THE IMPACT OF OIL PRICE VOLATILITY ON THE ECONOMIC DEVELOPMENT: THE LINEAR PROGRAMMING METHOD STUDY

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Abstract

In this study, the utilization of the linear programming method for the purpose of optimizing the impact of oil price volatility on economic development has been conducted accordingly. It utilised linear programming to ascertain how changes in oil prices have impacted the economy. Using the data gathered, the linear programming method has been demonstrated. Quality benchmarks for a number of characteristics have been calculated using the optimization of linear programming (Jarrett et al., 2019; Mo et al., 2019). The results of the linear programming, an examination of convergence was conducted. The four most important parameters have had growth regressions computed for the period 2010–2020 that factor in monetary development. These regression analyses have already been completed. Further, the well-developed static model exhibits linear effects within a finance-growth foundation. The findings have optimized CALP and financial growth accordingly. The proposed model was tested by running a cost-benefit analysis on a subset of the crude oil's qualitative characteristics. The model presented in this article considers not only consumer satisfaction with product prices but also producer satisfaction with those same prices.

Keywords: Trade Openness, Linear Programming, Fluctuation Prices, Optimization Process, Economics Analysis

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1. INTRODUCTION

To properly interpret these findings, keep in mind that linear programming (LP) is similar to the traditional demand-driven input–output (IO) model when presented in terms of relative shifts (Nemati et al., 2018). Because of this, the LP is vulnerable to the same constraints as the conventional IO paradigm.

Constraints in this setting include the inability to estimate the forward effects of changes in exogenous final demand and the need to assume constant coefficients. The estimation can only be done by looking backward, at the effects of changes in exogenous final demand, because of these constraints (Kolotilin et al., 2018).

On the other hand, natural and anthropogenic disasters both generate shocks to the relevant

economies, impacting both the demand and supply sides. It is possible, in theory, to estimate the effects of negative demand shocks using the conventional IO model because it is expected that both consumers and producers will react proportionally by lowering all of their purchases, which is another way of saying that they will employ fixed ratios. This makes it conceivable to assess the consequences of negative demand shocks. This takes place as a result of the default model's anticipation of parity-preserving ratios on both sides. The LP model is helpful for assessing the impact of these factors; yet, it is not devoid of the difficulties that are inherent to itself. It is essential to prevent double-counting an impact due to the fact that natural disasters induce exogenous shocks to total production and labour income, both of which are endogenous in all IO models (Nordhaus, 2019).

When it comes to supply chain management (SCM), the number of recent research that has contributed to the body of knowledge by taking economic considerations into account is relatively low. There is a set of SCM models that are based on money, and there is another group that is based on ideas and inventions. Both of these categories are potentially applicable to the classification of SCM models. Along with the other variables that are included in financial activities are one of the endogenous parameters that are taken into consideration. In addition to their roles as target functions and restrictions, these endogenous parameters are employed in the modelling and optimisation of financial activities. The research carried out by Garg and Végh (2019) is essential to the field of genetics since it contributes to the resolution of the initial group of issues associated with this category. Other people have combined a number of quantitative variables, including financial planning, cash flow, and others, into a unified model. When it was first proposed using an uneven, time-consuming, and deterministic paradigm for the mixed-integer linear program (MILP) in the batch process industry, they made the observation that the MILP method that they had developed had not yet been shown to be effective in the manufacturing of batch processes. In addition, they noted that the MILP method that they had developed had not yet been shown to be effective in the manufacturing of continuous processes. The deterministic LP model that Zhao et al. (2018) developed maximised cash flow while also optimising budgeting and plan planning. Using the multi-period model, companies are able to give their customers a selection of different service arcs to choose from. The most recent research was carried out by Zhang et al. (2018), and it focused on an all-encompassing agent-based system that made use of a variety of research methods. The budgeting model was constructed with the use of cash payments received for the usage of raw materials, labour, and transportation services, as well as cash received from the sale of products. In order to improve designs for batch storage networks, Galbusera and Giannopoulos (2018) created a plant optimisation model. This model takes into account production decisions in addition to financial ones. The distribution of cash flow is integrated with the production decisions in this model, which results in the formation of a consistent framework for manufacturing. In order to plan a chemical supply chain that is both effective and efficient, a thorough MILP model was developed. This approach utilised all-encompassing models that took into consideration every facet of the company's operations. We employed a deterministic version of Tsiakis and Papageorgiou's (TILP) model so that we could model the production and distribution network. A top objective was the upkeep of exchange rates that were both affordable and manageable, as well as the limitation of the influence of transaction fees and rate limitations. Saeedi et al. (2019) introduce the SCND model, which is a component of the work that they have done. A strategy known as a "MILP plan", stands for numerous products, locations, and strategies. The transfer price, the supplier allocation, and the transportation cost allocation are the three separate monetary considerations that are taken into consideration by this method.

