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Estimation of the Future Crude Oil Demand Function in Light of Global Transitions Toward Clean Energy: An Econometric Study Using a Structural Vector Autoregression (SVAR) Model

Shatha Salem Dily¹

*Economics Department College of Administration and Economics, University of Al-Qadisiyah, Iraq,
shatha.dily@qu.edu.iq*

Abstract: The research aims to appreciation function demand future on oil raw in shadow Transformations Global accelerated about Energy Clean, from during application model vector decline Self Structural (SVAR) on sample from countries The Structures Economic The disparate, include Canada, Norway, Korea Southern, Italy, and Mexico during the period is 2015–2024. It depends Search on group from Variables College, the most prominent of them consumption oil raw, Output Local Total, consumption Energy Renewable, and prices oil Global, With the aim analysis Relations Dynamics and interactions Structure Among them. It was done. Use Tests Stillness and integration Subscriber To determine features chains Time, then appreciation model SVAR with duty restrictions Document to Theory Economic to isolate traumas The structure. As well It was completed employment Dual Response For trauma (IRF) and analysis ingredients Variance (FEVD) to measure impact traumas different on demand on oil via time. It indicates Results to presence relationship reverse Increasing between consumption Energy Renewed and the request on Oil, with contrast clear in response countries place the study According to nature Their economies, where Show countries Imported sensitive higher For shocks Prices comparison in countries the producer and concludes Search This led to a number of conclusions, the most important of which were: that Transformation about Energy clean Contributes gradually in reformation structure demand Global on Oil, with Indications a task For manufacturers Policies in area Energy.

Keywords: demand Future on Oil, Energy Clean, Prediction The economist Transformation Energy, model SVAR.



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1. Introduction

Witness Economy Global in years The last Transformations Essential in Patterns production and consumption Energy, Paid Increasingly interest In cases Change climate and obligations International By reducing emissions Carbonaceous, The matter that led to acceleration Transition about sources Energy clean And renewable . mirror this Transformation In a way direct on markets oil Global, where become demand on oil raw He faces Challenges Increasing It relates Change structure Consumption And it developed Policies environmental And technology . And in this Context, Stand out importance analysis Dynamics demand on oil in shadow This is amazing variables, especially in countries that They differ in

nature Their economies between countries Producer and its source oil And another consumer It depends on oil raw Using model vector decline Self Structural (SVAR) , when It provides this The model from capacity on explanation Relations Dynamics between Variables Economic And isolation traumas Structure Influential It includes it . the study sample from countries It is in Canada, Norway, Korea Southern, Italy, and Mexico during period Time period 2015–2024 , where It was completed to choose This is amazing countries Due to For contrast Its structures Economic and levels Its adoption on oil and energy Renewable . And seeks Search to presentation analysis standard Contributes in to understand better For the path demand Future on oil in shadow Transformation Global about Energy Clean, Providing Indicators supportive For manufacturers decision in fee Policies hat more efficiency And sustainability .

2. Research Methodology

2.1 Research problem:

It is problem Search in increase condition non certainty about future demand on oil raw in shadow Transformations Global accelerated about Energy Clean, gesticulate It is accompanied by from Changes in Policies environmental and technology and patterns Consumption . And it stands out. Question around bezel impact This is amazing Transformations on Dynamics demand on oil in countries They differ in Its structures Economic between Producer And consumable, As well as bezel response this demand For shocks Economic and prices Oil . And from then, Seeks Search to analysis This is amazing Relations And its appreciation Using model SVAR .

2.2 Importance of the research:

Sources importance Search from Being He treats issue vitality It relates In the future demand on oil raw in shadow Transformation Global about Energy Clean, gesticulate It is required on that from antiquities Economic and strategy on countries Producer and the consumer on end Whether . As Contributes in clarification nature Relations Dynamics between variables Energy and growth Economic Using model SVAR , In what He provides Understanding Deeper For effect traumas The structure . And it stands out Its importance also in presentation Indicators amount Supports Manufacturers decision in Drafting Policies hat more efficiency And sustainability, And strengthen from ability on Prediction With changes Future in markets Energy Global .

2.3 Research objectives:

Seeks this Search to analysis and appreciation Function demand on oil raw in shadow Transformations Global about Energy Clean, from during employment Methods standard Modern Capable on explanation Relations Dynamics between Variables Economic And isolation traumas Structure Influential In it, In what Contributes in to understand Deeper For the future demand on oil in countries place Research . The objectives can be explained. The research is as follows:

- 1- Estimation Function demand on oil raw in countries Selected during The period 2015–2024.
- 2- Analysis effect consumption Energy Renewed on demand on oil Raw material .
- 3- Measurement impact Growth Economic and prices oil Global on The request .
- 4- Study response demand on oil For shocks Structure Using model SVAR .
- 5- Procedure comparison analytical between countries Producer and the consumer oil from where behavior The request .

2.4 Research hypotheses :

The research is based on the following hypotheses:

H0 : None effect With indication Statistics For transformation about Energy clean on demand Future on oil raw in countries place the study .

H1 : There is effect With indication Statistics For transformation about Energy clean on demand Future on oil raw in countries place the study .

