, to account for heterogeneity that might exist among countries due to country-specific characteristics, we perform a country-by-country analysis. Assuming a common threshold level in the relationship between oil prices and economic activity across all countries might be quite restrictive and perhaps unrealistic (Bentour, 2021). Hence, depending on their main economic activity and position as oil exporting or importing countries, various countries will experience varied effects from changes in the price of oil. Country-level heterogeneity should thus be considered. In other words, the relationship between oil price and GDP is extremely complex and differs according to specific economic and political events, and according to economic transition dynamics as well as several internal and external factors. Among these factors exhibiting heterogeneity are the country's status as either a net oil importer or net oil exporter, its income, the population level, the percentage of oil consumption (production) in total energy, and endowments in alternative energy sources to oil. Third, as far as we know, this is the first empirical work that tries to assess the time-varying threshold effect of oil prices on macroeconomic activities, using the novel time-varying threshold regression kink model of Yang and Su (2018). This model presents several appealing features. The first and maybe the most striking one is that it permits us to examine whether the relationship between oil prices and economic activity is time-varying and state-dependent. This is particularly important since due to changes in macroeconomic conditions and the occurrence of external shocks, such a relationship may not be constant but change over time (see, for instance, Cross and Nguyen, 2017; Gogolin et al. 2018). In this case, the traditional threshold models are misspecified as they ignore the time-varying property of oil price threshold levels, which can lead to misleading results and derivation of inconsistent conclusions and policy implications. Second, it allows us to determine the real pattern of the investigated relationship (discontinuous or kinked) among variables without assuming a priori the discontinuity of the regression function (Maddah et al., 2022). This is an important feature since it has been shown that oil prices exhibit in general a jump or a kink behavior (see for instance Wang and Zhang, 2014; Olayani, 2020; Zhang and Shang, 2023; Selmi et al., 2023), and thus their impact on macroeconomic variables may not be smooth (Jawadi and Ftiti, 2019). This implies that a regression kink model might be appropriate to capture the responsiveness of GDP components to oil price fluctuations. Third, the threshold kink model unlike the conventional nonlinear autoregressive distributed lag (NARDL) model –frequently employed in the related literature – that only discerns oil price variations, it can disentangle between large and small fluctuations in oil price changes, and therefore it may capture more accurately the response of macroeconomic indicators (Li and Guo, 2022). Fourth, it permits us to determine endogenously oil price threshold levels. Fifth, it enables us to consider the dynamic effects of oil prices on economic activity.

We believe that such an exercise, using recent data and a robust approach, is critically important, as it allows us to better understand how a rise in oil prices impacts a country's GDP according to a time-varying threshold. Thus, it provides important policy implications for governments to adjust their strategies and make appropriate decisions based on the macroeconomic environment.

In what follows, Section 2 reviews the theoretical and empirical research on the effects of oil prices on GDP. The research methodology approach is presented in Section 3. In Section 4, empirical findings are discussed. The conclusion and some policy implications are outlined in section 5.

2. Literature review

Numerous studies have empirically investigated the link between oil price and GDP, employing diverse methodological approaches and covering different countries. For example, Gadea et al. (2016), utilized the VAR model in the United States, establishing a connection between oil price and GDP. Rafik et al. (2009) using the VAR model and Granger causality to study the effects of oil price variations on Thailand, identified a significant negative effect on both investment and GDP in the importing country. Wu (2020) by adopting the Granger causality model in the context of Russia for the period 2000-2018, found a positive influence of rising oil prices on GDP. Other methodologies that have been adopted in the literature include Structural VAR Modeling (SVAR) by Berument et al. (2010); causality approach by Ghalayini (2011) and Bayraktar et al. (2016). Notably, the effects of oil price fluctuations on GDP vary for exporting and oil-importing economies. According to Ghalayini (2011), generally, rising oil prices should be seen as good news for oil-exporting countries and bad news for oil-importing countries of oil. The opposite should be expected when these prices fall. The GDP is considered among the most influenced economic variables by oil prices (Hamilton, 1983). Theoretically, it has been argued that a rise in oil prices would be beneficial to exporting countries. Indeed, revenues from the sale of oil in exporting countries can have a positive impact on GDP. For oil-producing countries, such as OPEC countries, oil revenues represent the largest share of GDP. When the price of oil increases, these countries increase their production. Moreover, since the export of oil is a real source of income for producing countries, an increase in export earnings following a rise in the price of oil leads to an increase in the income and savings of the State, which encourages exporting countries to invest more in new projects which pushes up the GDP rate. The result will therefore be healthy economic activity. In addition, the wealth will be transferred from oil-importing countries to oil-exporting countries, resulting in greater purchasing power for economic agents in oil-exporting countries (See Chuku et al., 2010; Algahtani, 2016). In an oil-exporting country, an increase in the price of oil leads also to an increase in oil revenues, thereby fostering investment and promoting the implementation of new projects. Dohner 's study (1981) was among the first studies that analyzed the positive effect of oil price increases on the GDP of exporting countries and supported the idea that increased oil revenues lead to an increase in savings, which stimulates in turn investment.

On the other hand, if an unexpected drop in oil prices occurs, government projects and investments remain unfinished, and disruptive effects have occurred in the balance of payments and public finances. Therefore, this government will be forced to borrow to cover the budget deficit that has occurred. Furthermore, according to Eltony and Al Awadi (2001) and Lorde et al. (2009), the rise in oil prices has a positive impact on exporting countries on public expenditure, tax revenue, and investments since oil production and profits lead to an increase in foreign investment linked to the activities of the sector tanker. According to Eltony and Al Awadi (2001) and Alekhina and Yoshino (2018), profits from accumulated oil revenues will be used through government spending to stimulate investment and economic growth. Conversely, a fall in the price of oil will hurt GDP: this fall is not beneficial and causes losses because it is difficult to reduce expenditure instantly. As exporting countries depend heavily on oil revenues, there will be a fiscal imbalance following this fall in oil prices (See Jawad and Niazi, 2017).

According to Alekhina and Yoshino (2018), a sharp drop in oil prices will negatively affect government revenue, leading to an increase in the budget deficit. Falling oil prices will indirectly limit access to credit, mainly for the private sector, and will lead to lower imports of intermediate products. Hence there will be a negative impact on the real GDP of oil-exporting countries. Moshiri and Banihashem (2012) studied the effect of oil prices on the economy of the six OPEC countries and found the existence of an asymmetric effect of oil prices on GDP. According to their results, during the period of rising oil prices accompanied by higher incomes, governments tend to spend aggressively on projects with unsustainable economic growth. These authors confirm the idea that a fall in oil prices would lead to the cessation of investment projects following a resource curse and stagnation of economic activities, and subsequently to a fall in the GDP rate. During the phase of lower oil prices, there will be significant reductions in revenue, major investment projects remain unfinished and, as a result, most economic activities are interrupted. Poor management is a factor that prevents OPEC countries from fully benefiting from rising oil prices while being fully responsive to falling oil prices.

For oil-importing countries, the effect depends on whether it is an increase or decrease in oil prices. We begin first with the effects of rising oil prices: Abel and Bernanke (2001) and Lardic and Mignon (2008) explained this impact theoretically: the increase in the price of oil leads producers who use oil in the manufacturing process in factories to increase production costs to restore their margins. The increase in production costs leads to a reduction in production, hence the decrease in growth rates and productivity. This results in the aggravation of the direct impact of the rise in oil prices on GDP. There is also an effect on purchasing power and consumer spending: There is a transfer of wealth from oil-importing countries to oil-exporting countries, leading to a drop in the purchasing power of companies and households in oil-importing countries, which negatively affects growth in these countries. Also, for importing countries, the rise in oil prices will harm the other components of GDP: the increase in oil prices could lead to substantial changes in the levels and patterns of investment, savings, and expenses. Dohner (1981) was among the first who supported the idea that importing oil for importing countries decreases their investment. As oil price increases are bad news for importing countries, oil price decreases have a positive impact on economic activity and GDP in these countries. On the demand side, lower oil prices transfer wealth to oil-importing countries resulting in a windfall gain for these countries. This wealth effect can in turn increase GDP through multiplier effects and can be more important in sectors that produce goods complementary to oil consumption, such as the automotive sector (See Bodenstein et al., 2011). On the supply side, for importing countries, the fall in oil prices increases production in the non-oil sector by reducing production costs for companies, mainly for sectors that are highly dependent on oil as a production input. This drop in costs leads to an increase in investments and production.

Besides the impacts of oil price fluctuations on supply and demand that have already been mentioned, it is important to mention that these changes also have an indirect impact on the foreign currency markets leading then to indirect impacts on real activity (Deyshappriya et al., 2023).

According to Dornbuch (1976), prices should decrease generally when the exchange rate declines, that is, when the home currency appreciates. Other works (Brooks, 2002; Usman and Musa, 2018; Zhu and Chen, 2019; Ha et al., 2020 and Pham et al., 2020) have used Dornbusch's work as their inspiration. Raw materials and input items are now included in international commerce due to globalization. The exchange rate has a crucial influence on the costs of imported goods when an economy is largely dependent on imports. It will result in a dramatic increase in the price of import inputs, a decline in the currency rate, and then a decrease in the GDP of oil-importing countries.

3. Econometric methodology and data

3.1- Econometric methodology

The primary objective of this study is to examine whether there exists a time-varying threshold effect of oil price on GDP by considering potential heterogeneity among countries.

We follow Hamilton (2011) to present the theoretical model that explains how oil prices can affect the economy. The oil prices might affect the economy across their consequences for both supply and demand. On the supply side, let Y be the output that depends on inputs of capital K, labor N, and energy E: $Y = F(K, N, E)$. Hamilton supposes that the capital stock is fixed in the short run and that wages adjust instantly to ensure that labor demand equals a fixed supply N. Then if X denotes the price of energy relative to the price of output,

$$\frac{\partial Y}{\partial X} = \frac{\partial F}{\partial E}\frac{\partial E}{\partial X} \qquad (1)$$

Multiplying (1) by X/Y results in

$$\frac{\partial lnY}{\partial lnX} = \frac{\partial F}{\partial E}\frac{E}{Y}\frac{\partial lnE}{\partial lnX} \qquad (2)$$

If the marginal product of energy equals its relative price (∂F/∂E = X), then

$$\frac{\partial F}{\partial E}\frac{E}{Y} = \frac{EX}{Y} = \gamma \qquad (3)$$

where γ denotes the firm's spending on energy relative to the value of its total output.

Thus, (2) can be written $\frac{\partial lnY}{\partial lnX} = \gamma \frac{\partial lnE}{\partial lnX}$

In other words, the elasticity of output for the relative price of energy would be the energy expenditure share γ times the price elasticity of energy demand.

Theoretical assessments encompass a range of direct and indirect mechanisms that delve into how oil price shocks transmit to GDP and its components. Starting with the direct demand-supply channel, early studies focused on the effects of oil prices on demand and supply. An escalation in oil prices triggers an income shift from oil-exporting to oil-importing nations, impacting consumer spending power [Alqahtani (2016), Alekhina and Yoshino (2018), Almutairi (2020)]. Consequently, oil-exporting nations experience increased investment projects, enhanced consumption power, and an improved trade balance. Conversely, importing countries face a reverse effect [Jawad and Niazi, 2017].

In response to the limited scope of direct channels, researchers have developed models relying on indirect transmission channels to capture a more significant impact of oil price shocks on GDP components. These transmission mechanisms amplify the effects of oil price shocks on various elements of GDP. The theoretical evaluation of GDP responses initiates with a production function linking output to inputs like labor. In this context, a surge in oil prices elevates the total price level, influencing unemployment according to the "Keynesian" Phillips curve [Phillips (1958)]. Based on Keynesian assumptions of rigid wages, employees consider nominal wages, leading to increased inflation but also revitalizing activity by stimulating consumption and effective demand. The impact extends to labor, aggregate demand, and different GDP components. The rise in demand contributes to reduced unemployment [Davis 1987a; 1987b; Karaki, 2018; Ordóñez et al., 2019; Nusair, 2020]. As unemployment rates decline, there is a subsequent increase in investment projects and public expenditure.

