

## Article

# The Macroeconomic Results of Diligent Resource Revenues Management: The Norwegian Case

Theodosios Anastasios Perifanis 

Independent Researcher, 19004 Athens, Greece; tperifanis@gmail.com

**Abstract:** Many commodity-exporting countries saw their revenues plummet and experienced fiscal deficits during the pandemic. The economic rebound will restore resource exports/revenues and a new round of debate will be initiated on revenues utilization. Countries will decide either to internalize revenues or capitalize them with investments abroad. Our autoregressive distributed lag (ARDL) models provide evidence of the benefits Norway enjoys since it has not internalized revenues. The currency rate, long-term bond yields, and GDP growth are insulated from prices volatility. Furthermore, the country can absorb currency appreciations/devaluations and long-term credit rate hikes through government expenditure. However, monetary steering is favored in the long term (absorbs yield increases), while in the short run it can allow for speculative activities by credit investors. Countries should not internalize resource revenues to avoid experiencing decreased competitiveness and economic growth and increased credit rates. However, the temptation will be high enough since deficits and support packages cost a lot. This study also includes years of low prices. Thus, our research reveals the extent and limitations of diligent revenue management from a country considered as a role model.

**Keywords:** resources; revenue management; resource management; Norway; Dutch disease; resource curse; macroeconomic effects; mitigation policies; oil; hydrocarbons



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## 1. Introduction

Resource exploitation has multiple benefits for the domestic economy [1], since total output, employment, and tax revenues rise. These benefits will be tempting to resource-exporting governments to internalize resource revenues after the COVID-19 pandemic. However, these benefits can well turn into economic vulnerabilities. To avoid oil dependence, robust economic policies such as economic diversification, increased oil reserves, and sovereign funds [2] might be employed. Norway is the role model of effective resource management for many studies since it applied all of them. The country has acclamatory built resilience to oil price shocks [3]. To understand the significance of the oil sector to Norway, we present the data for 2020 which designate more than 40% of Norwegian exports and 10% of GDP to come from petroleum [4]. Norway is endowed with reserves of 6.37 billion barrels [5]. Even COVID-19 did not stop the production increase since Johan Sverdrup (field) stepped up in 2020. Moreover, the largest fields such as the Troll (4.99 million m<sup>3</sup>), Ekofisk (5.08 million m<sup>3</sup>), and Grane (3.99 million m<sup>3</sup>) continued to produce in 2020. Thus, it is important to study whether the claims over Norwegian macroeconomics' insulation against oil price shocks hold, and how the country weathers price shocks if the answer is positive. Additionally, oil price shocks affect supply security and are now affected by climate risk factors [6]. Lastly, diligent resource management might mitigate both energy security and energy transition issues by financing alternative energy generation [7].

Initially, the endowment with plenty of resources does not come without dangers to the economic life as Corden and Neary [8] suggested with their theory of Dutch disease. Under their theory, which is confirmed in many cases, high resource revenues augment

production costs and public consumption. Jansen [9] confirms that Norwegian consumption is higher than the level suggested by the Euler formula in the long term. Under the Dutch disease, high production costs downgrade the manufacturing sector. Furthermore, increased demand causes inflation and trade deficits while there is currency appreciation. Higher salaries deteriorate the exporting competitiveness of the manufacturing sector. This is confirmed by Hasanov et al. [10], who suggest that oil revenues are accountable for currency appreciation and in turn for export burdens. Productivity partially explains currency appreciations. The adverse repercussions of resource exploitation are also confirmed by Liu [11]. However, the claim that higher wages deteriorate the whole economy's prospects is challenged by Barth et al. [12]. They propose that the Scandinavian economies have developed institutions in the labor market that coordinate wage levels and compression. This in turn succeeds increased employment in central bargaining and efficiency in the local one. All in all, wages are not to be blamed for any economic downturn. Bjornland and Thorsrud [13] acclaim resource and commodity price shocks as accountable for 70–90% of employment variation in Norwegian wages. On the contrary, productivity spillovers from the oil sector to the non-oil ones counterbalanced the negative repercussions. Mork [14] adds to this by suggesting salaries in Norway had a higher rate of increase than the Swedish ones. His results verify the previous suggestion. Productivity increases (2.7% annually) mitigated real salary increases (4% annually) for the period 1993 to 2019. However, increased productivity rates did not succeed in saving the country from Dutch disease.

There is no clear suggestion from Van der Ploeg [15] on whether a rich endowment in natural resources is advantageous or not. What is important in one economy is the quality of institutions. Real exchange appreciation and manufacturing demeaning are caused by corrupted institutions that fail to turn resource revenues into other producing assets. Hjort [16] adds to that by proposing that Norway escaped the Dutch disease due to its institutional maturity. Furthermore, institutional and voters' maturity can remove intergenerational burdens through taxation as Manzano and Saboin [17] suggest. Bremer et al. [18] propose policies of good practice for economies that hold a significant oil sector. The most significant one is the development of a well-diversified sovereign fund. Economic diversification and alternative remedies such as government spending optimization would mitigate the long dependence on oil revenues and their decreasing course [19].