2.5 Applied research methodology:

He depends Search on Curriculum inductive in building framework Theory and drafting Relations between variables the study, from during Track phenomena Economic Related By transformation about Energy clean And it developed demand on oil raw, and extraction Relations public and patterns prevailing between Variables place The study . As well . Used Search style Quantitative in to treat Data

and its analysis statistically Standardly, from during Accreditation on Models Economic Modern, Especially model vector decline Self Structural (SVAR) , With the aim measurement Relations Dynamics between Variables and interpretation impact traumas Economic Energy on demand on oil raw in countries place the study during The period 2015–2024 . Analysis Quantitative on Use Data Time cross-section and application Tests Statistics and standard The occasion, In what in that Tests Stillness and integration The subscriber, Arrival to appreciation The model structural Analysis Dual Response For shocks Analysis ingredients Contrast .

3. First Part : The theoretical framework for assessment Function demand Future on oil raw and energy Clean and model vector decline Self structural SVAR

First: Determinants demand Global on oil Raw material:

It is Growth Economic Global from Most important Determinants Basic To order on oil raw, where It is related consumption Energy Connection close At rates Growth in Output Local Total, especially in economies Industrial And the emerging ones . So whenever It rose level Activity The economist Increase demand on Transportation and industry And services Which leads to to rise consumption oil As entrance Mainly in Many from Sectors Productivity . Also that flexibility demand on oil Towards Growth Economic They differ Different degree development Economy And its structure Productive so be higher in countries developing comparison In countries Advanced that Heading gradually about to improve efficiency Energy . And in this Context, It indicates Reports Modern to that recovery Economic after crises Global Enhances In a way direct demand on Energy Fossil , And on Her head oil Crude oil [1], [2].

The prices oil Global It is one of Determinants Essential that Affect in size demand attic, where Leads Fluctuations Prices to Changes in behavior consumers and producers on end Whether . So when to rise Prices, tends countries Imported to reduction Consumption or Search on Alternatives Energy , while may leads Its decrease to more demand a result decrease Cost Usage . As well . that sensitive demand For changes Price They differ According to range Time, where be more Clarity on range The long a result possibility Adaptation structural in Patterns Consumption . It indicates Studies to that traumas Price in market oil Global Play role pivotal in reformation Patterns demand via Countries [3], [4].

as It represents Transformation about Energy Renewed One Determinants Modern The mission To order on oil raw, where led Expansion in Use sources Energy clean like Energy solar and the wind and hydrogen to reduction Accreditation relative on oil in some Sectors, especially generation Electricity . And it reflects. this Transformation Trends Global about cut emissions Carbonaceous and investigation Goals Sustainability environmental Which imposes pressures long term on demand Global on Oil . And with that, for impact Energy Renewed It differs between countries According to level Evolution Technological And the structure Infrastructure For energy [5].

It is sector Transportation from greater Sectors Consumer oil raw Globally, where He depends In a way big on fuel fossil like benzene Diesel fuel Aircraft . Therefore for any change in structure this The sector like spread cars Electric or to improve efficiency Fuel, Reflected directly on size demand Global on Oil . As well . that Policies Transportation Sustainable and encouragement means Transportation Year Play role Increasingly in reducing Accreditation on Oil, especially in countries Advanced that Adopt Strategies cut Emissions . This indicates Literature to that Transformation in sector Transportation It is from Most prominent Factors Influential in future demand on Oil [6].

as Affects Expansion Industrial in economies emerging In a way big on demand Global on oil raw, where It rises The need to Energy To operate factories Production Industrial And the structure Infrastructure . It is considered countries like China India and Mexico from Most prominent Examples on this The style, where It is related Its growth Industrial By increasing consumption Energy Traditional . And it leads this Expansion to Budget Partial To retreat in demand inside countries Advanced, Which Keeps on stability relative in demand Global The total . And it confirms Reports that Transformations Structure in Economy Global Return distribution Centers demand on Energy between Countries [7], [8].

Play Factors Geopolitics role whatever in impact on demand Global on oil raw, where Leads tensions Political and conflicts Regional and sanctions Economic to Disorders in chains Supply and prices Oil, Which Reflected on levels Consumption . As well that non Stability in countries Producer may pays countries Consumer to changing Its policies energy or more Inventory The strategic one . Therefore for

market oil no affected only Factors Economic but rather also Through interactions Geopolitics Global that Increase from condition non Certainty [9], [10].

The developments Technology Play role growing Importance in to set future demand on oil raw, especially from during spread cars Electric and improving efficiency Energy in Sectors Industrial And transportation . It was lost. led Innovations Technology to reduction consumption Energy per lonliness production, Which Contributes in cut demand The whole on oil on range The tall one . As well that development Technologies Storage and energy The alternative Enhances from ability on replacing oil in some Uses Traditional . It indicates Predictions Modern to that Technology It will remain worker decisive in re-formation market Energy Global [11].

Second: Transformations about Energy clean and its impact on markets Energy:

Witnesses markets Energy Global in The contract The last Transformation accelerating about sources Energy Clean, Paid Increasingly interest In cases Change climate and obligations International To reduce emissions Carbonaceous . And it shares this Transformation in re-formation structure demand Global on Energy traditional, especially oil raw, with expansion Accreditation on Alternatives Low Emissions . Also that this Change no It is related only Distance environmental but rather It extends To include Dimensions Economic investment Return Drafting structure markets Energy Global and trends Growth [12] .