Another indirect transmission channel involves production costs (Lardic and Mignon, 2008; Salisu et al., 2017; Mellquist and Femermo, 2007). Industries heavily depend on petroleum, with manufacturing playing a pivotal role in GDP, acting as a significant driver of economic growth through its substantial contribution to total production, employment, income, and long-term economic development. A rise in oil prices, as noted by Manyika (2012) and Herman (2016), can profoundly impact industrial production and output. Oil price shocks may elevate the marginal cost of production across various industries, leading to reduced output and increased unemployment. The heightened production costs resulting from an oil price increase may consequently lead to lower consumption by households**.**

Yet another critical channel through which oil price effects influence GDP and its components is the exchange rate (Dornbuch, 1976; Ha et al., 2020; Pham et al., 2020). The globalized nature of trade has integrated raw resources, input commodities, and imported items into worldwide commerce, making the exchange rate a significant contributor to the responses of GDP components to oil price effects. A depreciation in the currency rate, driven by high manufacturing and production costs, may negatively impact the balance of trade in importing nations while improving net exports for exporting countries. In economies heavily reliant on imports, the exchange rate plays a crucial role in determining the cost of imported raw materials. This could lead to a substantial increase in the price of imported inputs, resulting in a decline in the trade balance, a reduction in consumption and purchasing power in oil-importing nations, while oil-exporting countries anticipate increased exports with a rising exchange rate. Consequently, these exporting nations are poised to accumulate a larger surplus, which can be allocated towards increased government expenditures, household consumption, and funding for various projects and investments (Deyshappriya et al., 2023).

Therefore, based on this theoretical framework and drawing on the empirical findings of Van Wijnbergen (1985), Chang and Wong (2003), Charfeddine and Barkat (2020), Kandemir Kocaaslan (2021), and Deyshappriya et al. (2023), we assume that oil price, unemployment rate, industrial production index and the real exchange rate are the main determinants of the GDP and its components[2], and we start first by considering the following conventional linear model:

$$Y_t = c_1 + \beta_1 OP_t + \beta_2 Unemp_t + \beta_3 Produ_t + \beta_4 Exch_t + u_t \quad (4)$$

, where Y_t is the vector of endogenous variables, including GDP and its components[3], consumption, investment, public expenditure, and net exports.[4] *OP* is the oil prices *Unemp* is the unemployment rate, *Produ* is the industrial production index, *Exch* is the real exchange rate,

[2] The basic motivation to examine the impact of oil price on the different components of GDP is that they may react differently to oil prices due to their weight for each economy and due to the sensitivity of every component toward oil price effect.
[3] All GDP components are normalized by population.
[4] We rely here on the "expenditure approach" that divides GDP according to who spends it: consumption (households), investment (businesses and households), public expenditure (governments) and net exports (rest of the world) (see Landefeld et al., 2008; Chien and Hu, 2008 and Ofili, 2014; Zúniga-Gonzalez, 2022).

and u_t is a white noise error term. A detailed description of the variables and their sources is provided in Appendix A.

However, equation (4) does not consider the potential threshold effect of oil price. Therefore, to allow for such a threshold effect we adopt the time-varying threshold model with an unknown threshold proposed recently by Yang and Su (2018). This model extends the constant-threshold regression kink model of Hansen (2017) by allowing for a time-varying, state-dependent threshold. This model allows us to investigate if the threshold effect of oil price on GDP is not constant and varies over time, particularly during a major crisis affecting oil prices. This approach extends the scope of the traditional kink threshold model by capturing the time-varying heterogeneous interactions across different phases. This pattern is highly dependent on the extent and sign of the oil price variations and the level of economic growth in each country.

According to Yang and Su (2018), the regression kink model estimates a ‘‘kink” in the outcome associated with a continuous policy variable when the variable has a kink. Hence, in this model, the regression function is continuous but the slope has a discontinuity at a threshold point (‘‘kink”).

According to Yang and Su (2018), equation (4) can be rewritten as follows:

$$Y_t = c_1 + \beta_{1L}(OP_t - \gamma_t)_- + \beta_{1H}(OP_t - \gamma_t)_+ + \beta_2 Unemp_t + \beta_3 Produ_t + \beta_4 Exch_t + u_t \tag{5}$$

where γ is the threshold parameters or the “kink points” at which a possible regime switching holds, and where u_t is white noise error terms. In this model, we distinguish between two different regimes, one with “lower oil price levels” and the other with “higher oil price levels”. As in Yang and Su (2018), we use $(OP_t - \gamma_t)_- = min[(OP_t - \gamma_t), 0]$ and $(OP_t - \gamma_t)_+ = max[(OP_t - \gamma_t), 0]$ to denote, respectively, the “negative part” and “positive part” of $(OP_t - \gamma_t)$. γ_t is a time-varying threshold (tipping point), which is specified as a linear combination of observable exogenous or predetermined variables q_t.

$$\gamma_t = \gamma_0 + \gamma_1 q_t \tag{6}$$

where γ_0 represents an unknown threshold intercept, is γ_1 an unknown slope parameters. In this paper, we will assume that the time-varying threshold effect of oil price on GDP (γ_t) likely depends on three macroeconomic variables, namely, energy shares, GDP, and exchange rate.

The economic intuition behind our time-varying threshold kink model is straightforward, arguing that oil price has a differentiated impact on GDP (and its components) conditional to a threshold. According to Dueker et al. (2013), « usually high/low values of an economic variable may sometimes be best thought of in relative terms ». So, the level of oil price can be considered as high or low not in absolute terms but relative to appropriate GDP or its components. As GDP components are typically time-varying, the oil price threshold is unlikely to be constant. Accordingly, the same level of oil price can be regarded as high under a certain situation but only moderate under other situations. In this paper, we will try therefore to determine whether the effect of oil price on GDP (or its components) can be adequately characterized using the Yang and Su (2018) model where a time-varying threshold is allowed.

According to Yang and Su (2018), the parameters of the time-varying threshold (γ_0 and γ_1) can be given as

$$(\hat{\gamma}_0;\ \hat{\gamma}_1) = \underbrace{argmin}_{(\gamma_0\,,\gamma_1)\in\Gamma_0\times\Gamma_1}\ \widetilde{SSR}_T(\gamma_0\,,\gamma_1) \qquad (7)$$

Where Γ_0 and Γ_1 is strict subsets of the support of the oil price variable. A standard two-step approach based on concentration and grid search can be used to compute the estimates. First, for each γ_0 , we vary $\gamma_1 \in \Gamma_1$ and compute the sum of squared errors $\widetilde{SSR}(\gamma_0\,,\gamma_1)$ Second, we find the minimum $\widetilde{SSR}_T(\gamma_0\,,\tilde{\gamma}_1)$, and then the least-squares estimates $(\hat{\gamma}_0;\ \hat{\gamma}_1)$ are the values which jointly minimize $\widetilde{SSR}_T(\gamma_0\,,\tilde{\gamma}_1)$.

This model also developed test statistics for threshold effects (F_{1C} and F_{1T}) and threshold constancyF_2. A standard test for the null hypothesis of the linear model against the constant threshold model in Yang and Su (2018) is

$$F_{1C} = \frac{SSR_0 - SSR_C}{SSR_C/T} \qquad (8)$$

Furthermore, the F-statistic for the null hypothesis of the linear model against the time-varying threshold model (4) is:

$$F_{1T} = \frac{SSR_0 - \widetilde{SSR}_T(\hat{\gamma}_0;\hat{\gamma}_1)}{\widetilde{SSR}_T(\hat{\gamma}_0;\hat{\gamma}_1)/T} \qquad (9)$$

A standard test for the null hypothesis of the constant threshold against the time-varying threshold model can be given by:

$$F_2 = \frac{SSR_C - \widetilde{SSR}_T(\hat{\gamma}_0;\hat{\gamma}_1)}{\widetilde{SSR}_T(\hat{\gamma}_0;\hat{\gamma}_1)/T} \qquad (10)$$

See Yang and Su (2018) for more details on the calculation algorithms of these statistics.

3.2- Data

We use Quarterly data covering a sample of 20 countries including 10 oil-importing countries (India, China, United States, South Korea, Germany, the Netherlands, Italy, Spain, UK, and Singapore) and 10 oil-exporting ones (Saudi Arabia, Russia, Canada, Norway, Brazil, Mexico, Colombia, Ecuador, Algeria, and Indonesia). The choice of these countries is dictated by data availability. The 20 oil-exporting and oil-importing nations chosen in our sample are among the top oil exporters and importers in the world.[5] Indeed, based on total cost, these oil-importing countries purchased 70.4% of all crude oil imported in 2021 and the oil-exporting countries accounted for 49.7% of globally exported crude oil in 2021. Quarterly data over the 1995Q1-2023Q2 period[6] are employed here to carry out the estimations[7]. All data sources and definitions are detailed in Appendix A. To give an idea of the evolution of the model variables during our study period; we have presented in the appendix B some descriptive statistics. According to this table, the highest oil price is 123.97$ was 1 April 2008. The average value of oil prices throughout the period is 55.08$. Singapore has the highest percentage of oil shares relative to the overall energy. Indeed, the oil-to-energy shares is equal to 96%. Spain has the highest average unemployment rate with a rate of 15.96%.

Various events occurred within our sample period including the Global Financial Crisis (2008), the oil price plunge of 2014-2016, the Russian Ukrainian war (2014 and 2022) and the recent Covid pandemic. For that reason, we incorporate in equation (5) fourth dummy variables to take this disruption into account.

4. Empirical results and discussion

We begin this part with the presentation of the results of the threshold constancy test (the constant threshold against the time-varying threshold). As mentioned in the introduction, in this paper we assume that the time-varying threshold effect of oil price on GDP (γ_t) depends on three macroeconomic variables, namely, energy shares, GDP, and exchange rate. In choosing among these three threshold determinants, we employ a stepwise approach. Initiating this selection process, we estimate three models, each incorporating one of the three covariates, and opt for the most effective one based on the R-squared. Following this approach, the model with

[5] The lack of data availability prevented us from including the member nations of the Gulf Cooperation Council (GCC) in our sample. These countries, including Iraq, United Arab Emirates, Oman, and Qatar, are among the top major oil-exporting nations. The two components (investment and public expenditures) are missing for Iraq. Furthermore, data for all four components of GDP is unavailable for United Arab Emirates, Oman, and Qatar.
[6] Except Algeria and Saudi Arabia (over the Q1 2005-Q2 2023 period) due to the lack of data availability.
[7] The data are available from the corresponding author upon request.

energy shares emerges as the most fitting. Notably, the R-squared for the model incorporating energy shares is 0.21, surpassing the values for the models incorporating GDP (0.14) and the exchange rate (0.17).

As they are voluminous, only the results with energy shares are presented here (Table 1). The p-values are calculated with 1000 bootstrap replications. The rest of the results of selecting the threshold in terms of exchange rate and GDP are available from the corresponding author upon request.