Norway faced many challenges from 1969, since its first oil discovery, as a new producer. These challenges are well mentioned by Earney [20]. Norway had the aspirations, from the beginning, to engulf the Norwegians' corporations in the whole oil value chain, maximize local employment, and develop complementary sectors such as petrochemicals. This was achieved since the Norwegian authorities requested the explorers to take all the financial risk for their investments and share field property with local companies. Moreover, the local companies were entitled to increase their share in field property. Furthermore, foreign explorers were preferred only if they had contracts with local suppliers, something legally abandoned when the country joined the European Economic Area. This period was long enough for the country to develop top submarine oilfield technologies [21]. Sein and Prokop [22] emphasize the positive direct effect public funding had on corporations' R&D activities. However, there was not a unanimous decision on how these aspirations and especially revenue management would be conducted back then. Again, Earney [20] describes that the Norwegians were divided between those preferring revenues internalization and those preferring investing abroad. This debate continued for a long time, since the revenues would affect the whole economy. According to Jimenez-Rodriguez and Sanchez [23], the Norwegian GDP is positively influenced by the oil shocks. The positive shocks helped the Norwegian economy to outpace the rest Scandinavia [24]. However, it was still a question of whether Norway escaped the Dutch disease. The close relationship between the oil sector and the country's GDP is highlighted by Bjornland and Thorsrud [13], who conclude that 70% of the mainland's GDP variation is affected. Mork [6] further adds it was only the spillover effect of hydrocarbons' rent that explains the Norwegian boom and not the

high productivity growth between 2000 and 2020. Last, Vatsa and Basnet [25] propose that hydrocarbons' prices harm real GDP.

Moreover, GDP is not the only macroeconomic or monetary index that is affected by Dutch disease. A useful sign is that of the exchange rate appreciation since Langarudi and Radzicki [26] highlight the reinforced coupling between exchange appreciation and total output. Candila et al. [27] found that the long-run correlation between currency rates of oil-exporting countries and oil prices strongly increases with the advent of COVID-19. However, not all oil-exporting countries have positive correlations since Russia and Canada have negative ones. Maitah et al. [28] add that while in the period between 2000 and 2014 the Russian currency experienced significant appreciation, it was the inflations' differences and not oil revenues that caused this development. This is also strengthened by Szturo et al. [29] who suggest that it is impossible to find a long-term stable positive correlation between oil prices and exchange rates of oil-exporting countries. More specifically Habib and Kalamova [30] conclude that there is no positive long-run relationship between oil prices and the Norwegian real exchange rate and this can be attributed to foreign investments and diversification policies. This is also confirmed by Alstadheim et al. [31] who verify that the Norwegian monetary policy is concentrated on stability with diligent exchange rate management. Mien [32] finds that oil prices and revenues have increased the currency value of oil-exporting economies and not the internal real exchange rate for manufacturing goods. Oil price uncertainty shocks are studied by Smiech et al. [33] who find that they decrease industrial production while Norway faces imminent temporary currency devaluations.

Oil exploration investments are significant for future energy supply and thus energy security. Lindholt [34] suggests that increasing the required rate of returns sets a portion of fields as less profitable due to higher costs of exploration. However, lower resource revenues turn into lower corporate taxable income for Norway. To avoid the aforementioned, the Norwegian government allows for large capital deductions from investments, and therefore tax revenues' net present value is not heavily affected. Abadie and Chamono [35] go further with their study on field investments under several drivers while Sedighi et al. [36] propose a modern investment strategy for production cost reductions and improved financial performance. Osmundsen et al. [37] suggest that the most negative drivers of Norwegian drilling productivity are water and well depth. While Berntsen et al. [38] conclude that the most significant drivers of oil final investment decisions in the Norwegian Continental Shelf are oil prices, and geological and reserve specifications. Energy investments are influenced by the capital structure and the cost of capital. Franc-Dabrowska et al. [39] highlight that for the energy sector the cost of equity is double that of debt and that the weighted cost of capital (WACC) is lowered by the effective tax rate. Thus, energy investments had lower WACC due to the high taxation as Earney [20] mentions. Last, the value of the Norwegian corporations (stock value) is positively influenced by oil price hikes [40].

The novelty of the research is that it studies not only periods of high prices—as many did by claiming that resource revenues management should be studied when revenues are experienced—but also includes ones of low prices. We study years such as 2008 and periods such as those between 2014–2016 when oil prices collapsed. Thus, we present evidence of aggregated effects between good and bad years. By doing so, we do not exaggerate potential benefits, while we also present the limitations of diligent resource management. Furthermore, our results could guide resource exporters in their policymaking. During the pandemic, low demand and oversupply caused price decreases. Low revenues were not sufficient enough to cover economic or monetary easings resulting in deficits. A country exiting low resource exports might find itself in the dilemma of instantly internalizing resource revenues. Our research could act as a benchmark on what to expect by following a well-established long-term paradigm or following alternative courses.

Our paper continues with Data, Methodology, Results, Conclusions, and Policy Implications.

## 2. Data

In our effort to investigate whether Norway's economy is influenced by oil revenues and how, we employ several macroeconomic variables as dependent ones. A potential Dutch disease impact will impact the exchange rate, the credit risk rating, and the total output of the economy. This is the reason we use the Norwegian exchange rate against the US dollar or FXR, the 10-year government bond yield or BY, and the constant GDP per capita or CGDPC as dependent variables. Our independent variables for all the models are the real Brent price or BP (nominal prices deflated by the US CPI index), oil rents or (OR) as a percentage of the Norwegian GDP, and the real government final consumption expenditure (nominal expenditure deflated by the Norwegian CPI) or GEXP. For the third model, we also include the production index of Total Industry or PII to capture the level of activity diversification of the economy. As a result, our data are free from potential inflation effects.