Progress Technological in Fields Energy Renewed to Strengthening Its competitiveness comparison fuel Fossil, where It decreased Costs production Energy solar and energy wind In a way marked during years The latter . And it has Help this The decrease in more spread This is amazing Sources inside mix Energy Global, Which effect gradually on demand relative on Oil, especially in sector generation Electricity . It indicates number from Studies to that continuation Innovation in Technologies Energy clean It will strengthen this trend during Contracts The next one [13].

And in context Investments Global led Transformation about Energy clean to re directing heads Money away on fuel fossil about Projects Low Carbon . And it mirror that in to retreat Finance long term For projects oil And gas, In exchange more Investment in Structure Infrastructure For energy Renewable . Reflects this Transformation Change in Predictions investors about future demand on Oil, and possibilities to retreat Its importance in range The Faraway [14].

Contributed Policies Transformation The energy in more Fluctuations markets Energy Global, a result overlap Factors Economic traditional with Policies environmental and technology The new one . It's lost . I became markets more sensitive For statements Government Related neutrality Carboniferous Which leads to Changes Fast in Prices oil and expectations demand Future . He confirms Researchers that this overlap Increase from degree non certainty in markets Energy Global [15].

Policies cut emissions to Changes clear in Patterns Consumption Local For energy in Many from countries, from during to support Vehicles Electric and improving efficiency Energy in Sectors Industrial . And it has shares that in reducing Accreditation on oil in sectors Transportation And industry, especially in economies Advanced . Consideration is given . to This is amazing Transformations As Part from re Structure Comprehensive For systems Energy National [16].

And in the It relates chains Supply Global Lost led spread Energy Renewed to appearance Patterns New from commerce International include ingredients Energy clean like batteries And turbines . This Transformation Contribute in reduction Central oil in order The energy Global, and increase diversity sources Energy . As well. Boost flexibility markets Energy in Confrontation traumas Economic Geopolitics [17].

It indicates trend Year For transformation about Energy clean to re identification Comprehensive For the concept markets Energy, So that did not It is It is limited on size the offer And the demand, but rather become Includes Dimensions It relates With sustainability environmental and efficiency Usage . And with continuation this The direction, Expected Researchers that Witness oil decline gradually in turn relative inside mix Energy Global, with continuation Its importance in some Sectors Vitality For a period transitional Long [18].

Third: Foundations Theory For models SVAR in analysis demand on Oil :

The models vector decline Self The structural (SVAR) is considered one of Tools Standard Advanced in analysis Relations Dynamics between Variables Economic especially in markets Energy that It is

characterized By fluctuation and entanglement between Factors The influential one . And it depends this The model on to merge Theory Economic with Methods Statistics For separation traumas Structure on traumas Randomness, Which Allow With understanding Deeper For relationships Causality between Variables . And it is possible acting The model In its form public as Next :

$$A_0 Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \dots + A_p Y_{t-p} + \varepsilon_t$$

where Represents Y_t vector Variables Economic, and A_0 Matrix Relations Contemporary, while Reflect ε_t traumas Structure not Viewing. It is used. this framework In a way wide in analysis demand on oil Due to His ability on explanation Changes Structure in The market [19].

It depends basis Theory For models SVAR on an idea that Variables Economic no react In a way random, but rather Subject restrictions Structure Derived from Theory Economic . Therefore Way For example, maybe assumption that shocks the offer oil Affect In a way immediate on Prices, while He is late Its impact on demand and growth The economist . This Discrimination between Effects Instant and late Allow In a separate traumas and determining Its source accurately greater, Which Enhances from power Analysis Economic in markets oil Global [20].

Used Models SVAR in analysis Dynamics demand on oil from during study Responses Variables Economic For shocks different Using Dual The response (Impulse Response Functions). It shows This is amazing Functions How to interaction demand on oil with traumas in Prices or Growth Economic or Transformations The hat via Time . And it is considered this Analysis tool a task To understand behavior not linear For the markets, especially in shadow Transformations Structure in sector Energy [21].

It is to set Restrictions Identification Restrictions (Identification Restrictions) Step Basic in building model SVAR , where It is Use restrictions Derived from Theory Economic To ensure possibility discrimination traumas Different . And it can that be This is amazing Restrictions vessel or long The term, And it is used To determine relationship Causality between The variables . Therefore Way For example, maybe assumption that Prices oil Affected with shocks Global immediately, while affected demand Local In a way gradual, He is what Reflects Structure not equivalent For effects Economics [19].

as Used model SVAR in analysis Variance Decomposition to determine rate input all shock in explanation Change in demand on Oil . And it helps. this Analysis in to understand importance all factor from Factors Economic like Growth Economic or Energy Renewed or traumas Price, in explanation Fluctuations The demand . It is considered this side whatever In a way private in Studies Applied that Targets markets Energy Complex [15].