Table 1: The statistic (F_2) of time varying threshold test (linear Vs varying kink)

	Global GDP	Investment	Public expenditures	Consumption	Net Exports
			Exporting countries		
Saudi Arabia	2.53(0.6)	4.71*(0.1)	2.88**(0)	3.55(0.4)	0.55(0.9)
Russia	14.47***(0)	29.71***(0)	2.22(0.6)	23.35***(0)	6.86*(0.1)
Canada	17.16***(0)	12.05***(0)	4.01(0.3)	7.71***(0)	4.01(0.5)
Norway	3.99(0.3)	3.02(0.2)	2.67(0.3)	2.77*(0.1)	1.87(1)
Brazil	24.56***(0)	19.5***(0)	2.15(0.5)	13.03***(0)	2.92(0.3)
Mexico	1.39(0.8)	1.8(0.8)	2.79(0.4)	1.35(0.9)	2.26(0.6)
Colombia	30.53***(0)	8.32*(0.1)	12.51***(0)	0.78(0.9)	5.89(0.2)
Ecuador	4.72(0.2)	3.46(0.4)	4.14*(0.1)	6.93*(0.1)	3.67(0.3)
Algeria	5.15(0.2)	13.74***(0)	2.85(0.5)	0.7(0.6)	7.89***(0)
Indonesia	7.22(0.2)	3.24***(0.1)	1.08(0.8)	6.3***(0)	2.53(0.4)
			Importing countries		
India	28.95***(0)	22.55***(0)	10.26*(0.1)	22.06***(0)	9.57***(0)
China	4.6(0.2)	8.29*(0.1)	3.7(0.2)	3.34(0.2)	5.01***(0)
United States	8.71(0.3)	10.45(0.2)	7.35(0.2)	9.23(0.2)	7.87***(0)
South Korea	15.32***(0)	16.19***(0)	1.88***(0)	4.72(0.3)	8.48(0.2)
Germany	2.36(0.5)	4.24*(0.1)	5.51***(0)	4.72(0.3)	9.17***(0)
Netherland	4.04(0.3)	15.23*(0.1)	2.92(0.7)	0.51(0.9)	8.27***(0)
Italy	12.35***(0)	29.29***(0)	38.08***(0)	1.94(0.8)	8.61(0.2)
Spain	2.68(0.5)	36.11***(0)	31.19***(0)	3.12(0.5)	2.66(0.3)
United Kingdom	3.45(0.3)	3.05(0.2)	4.97(0.4)	0.23(1)	0.94(0.8)
Singapore	1.91(0.6)	1.64(0.4)	23.11***(0)	4.11*(0.1)	21.93***(0)

* = Significant at 10%, ** = Significant at 5%, ***= Significant at 1%

Table 1 displays the results of the F2 statistic, where in we consider the threshold as a function of energy shares. The null hypothes is for this test posits a constant threshold against a time-varying threshold. Notably, the null hypothesis is rejected in 46 instances. This rejection is more pronounced, indicating a time-varying threshold, particularly in the context of "Investment," where it holds true for 14 out of 20 countries, and for all five components in the case of India.

Next, we discuss the results associated with establishing the threshold as a function of energy shares. We first present and analyze the main results of testing for threshold effect in the oil price-GDP link. Then, we proceed to the estimation results that allow for GDP components' heterogeneity in their responses to oil prices.

In Table 2, we start with analyzing the estimated results of the time-varying threshold of the equation of GDP. According to Tables 1 and 2, both the null hypothesis of linearity and the null hypothesis of constant threshold are rejected (according to F_{1T} and F2, respectively) for Russia, Brazil, Colombia, India, US, South Korea, and Italy Thus, these results suggest the presence of oil price– threshold effects on GDP. For these countries, the estimated energy shares coefficient ($\boldsymbol{\gamma_1}$) is generally positive. Therefore, the effect of energy shares on the threshold is positive and statistically significant. To take a further look at the time-varying threshold of the model with energy shares, we illustrate the estimated thresholds in Appendix C. The dashed line presents the oil price, and the solid line refers to the estimated time-varying threshold. The resulting thresholds in Appendix C vary from year to year. For the majority of countries (except for Canada and Brazil) the oil price series is above the threshold series. To have a clearer idea about the threshold series of each country, we present in Appendix H some descriptive statistics (Mean, Standard deviation, Min, and Max) for the threshold series. As we can see from the table H1 in Appendix H, Korea presents the higher time-varying threshold with max=89.148 and India presents the lower one (33.342). According to the standard deviation, India presents the threshold as the most volatile among the 7 countries under investigation.

Once it is settled that the nexus between oil price and GDP is subject to threshold effect for these countries (according to F-statistic in table 2), the next plausible question would be whether the level of oil price affects differently GDP in the two identified regimes of high and low level of oil price. According to Table 2, the coefficient of oil price in the lower regime (β1L) is statistically significant for 3 exporting countries (Russia, Canada, and Brazil), with a negative sign. However, in the upper regime, where the oil price is exceeding the threshold level, the estimated coefficient of oil price,$\boldsymbol{\beta_{1H}}$, is positive in the 4 exporting countries (Russia,

Table 2: The dependent variable global GDP									
Country	F_{1T} **test**	γ_0	γ_1	β_{1L}	β_{1H}	$GDP_{\{-1\}}$	**Unemp**	**Produ**	**Exch**
Exporting countries									
Saudi Arabia[£]	1.98	100	-3.9	-0.001	-0.007	0.71	-0.07	0.01	-0.008
Russia[&%]	10.7***	41*	4.8*	-0.09*	0.01*	0.68	-0.12*	0.1*	-0.002*
Canada[%#]	15.304**	85*	5*	-0.002*	0.004*	1.006	-0.02*	-0.003	0.003
Norway[%£#]	1.95	93*	3.9	0.005	0.06*	0.98	-0.13	0.01*	-0.009
Brazil[£]	19.84***	81*	3.7*	-0.0001*	0.00005*	1.01	0.0001	0.0002*	0.0004
Mexico[%]	1.15	21	-4	0.01	-0.0001	0.76*	-0.05	0.005	-0.002*
Colombia	28.59*	51*	4.4*	-1.37	0.62*	0.56*	-5.29*	0.94	-0.97*
Ecuador	4.17	29	-4.7	0.0002	0.0002	0.09	0.00002	0.00004	0.0002
Algeria	4.61	57*	4.3	-0.04	0.01*	0.45	-0.21	-0.0005	-0.03
Indonesia	6.38	47	-2.8*	-0.69	0.28*	1.02	1.35	0.85	0.43
Importing countries									
India[£]	21.37*	47*	-3.8*	1.93*	-0.3	0.84*	-13.6	12.03	2.5
China[#]	4.08	98*	-3.4*	-0.01	0.14	0.79*	-0.39*	0.07	0.12
United States[%#]	6.51	45	2.5	-1.53	-0.34*	1.02	-1.07*	2.1	-1.33
South Korea	14.22**	86*	5*	-2.51	1.98*	0.64*	-8.86	7.35	0.94
Germany[&%#]	1.89	67*	-2.9	-0.00005	-0.0006	0.63*	-0.01	0.003	0.001
Netherland[&]	3.67	32	-5	-0.002*	-0.0004	0.9*	-0.001	0.004	0.002
Italy[%#]	10.41**	39*	5*	0.004*	0.0002*	0.3	0.003	0.0003*	0.005
Spain[#]	2.21	31	5*	0.0001	0.00003	0.8	0.001	0.001	0.002
United Kingdom[&#]	2.83	47*	-3	0.0005*	0.0002	0.96*	0.002	0.001	-0.0007
Singapore	1.37	67*	4.3	0.0004*	-0.0011	0.97*	-0.009	0.0007	0.0009

# indicates that the Global Financial Crisis dummy was significant; & indicates that the russian-ukrainian war dummy was ant (2014 or 2022); % indicates that the oil price plunge of 2014-2016 dummy was significant. £ indicates that the COVID-19 pandemic was significant. * = Significant at 10%, ** = Significant at 5%, ***= Significant at 1%

Canada, Brazil and Colombia). This outcome is opposite to that found by Alimi and Aflouk (2017). Using the Panel Smooth Transition Regression (PSTR) model to analyze the impact of oil price changes on GDP growth rate in the Golf Corporation Council (GCC) economies, the authors establish the presence of a threshold level and conclude that an oil price shock has a positive effect on output when the change is smaller than the threshold levels, but such a positive effect is dampened when the change is greater than the threshold levels. Our result however is consistent with the result of Nusair (2016). Using the NARDL model for the GCC countries, his result suggests a positive response of real GDP to positive changes in oil prices and a negative response of real GDP to negative changes in oil prices. Also, another study by Ito (2010) adopting the VAR model and focusing on a net oil exporting country "Russia" for a period ranging from 1994-2009 found that the increase in oil prices positively affected the GDP. For Saudi Arabia in particular, our results show that the effect is significant only when there is an increase in the price of oil above the threshold which is somewhat different from the findings of Jawadi and Ftiti (2019) who used the threshold autoregressive model (TAR) and reported a positive connection between oil price and Saudi Arabia's economic growth in the two detected regimes.

As for oil-importing countries, in the lower regime, a significant connection between oil prices and economic growth is documented for 2 out of the 3 countries presenting a threshold effect (India and Italy). Such a connection is found positive for these mentioned countries. While in the upper regime, where the oil price is greater than the threshold level, the connection between the oil price and the oil-importing country's GDP turns out to be negative for India. Of note, this pattern is opposite to that found in oil-exporting countries.
Our finding for South Korea indicates that the effect of oil prices on its GDP is insignificant when oil prices are below the threshold but becomes negative and significant when there is an increase in the price of oil above the threshold. Our result confirms Guo and Kliesen's (2005) findings. They examined the relationship between oil prices and GDP for an importing country (United States) and discovered that there is a negative impact of oil prices on GDP when the oil price is greater.

Our findings align partially with the outcomes reported by Jiménez Rodríguez and Sanchez (2005). Their research indicates that in countries belonging to the Organization for Economic Co-operation and Development (OECD), the ascent in oil prices is more pronounced and exerts a greater impact on GDP rates than their decline. Additionally, their study highlights a positive correlation between rising oil prices and the GDP of exporting nations, while importing countries experience a negative impact. Essentially, net oil-exporting nations reap benefits from increased oil prices, whereas net oil-importing countries face adverse consequences.

All in all, it appears that the oil price effect is positive for most exporting countries when the oil price is above the threshold (Russia, Canada, Brazil, and Colombia), thus confirming the literature since the rise in oil prices is beneficial for the GDP of these countries. Indeed, profits from accumulated oil revenues will be used through government spending to stimulate investment and economic growth. However, in the case of oil-importing countries, with the rise of oil prices, there is a transfer of wealth from oil-importing countries to oil-exporting countries, leading to a drop in purchasing power for businesses and households in oil-importing nations, which negatively affect growth confirming the results of Lardic et Mignon (2008), Zhao et al. (2016) and Alekhina and Yoshino (2018).

Regarding the other control variables, the results indicate, as expected, that the coefficient of the variable industrial production index *(Produ)* is positive and statistically significant at the 5% level in almost all countries (oil-importing countries as well as oil-exporting countries).

As the Industrial Production Index measures the level of real output of businesses integrated into the industrial sector of the economy (manufacturing, mining such as oil field drilling services, and utilities such as oil field services, electricity, and gas), each increase in this index stimulates the economic growth of this country. It is often used in conjunction with a labor input variable. Such a variable shows the efficiency with which industrial labor is employed. The higher the industrial production index, the higher the employment rate and the lower the unemployment rate. Manufacturing is an important contributor to gross domestic product and an engine of economic growth, which is reflected in its high share of total output, employment, and income, and in creating sustainable economic growth (Manyika, 2012; Herman, 2016).

The unemployment rate effect is significant and negative in most estimated models in exporting countries (except Italy). The Covid dummy variable exhibits a significant coefficient in Brazil and India. However, the oil shock of 2014-2016 (the oil price plunge) is significant for Russia, Canada, and Italy. This result demonstrates that this global crisis has amplified the effects of oil prices for both oil-importing and oil-exporting countries due to these countries' dependence on this source of energy and that the harm caused by the plunge of oil prices has amplified the effects on economic growth in these countries. Also, the dummy variable related to the Russian-Ukrainian war (2014-2022) is significant for Russia. Russia as a main supplier of oil in the world is affected by this political crisis. The extended war between Russia and Ukraine has increased instability and geopolitical threats, producing considerable disruptions in financial and economic markets, especially the oil market (Wang et al., 2022; Agyei, 2023).