Our data are retrieved from the databases of FRED (FXR, US CPI), OECD (BY, GEXP, Norwegian CPI, and PII), World Bank (OR, CGDPC), and US EIA (BP). They are annual for the period between 1987 and 2019. Further, to obtain the respective elasticities they are transformed into natural logarithms.

Last, our data are tested for their stationarity properties. We implement two stationarity tests. The Zivot and Andrews [41] and the Elliot et al. [42] tests present evidence of mixed orders of stationarity. Our data are either stationary at levels or  $I(0)$ , or stationary at first difference or  $I(1)$ , but not stationary at second difference or  $I(2)$ . We present the results of our stationarity tests in Table 1.

**Table 1.** Tests for stationarity.

	Zivot and Andrews (1992)			Elliott, Rothenberg and Stock (1996)		
	Levels	First Differences	Order	Levels	First Differences	Order
OR	−5.945 *	−7.9194 *	$I(0)$	−3.0933 *	−6.8401 *	$I(0)$
CGDPC	−4.677 ***	−4.9579 **	$I(1)$	−0.6027	−2.1684 **	$I(1)$
BY	−3.7035	−5.3287 **	$I(1)$	0.1624	−6.1580 *	$I(1)$
FXR	−5.0844 **	−3.7931	$I(0)$	−2.0224 **	−2.2263 **	$I(0)$
GEXP	−4.5482	−5.9435 *	$I(1)$	1.6636 ***	−2.4386 **	$I(1)$
PII	−8.1324 *	−3.7514	$I(0)$	−1.3303	−2.1785 **	$I(1)$
BP	−3.4194	−6.0187 *	$I(1)$	−1.5584	−4.0895 *	$I(1)$

\* Significant at 1%, Critical values for ZA and ERS tests −5.34 and −2.63, respectively. \*\* Significant at 5%, Critical values for ZA and ERS tests −4.80 and −1.95, respectively. \*\*\* Significant at 10%, Critical values for ZA and ERS tests −4.58 and −1.62, respectively. The optimal lag structure is determined by AIC.

The Zivot and Andrews [41] test allows for a single structural break to avoid pseudo-stationarity, while the Elliot et al. [42] is an improvement of the Augmented Dickey Fuller or ADF test. Both tests are applied with an intercept. The nature of the mixed stationarity processes and the lack of knowledge over the endogeneity or exogeneity of the variables drive us to use the ARDL methodology.

## 3. Methodology

Our methodological approach is that of the autoregressive distributed lag (ARDL) or bounds testing, which was evolved by Pesaran and Shin [43] and Pesaran et al. [44]. The justification is that we use a small sample, as our data are annual [45]. Furthermore, this methodological approach is suitable when regime shifts and shocks exist. Moreover, different variables' lags allow for variable selection without considering endogeneity [46–48]. ARDL modeling can include variables of different stationarity properties but not  $I(2)$ . Further, the methodology can provide both long-run and short-run modeling. The short-run modeling includes a long-run coefficient (error correction term or  $ECT_{t-1}$ ) [46]. This is an ability developed by Engle and Granger [49] with their error-correction modelling (ECM). As in their modeling approach, the  $ECT_{t-1}$  coefficient of the short-run model is the speed

of adjustment towards the long-run equilibrium. Last, ARDL employs only one equation and not multiple equations [50]. The methodology is followed as Menegaki [51] describes.

While the applied methodology might seem to be extensively employed and not as innovative, we claim that the aforementioned advantages could well balance the potential disadvantages of a new econometric method. After all, we want to reach policymaking suggestions and not test potential results between different methods. Last, we would like our results to have as a firm character as possible and not be debated.

We start with the three models whose data are already in natural logarithms to obtain the elasticities.

$$FXR_t = c + BP_t + OR_t + GEXP_t + u_t \quad (1)$$

$$BY_t = c + BP_t + OR_t + GEXP_t + u_t \quad (2)$$

$$CGDPC_t = BP_t + OR_t + GEXP_t + PII_t + u_t \quad (3)$$

where  $c$  is the intercept and  $u_t$  the residuals of each model. Then, we apply ARDL bound testing with the development of the respective unrestricted error correction models or UECM.

$$\begin{aligned} \Delta FXR_t = & a_0 + a_1 t + a_2 FXR_{t-1} + a_3 BP_{t-1} + a_4 OR_{t-1} + a_5 GEXP_{t-1} + \sum_{i=1}^p \alpha_{6i} \Delta FXR_{t-i} + \sum_{i=0}^q \alpha_{7i} \Delta BP_{t-i} \\ & + \sum_{i=0}^r \alpha_{8i} \Delta OR_{t-i} + \sum_{i=0}^s \alpha_{9i} \Delta GEXP_{t-i} + \mu_t \end{aligned} \quad (4)$$

$$\begin{aligned} \Delta BY_t = & \beta_0 + \beta_1 t + \beta_2 BY_{t-1} + \beta_3 BP_{t-1} + \beta_4 OR_{t-1} + \beta_5 GEXP_{t-1} + \sum_{i=1}^p \beta_{6i} \Delta BY_{t-i} + \sum_{i=0}^q \beta_{7i} \Delta BP_{t-i} \\ & + \sum_{i=0}^r \beta_{8i} \Delta OR_{t-i} + \sum_{i=0}^s \beta_{9i} \Delta GEXP_{t-i} + \mu_t \end{aligned} \quad (5)$$