The fundamental IO model, on the other hand, cannot be used to predict the consequences of shocks to the supply of products and labour for a number of different reasons. Companies will not immediately lower their purchases across the board when they are confronted with a negative supply shock. Instead, they will explore different ways to solve the problem. You have the option of selecting a replacement from one of these three primary groups: 1) Companies have the ability to search for a diverse group of regional manufacturers of a certain product. The supply-market share of the product at hand will shift as a direct result of this development in the industry. During the construction of symmetric LP, this fixed ratio assumption is typically masked as something else (Coase, 2019). As a direct consequence of this, 2) Companies now have multiple options from which to choose when deciding where to get their supplies. Because of this, it is necessary to do a new calculation to determine the product's levels of self-sufficiency and imports. This assumption is virtually always made in a covert manner, despite the fact that it is extensively acknowledged in the IO literature (Malekpoor et al., 2018). When developing a new product, businesses frequently look for ways to achieve the same result that are either more affordable or more easily accessible. One example of this would be switching some of the product's components from metal to plastic. A change in the real technical coefficients is the response that is least likely to occur, at least in the short run. This is because such a change would necessitate a change in the production process of the product.

The manuscript comprises several sections. Section 1 encompasses an introduction that provides the background information and states the objective of the study. Section 2 reviews previous studies and highlights the research gap. Section 3 outlines the research methodology, explaining the approach used to analyze the provided data. Section 4 presents the research findings and provides a comprehensive discussion. Lastly, Section 5 offers a summary of the study's findings and potential directions for future research.

2. LITERATURE REVIEW

According to Goodarzian et al.'s (2020) research, a major component of both exogenous and endogenous models of economic growth is the connection between the growth of the financial

sector and the increase of gross domestic product (GDP). Estimates on the topic based on empirical data are all over the place, despite the fact that there is an evident theoretical demonstration that growth and finance are tied to one another. Not only has the sign of this relationship been a topic of discussion, but so has the subject of whether or not there is a lead-lag impact (Chen et al., 2018). There is some evidence to suggest that increasing financial development and economic growth go hand in hand. This may be due to the potential benefits that increased finance may have on capital allocation, fewer adjustment costs, increased lending to families and enterprises, and increased high-return investment. This is owing to the fact that there is a probability that more funding might result in better capital allocation. According to Shuai et al. (2018) and van Eyden et al. (2019), in order for economies to grow, there needs to be access to financial tools and intermediaries that lower the costs of getting and exchanging information, as well as the costs of completing financial transactions. This is because economies cannot advance without these tools and intermediaries. However, if resources were inappropriately allocated to low-return projects, an increase in finance could stifle economic growth. This would result in boom-and-bust short cycles, which would have a negative impact on long-term output. This would occur as a direct consequence of inefficient resource distribution (Wang et al., 2022).

This approach to the age-old problem of deciding which companies to invest in was primarily made possible by the pioneering work of Markowitz (1952), which helped to set the stage for it. We are taking great care in our stock picks so that we can realise the greatest possible returns in the future. In the future, in order for businesses to grow the amount of money they take home in profits, they will need to increase the amount of risk that they are willing to accept. The expected rate of return on investment, in addition to the standard deviation of that rate of return, is said to be one of the two elements that can influence the returns on an investment in the future, in accordance with the Markowitz theory. To restate this idea, in order for quadratic programming to be useful, there must be at least one and no more than three side restrictions. Markovitz (1952) added a variety of assumptions and implications, such as returns, into his medium-variance model. This was done to ensure that the mean and variance were sufficient to completely define the portfolio return distribution function. The impact on returns is one of the repercussions that will occur. The popularly held perspective, on the other hand, is not supported by the statistics in a few of these instances. According to the findings of several studies, fat-tailed distributions can be discovered in statistical analyses of financial data. To restate this idea, the amount of the loss or gain will be far more than what was anticipated if it is supposed that such losses or gains are within the bounds of what may be considered usual. If we suppose that the utility function of the person making the decision is quadratic, we can increase the likelihood that the mean-variance method will be utilised. The utility function for wealth begins to diminish, however, if a certain threshold is crossed in terms of wealth accumulation. Based on these findings, it seems prudent to conduct additional research into the programming of portfolio models. Recent investigations into the optimisation of investment portfolios recommend considering many alternative kinds of return. The majority of the models that are considered to be the most fundamental are, in reality, just more complicated variations of the Markowitz (1952) model. Instead of utilising the variance, modern descriptions of returns to portfolio investors use statistics taken from the extremes of the distribution of those returns. When planning an expansion, it is essential to take into account any hidden deviations from the goals that may have occurred.