As already pointed out in the introduction, GDP components may respond differently to oil prices. For this reason, it is interesting to decompose GDP into its components, namely, investment, public expenditure, consumption, and net exports; highlighting each of these components is more sensible to oil price changes. Table 3 reports the estimates of the investment equation, while Tables (4), (5), and (6) display results from estimating net exports, public expenditure, and consumption equations respectively.

According to Tables 1 and 3, both the null hypothesis of linearity and the null hypothesis of constant threshold are rejected (according to F_{1T} and F2, respectively) for 6 oil-exporting countries among 10 (Saudi Arabia, Russia, Canada, Brazil, Algeria, and Indonesia) and 7 importing countries among 10 for under study (India, China, South Korea, Germany,

Table 3: The dependent variable Investment									
Country	**F test**	γ_0	γ_1	β_{1L}	β_{1H}	$INV_{\{-1\}}$	**Unemp**	**Produ**	**Exch**
Exporting countries									
Saudi Arabia%	3.98*	85*	4.8*	0.001*	-0.0016	0.11*	0.0003	0.006*	0.0003
Russia&	19.4**	55*	-3*	-0.04*	0.01*	-0.28	0.09	0.1*	0.001
Canada£	10.54***	86*	5*	-0.0008*	0.001*	0.96*	-0.008*	-0.001	0.001
Norway%#	2.68	46*	-5	0.01	0.005	0.64	-0.07	-0.01	-0.02
Brazil	17.207**	81*	3.7*	-0.0002	0.0002*	0.0009	0.0009	0.0006*	0.0002
Mexico%	1.59	68*	-4.7	0.0008	-0.003	0.6	-0.01	0.002	-0.0008
Colombia	7.81	90*	5	0.25	-0.48	0.62*	-1.85	-0.01	-0.15*
Ecuador	3.1	20	-5	0.0003	0.0001	0.95*	0.00005	0.0001	-0.0004
Algeria%£	12.53*	50*	-0.9*	-0.02	0.005*	0.35	-0.07*	-0.002	-0.01*
Indonesia	3.14*	39*	5*	0.57	-0.03	0.98*	2.79	0.05	-0.29*
Importing countries									
India	20.18*	47*	-5	4.77*	-0.19*	0.63	-8.78	5.64	2.48
China%£	8.09*	65*	-5*	-0.01*	0.006*	0.28	-0.47*	0.01*	0.06
United States#	8.15	63*	5	-0.22	-0.02	1.01	-0.16*	0.44*	-0.31
South Korea£	16.10***	88*	5*	2.01*	-1.8*	0.07	-9.65	5.52	1.24
Germany	4.29*	30*	3.1*	-0.0008	-0.0001	0.08	-0.006	0.001	0.0002
Netherland#	13.51**	51*	-4.5*	0.001	-0.0003	0.04	-0.008*	0.001*	0.002
Italy	25.34***	42*	5*	0.0008	0.0002	-0.0001	-0.00001	0.0007	0.0001
Spain#	31.38***	42*	5*	0.001	0.0001*	0.43*	-0.0009*	0.0007	0.0009
United Kingdom#	2.17	34	-5	0.0002*	0.0001	0.57	-0.002*	0.0009	-0.0007*
Singapore	1.46	100*	5	0.0001*	-0.001*	0.6	-0.0005	0.00005	0.0005

# indicates that the Global Financial Crisis dummy was significant; & indicates that the russian-ukrainian war dummy was significant (2014 or 2022); % indicates that the oil price plunge of 2014-2016 dummy was significant. £ indicates that the COVID-19 pandemic dummy was significant. * = Significant at 10%, ** = Significant at 5%, ***= Significant at 1%

Netherland, Italy, and Spain). Thus, these results suggest the presence of oil price–threshold effects on Investment. For these countries, the estimated energy shares coefficient (γ_1) is positive for 8 countries and negative for 5 countries. Therefore, the effect of energy shares on the threshold can be positive or negative. To take a further look at the time-varying threshold of the model with energy shares, we illustrate the estimated thresholds in Appendix D. The resulting thresholds in Appendix D vary from year to year. For the majority of countries (except for Saudi Arabia, Canada, Brazil and Korea) the oil price series is above the threshold series during, generally, the entire study period. As we can see from table H2 in appendix H, Saudi Arabia presents the higher time varying threshold with max=88.268 and Germany presents the lower one (31.069). According to the standard deviation, Indonesia presents the threshold as the most volatile among the 13 countries under investigation.

According to table 3, for the group of oil-exporting countries, the coefficient of oil price in the first regime (op< threshold) **is** statistically significant for only 3 exporting countries among 6. Looking at the coefficient $\boldsymbol{\beta_{1L}}$, it is negative and significant for Russia and Canada. This result is expected since unfavorable variations in oil prices for exporting countries negatively affect investment (Dohner, 1981). Furthermore, when the oil price is above the threshold, then we are in regime 2, and the sign of $\boldsymbol{\beta_{1H}}$ becomes positive for Russia, Canada, and Algeria. These results confirm the result of Dohner (1981) who was among the first who supported the idea that the increase in oil prices for exporting countries leads to an increase in income, which stimulates savings and investment. Rotimi and Ngalawa (2017) also explained that increasing oil prices will help oil-exporting nations' economies by providing the necessary funding for their countries' economic development. Thus, it appears that in most cases for the exporting countries containing a time-varying threshold, the effect of oil price is negative in the lower regime and positive in the upper regime.

Moving on to the second group containing oil-importing countries, it appears that in most cases, the effect of oil prices is positive in the lower regime and negative in the upper regime (India, South Korea, Singapore). As mentioned in the literature section, increasing oil prices will hurt investment for importing countries and have a positive effect on exporting countries. Our results confirm the results of Henriques and Sadorsky (2011) and Elder and Serletis (2010a) who supported the idea that the surge of oil prices for importing countries harms investment decisions, which reduces overall investment and GDP. Also, Rafiq et al. (2009) found that oil price hikes have a detrimental and negative impact on investment and GDP in Thailand selected as a net oil importer.

According to Table 3, the COVID dummy variable exhibits a significant coefficient for Canada, Algeria, China, and South Korea. It demonstrates that the global Covid pandemic has amplified the effects of oil prices for both oil-importing and oil-exporting countries due to these countries' dependence on this source of energy and that the harm caused by this pandemic (an economic slowdown due to the closing of markets) has amplified the effects on economic growth in these countries, supporting the findings of Arezki and Nguyen (2020). Due to transportation network interruptions brought on by the epidemic, industries have been forced to close and investment and intermediate inputs have decreased (Albulescu, 2020; Algamdi et al., 2021).

We also note, according to Table 3 that the production price index has a positive impact on investments since the increase in oil revenues encourages investment in new companies and new factories, which leads to an increase in production, leading to a rise in the production index. With these new factories and the hiring of new employees, the employment rate increases with a drop in the unemployment rate. This has a positive effect on GDP and investment in exporting countries. However, for importing countries, a rise in oil prices raises the cost of production, which discourages investment. In addition, the depreciated currency rate harms investment for the oil-importing countries. Rising oil prices lead to more inflationary pressure, which decreases real interest rates. As a result, both investment and economic growth are impacted negatively by the lower real interest rate (Deyshappriya et al., 2023).

Table 4 presents the results of the estimation of the impact of oil prices on public expenditure. From the F-test results in Table 4, we can see that the null hypothesis of no threshold effect can be rejected at the 10% significance level for 3 exporting countries (Saudi Arabia, Colombia, and Ecuador) and 5 importing countries (India, Germany, Italy, Spain and Singapore) in our sample. This advocates the presence of oil prices–effects on public expenditure.

For these countries, the estimated energy shares coefficient ($\boldsymbol{\gamma_1}$) is generally positive. Therefore, the effect of energy shares on the threshold is positive. To take a further look at the time-varying threshold of the model with energy shares, we illustrate the estimated thresholds in Appendix E. For the majority of countries (except for Saudi Arabia, Ecuador, and India) the oil price series is above the threshold series during, generally, the entire study period.

As we can see from Appendix E and Table H3 in Appendix H, Italy presents the threshold as the most volatile (0.339). However, Saudi Arabia presents the higher time-varying threshold with max=98.404 and India presents the lower one (41.75).

Table 4: The dependent variable Public expenditures									
Country	**F test**	γ_0	γ_1	β_{1L}	β_{1H}	$Expen_{\{-1\}}$	**Unemp**	**Produ**	**Exch**
Exporting countries									
Saudi Arabia	2.59*	95*	5**	0.002*	-0.002	-0.11*	-0.001*	0.006**	0.007
Russia	1.98	99	-1.1*	0.006	-0.007	0.88*	0.01	0.006*	0.0001
Canada%#	3.89	83	5	0.0002	-0.0003	0.09	-0.0005	0.0005	0.0006
Norway£#	2.47	94	5	0.001	-0.003*	0.99	-0.002	0.001	-0.002
Brazil	1.91	81	3.7*	-0.0001	0.0004*	0.0006	0.005	0.0003	-0.00003*
Mexico	2.09	43	3.9	0.0004	-0.0005	0.08	-0.004	0.0005	-0.0001
Colombia	10.09*	58*	4.9*	-0.4*	0.15*	-0.26	-1.38	0.56	-0.33
Ecuador£	3.98*	100*	-1.6*	0.0001	-0.0003	0.98*	-0.0001	0.0001	-0.0004
Algeria%	2.11	100*	5	0.002	-0.03*	0.07	0.001	0.02	0.007
Indonesia	1.05	92*	2.8*	0.002	0.11	1.008	0.29	0.04	-0.09
Importing countries									
India	9.37*	84*	4*	0.69	-1.9	0.2	-6.8	0.05	5.96
China£#	2.9	56	1.9*	0.004*	-0.003	0.7*	-0.03	-0.0003	0.02
United States£#	7.08	45	-5	0.07	-0.01	0.98*	-0.19	0.02	0.01
South Korea	1.81	20	-4.1	2.1	-0.05	0.9*	1.68	0.31	0.91
Germany#	5.42*	51*	5*	0.0001	-0.0002	0.25	-0.005	0.0009	0.0005
Netherland#	2.27	30	-4.3	-0.001	-0.0001	0.86*	-0.001	0.001	0.0009
Italy	28.68***	40*	5*	0.002*	0.0001	-0.3	0.002	0.0002	0.002
Spain%£	30.07***	43*	5*	0.0001*	-0.00005	0.2	0.0008	0.0002*	0.0008
United Kingdom#	3.89	41*	4.5*	0.0002	0.00001	0.8*	-0.00007	0.0009	-0.0001*
Singapore	20.43***	53*	-4.5*	0.001*	-0.001*	-0.34	-0.001*	0.001	0.007*

# indicates that the Global Financial Crisis dummy was significant; & indicates that the russian-ukrainian war dummy was significant (2014 or 2022); % indicates that the oil price plunge of 2014-2016 dummy was significant. £ indicates that the COVID-19 pandemic dummy was significant. * = Significant at 10%, ** = Significant at 5%, ***= Significant at 1%

The regression results displayed in Table 4 show that for oil-exporting countries, the coefficient of oil price in the first regime is negative and significant only for 1 oil-exporting nation among the 3 countries involved in the time-varying thresholds (Colombia). This result indicates that a drop in oil prices will be detrimental to public expenditures. However, in the upper regime, a significant positive association between oil prices and public expenditures occurs for Colombia. This confirms the argument that oil revenue presents the key instrument of public expenditure (Adedokun, 2018). Indeed, public revenues of oil-exporting countries increase due to oil revenues. The latter are either saved in a sovereign wealth fund or used to finance public expenditure. Therefore, oil prices and government spending are directly linked to each other. Oil revenues could be a contributing factor for oil-exporting countries whose expenditures are covered by tax revenues (Sadeghi, 2017).