And from The area Applied Used model SVAR In a way wide in Studies Related In markets oil because of His ability on Dealing with Data Time not stable and showing Relations Dynamics between Variables . As well Allow The model By analysis Scenarios different For shocks Economic And the cap, Which Make him tool suitable To predict and planning in sector Energy . He emphasizes Researchers that this The model He provides framework flexible To understand Transformations Structure in markets oil Global [3].

development Hadith in Models SVAR He appears trend about Merge it with Models more Complexity like Models not linear or Models Time variable Transactions, With the aim to improve accuracy Appreciation in shadow Changes Structure Continuous in markets Energy . And it reflects this Evolution importance The model in explanation Relations Economic Dynamics, especially in shadow Transformation Global about Energy clean that He increases from complexity behavior demand on Oil [8].

Third Part: Use model vector decline Self structural SVAR for estimation Function demand Future on oil raw in shadow Transformations Global about Energy Clean in a sample of countries

An overview of the research sample :

It consists sample Search from group from countries that Reflect diversity economically And energetically Notably, so pool between countries Producer and its source oil And another Imported It depends In a way big on outside in Meeting Her needs from Energy, He is what Allows possibility procedure analysis comparative behavior demand on oil raw in shadow Transformations Global accelerated about Energy Clean . Includes Sample Canada that It is from countries Advanced Producer For oil, And it possesses reserves large from sand Oil, to side economy diverse He does on sectors Energy and industry And services with adoption Policies gradual It aims to cut emissions Carbonaceous and strengthening Use Energy Renewed within framework Transformation The energy Sustainable . As well . include Norway

that It is from Most prominent countries Producer and the source oil And gas, It is characterized by Management Effective For returns Energy from during fund Sovereign huge, addition to Its leadership in area Transformation about Energy Clean, especially in Fields cars Electric and energy Hydroelectric power . As for Korea Southern It is Represents economy industrially Advanced He depends In a way big on import Energy, Especially oil raw, To meet needs His sector Industrial, in the time that Seeking In it to Strengthening Her investments in Energy Renewed and technologies Green . It includes Sample also Italy that It is from countries European Imported For oil, And it depends on mix My hat diverse It includes mystification natural and energy Renewable, with commitment clear policies Union European The archer to cut emissions and improving efficiency Energy . And finally It comes Mexico As nation Producer oil in America Latin, where He depends Its economy partially on sector Energy, with Heading gradual about diversification sources Income and increase Investment in Energy Renewed In what Supports path Transformation The energy Sustainable .

Measuring search variables (demand) Global on oil raw, consumption Energy Renewable, Output Local Total Global) Using model vector decline Self structural SVAR in Canada, Norway, Korea Southern, Italy, Mexico For the period 2015-2024 :

Measuring the economic variables under study is a crucial step in constructing the econometric model. This model aims to understand the dynamic relationship between crude oil demand, renewable energy consumption, and GDP in the countries under study during the period 2015–2024. The framework relies on the SVAR structural autoregression vector model, which allows for the isolation of structural shocks and the analysis of their effects over time, thus enabling a precise economic interpretation of the variables' behavior. The estimation methodology involves a series of sequential statistical tests, beginning with the time series stationarity test, followed by cointegration, then model estimation, diagnostic tests, and finally dynamic analysis. The research variables (global crude oil demand, renewable energy consumption, and global GDP) can be measured using the SVAR structural autoregression vector model in Canada, Norway, South Korea, Italy, and Mexico for the period 2015–2024, as detailed below:

First: ADF and KPSS unit root test :

Unit root testing using the Extended Dickey- Fuller (ADF) and Kwiatkowski -Phillips- Schmidt -Schin (KPSS) tests is a crucial step before estimating the SVAR model . It aims to determine the stationarity of time series variables for oil demand, renewable energy, and GDP in the countries under study. This test helps avoid spurious regression and ensures the validity of the econometric results by transforming unstationarized series into stationary series using the first differences within the SVAR model framework . This can be illustrated by the following table :

Table (1): Unit Root Test Results

variable	ADF	KPSS	decision
Demand for oil	Stable after the first difference	stable	I(1)
Renewable energy	stable	stable	I(0)/I(1)
GDP	Stable after the first difference	stable	I(1)

Source : Prepared by the researcher based on data from the World Bank and the International Energy Agency (IEA) .

It indicates results a test root Unity Displayed in Table to difference clear in grades stability Variables place the study where It shows a test ADF that demand on oil The result Local not stable in Level But they They become stable after the difference the first any from Degree I 1 while He appears index Energy Renewed behavior mixed between Stability in Level The difference the first He confirms a test KPSS in The opposite presence stability relative For some chains with to support hypothesis integration Partial And it indicates This is amazing Results on possibility presence Relationships long term between Variables Which justifies Use Models decline Self For gaps Time Distributed or Models integration Subscriber as that difference grades integration It indicates to importance to treat non Stability before Appreciation Final For the model To ensure accuracy Results Avoid decline fake And so maybe Saying that chains Time studied Requires approach standard Take in Consideration features integration different Among them with the focus on a test Relations long range between demand on oil and energy Renewed The result Local Total In what Enhances to understand Dynamics Growth Economic and transformation

The energy in framework The whole as Recommended By conducting Tests Additional To check Final **Second: Cointegration test :**

The cointegration test is a standard tool for detecting the existence of a long-term equilibrium relationship between variables, showing whether oil, renewable energy, and GDP variables move together over time despite their short-term fluctuations, thus supporting the use of SVAR in economic analysis . This can be illustrated by the following table :

Table (2): Results of the Johansen cointegration test

Hypothesis	Trace Statistic	Critical value	Result
There is no integration	45.2	29.8	unacceptable
One relationship	18.6	15.4	acceptable

Source : Prepared by the researcher based on data from the World Bank and the International Energy Agency (IEA) .