Companies with continuous and two-way links in their supply chains are better able to add value to the products they sell, as stated by the research of Khodaei et al. (2018), who coined the term “supply chain network”. There is a predetermined order of operations, the primary processes of which are the acquisition of raw materials, the execution of production, the management of inventory, and the distribution of finished goods to customers (Di Somma et al., 2018). They state that SCM plans the best possible supply chain layout. Facility location models are used to make these long-term strategic decisions. However, due to the characteristics of the supply chain ecosystem, these models are useful during SCND (Di Somma et al., 2018). Furthermore, more intricate supply chains call for time-based decision criteria and dynamic location models with longer planning horizons (Tirkolaee et al., 2020). Companies can gain an edge in the market by overseeing production all the way from the raw materials to the finished goods, as suggested by the aforementioned study. These models also oversee the distribution and supply chains that make up their own systems. Many effective models for supply chain design and management have been created; however, most of these models do not incorporate crucial revenue and marketing concerns, such as determining the amount of investment to make and the best way to make it. Interest rates and currency exchange rates are just two of many economic factors that have a profound effect on the overall supply chain structure. Companies such as the federal government, state governments, and county governments, and other taxes such as the corporate income tax, transfer costs, and currency exchange are all are important considerations in a supply chain design model for globalization. Financial data in the models, such as revenue, costs, and net profit from financial transactions, allows for analysis of the effects of production decisions on financial transactions, which is essential for determining which production decisions maximise net profit. As a result, the company’s manufacturing decisions can be optimised, giving it a competitive edge (van Eyden et al., 2019).

There are currently solutions available through quadratic programming models that are almost as excellent as those provided by linear models. It is possible that this will make non-algebraic models more appealing by providing more actual characteristics and making use of integer variables. This may significantly reduce the difficulty of the problem, which will make LP solvable models more competitive in comparison to quadratic models,

for which there are no solutions. Furthermore, the capabilities of modern computers have resulted in an unprecedented level of invention. One of the most important results of recent optimization research is the development and implementation of novel statistical methods (Jarrett et al., 2019; Mo et al., 2019).

In this study, the impacts of changes in oil prices on the development of economic growth as analysed by applying linear programming methods have been optimised and analysed accordingly. This was done in order to determine whether or not there is a correlation between the two.

3. RESEARCH METHODOLOGY

3.1. Research data

As can be seen in Table 1, the price of oil has been utilized as a primary indicator of the state of the Iraqi economy. The price of oil from 2003 to 2020 has been taken into consideration. These variations have been adjusted properly to achieve optimal performance.

Table 1. Research data for 2010–2020

Years	*Nominal oil price*	*Real oil price*	*Export rate*
2010	60.4	68.27	79.04
2011	107.46	88.50	104.01
2012	109.45	92.40	105.01
2013	105.87	88.40	104.08
2014	96.29	79.60	96.24
2015	49.49	46.13	50.75
2016	55	44.5	40.6
2017	56.34	65.3	46.6
2018	75.3	66.4	66.5
2019	65.3	76.4	56.47
2020	69	55.6	46.7

The following are the underlined assumptions for the models in this research work:

1) The training program continues for 20 days.
2) The cost of extraction of crude oil.
3) The cost of transferring crude oil.
4) The cost of training an Assistant Director.
5) The cast of training a Manager.
6) The objective function also has a linear relationship with the decision variables.

3.2. The proposed research model

The objective of this general linear programming model is to maximize customer satisfaction. In this model, the objective function is interpreted as the product of the relevance of quality features and quality levels. This study focuses on the manufacturer's budget constraint, which encompasses the key challenges faced in producing a desired product. Maximizing the utility function within the economic problem is therefore considered as the solution, which can be achieved through a linear programming approach.

$$Pr(A) + 2p(1-p)Pr(B) \quad (1)$$

$$pPr(A) + (1-p)Pr(B) = 02 \quad (2)$$

The given scenario involves three grades: grade A, grade B, and grade C. The marginal utility of grade A is equal to one unit of price, the marginal utility of grade B is two-and-a-half times one unit of price, and the marginal utility of grade C is zero. Correspondingly, the prices of these grades are one unit of price, two-and-a-half times one unit of price, and zero, respectively.

The educational establishment is faced with a challenging decision. They must choose between two grading policies: one that has a low probability of producing an A grade but can attract both negative and positive employers, or one that has a high probability of producing a B grade but can only attract positive employers.