Looking at the second group of countries (oil-importing), in the lower regime, when the oil price is below the threshold, the coefficient of oil price is found significant and positive in three countries among the 5 (Italy, Spain and Singapore). However, for the second regime, when the oil price is above the threshold, we see that it becomes negative. It is clear therefore that the oil price spike will harm public spending for importing countries.

Our results confirm the result of El Anshasy and Bradley (2012) who used a panel of 16 oil-exporting countries over the period 1957-2008 and showed that in the short term, public expenditure increases with the increase in oil-exporting countries' revenue. Similar results are reported by Garkaz et al. (2012), who find a statistically significant and positive impact of oil export revenues on government spending in one oil exporting country (Iran). Our results also confirm the results of Raouf (2021). He made a comparison between exporting and importing countries. He explained that, in oil exporting countries, the income generated by the increase in oil prices contributes to increasing the rate of country growth and improving current and capital expenditure or, in other words, the government will use these revenues to spend and invest more. In the case of oil-importing countries, the increase in oil prices will affect the GDP in two different ways as it affects the funds available to import the materials needed for the production process and at the same time restricts the funds needed to invest. This will in turn lead to a reduction in expenses.

We turn now to the results of the estimation of the impact of oil prices on consumption presented in Table 5. According to the F-test results, it can be seen that the null hypothesis of no threshold effect can be rejected at the 10% significance level for 6 oil-exporting countries among 10 (Russia, Canada, Norway, Brazil, Ecuador, and Indonesia) and for 2 importing countries among 10 (India and Singapore) for under study, suggesting the presence of oil price–effects on consumption.

For these countries, the estimated energy shares coefficient ($\boldsymbol{\gamma_1}$) is positive for the case of (Russia, Canada, Brazil, and Singapore) and is negative for (Norway, Ecuador, Indonesia, and India). To take a further look at the time-varying threshold of the model with energy shares, we illustrate the estimated thresholds in Appendix F. For the majority of countries (except for Canada) the oil price series is above the threshold series during the entire study period. As we can see from Appendix F and Table H4 in Appendix H, Ecuador presents the threshold the most volatile among the 8 countries under investigation (standard deviation=0.26). Canada presents the higher time-varying threshold with max=82.771 and Ecuador presents the lower one (24.346).

According to table 5, for oil-exporting countries, the coefficients of oil price are mostly

Table 5: The dependent variable Consumption

Country	F test	γ_0	γ_1	β_{1L}	β_{1H}	$Cons_{\{-1\}}$	Unemp	Produ	Exch
Exporting countries									
Saudi Arabia#	2.97	50	5	-0.002	-0.0001	0.7*	-0.009*	0.003	0.001*
Russia&	21.7**	45*	3.6*	-0.03*	0.006*	0.81*	-0.04*	0.03*	-0.0007*
Canada%	6.89**	81*	5*	-0.001*	0.001*	0.98*	-0.018*	-0.002	0.001
Norway#	2.69*	35*	-5*	0.01	0.002	0.82*	-0.07*	-0.01	-0.01*
Brazil	12.37*	44*	4.2*	-0.0001*	-0.0001	1.02	0.0003	0.0001	-0.0005*
Mexico£#	1.27	68*	-5	0.001	-0.0004	0.76*	-0.03	0.003	-0.001
Colombia	0.64	39	4.9	0.49	0.01	0.68	-1.22	0.74	-0.2
Ecuador%	5.97*	28*	-4.4*	0.0002	0.0002*	0.09	-0.00005	0.0003	0.0001
Algeria	0.57	100	5	-0.0004	0.001	0.4	0.005	-0.001	0.002
Indonesia£	5.94*	46*	-0.3*	-0.31*	0.15*	1.02	1.2	0.46*	0.84
Importing countries									
India	21.97*	47*	-3.8*	7.2*	-0.27*	0.83*	-9.05	6.9	2.32
China£	2.97	40	4.7	0.03	-0.01	0.7*	-0.4	0.02	*0.09
United States%	8.04	45	2.5*	-1.23*	-0.32	1.02	-0.32	1.72*	-1.06*
South Korea£#	3.54	21	-4	-5.08	-0.26	0.83*	-5.27	1.46	1.14
Germany#	3.81	65*	-5*	0.0002*	-0.0003	0.46	-0.007*	0.001	0.0005
Netherland	0.5	30	-4	0.0003	0.0004	0.97	-0.0001	-0.0001	0.0002
Italy	1.57	86*	5	0.0002*	0.003*	0.9	-0.11*	-0.011	0.0007
Spain	2.89	26*	4.4	0.0008*	0.009	0.93*	0.0008	0.0005	0.0001
United Kingdom&£#	0.11	20	-5	-0.0007	0.0002*	0.8*	-0.004*	0.0006	-0.0009
Singapore	3.89*	24*	4.7*	0.001*	-0.00009*	0.74	-0.004*	0.001	0.004

# indicates that the Global Financial Crisis dummy was significant; & indicates that the russian-ukrainian war dummy was significant (2014 or 2022); % indicates that the oil price plunge of 2014-2016 dummy was significant. £ indicates that the COVID-19 pandemic dummy was significant. * = Significant at 10%, ** = Significant at 5%, ***= Significant at 1%

negative in the lower regime, $(\boldsymbol{\beta_{1L}})$, while it turns out to be significantly positive in the upper regime $\boldsymbol{\beta_{1H}}$. Our result confirms the result of Gelb (1988) who explained that the increase in the price of oil would increase revenues, which would increase public expenditure according to the duration of project productivity and accordingly increase the level of public consumption in six oil-exporting countries. Besides, Nusair (2016) found that a spike in oil prices is resulting in a wealth shift from oil-importing to oil-exporting countries, which might improve GDP and national income through higher export revenue, leading as a result to an increase in consumer demand and consumer spending power.

The opposite pattern seems to hold for oil-importing countries that confirm the presence of oil price–threshold effects on consumption. That is, the coefficients of oil price are positive when the oil price is below the threshold, and negative when the oil price is above the threshold (India and Singapore). This means that a decline in oil prices would generate positive effects on consumption in the oil-importing nations, confirming the results of De Michelis et al. (2019). By studying the effects of oil prices on consumption for a panel of 55 countries, they found that oil price declines do better than the harm of oil price hikes in oil-importing countries. This also suggests that the oil price spike will hurt consumption for countries' oil importers which confirms the result of Bodenstein et al. (2011). Following the transfer of wealth from importing countries to exporting countries after a rise in oil prices, there will be an exceptional income gain for consumers in exporting countries and the reverse for importing countries. This wealth effect may in turn depress consumption and subsequently economic growth in oil-importing countries and may be more important in sectors that consume goods complementary to oil consumption, such as the automotive sector and the result will be a drop in the GDP rate.

The variable industrial production index (Produ) in Table 5 positively affects “consummation” except in Canada. As this variable calculates the variations in a basket of industrial commodities' output including manufacturing, mining, and electricity. These sectors, that use oil in the production process and will willingly be used for consumers, would contract (expand) in response to a rise (reduction) in oil prices (Lilien, 1982; Kandemir Kocaaslan, 2021).

Finally, we pass on the results of the estimation of the impact of oil prices on net exports presented in Table 6. According to table 1 and 6, both the null hypothesis of linearity and the null hypothesis of constant threshold are rejected (according to F_{1T} and F2, respectively) for 2 exporting countries (Russia and Algeria) and 6 importing countries (India, China, US Germany, Netherland, and Singapore) in our sample. This confirms the presence of time-varying threshold oil price effects on net exports.

For these countries, the estimated energy shares coefficient ($\boldsymbol{\gamma_1}$) is generally positive for 6 countries and negative for 2 countries. Therefore, the effect of energy shares on the threshold can be positive or negative. To take a further look at the time-varying threshold of the model with energy shares, we illustrate the estimated thresholds in Appendix G. The resulting thresholds in Appendix G vary from year to year. For the majority of countries (except for China, the US, and Germany) the oil price series is above the threshold series during the entire study period. As we can see from Table H5 in Appendix H, Singapore presents the threshold as the most volatile among the 8 countries under investigation (standard deviation=0.208). The US presents the higher time-varying threshold with max=102.026 and India presents the lower one (34.382).

The regression results displayed in Table 6 show that, for all the oil-exporting countries, the coefficients of oil prices are not significant in the lower regime. However, in the second regime, the coefficients of oil prices are negative.

Moving on to the second group containing the oil importing countries, the effect is significant and positive when oil prices are below the lower threshold (United States, Netherlands, and Singapore) but becomes significantly negative when there is an increase in the price of oil above the threshold (the second regime).

The findings in Table 6 indicate that oil prices have a larger effect on exports for importing countries when its level surpasses the optimal threshold level, confirming the results of Chaudhry et al. (2021) which showed that an increase in the price of oil is not in favor of the

Table 6: The dependent variable Net Exports

Country	F test	γ_0	γ_1	β_{1L}	β_{1H}	$Expo_{\{-1\}}$	Unemp	Produ	Exch
Exporting countries									
Saudi Arabia	0.55	50	-5	-0.005	-0.003	0.8	-0.05	0.003	-0.01*
Russia&	6.86**	77*	2.1*	0.003	-0.01*	0.84*	0.04	0.006*	0.0003
Canada#	3.97	57	4.8*	-0.0004	-0.0003	0.08	-0.0003*	-0.0002	0.0001
Norway#	1.37	93*	1.5	0.01	0.04*	0.4*	-0.08	0.02*	0.01
Brazil	2.08	92	3*	-0.0002	0.0002*	0.019	0.0002	0.0001	-0.0008
Mexico	2.11	97*	5	-0.0002	-0.003	0.06	0.006	0.0001	0.0005
Colombia	3.28	92*	4.5	-0.15	0.32	0.77*	-0.68	0.05	-0.01*
Ecuador#	2.92	20	-5	-0.0004	-0.0001	0.07	0.0002	0.0001	0.0003
Algeria	7.31*	52	3.1*	0.07	-0.007	0.09	-0.27	0.02	-0.04*
Indonesia	2.46	81*	5	-0.07	0.23*	0.7	-2.6	-0.19	0.57
Importing countries									
India#	8.28*	33*	5*	2.02*	-0.38	0.41	0.86	-1.33	0.07
China£	4.82*	71*	-2.5*	0.03*	-0.01	-0.02	0.5	0.03	-0.02
United States&#	7.12*	100*	5*	0.18*	-0.61*	0.75*	-1.25*	-0.81	0.26
South Korea	7.29	53	5*	1.41*	-0.33	0.29	2.13	1.33	14.89
Germany&#	9.17**	97*	5*	-0.0001*	-0.001	0.4	0.0001	0.001*	0.0008
Netherland&	7.17**	58*	-5*	0.0009*	-0.0001*	0.13	-0.001*	0.0007	0.001
Italy%#	7.24	86*	-5	-0.0002	0.0002*	0.37	0.0008	-0.0004	0.0004
Spain£#	2.08	32	3.8	0.0002	-0.00009	0.5	-0.0006*	-0.0006	-0.0002*
United Kingdom£#	0.80	37*	3.7	-0.0002	-0.0003	-0.09	-0.0004	-0.0004	0.0004
Singapore	21.34***	61*	4.5*	0.002*	-0.002	0.7	0.009	-0.001	0.004

# indicates that the Global Financial Crisis dummy was significant; & indicates that the russian-ukrainian war dummy was significant (2014 or 2022); % indicates that the oil price plunge of 2014-2016 dummy was significant. £ indicates that the COVID-19 pandemic dummy was significant. * = Significant at 10%, ** = Significant at 5%, ***= Significant at 1%

trade balance of oil-importing countries. Soaring oil prices tend to deteriorate the trade balance and the economic growth of these countries. According to Chaudhry and al. (2021) findings, lower oil prices improve the trade balance as well as economic growth. Also, Rafiq et al. (2016) explored the effect of oil prices on oil trade balance in exporting and importing countries. The results showed that the price of oil harmed the trade balance of oil-importing economies. Also, we notice particularly in nations that import oil, a rise in the price of oil increases the demand for foreign currencies, which increases the exchange rate (depreciation). The trade balance may get worsened due to the depreciated exchange rate, which will therefore slow the importing nation's economic expansion (Deyshappriya et al., 2023).