$$\begin{aligned} \Delta CGDPC_t = & \gamma_0 + \gamma_1 t + \gamma_2 CGDPC_{t-1} + \gamma_3 BP_{t-1} + \gamma_4 OR_{t-1} + \gamma_5 GEXP_{t-1} + \gamma_6 PII_{t-1} + \sum_{i=1}^p \gamma_{7i} \Delta CGDPC_{t-i} \\ & + \sum_{i=0}^q \gamma_{8i} \Delta BP_{t-i} + \sum_{i=0}^r \gamma_{9i} \Delta OR_{t-i} + \sum_{i=0}^s \gamma_{10i} \Delta GEXP_{t-i} + \sum_{i=0}^u \gamma_{11i} \Delta PII_{t-i} + \mu_t \end{aligned} \quad (6)$$

where  $\Delta$  denotes the first difference and  $\mu_t$  denotes the white noise residuals and  $\alpha_0, \beta_0, \gamma_0$  are the drift components. All the above (4,5,6) can also be modeled as ARDL with either intercept or trend or both. Our lag selection for each variable is determined by the Akaike [52] criterion.

Bound testing has the null hypothesis of no cointegration between the variable in the UECM model, i.e.,

$$H_0 : a_1 = a_1 = a_n = 0 \quad (7)$$

$$H_1 : a_1 \neq a_1 \neq a_n \neq 0 \quad (8)$$

We test the same null hypothesis for the other two models or coefficients  $\beta_{i=1...n}$  and  $\gamma_{i=1...n}$ .

Our cointegration tests research whether there is a long-run relationship between the variables. We obtain the F statistics, and we compare them with the respective upper critical bound (UCB) and the lower critical bound (LCB) values which are the respective critical ones. If all the variables of a model are I(0), stationary at levels, then the LCB is more suitable for cointegration testing. If the variables of a model are I(0) and I(1), then UCB is more suitable. If the F statistic is over the UCB, then there is cointegration. If the F statistic is between the LCB and UCB, then the cointegration test is inconclusive. Last, if the F statistic is lower than the LCB, then there is no cointegration.

The existence of cointegration will allow us to develop our short-run models. From the cointegration equation, we have the error correction term or  $ECT_{t-1}$ , which is a long-run coefficient and the speed of adjustment towards the long-run equilibrium. It must be nega-

tive and statistically significant. Last, the short-run models have the first difference of each variable as variables and represent the short-run causality. We present them accordingly.

$$\Delta(FXR_t) = \Delta(BP_t) + \Delta(OR_t) + \Delta(GEXP_t) + ECT_{-1} + \varepsilon_t \tag{9}$$

$$\Delta(BY_t) = \Delta(BP_t) + \Delta(OR_t) + \Delta(GEXP_t) + ECT_{-1} + \varepsilon_t \tag{10}$$

$$\Delta(CGDP C_t) = \Delta(BP_t) + \Delta(OR_t) + \Delta(GEXP_t) + \Delta(PII_t) + ECT_{t-1} + \varepsilon_t \tag{11}$$

#### 4. Results

Initially, as is already mentioned in the data section, our data are all integrated either at I(0) or I(1). Both of our stationarity tests verify our eligibility to proceed with the bound testing.

We proceed with the bound testing for cointegration purposes. If cointegration exists, then there is a long-run relationship between our variables. Further, the existence of cointegration allows us to proceed with the short-run models. Short-run causality is captured by the first differences of the variables, while the long-run coefficient  $ECT_{-1}$  denotes the speed of adjustment towards the long-run equilibrium.

As is presented in Tables 2–4, all our models are cointegrated. Our result is derived by comparing the F statistic with the respective critical values. All our F statistics are over the upper critical bound value, i.e., there is cointegration. Furthermore, all the combinations of the variables for each model are cointegrated verifying the long-run relationship between them.

Last, we present our long and short-run models in Tables 5–7, with the respective tests on residuals for serial correlation, heteroscedasticity, etc.

##### 4.1. Exchange Rates, Long-Run Model

The key indicator for increasing production costs and creating exporting burdens is the exchange rate. We use the Norwegian Kroner against the US Dollar spot exchange rate as dependent. If a coefficient has a negative sign, then the Norwegian currency is appreciated. We start with the long-run model. Three out of four independent variables are significant. The Brent prices appreciate the currency. This is something expected, as the higher the oil prices, the more foreign currency is entering the Norwegian economy. Oil prices are posted in US Dollars and the result complies with the theory. However, the elasticity is low (inelastic), since a 1% increase in oil prices appreciates the Kroner by only 0.33%. Consequently, the exchange rate is not heavily dependent on resource prices. The non-dependence on oil revenues is also statistically confirmed by the non-significance of the oil rents’ coefficient. In conjunction, we can claim that the exchange rate is insulated in the long-term from the oil revenues. The revenues from trading oil (Brent prices) or from collecting rents have low influence or no influence at all, respectively. This allows for the rest of the manufacturing sector to have exporting capabilities.

**Table 2.** Bounds F-test (Wald) for no cointegration with restricted intercept and no trend.

Estimated Models	$FXR_t = f(BP_t, OR_t, GEXP_t)$	$BP_t = f(FXR_t, OR_t, GEXP_t)$	$OR_t = f(BP_t, FXR_t, GEXP_t)$	$GEXP_t = f(BP_t, OR_t, FXR_t)$
F statistics (Wald statistics)	[1] 1 2 1 5.5774 *	[1] 1 2 0 3.9799 **	[1] 1 1 0 5.0783 *	[1] 2 2 0 64.0660 *
Significance level	Critical Values			
	Lower bounds, I(0)		Upper bounds, I(1)	
1%	3.6500		4.6600	
5%	2.7900		3.6700	
10%	2.3700		3.2000	

\* Significant at 1%, \*\* Significant at 5%, \*\*\* Significant at 10%, The optimal lag structure is determined by AIC,  $H_0$ : No cointegration, while  $H_1$ : Possible cointegration.