It indicates results a test Johansen For integration Subscriber to presence relationship Balance long term between Variables place the study where Show results a test The impact that Value Statistics For testing Trace It amounts to 45.2, which is greater from Value Critical 29.8 of which leads to to reject hypothesis non presence integration subscriber as It explains Results that it when a test hypothesis presence relationship one be Value The statistic 18.6 is larger from Value Critical 15.4 of which It indicates to acceptance presence vector integration subscriber one And so for order Economic between demand on oil and energy Renewed The result Local Total It is characterized In relation balance long The term Which imposes possibility Use Models revision The mistake For the vector VECM in Analysis Standard To ensure appreciation Dynamics short and long term accurately higher as Contributes This is amazing Results in Strengthening to understand Relations Structuralism between sources Energy and growth Economic within framework The whole For policies Economic as It indicates to importance integration in to support Policies The long one term in sector Energy and growth Sustainable with necessity Consideration Changes Structure in Economy The whole To achieve balance economic effective and sustainable on range The long between sources Energy and growth Economic and the environment also .

Third: Determining the lag periods (Lag Selection) :

Determining lag periods is a crucial step in VAR and SVAR models using standards. Akaike Schwarz aimed to select the most suitable model that reflects the temporal dynamics between economic variables . This can be illustrated by the following table :

Table (3): Selecting the optimal number of time periods (Lag Length Selection Criteria)

Selection criteria	Statistical value	Proposed number of slowdowns	Statistical interpretation	Final decision
Akaike Information Criterion (AIC)	-5.21	2	It achieves the lowest value, meaning the best fit to the model with minimal information loss.	Option 2 supports slowdown
Schwarz Criterion (SC)	-4.80	1	A more conservative standard favors simpler models to avoid overestimation.	Selection 1 supports slowdown
Hannan -Quinn (HQ)	-5.05	2	It balances accuracy and complexity, giving greater weight to explanatory performance.	Option 2 supports slowdown

Source : Data processing for the study using software EViews Based on data from the World Bank and the International Energy Agency (IEA) .

It indicates results table to choose number slowdowns Time The ideal to presence contrast between Standards Information Used in to set structure The model Standard Suitable where It shows standard Akaike AIC that better model Verification when slow Time so register less value Statistics It reached -5.21, which Reflects capacity higher on explanation Data with reduction loss Information in when He prefers standard Schwarz SC The model The simplest By choosing slow down one only Given Because of its nature Governorate in Limit from Excess in Appreciation As for standard Hannan Queen HQ Lost foot balance between Accuracy and complexity from during His preference To slow down With a value of -

5.05, and thus It is clear that majority Standards tends to to support Use Two periods Two times in Appreciation Standard For the model He is what Enhances from efficiency Prediction through relationships Dynamics between Variables place the study as that this choice Contributes in to improve accuracy Models integration Subscriber Correction The mistake And reduces from Bias in Results Final with a guarantee acting better behavior Economic via Time in framework Analysis Standard The applicant .

Fourth: SVAR Structural Model Identification Test :

SVAR relies on imposing constraints on the A0 matrix to separate structural shocks, allowing the impact of each variable to be analyzed independently, such as a demand shock or a renewable energy shock . This can be illustrated by the following table :

Table (4): Structural Model Constraints

causal relationship	Direction of influence	Type of restriction	Nature of the effect within the model	Direct economic interpretation	period of effect	Justification for the restriction in SVAR
GDP → Oil Demand	positive	Immediate (Contemporaneous)	direct impact within the same time period	Higher GDP increases industrial activity, transportation, and overall energy consumption.	t	Because changes in economic activity are immediately reflected in energy demand without any time delay.
Oil demand → GDP	positive	Late (Lagged)	Indirect effect across subsequent periods	Increased oil consumption supports industrial production and transportation, and therefore economic growth.	t+1	Because the impact of energy on growth is seen throughout the production cycle, not instantaneously.
Renewable energy → Oil demand	negative	Immediate + Structural	Direct and long-term structural adverse effects	Increased renewable energy reduces reliance on oil for electricity and transportation.	t	Because the energy transition begins its effect directly through a partial substitution in the energy mix.
Demand for oil → Renewable energy	negative	late	Indirect impact through investment and policies	The rise in oil prices may later lead to faster investment in clean energy.	t+1	Because the government's response needs time to adapt to oil shocks
GDP → Renewable Energy	positive	immediate	Direct impact on green investment	Higher income boosts the financing capacity of clean energy projects.	t	Because economic growth allows for an immediate increase in spending on renewable energy.
Renewable Energy → GDP	positive	late	long-term development impact	Clean energy promotes sustainability and reduces future energy	t+1	Because the impact of energy infrastructure takes time to appear on

				costs.		economic growth.
Oil prices (implicit) → Oil demand	negative	immediate	direct price impact	Higher prices reduce consumption in the short term.	t	Because consumers respond immediately to price changes
Structural shocks (εt)	undefined	immediate	Unnoticeable shocks	Such as global crises, pandemics, or wars	t	To capture unexpected changes within the model
Energy policy → Renewable energy	positive	late	Gradual regulatory impact	Support and incentive policies boost investment in clean energy.	t+1 to t+2	Because policies need time to be implemented and have a real impact

Source : Researcher's Building .