Additionally, we notice that the dummy variable of COVID-19 is significant for 2 importing countries but insignificant in exporting countries showing that the COVID-19 current pandemic has impacted all economic activities as well as raw material markets like the price of oil and crucial economic sectors like the trade sector due to the economic slowdown and closing leading to negative impact on the trade balance specially for the importing countries (Arriola et al., 2022). Additionally, the Russian-Ukrainian war (2014,2022) has impacted the oil price-trade relationship for 4 countries (Russia, the United States, Germany, and the Netherlands). Due to this political war, the regular transportation of oil and refined goods has been upended affecting trade and resulting in one of the most significant upheavals in the worldwide energy sector in decades [Appiah-Otoo (2023)]. However, the United States is the most sensitive to the impacts of the financial crisis of 2008 on the oil price-trade link confirming Chang's (2011) findings. This event started in the USA and caused several economic recessions is defined as one of the most serious economic crises that happened in the United States [Ökte (2012)].

Our empirical study underscores the divergent impact of oil prices on oil-importing and oil-exporting economies: the surge in oil prices detrimentally affects importing countries while proving advantageous for exporting nations. The nonlinear threshold findings, as illustrated in the tables, emphasize that the relationship between oil prices and GDP undergoes variations contingent upon the specific country and its constituent components. Our results robustly affirm the presence of non-linearity in this relationship. Furthermore, our empirical exploration highlights the substantial volatility inherent in markets, contributing to a dynamic and variable oil price-GDP relationship over time, particularly during periods of crisis. The time-varying nonlinear model we employ delineates how GDP variations in each oil-exporting or importing country respond to changes in oil prices using a non-constant threshold. Importantly, this nonlinear threshold is not a fixed kink point but a curve that fluctuates across time and distinct periods.

Based on the estimations utilized in this study, it appears that such crises as the financial crisis, the COVID-19 epidemic, and the Russian war have an impact on the trajectory of crude oil prices and economic growth. Due to geopolitical instability caused by these crises, the oil market cannot rely on oil producers to manage supply. This causes panic in the oil market, which consequently harms economic growth.

5. Conclusion and policy implications

In this paper, we argued that the relationship between oil price and GDP is nonlinear and subject to time-varying threshold effects. Standard regression models that assume a linear relationship between the two variables may have led to biased and misleading results. We investigated possible threshold effects by employing a novel time-varying threshold model for a sample of 20 top-oil importing and oil-exporting countries using quarterly data covering the period from 1995Q1 to 2023Q2. Subsequently, GDP was decomposed into its main components (investment, net exports, public expenditure and consumption) to unravel the distinct threshold effects of oil prices on each of these components.

Overall, our empirical study showed strong evidence for the existence of potential nonlinearity and time-varying threshold effects in the impact of oil price on the GDP of both oil-importing and oil-exporting countries, but the patterns are likely to be contingent upon the net position of the country in the oil market. For most of the oil-exporting countries examined, our findings indicate that lower oil prices have a detrimental effect on economic growth, whereas higher oil prices exhibit a positive influence. The reverse outcome holds for most oil-importing countries. In addition, the presence of the oil price threshold effect persists across all individual GDP components. Notably, our research unveils a substantial heterogeneity in the oil price thresholds across the investigated countries, challenging the notion of a universal threshold applicable to all.

These findings suggest that a sustained rise in oil prices fosters the economic growth of oil-exporting countries and offers them an opportunity to enhance investments and increase their public expenditures. For oil-importing countries, lower oil prices should alleviate the cost of production, thereby promoting exports and boosting economic growth, while a sustained decline in oil prices represents a great opportunity to stimulate investments and public expenditures. Given the nonconstant nature of the threshold, this empirical study presents compelling evidence of distinct periods marked by political and economic tensions that have influenced the oil–GDP relationship. Such periods include the Global Financial Crisis (2008), the oil price plunge of 2014–2016, the Russian–Ukrainian war (2014 and 2022) and the recent COVID-19 pandemic.

This study has important policy implications. The findings highlight that a sustained rise in oil prices could adversely affect the economic growth of oil-importing countries. To mitigate this impact, governments in such countries should actively reduce their dependence on imported oil and transition towards alternative energy sources. Shifting away from fossil fuels and adopting energy-efficient technologies will help decrease reliance on imported oil. Policymakers in oil-importing nations must also consider the nonlinear effects of oil prices on public expenditure, consumption and investment when formulating budgetary policies.

For governments facing constrained budgets and high public expenditures, particularly those vulnerable to the adverse effects of surging oil prices on growth, an effective response involves strategic allocation of funds towards productive infrastructure investments that lower production costs. In addition, the implementation of efficient instruments, such as investment subsidies and reduced expenditure taxes, is crucial to initiate new investments while minimising capital expenditures.

In the context of oil-exporting countries, diversifying the economy is imperative to reduce reliance on oil revenues and counter the adverse effects of declining oil prices on economic activity. Measures for economic diversification should be implemented, especially during periods of oil price spikes, and could include policies to shift towards sustainable energy sources. The early stages of renewable energy development present a lucrative opportunity for nations to increase output levels. Governments should prioritise the development of renewable energy sources to expand the energy supply for the population.

Our findings underscore the significance of the energy consumption share as a critical moderator of the oil price threshold, contributing to a nonlinear influence on the oil price–economic activity relationship. Policymakers are advised to minimise the percentage of oil-energy share consumed, favouring the adoption of alternative renewable energy sources that enhance productivity while reducing reliance on oil. Emphasising the development of renewable energy sources should be a governmental priority to enhance energy supply for the general population.

Appendix

Appendix A: Data presentation

Variables	Description	Definition	Source	Unit of measure
OP	Spot oil price (WTI)	West Texas Intermediate oil per barrel in Dollars ($)	EIA (Energy Information Administration)	Dollars/barrel
GDP	GDP	Gross domestic product	IMF (International Monetary Fund)	Million (Dollars)
$Cons$	Consumption	The volume of consumption sending on goods and service	IMF (International Monetary Fund)	Million (Dollars)
INV	Investment	The volume of investment spending on business	IMF (International Monetary Fund)	Million (Dollars)
$PUBEXP$	Public expenses	The volume of government spending on public services and goods	IMF (International Monetary Fund)	Million (Dollars)
$NETEXP$	Net exports	Volume of net exports	IMF (International Monetary Fund)	Million (Dollars)
$Unemp$	Unemployment rate	the percentage of unemployed people among the active population	IMF (International Monetary Fund)	percentage
$Exch$	Real Exchange rate	The exchange rate refers to the ratio of currencies to each other.	IMF (International Monetary Fund)	percentage
$Produ$	Industrial production index	Represents the variations in a basket of industrial commodities' production over a period of time	IMF (International Monetary Fund)	index
Energy shares	Energy shares	The percentage of oil consumption among the total energy	EIA (Energy Information Administration)	percentage

Appendix B: descriptive statistics

	GDP	Investment	Pub.expend	Consumption	Net Exports	Unemp	Produ	Exch	Enr.Shar
Saudi Arabia									
Mean	0.01	0.004	0.003	0.006	0.002	5.27	108.2	3.75	0.62
Std.dev	0.005	0.001	0.001	0.002	0.001	0.73	16.42	0	0.04
Min	0.007	0.001	0.001	0.002	-0.001	3.4	76.83	3.75	0.53
Max	0.029	0.008	0.007	0.01	0.005	6.98	130.96	3.75	0.68
Russia									
Mean	0.091	0.018	0.016	0.046	0.007	7.11	99.24	37.6	0.2
Std.dev	0.01	21.47	25.36	2.3	0.007	0.04	0.014	0.018	0.08
Min	0.001	0.0002	0.0003	0.0009	-0.00004	3.77	57.04	4.51	0.18
Max	0.29	0.08	0.06	0.14	0.04	13.6	155.68	87.03	0.24
Canada									
Mean	0.01	0.002	0.002	0.006	0.00003	7.33	112.3	1.27	0.32
Std.dev	0.003	0.0009	0.0007	0.001	0.0002	1.28	7.73	0.17	0.015
Min	0.005	0.0009	0.001	0.002	-0.0004	5.2	90.97	0.97	0.29
Max	0.019	0.004	0.003	0.01	0.0005	13.05	126.92	1.59	0.35
Norway									
Mean	0.11	0.026	0.025	0.048	0.013	3.88	105.17	7.37	0.23
Std.dev	0.05	0.012	0.011	0.018	0.014	0.69	10.339	1.37	0.01
Min	0.042	0.008	0.008	0.02	-0.004	2.3	83.13	5.08	0.211
Max	0.281	0.056	0.051	0.091	0.101	5.53	125.53	10.86	0.26
Brazil									
Mean	0.004	0.0008	0.0009	0.002	0.00002	7.91	84.88	2.63	0.47
Std.dev	0.003	0.0005	0.0006	0.002	0.0001	2.94	10.91	1.26	0.018
Min	0.0008	0.0001	0.0001	0.0005	-0.0002	3.9	62.45	0.86	0.44
Max	0.012	0.002	0.002	0.007	0.0004	14.66	107.02	5.58	0.51
Mexico									
Mean	0.027	0.006	0.003	0.019	-0.0003	4.07	89.19	13.28	0.55
Std.dev	0.015	0.003	0.001	0.01	0.0005	0.89	46.41	4.37	0.069
Min	0.003	0.006	0.0003	0.0027	-0.002	2.38	32.72	6.31	0.42
Max	0.058	0.015	0.007	0.043	0.002	7.03	166.14	23.51	0.65
Colombia									
Mean	3.25	0.86	0.47	2.9	-0.16	11.08	98.49	2383.44	43.26
Std.dev	0.81	0.27	0.182	1.15	0.14	1.98	29.2	860.97	0.02
Min	1.532	0.303	0.2	1.02	-0.57	7.49	51.51	854.45	0.385
Max	4.94	1.53	1.01	5.74	0.0009	18.71	157.41	4808.38	0.47
Ecuador									
Mean	0.0008	0.0002	0.0001	0.0005	-0.00006	5.18	93.58	1042.07	0.76
Std.dev	0.0005	0.0001	0.00007	0.0002	0.00002	0.91	15.2	2945.32	0.059
Min	0.0001	0.00002	0.000009	0.00009	-0.00006	3.4	62.16	1	0.63
Max	0.0016	0.0004	0.0002	0.001	0.0004	7.97	120.03	20243	0.83
Algeria									
Mean	0.11	0.05	0.02	0.04	0.002	12.02	105.86	95.46	0.34
Std.dev	0.012	0.003	0.003	0.003	0.01	1.48	7.46	25.66	0.02
Min	0.096	0.046	0.012	0.03	-0.017	9.5	95.51	61.19	0.308
Max	0.15	0.059	0.029	0.047	0.045	14.6	129.808	144.98	0.387
Indonesia									
Mean	16.03	4.78	1.72	9.53	-0.48	12.46	93.58	53.26	0.32
Std.dev	13.76	3.97	1.508	8.309	0.52	4.14	24.28	13.48	0.03