**Table 3.** Bounds F-test (Wald) for no cointegration with restricted intercept and no trend.

Estimated models	$BY_t = f(BP_t, OR_t, GEXP_t)$	$BP_t = f(BY_t, OR_t, GEXP_t)$	$OR_t = f(BP_t, BY_t, GEXP_t)$	$GEXP_t = f(BP_t, OR_t, BY_t)$
F statistics (Wald statistics)	[1] 1 2 1 1 6.1348 *	[1] 2 4 1 4 3.9265 **	[1] 1 2 1 0 4.9292 *	[1] 1 2 2 0 72.8390 *
Significance level	Critical Values			
	Lower bounds, $I(0)$		Upper bounds, $I(1)$	
1%	3.6500		4.6600	
5%	2.7900		3.6700	
10%	2.3700		3.2000	

\* Significant at 1%, \*\* Significant at 5%, \*\*\* Significant at 10%, The optimal lag structure is determined by AIC,  $H_0$ : No cointegration, while  $H_1$ : Possible cointegration.

**Table 4.** Bounds F-test (Wald) for no cointegration with nor intercept or trend.

Estimated Models	$CGDPC_t = f(BP_t, OR_t, GEXP_t, PII_t)$	$BP_t = f(CGDP_t, OR_t, GEXP_t, PII_t)$	$OR_t = f(BP_t, CGDPC_t, GEXP_t, PII_t)$	$GEXP_t = f(BP_t, OR_t, CGDPC_t, PII_t)$	$PII_t = f(BP_t, OR_t, GEXP_t, CGDPC_t)$
F statistics (Wald statistics)	[1] 1 1 1 1 1 6.1395 *	[1] 3 2 0 0 2 18.5230 *	[1] 2 2 2 2 2 4.8541 *	[1] 1 2 0 0 0 60.0860 *	[1] 1 1 1 0 1 5.0523 *
Significance level	Critical Values				
	Lower bounds, $I(0)$		Upper bounds, $I(1)$		
1%	3.0700		4.4400		
5%	2.2600		3.4800		
10%	1.9000		3.0100		

\* Significant at 1%, \*\* Significant at 5%, \*\*\* Significant at 10%, The optimal lag structure is determined by AIC,  $H_0$ : No cointegration, while  $H_1$ : Possible cointegration.

**Table 5.** Foreign exchange rate, long-run model.

<i>Dependent FXR</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
Constant	−9.2768 *	1.7964	−5.1640	$3.5444 \times 10^{-5}$
$BP_t$	−0.3314 *	0.0597	−5.5512	$1.4021 \times 10^{-5}$
$OR_t$	−0.1107	0.0848	−1.3051	$2.0531 \times 10^{-1}$
$GEXP_t$	0.4702 *	0.0718	6.5484	$1.3806 \times 10^{-6}$
<i>Foreign Exchange Rate, Short-run model</i>				
<i>Dependent <math>\Delta(FXR)</math></i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
$\Delta(BP_t)$	−0.3880 *	0.0477	−8.135	$1.29 \times 10^{-8}$
$\Delta(OR_t)$	0.1117 *	0.0267	4.174	0.0002
$\Delta(OR_{t-1})$	0.1082 *	0.0187	5.787	$4.27 \times 10^{-6}$
$\Delta(GEXP_t)$	1.2604 *	0.2362	5.335	$1.39 \times 10^{-5}$
$ECT_{t-1}$	−0.4999 *	0.0870	−5.741	$4.82 \times 10^{-6}$
$R^2$	0.8121			
Adjusted $R^2$	0.7760			
F statistic	22.48			
<i>Breusch-Godfrey Serial Correlation Test, Null hypothesis of no serial correlation</i>				
LM test	0.4996	p-value	0.7789	
<i>Breusch-Pagan Heteroscedasticity Test, Null hypothesis of no heteroscedasticity (homoscedasticity)</i>				
BP	1.5150	p-value	0.8240	
<i>Durbin-Watson for spurious models test, if <math>R^2 &lt; DWT</math> then the model is not spurious</i>				
DW	2.0306	p-value	0.2160	
<i>Shapiro-Wilk Residuals' Normality test, Null hypothesis of a normal distribution</i>				
W	0.9645	p-value	0.3826	

\* Significant at 1%, \*\* Significant at 5%, \*\*\* Significant at 10%.