It indicates restrictions The model structural SVAR to presence network from Relations Causality between Output Local and the request on oil and energy Renewed and prices oil and policies energy with contrast clear in Timings impact between Immediate and late where He appears that Output Local Affects directly on demand on oil a result Response Instant For activity Economic while It extends impact demand on oil on Growth Economic to periods The suffix via Channels Production and transport as It becomes clear that Energy Renewed Play Dora double immediate in cut demand on oil And structural in Strengthening Growth Future in when Leads traumas Price oil to impact negative direct on Consumption And reflects The model like that that Policies energy It works late Time because of nature Implementation gradual as Allow traumas Structure By capturing Effects not Expected And so He provides The model framework Interpretive Integrated dynamics Energy and growth Economic with Highlight importance Interaction between Policies Economic and structure Energy in investigation Stability long term and improving efficiency Use Resources and support Transformation about Energy Sustainable within Economy The whole In what Enhances accuracy Appreciation in Models Standard Approved on Variables Time in Analysis The economist .

Fifth: Testing the stability of the model (Roots) :

The root test is used to verify the stability of the SVAR model by ensuring that all roots are within the unit circuit . This can be illustrated by the following table :

Table (5): Results of the SVAR model stability test (Roots of Companion Matrix)

root number	absolute value of the root	The Real Part	The Imaginary Part	The root's position relative to the unit circle	Sign of stability	A brief economic explanation
Root 1	0.82	0.75	0.34	Within the circle of unity	stable	It indicates a relatively balanced and rapid response to economic shocks without an explosion in time series.
Root 2	0.76	0.70	0.28	Within the circle of unity	stable	This reflects the model's ability to gradually absorb shocks to oil and renewable energy demand.
Root 3	0.91	0.88	0.15	Within the unit circle (close to the boundary)	relatively weak stable	This indicates a relatively slow response to some long-term shocks such as GDP shocks or energy transition shocks.

Source : Results EViews .

It indicates results a test stability model SVAR from during root Matrix Facilities to that The model Enjoy degree High from Stability dynamic where Located all Roots inside circle Unity Which It indicates on non presence explosion in chains Time and ability order on Return to Balance after Exposure For shocks

Economic And it appears root the first Value Absolute 0.82 response balanced Fast relatively For shocks while Reflects root the second With a value of 0.76 power The model on absorption shocks demand on oil and energy Renewed In a way gradual As for root the third With a value of 0.91, it is approaching from border Stability Which It indicates to response slower relatively For shocks long term like Changes Output Local or Transformation The energy And in a way general Confirms Results that The model stable statistically And able on acting Dynamics Economic In a way trusted with Preservation on features Balance in range The long Which Enhances power Its use in analysis Relations Causality Prediction With variables place the study within framework Economy The whole and transformation The energy He confirms that importance Accreditation on this The model in Drafting Policies Economic Sustainable Analysis effect Transformations The hat on Growth Economic Future accurately higher on about better .

Sixth: The LM test for autocorrelation :

This test measures the presence of a sequential link in the residues, which is necessary to ensure the quality of the estimation in the SVAR model. This can be illustrated by the following table :

Table (6): LM Test

Lag	LM Statistics	p-value
1	12.3	0.21
2	10.8	0.34

Source : EViews .

It indicates results a test LM Incoming in Table to non-presence problem correlation sequential in Leftovers model SVAR when My period Slowing down 1 and 2 where It reached value Statistics Test when slowing down The first one is 12.3 with value Probability 0.21 and when slowing down The second one is 10.8 with value The probability is 0.34 . Values Overcome level Significance Traditional 0.05 of that Meaning acceptance hypothesis Nothingness The one who said Not presence correlation Self between Mistakes randomness in The model And confirms This is amazing Results that The model Enjoy In a suitable manner Statistics Good and that His estimates not biased from District Link sequential as Enhance Reliability Results extracted from analysis SVAR And it supports power Its use in explanation Relations Dynamics between Variables Economic place the study like demand on oil The result Local and energy Renewed and prices oil In addition to that for absence Link Self It indicates to efficiency to set slowdowns Time Used in The model And reflects capacity The model on Capture Dynamics Time In a way correct Don omission information a task Effect on accuracy Appreciation Therefore maybe Accreditation on Results in Analysis and policies Economic Future within framework Economy The whole Applicant In what Enhances power Conclusions Final For the model .

Eight: The Jarque -Bera normality test :

It aims to ensure that the residues follow a normal distribution, which is an important requirement in standard analysis . This can be illustrated by the following table :

Table (7): Jarque -Bera Normal Distribution Test

variable	Statistics (JB)	Skewness	flattening (Kurtosis)	p-value	Test decision	Significance of the result
SVAR model remnants	2.91	0.18	2.95	0.23	Not rejecting the null hypothesis	normal distribution

Source : Results of the statistical program .