Min	2.16	0.58	0.21	1.54	-2.37	5.63	47.27	31.42	0.27
Max	50.57	14.87	6.15	30.64	0.61	20.07	144.16	82.79	0.38
India									
Mean	6.71	2.39	0.59	3.83	0.1	5.2	97.71	1027.47	0.508
Std.dev	5.47	1.79	0.48	3.03	0.16	1.2	9.72	3531.08	0.07
Min	0.46	0.184	0.034	0.34	-0.23	3.2	75.69	2219	0.38
Max	18.91	5.64	1.5	10.38	0.79	8	120.16	16367.01	0.63
China									
Mean	0.33	0.07	0.03	0.21	0.012	4.38	96.5	7.77	0.18
Std.dev	0.1	0.017	0.015	0.08	0.018	1.51	12.62	0.03	0.02
Min	0.18	0.04	0.01	0.116	-0.02	2.17	58.20	7.73	0.15
Max	0.53	0.11	0.07	0.38	0.05	8.5	123.97	7.85	0.22
United States									
Mean	11.407	2.4	1.68	7.67	-0.38	5.66	102.68	1	0.38
Std.dev	3.8	0.78	0.52	2.62	0.17	1.83	8.78	0	0.011
Min	5.64	1.18	0.84	3.64	-0.77	3.34	78.18	1	0.36
Max	20.3	4.302	2.77	13.81	-0.039	12.89	114.12	1	0.4
South Korea									
Mean	11.92	3.67	1.79	5.97	0.35	3.47	84.55	1122.226	0.48
Std.dev	5.21	1.61	1.05	2.36	0.41	1.109	30.18	145.52	0.075
Min	3.76	1.26	0.37	2.09	-0.83	1.83	32.61	758.1	0.408
Max	21.35	7.39	4.21	10.42	1.25	8.37	131.58	1434.8	0.65
Germany									
Mean	0.007	0.001	0.00	0.004	0.0003	6.39	98.5	2.02	0.37
Std.dev	0.001	0.00039	0.0004	0.0007	0.0002	2.37	11.09	0.54	0.02
Min	0.005	0.001	0.001	0.003	-0.00005	2.87	76.37	1.23	0.34
Max	0.012	0.002	0.002	0.006	0.0008	11.5	115.73	3.41	0.41
Netherland									
Mean	0.008	0.001	0.002	0.003	0.0007	5.73	91.93	1.79	0.49
Std.dev	0.002	0.0005	0.0006	0.0008	0.0003	1.57	8.98	0	0.018
Min	0.004	0.0008	0.0009	0.002	-0.0007	2.83	66.83	1.79	0.45
Max	0.014	0.0035	0.0036	0.006	0.001	8.93	110.78	1.79	0.53
Italy									
Mean	0.006	0.001	0.001	0.003	0.000008	9.65	104.08	53.26	0.44
Std.dev	0.001	0.0002	0.0002	0.0006	0.0001	1.87	11.41	13.48	0.067
Min	0.003	0.0007	0.0006	0.002	-0.0002	5.73	74.05	31.42	0.35
Max	0.009	0.001	0.001	0.005	0.0004	13.73	123.94	82.79	0.57
Spain									
Mean	0.005	0.0011	0.0009	0.002	0.000006	15.97	104.99	190.551	0.5
Std.dev	0.0003	0.0003	0.0007	0.0001	0.0001	5.08	12.04	43.37	0.037
Min	0.002	0.0005	0.0003	0.001	-0.0004	7.93	76.69	121.37	0.43
Max	0.007	0.001	0.001	0.004	0.0003	26.93	131.63	356.75	0.56
United Kingdom									
Mean	0.006	0.001	0.001	0.004	-0.00007	5.76	103.9	0.65	0.37
Std.dev	0.001	0.0003	0.0004	0.001	0.0001	1.41	8.36	0.08	0.01
Min	0.003	0.0005	0.0005	0.002	-0.0005	3.6	84.24	0.49	0.34
Max	0.0099	0.002	0.002	0.006	0.0003	8.73	122.04	0.9	0.4
Singapore									
Mean	0.014	0.0035	0.0014	0.005	0.0038	3.31	100.30	1.47	0.89
Std.dev	0.0068	0.0013	0.0008	0.002	0.002	1.06	10.39	0.17	0.046
Min	0.005	0.001	0.003	0.002	0.0007	1.4	79.24	1.22	0.83
Max	0.029	0.006	0.0038	0.009	0.011	6	120	1.85	0.96
Oil price									
Mean	55.08								
Std.dev	28.63								