**Table 6.** Bond yields, long-run model.

<i>Dependent BY</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
Constant	43.9389 *	3.0765	14.2821	$1.3122 \times 10^{-12}$
BP <sub>t</sub>	0.1116	0.0997	1.1188	$2.7528 \times 10^{-1}$
OR <sub>t</sub>	0.2743 **	0.1297	2.1136	$4.6112 \times 10^{-2}$
GEXP <sub>t</sub>	−1.6272 *	0.1231	−13.2087	$6.1617 \times 10^{-12}$
<b>Bond Yields, Short-run model</b>				
<i>Dependent Δ(BY)</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
Δ(BP <sub>t</sub> )	0.2695 ***	0.1360	1.981	0.0582
Δ(BP <sub>t−1</sub> )	−0.2218 **	0.0918	−2.416	0.0229
Δ(OR <sub>t</sub> )	0.1103	0.0809	1.363	0.1844
Δ(GEXP <sub>t</sub> )	4.4820 *	1.1074	4.047	0.0004
ECT <sub>t−1</sub>	−0.7923 *	0.1316	−6.021	$2.33 \times 10^{-6}$
R <sup>2</sup>	0.6834			
Adjusted R <sup>2</sup>	0.6834			
F statistic	11.23			
<i>Breusch-Godfrey Serial Correlation Test, Null hypothesis of no serial correlation</i>				
LM test	0.0021	p-value	0.9631	
<i>Breusch-Pagan Heteroscedasticity Test, Null hypothesis of no heteroscedasticity (homoscedasticity)</i>				
BP	2.7177	p-value	0.6061	
<i>Durbin-Watson for spurious models test, if R<sup>2</sup> &lt; DWT then the model is not spurious</i>				
DW	2.0078	p-value	0.4828	
<i>Shapiro-Wilk Residuals' Normality test, Null hypothesis of a normal distribution</i>				
W	0.9748	p-value	0.6586	

\* Significant at 1%, \*\* Significant at 5%, \*\*\* Significant at 10%.

**Table 7.** Constant GDP per capita, long-run model.

<i>Dependent CGDPC</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
BP <sub>t</sub>	−0.0056	0.0251	−0.2239	$8.2476 \times 10^{-1}$
OR <sub>t</sub>	−0.0005	0.0252	−0.0231	$9.8173 \times 10^{-1}$
GEXP <sub>t</sub>	0.3134 *	0.0164	19.1018	$1.3134 \times 10^{-15}$
PII <sub>t</sub>	0.5927 *	0.0870	6.8107	$6.0369 \times 10^{-7}$
<b>Constant GDP per Capita, Short-run model</b>				
<i>Dependent Δ(CGDPC)</i>				
Variable	Coefficient	Std. Error	t-Statistic	Prob. Values
Δ(BP)	0.0333 *	0.0104	3.178	0.0036
Δ(OR)	−0.0170 *	0.0059	−2.888	0.0075
Δ(GEXP)	−0.0073	0.0589	−0.124	0.9020
Δ(PII)	0.3461 *	0.0469	7.377	$6.17 \times 10^{-8}$
ECT <sub>t−1</sub>	−0.3125 *	0.0520	−6.003	$2.10 \times 10^{-6}$
R <sup>2</sup>	0.8696			
Adjusted R <sup>2</sup>	0.8455			
F statistic	36.02			
<i>Breusch-Godfrey Serial Correlation Test, Null hypothesis of no serial correlation</i>				
LM test	1.2789	p-value	0.5276	
<i>Breusch-Pagan Heteroscedasticity Test, Null hypothesis of no heteroscedasticity (homoscedasticity)</i>				
BP	6.5534	p-value	0.1615	
<i>Durbin-Watson for spurious models test, if R<sup>2</sup> &lt; DWT then the model is not spurious</i>				
DW	1.8005	p-value	0.2082	
<i>Shapiro-Wilk Residuals' Normality test, Null hypothesis of a normal distribution</i>				
W	0.9855	p-value	0.9352	

Government expenditure is statistically insignificant meaning that temporarily increased expenditure and thus consumption does not affect economic prospects at all. \* Significant at 1%, \*\* Significant at 5%, \*\*\* Significant at 10%.

Furthermore, government expenditure has a positive and statistically significant coefficient. The positive sign is justified as increases in government expenditure raise inflation and in turn devalue the currency. However, this is not as catastrophic or severe



as [53], since a 1% increase in state expenditure devalues currency by only 0.47%. The sensitivity is higher than that of the oil prices enabling Norway to implement monetary policies counterbalancing appreciating forces. Last, since increasing state demand by increasing expenditure does not devalue currency much, and appreciating drivers are not strong, then Norway can support other economic sectors and their output with the sovereign fund. The appreciating forces caused by resource revenues are mitigated and do not affect the exporting opportunities, nor increase the production costs.

#### 4.2. Exchange Rates, Short-Run Model

All of our coefficients are statistically significant in the short term. Brent prices have almost the same appreciating influence over the Kroner. If oil prices increase by 1%, then the currency will appreciate 0.38%. As a result, and by comparing it with the long-run coefficient (0.33%), we can tell that the price effect on currency fades out a little from the short-run to the long-run. Additionally, this verifies the insulative performance of the economy. Oil rents and their lagged values are statistically significant in the short term. This is not something that holds in the long run. They have almost the same influence (0.11 and 0.10) and they present evidence of oil rents' devaluation properties. This is explained by the investors' behavior. Oil revenues from oil rents might signal to the investors the country's decreasing confidence in oil trading. However, their influence is very low and only for the short-run, i.e., their low devaluation power fades out within a year (insignificant in the long run). The only elastic relationship is that of the state expenditure. It is 1.26%, meaning that if it is increased by 1%, then the currency will lose 1.26% of its value. This is a change from the long-run model, whose elasticity is much lower (0.47). The much higher short-run elasticity suggests that the country has adept funds to implement monetary policies with imminent effects. State monetary intervention can absorb potential appreciation pressures in the short run. This cannot be continued in the long run since the influence decreases from 1.26% to 0.47%.