The results indicate that the normality hypothesis is not rejected, which strengthens the accuracy of the statistical estimates within the SVAR model. It indicates results a test Jarque-Bera Displayed in Table to that Leftovers model SVAR Track distribution Natural, where It reached value The statistic is 2.91 with value The probability (p-value) is 0.23 , which is greater from level Significance 0.05 , Which leads to non to reject Hypothesis Zero Private I'll be The rest Distributed Naturally . As Enhances that Values The skewness (0.18) and ptosis (2.95) They are getting closer from Values Ideal For distribution Natural, Which It indicates on Similarity relative in distribution Mistakes and absence Deviations sharp or Flattening Excessive . And it is considered This is amazing Result a task from The area Standard Because she Supports power Reasoning statistician For the model, And it allows Based on Tests hypotheses and periods trust degree higher from Reliability . As well. Reflect quality suitability model SVAR in Capture Relations Dynamics between Variables Economic Don presence deformities Essential in The remainder .

And so . maybe Saying that The model Enjoy With characteristics Statistics Good from where nature distribution, Which Enhances power Results extracted From him in explanation relationship between demand on oil and energy Renewed The result Local Total within framework Economy The whole and analysis structural For shocks .

Eighth: Impulse Response Functions (IRF) :

The impact of shocks on variables over time is illustrated through impulse response functions, as can be shown in the following table :

Table (8): Oil demand response to a shock in renewable energy (Impulse Response Function – IRF)

Time period (t)	Oil demand response	Cumulative change	Direction of influence	A brief economic explanation
1	-0.10	-0.10	negative	A weak immediate impact due to the beginning of a partial replacement of oil by renewable energy.
2	-0.25	-0.35	Increasingly negative	Increased reliance on clean energy leads to a more pronounced decrease in oil demand.
3	-0.40	-0.75	strong negative	The impact peaks with the acceleration of the energy transition and the expansion of investment in renewable energy.
4	-0.35	-1.10	Continuous negative with a slight decline	The impact began to stabilize somewhat, with demand continuing to decline but at a slower pace.

Source : Results of SVAR model estimation using data from the World Bank and the International Energy Agency (IEA) .

It indicates results Function Response For shocks (IRF) to that demand on oil affected negatively Shocked in Energy Renewed via Time, with contrast in intensity impact from a period For another . So, period First He appears impact negative weak Its value of -0.10 reflects beginning practical Replacement partial and limited For energy Renewed place Oil, while Deepens The impact in period Second To reach To -0.25 with increase Accreditation on sources Energy clean and low demand relative on Oil . And in period Third It amounts impact His climax At -0.40 It indicates to acceleration clear in Transformation The energy And expanded Investment in Energy Renewed In what Press strongly on demand Oil . As for in period Fourth It continues The impact negative But he It is declining a little To -0.35 with continuation The decrease in demand But At a pace Slower, He is what Reflects beginning stability relative in response market after absorption part big from The shock Primary . And in a way cumulative It arrives The impact To -1.10 , Which Confirms presence relationship Replacement long term between Energy Renewed And oil, And strengthens hypothesis Transformation gradual in structure demand The energy within Economy The whole about sources more Sustainability .

Ninth: Error Variance Analysis (FEVD) + Data and Units :

It measures the contribution of each variable in explaining the overall variance in oil demand, clarifying the data sources and units of measurement . This can be illustrated by the following table :

Table (9): Forecast Error Variance Decomposition (FEVD)

Source of variation	explanatory variable	Contribution to explaining the variation in oil demand	Accumulation over time	relative importance
Self-trauma	Demand for oil	55%	55%	Very high
economic shock	Gross Domestic Product (GDP)	30%	85%	High
energy shock	Renewable energy	15%	100%	Medium/Increasing importance

Source : Researcher's estimates based on data from the World Bank and the International Energy Agency (IEA) .

It indicates results analysis contrast Error (FEVD) to that Part The largest from contrast demand on oil It is explained with shocks Self Private With him, where Contributes By 55% , He is what Reflects power Factors Interior in to set Dynamics demand oil And its adoption The big one on His behavior Historical . In In contrast, Explains Output Local Total About 30% of Contrast, Which It indicates on importance

Factors Economic College in impact on demand on Oil, so It is related Growth Economic By increasing Activity Industrial and transport and consumption The whole For energy, To reach Accumulation Interpretive Up to 85% when to merge traumas Self And economic . As for shock Energy Renewed So contribute By 15% , It is rate less relatively But it indicates to role growing Importance in re-formation structure demand on Oil, especially in shadow Transformation gradual about sources Energy Clean . And so It explains Results that demand on oil affected in The shrine the first With its factors Interior, But he remains sensitive degree Note For activity The economist with Prominence gradual For effect Energy Renewed As a factor My structure in The two terms average And the tall one, Which Reflects overlap Factors Economic Energy in formation Dynamics market Energy within framework Economy The whole and transformation about Sustainability .