Min	12.81
Max	123.97

Appendix C: Time Varying Threshold effect for the GDP equation

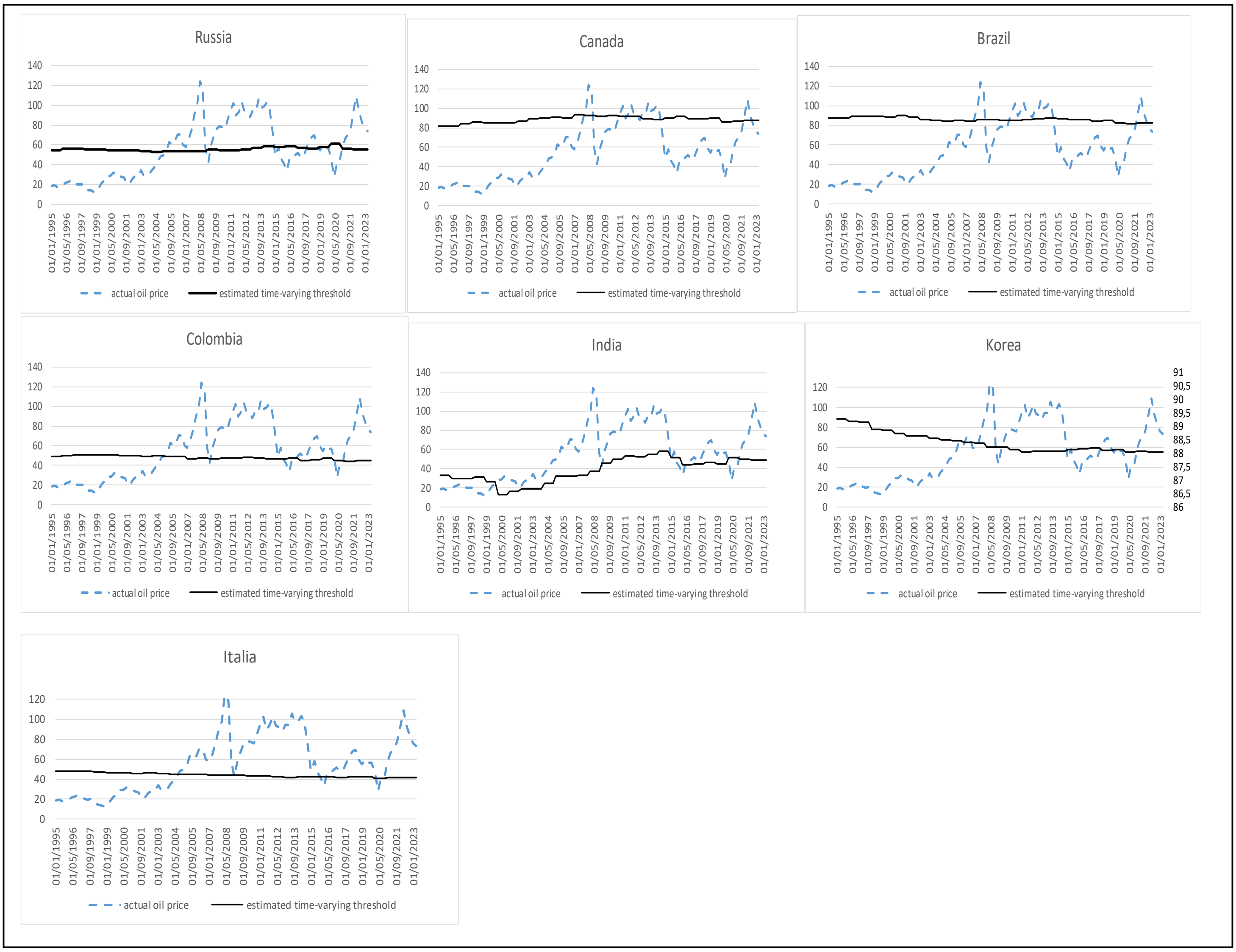

Figure 1: Authors' computations

Appendix D: Time Varying Threshold effect for the investment equation

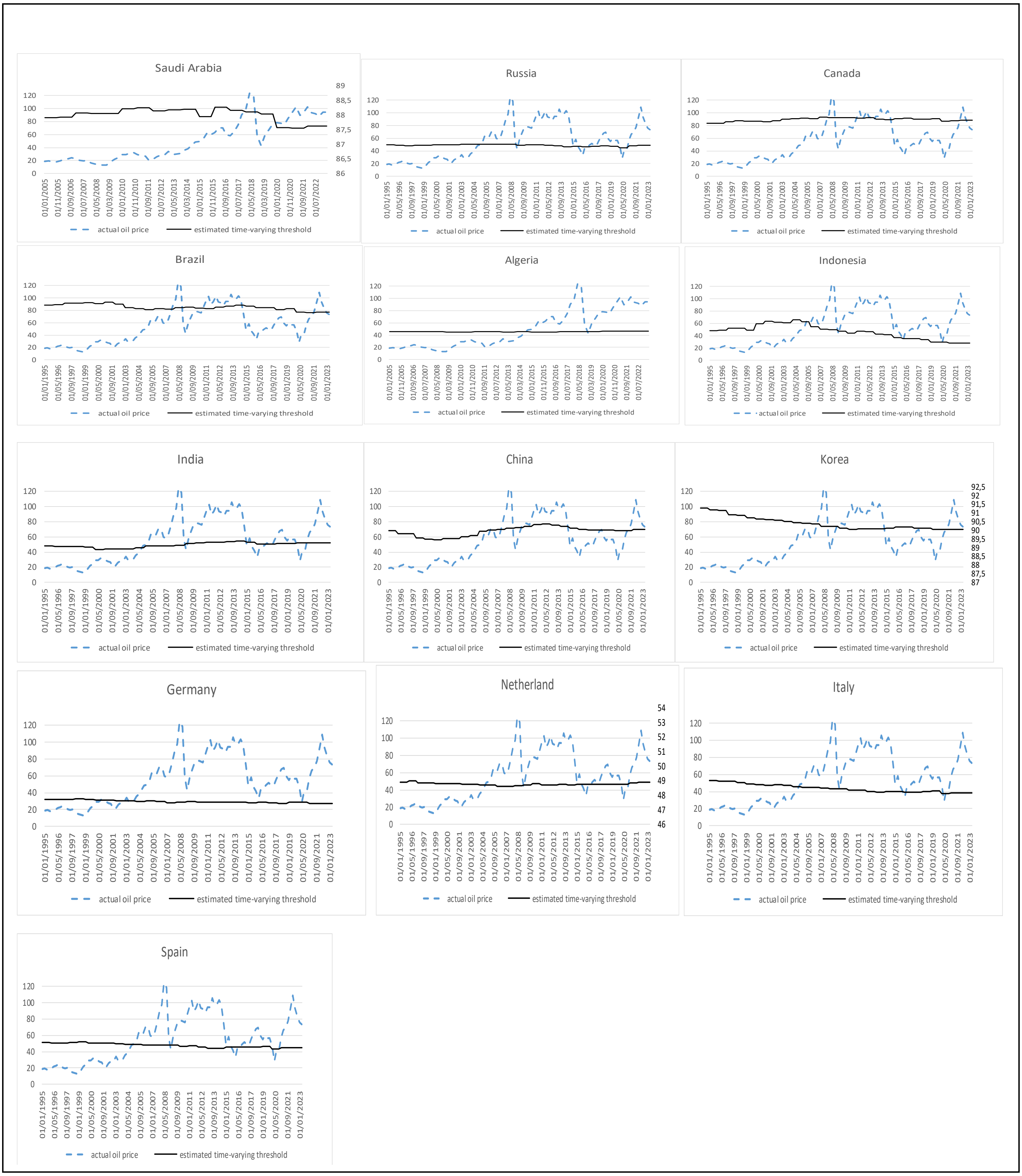

Figure 2: Authors' computations

Appendix E: Time Varying Threshold effect for Public expenditures equation

Figure 3: Authors' computations

Appendix F: Time Varying Threshold effect for consumption equation

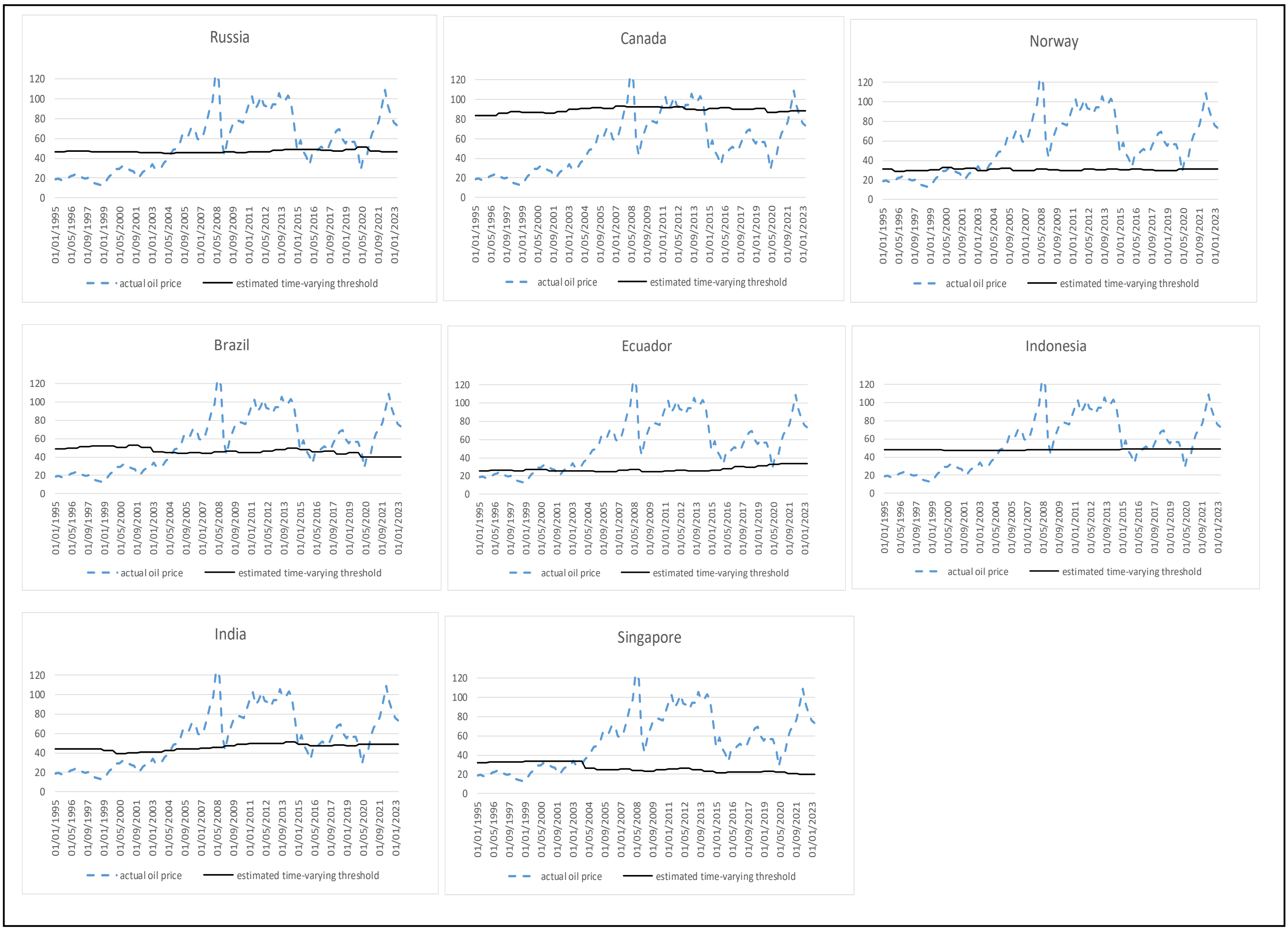

Figure 4: Authors' computations

Appendix G: Time Varying Threshold effect for Net Exports equation

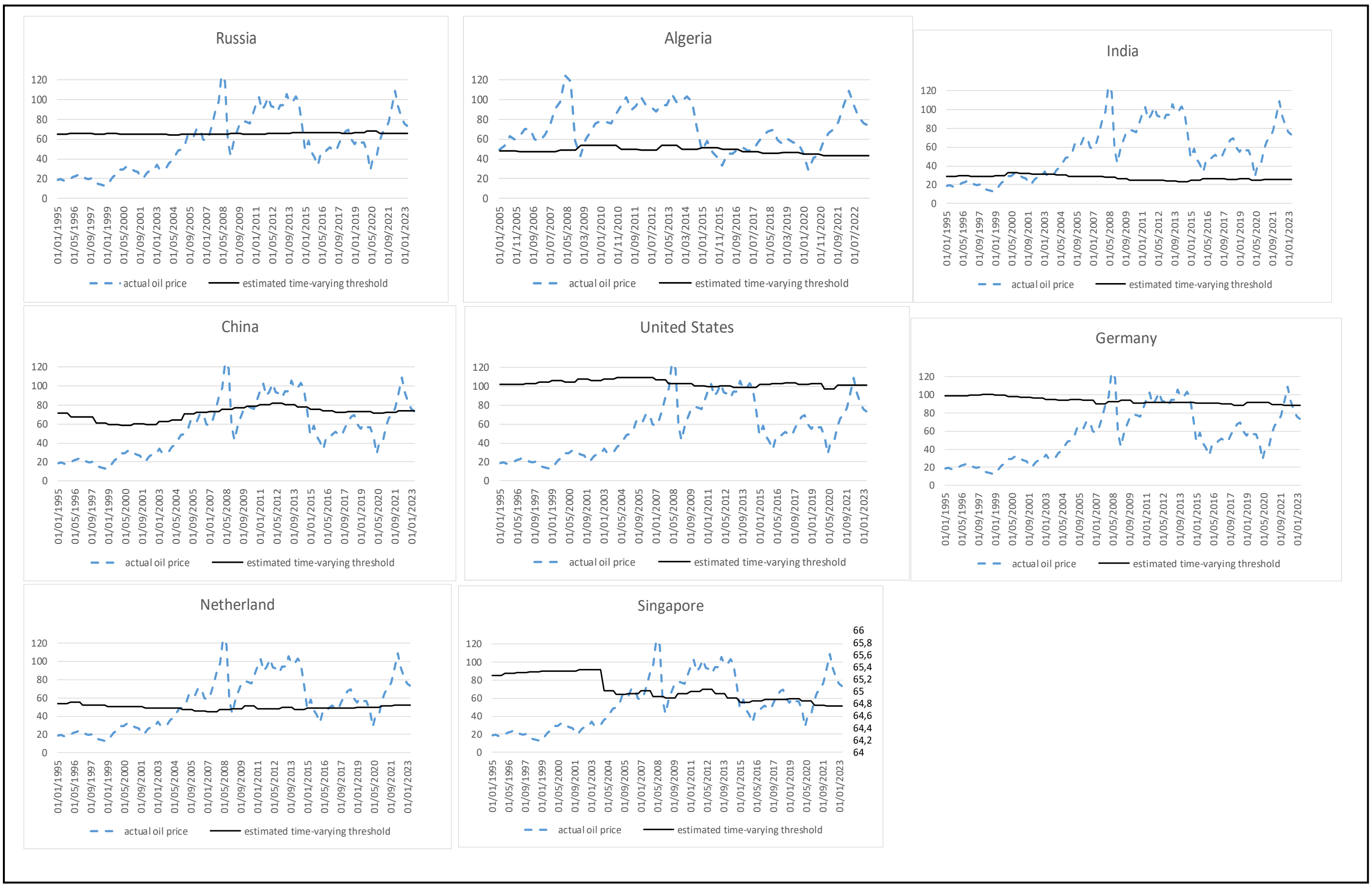

Figure 5: Authors' computations

Appendix H:

Table H1: Descriptive statistics for estimated time-varying threshold: Global GDP				
Country	**Mean**	**Std.Dev**	**Min**	**Max**
Exporting countries				
Russia	41.987	0.067	41.895	42.188
Canada	86.647	0.079	86.476	86.7
Brazil	82.762	0.086	82.634	83.448
Colombia	52.903	0.122	52.694	53.286
Importing countries				
India	43.658	1.18	32.341	48.851
Korea	88.406	0.37	88.044	89.148
Italy	41.216	0.339	40.75	41.752

Table H2: Descriptive statistics for estimated time-varying threshold : Investment				
Country	**Mean**	**Std.Dev**	**Min**	**Max**
Exporting countries				
Saudi Arabia	88.007	0.226	87.559	88.268
Russia	54.383	0.04	54.256	54.44
Canada	87.647	0.07	87.476	87.771
Brazil	82.762	0.06	82.634	82.887
Algeria	49.687	0.02	49.65	49.7225
Indonesia	41.54	0.38	40.922	42.191
Importing countries				
India	45.376	0.15	45.071	45.617
China	64.05	0.1	63.863	64.208
Korea	90.406	0.37	90.044	91.279
Germany	31.157	0.06	31.069	31.274
Netherland	48.77	0.08	48.601	48.973
Italy	44.216	0.339	43.750	44.867
Singapore	44.502	0.187	44.198	44.796

Table H3: Descriptive statistics for estimated time-varying threshold : Public expenditures				
Country	**Mean**	**Std.Dev**	**Min**	**Max**
Exporting countries				
Saudi Arabia	98.132	0.236	97.666	98.404
Colombia	60.119	0.136	59.887	60.333
Ecuador	98.773	0.094	98.671	98.989
Importing countries				
India	85.299	0.124	85.105	85.543
Germany	52.866	0.101	52.724	53.055
Italy	42.216	0.339	41.75	42.867
Spain	45.502	0.187	45.198	45.796
Singapore	48.963	0.208	48.637	49.245

Table H4: Descriptive statistics for estimated time-varying threshold : Consumption				
Country	**Mean**	**Std.Dev**	**Min**	**Max**
Exporting countries				
Russia	45.74	0.05	45.67	45.891
Canada	82.647	0.079	82.476	82.771
Norway	33.811	0.054	33.698	33.941
Brazil	46	0.078	45.854	46.142
Ecuador	24.625	0.26	24.346	25.221

Indonesia	45.847	0.022	45.808	45.884
Importing countries				
India	45.765	0.118	45.534	45.949
Singapore	28.215	0.217	27.921	28.556

Table H5: Descriptive statistics for estimated time-varying threshold : Net Exports				
Country	**Mean**	**Std.Dev**	**Min**	**Max**
Exporting countries				
Russia	77.431	0.029	77.391	77.52
Algeria	53.075	0.075	52.955	53.202
Importing countries				
India	34.623	0.155	34.382	34.928
China	70.525	0.05	70.431	70.604
US	101.916	0.058	101.808	102.026
Germany	98.866	0.101	98.724	99.055
Netherland	55.522	0.092	55.334	55.748
Singapore	65.036	0.208	65.362	65.362

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