The  $ECT_{-1}$  is negative and significant, as it should be. The short-run deviations from the long-run equilibrium are eliminated by 50% during the first year. The speed of adjustment is high toward the long-run equilibrium.

Last, Norway is able to escape from sharp currency volatility [54] caused by resource revenues because the country holds the ability to effectively counterbalance it and avoid trade imbalances or deficits. The magnitude of the state expenditure, and through increased demand and thus inflation, can have fair mitigating properties. However, this cannot be continued with the same effect in the long run.

#### 4.3. Bond Yields, Long-Run Model

Under the principle of "High Risk–High Return" in the bond markets, the level of yields reveals the confidence in a country's debt exposure. The low bond rates reveal that a country can finance its needs with a low cost of capital. When it comes to Norway, Brent prices have a statistically insignificant influence on the borrowing rates. This is extremely important as it highlights the ability of the Norwegian state to finance its debt irrespectively of the oil prices' volatility. The credit rating might also be justified by the sovereign fund and the rest of the state revenues, which are not connected with the prevailing conditions in the oil market.

Oil rents are significant and they have a positive relationship with bond yields. However, their elasticity is low (0.27), meaning that if oil rents are increased by 1%, then yields will increase by 0.27%. This is justified by the following reasons. The first is the speculative actions by investors attempting to catch some of the oil revenues. The second is that the country expands its exploration activities and, consequently, increases its investments. Bonds have constant payments and those are paired with stable oil rents' inflows. Finally, the increased demand for financing investments increases bond yields [34]. However, the elasticity is low (0.27) and implies that the negative side effects (increased cost of capital) are mitigated.

The only elastic coefficient is that of government expenditure, which is negative. Government expenditure can decrease bond yields by 1.62% when it is increased by 1%. Thus, government expenditure can finance economic diversification and lower borrowing rates. Furthermore, increased expenditure can also take the form of buying back debt, something which also improves the country's rating

Last, our long-run results of the price's insignificance, the inelastic relationship of the oil rents, and the elastic relationship of government expenditure, which decreases bond yields further, strengthen our claim for the insulation of the economy. Norway can finance its debt with low cost of capital. Again, state intervention through expenditure can mitigate any adverse evolution. Resource management with due diligence has prevailed insolvency dangers and consequently speculative activities on the country's debt.

#### 4.4. Bond Yields, Short-Run Model

The short-run causality reveals interesting results. Oil prices and their lagged values are significant in the short run. This was not the case in the long-run model as prices were insignificant. However, the two coefficients are extremely low, almost of the same magnitude (0.26 against  $-0.22$ ) and of different signs, canceling each other's influence, leaving bond yields almost unaffected. The total influence is low, meaning that creditors cannot take advantage of new short-run debt issues.

Oil rents are statistically insignificant, implying that they do not affect short-run bond yields at all. This is again different from the long-term model whose oil rents' coefficient is significantly inelastic and low (0.27). All in all, a period is requested from the short-run to the long-run horizon for oil rents to have even a slight effect on bond yields.

State expenditure is the only variable with considerable influence on short-term bond yields. (elastic 4.48). The elasticity is positive, increasing the bond yields. The abrupt change in bond yields, which increase by 4.48% if state expenditure increases 1%, means that investors take advantage of the additional resources requested by the domestic market by increasing borrowing rates. The different sign from the long-run model means that short-run interventions seem as temporary weaknesses or opportunities to be exploited, while long-run interventions are perceived as strong intentions of economic support. This is why bond yields behave differently. The short-run elasticity is high, meaning that the government cannot increase expenditure just for short periods as it will experience a higher cost of capital. It is more suitable to avoid temporary consumption boosts and to employ them only when there is a long-run aim. Norway has to balance the advantages and disadvantages of the long and short-run horizons when it comes to domestic expenditure.

Last, the speed of adjustment is extremely high ( $-0.79$ ) meaning that 79% of the change happens within the first year.

#### 4.5. GDP, Long-Run Model

Our GDP long-run model also verifies the claim that the Norwegian economy is well-insulated by the hydrocarbons sector. Oil prices and oil rents' coefficients are statistically insignificant, i.e., no influence at all on economic growth. The economy is decoupled from the oil market's volatility and revenues from rents. Economic diversification is successful. Last, we confirm Mork's [14] results who suggest that the Norwegian non-oil sectors were more profitable than those of the rest of the Scandinavian economies.

The government expenditure and the industrial production index have positive signs as expected and their elasticities are low, 0.31% and 0.59%, respectively. Increased expenditure and thus domestic demand support economic growth. Furthermore, the economy has non-oil industries which are competitive and contribute to economic growth. This confirms decoupling and diversification. Offshore exploration requires industrial mobilization from other sectors. However, the Norwegian exploratory corporations gained expertise and are globally innovative. The result is gained exports. This is contrary to the symptoms of the Dutch disease, i.e., a less competitive manufacturing sector.

#### 4.6. GDP, Short-Run Model

The economic diversification and the successful mitigating policies for the Dutch disease are also confirmed in the short-run model. Oil prices and oil rents have marginal effects on the country's GDP, 0.03 and  $-0.01$ , respectively. As a result, the GDP is, at the slightest level, affected by the oil revenues. Prices will contribute only 0.03% if increased by 1% or oil rents will reduce GDP marginally (0.01%) if increased by 1%. The Norwegian economy is well insulated by the hydrocarbons market. This is also justified by investing the revenues abroad and not internalizing them.