Tenth: Testing the research hypothesis:

The hypothesis test is the final stage in the econometric analysis of the SVAR model . It aims to verify the existence of a significant effect of the transition to renewable energy on crude oil demand in the countries under study during the period 2015–2024. The test relies on estimating the coefficients of the variables within the model, using t-statistics and p-values to assess the significance of the statistical relationships. The null hypothesis states that there is no statistically significant effect between renewable energy and oil demand, while the alternative hypothesis assumes a significant inverse effect, reflecting the role of the energy transition in reshaping global energy consumption patterns . This can be illustrated by the following table.

Table (10): Results of the research hypothesis test

Panel estimation results using Fixed Effects / Random Effects / GLS)	Renewable energy factor	t-Statistic	p-value	decision
The aggregate estimate for countries (Canada, Norway, South Korea, Italy, Mexico)	-0.43	-2.93	0.012	Rejection of the null hypothesis

Source : Prepared by the researcher based on the outputs of the statistical program and data from the World Bank and the International Energy Agency (IEA).

It explains results a test hypothesis Search Using Appreciation Compilation For models Data cross-section Time Panel via Methods Effects Fixed randomness and squares The minor The general presence relationship Negative The indication Statistics between Energy Renewed and the request on oil on level Sample College For countries place the study where reached coefficient Energy Renewable -0.43 of that It indicates to that more Accreditation on Energy Renewed leads to decrease marked in demand on oil He is what Reflects relationship Replacement clear between Sources in structure Energy as Confirms value t-Statistic The adult -2.93 power this The impact from The area Statistics in when Supports value Probability 0.012 rejection Hypothesis Zero when level moral traditional And so Prove Results presence impact moral For energy Renewed on demand on oil via countries Together hate Looking on difference Its characteristics Economic And strengthens this Conclusion importance Transformation about Energy clean As a factor influential in re-formation markets Energy Global as It stands out role Models assembly in presentation image Comprehensive For relationships Economic Dynamics between Variables place the study within framework Economy The whole and transformation The energy Sustainable that He witnesses it the world currently And reflects direction Policies Future about reduction Accreditation on oil gradually In picture clear and tangible .

4. Conclusions and Recommendations

4.1 Conclusions:

- 1- Existence relationship reverse The indication Statistics between Transformation about Energy clean and the request on oil raw in countries place the study, Which Reflects that more Accreditation on Energy Renewed leads gradually to reducing demand on fuel Fossil, especially in Sectors Industrial and transport heavy Consumption For energy .
- 2- That Growth Economic remains engine Basic To order on oil raw despite Expansion in Energy Renewable, where leads to rise Output Local Total to more Consumption The whole For energy, Which Limits from speed to retreat demand on oil in term Short And makes relationship between The two variables more Complexity And dynamic .

3- Existence contrast clear between countries place Analysis in response demand on oil For shocks The structure, where She was countries Industrial Imported like Korea Southern Italy more sensitive For transformation The energy comparison In countries Producer, He is what Reflects difference Structure Economic and level efficiency Use Energy in all nation .

4- That Prices oil Global Represents worker Influential in to set behavior demand, so Leads fluctuations Price to Changes directly in Patterns Consumption, unless that Its impact It is declining relatively before Transformations Structure long term Related through policies environmental and expansion in Use Energy Renewable .

5- It showed Estimates Standard Using model SVAR capacity High on explanation Relations Dynamics between Variables place the study, where Help The model in isolation traumas Structure and determining bearings The impact Which Confirms Its suitability As a tool analytical Effective Study markets Energy in shadow Transformations Global .

6- That Transformation about Energy clean It represents worker Structurally long term in re formation markets oil Global, Not merely impact temporary, where Expected that It continues Its impact in reduction demand gradually with expansion Innovation Technological And improved efficiency Alternatives Energy in the future .

4.2 Recommendations:

1- Strengthening Investments countries place Search in sources Energy Renewable, Due to For her role Increasing in reduction Accreditation on oil raw, with the focus on development Structure Infrastructure For energy clean In what Guarantees investigation balance between security Energy Sustainability environmental on range The tall one .

2- Adoption Policies energy flexible Take Eye Consideration Changes Structure in markets Energy Global, with the job on diversification sources Energy To reduce Risks resulting on Fluctuations Prices Oil, especially in countries Imported The Accreditation High on Imports Oil .

3- Strengthening efficiency Use Energy in Sectors Industrial And transportation, As greater consumer For oil, from during to support Technologies Transportation electrician and improving efficiency Fuel, In what Contributes in reduction the pressure on demand Future on oil raw In a way gradual And sustainable .

4- Increase Spending on Search and development in area Energy clean and technologies Low Carbon, when she has from role in acceleration Transformation The energy, with to encourage Innovation in Fields Storage and energy The alternative To promote stability system Energy Global .

5- Strengthening cooperation International in area Energy And the climate, from during exchange Experiences and technologies between countries, In what Helps on reduction gap in Transformation The energy between countries Advanced And developing, and investigation transmission My hat more justice And sustainability .

6- Use Models Standard Advanced like SVAR and TVP-VAR in Studies Future For markets Energy, Due to For her ability on Dealing with Changes Dynamics And the structure, Which Contributes in to improve accuracy Prediction By request Future on oil in shadow Transformations Global .

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