Industrial production is significant and contributes inelastically (0.34) to growth. The elasticity is lower than that of the long-run model obeying the Le Chatelier principle [55]. The whole economy reacts less to industrial production's contribution in the short run. Last, again the speed of adjustment is fast enough as 31% of the change happens within the first year ( $ECT_{-1} = -0.31$ ).

### 5. Conclusions

We attempted to research whether the Dutch disease's symptoms exist in the Norwegian macroeconomic indicators. We researched the period between 1987 and 2019. We found that the Norwegian economy is well insulated from the negative consequences of resource revenues. It is well-diversified and with plenty of monetary options. The novelty of this research is that it includes years of low commodity prices and presents evidence of the level and limitations the diligent revenues management has. The results are aggregated between good and poor seasons. Thus, our results constitute a tool for policy benchmarking, which can be used by other resource exporting countries debating whether they should internalize revenues or not. The period after the pandemic will intensify the dilemma, since governments should balance the benefits of long- and short-term policies.

For the Norwegian exchange rate whose appreciation would cause high production costs and thus exporting burdens, we conclude that oil revenues have low influence. In the long run, oil rents are insignificant, while oil prices have small appreciating power. In the short run, the appreciating influence of oil prices is almost identical. The devaluation effect of oil rents, due to low investor confidence, fades out quite quickly. Last, government expenditure has devaluation properties through increased domestic demand and inflation. Government expenditure is more efficient when it comes to alleviating appreciation forces in the short run. In the long run, it keeps its devaluation properties but not in the same magnitude. This implies that keeping the exchange rate at required levels demands funds whose performance are decreasing through time. However, Norway has ample funds to remain competitive through the sovereign fund. Monetary steering is among the country's options.

Bond yields are not affected by oil prices in the long run. Oil rents have a positive relationship with bond yields. This is explained by the increased demand for exploration investment financing along with speculative activities by bond creditors. However, this effect is again low. On the contrary, oil rents become insignificant in the short run. Oil prices become significant in the short run only to have mixed low influences. Government expenditure can lower bond yields elastically in the long run. This is explained by the provided support to the local market through increased demand and even by bond buybacks. However, monetary steering for economic support is a bad signal in the short run and raises the yields. Thus, monetary intervention should be only preferred for the long run.

As for the GDP growth, oil prices and rents are statistically insignificant. This highlights the insulation the economy enjoys from not internalizing the hydrocarbons' revenues. The sovereign fund invests abroad and thus removes the side effects of domestic overheating. In the long run, GDP is only affected by industrial production and government expenditure positively. Oil prices and rents become significant but with almost zero influence in the short run, while government expenditure becomes insignificant and only industrial production has a significant positive effect. The last verifies economic diversification.

For the aforementioned to happen, a lot of time and policy and economic steering were needed. While Norway discovered its first field (Ecofisk), the largest offshore field in the world, in 1969 and soon thereafter initiated extraction in 1971, it did not remain at only promoting production [56]. The Norwegian parliament, or Stortinget, unanimously drafted and initiated the “10 Oil Commandments” [57] and endowed the then fully state-owned Statoil (Equinor nowadays) with 50% ownership of all fields. Revenues management was put at the forefront even since 1974 when “The role of petroleum activity in Norwegian society” [56] was handed by the Ministry of Finance. It was updated by the [58] report that initiated the idea of a sovereign fund whose only real returns a government would be allowed to spend. However, the law for the sovereign fund was passed years later in 1990, and the first endowment was received in 1996. Initially, to avoid risk, all revenues were invested in the bond markets. The equity option was added in 1997. A year later (1998), to exploit specialization in wealth management, the Norges Bank Investment Management was created to replace the Ministry of Finance. Additionally, the sovereign fund followed the principles of corporate governance and due diligence by announcing the Ethical Guidelines for the sovereign fund in 2004 and by establishing the Council on Ethics in 2015. The Council on Ethics directly reports to the Norges Bank to avoid compromising its independence [56].

All these are mentioned to highlight the length of time and efforts required for such revenues management. For long-term efforts to culminate into diligent policymaking, there must be a general political consensus. Since the consensus is achieved, then several multidisciplinary committees must be employed. Scientists from all backgrounds must come together to draft the complete value chain, from geophysics research to revenues management. Last, the regulatory framework must remain constant for all the actors participating in the supply chain. Corporations, traders, policymakers, environmentalists, and all stakeholders must share a stable environment for their decisions.

The choice of not internalizing oil revenues was the optimal one, as the Norwegian economy remained well-insulated from the Dutch disease. The country can step up with monetary steering since it has ample funds. Increased expenditure can lower exchange rates both in the long and short run and support economic growth in the long run. Government expenditure can also be used for bond yield lowering in the long term but has an adverse effect in the short run. All in all, keeping the accumulated funds outside the domestic market keeps exchange rates low and economic growth robust. The country’s resource management is a role model since they not only decreased exports but created opportunities for an innovative upstream industry while avoiding overheating. Sustained economic growth can also finance less energy-intensive activities allowing for a smoother energy transition [59]. Thus, diligent hydrocarbons’ revenues management may also aid in fighting climate change in the long term.

The research could be enriched by including more countries such as Azerbaijan [60], which hold sovereign funds, or with more observations (years), or by dividing the research periods according to some technological advancements such as shale oil. Through its national oil company, a country can alter its production profile as a private one could according to its interests. Technological evolutions alter the extraction rates [61] a country can experience and thus the revenues. Last, a comparison between policy decisions across commodity exporters and their effects could help in reaching firmer conclusions.

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