3.3. Linear programming method

The following model has been utilised for the integration process throughout this particular study. For the past 10 years, the optimization has been carried out with the help of seven different variables. The process of integration has been completed by using software available online, and the model has been modified and tested accordingly. Use the method for 1–5 integer programming problems to solve the following linear programming problem.

$$MaxX = 100x1 + 60x2 + 10x3 + 40x4 + 50x5$$

subject to

$$\begin{gathered} 35000x1 + 10000x2 + 25000x3 + 90000x4 + \\ 34300x5 \leq 120000 \end{gathered} \quad (3)$$

$$4x1 + 2x2 + 7x3 + 3x4 \leq 12$$

$$x1 + x2 \leq 1$$

$$\text{and } x1, x2, x3, x4 \geq 0$$

4. RESULTS AND DISCUSSION

4.1. Convergence linear programming (CALP)

As a quick summary of the satisfied customers, we can say that costs in production are projected to go up by 0.632% after the LP model is put into place. Following the implementation of the LP model, an uptick in customer satisfaction of 0.9615% is forecasted. Prior research has shown that the increase in customer satisfaction is larger than the percentage of extra cost associated with creating higher-quality goods or services. Because of this, the linear programming-determined optimal quality levels can be used in the actual implementation. In an effort to meet the needs of the client, this research makes use of the linear programming formulation for the first time. This is necessary because of the constraints placed on manufacturers by quality-of-production costs. Results for the product bike in this study were derived only from a survey of adults interested in purchasing a bike and information supplied by a major bicycle producer in Chennai. The best quality values established through this study are generalizable to

all bicycle types and all geographic regions. A higher value for "D" in the linear programming formulation is needed to achieve a higher quality level in the optimal quality feature mix. This is so because more functionality is required for higher quality. It can change depending on a number of external circumstances, including the manufacturer's financial stability, the price of similar name-brand items offered by other firms, the level of market penetration, and consumers' quality expectations. The linear programming model utilised in this study was developed on the premise that increased customer satisfaction and less financial strain can be achieved by increasing product quality features. Although this assumption is founded on a variety of useful assumptions, it is not always correct. The relationship between the choice variables and the objection function could not be linear. When this occurs, linear programming techniques are used to get the best possible answer.

4.2. Results of the estimation process

In the course of this research, a model has been developed and evaluated for its ability to anticipate fluctuations. This forecast has been analyzed, and the results have been explained below. The model addresses four primary parameters, which are known as Risk of fluctuation, Income, Expenses, and Others. These are the parameters that are dealt with by the model. In the course of this programming, the following eight primary variables have been utilized. Their values for the period 2010–2020 are as follows:

$$Variables = (Risk\ of\ fluctuation)C1X2 + (Domestic\ index)C2X2 + (Costs)C3X3 + (Others)C4X4 \quad (4)$$

where, *C1, C2, C3,* and *C4* represent the average cost of the crude oils.

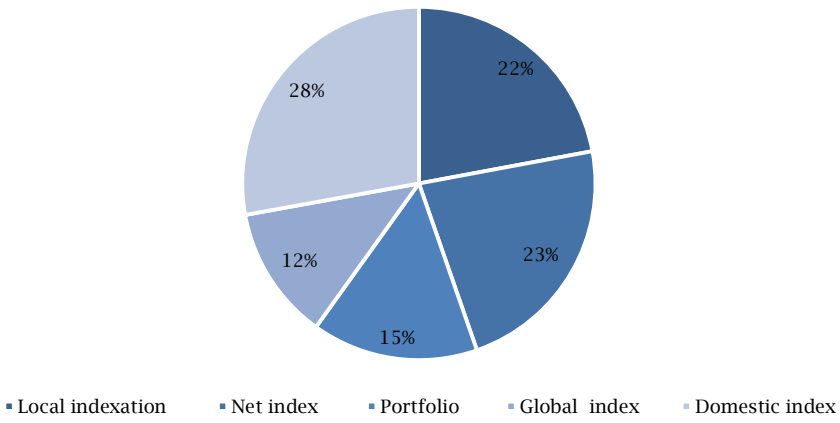
Table 2. Details of the main variables

Items	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*
Risk of fluctuation	100	435	334	983	445	23	453	532	445	224	112
Domestic index	443	983	872	762	331	983	765	332	877	982	112
Costs	982	4100	9823	972	977	332	441	332	887	220	192
Others	1002	433	443	443	342	983	433	5	983	335	213

4.3. Linear programming approach in the risk estimation

Next, we will inquire into the usefulness of the value-at-risk model for those who are tasked with making decisions. Experimentation of this kind is where we get started. 2003 to 2020: We made the decision to consider the following variables: *AVaR* is equal to 0.1, *rVaR* is equal to 14 of *rVaR DJ*, and *PI* is equal to 1/100. The following is the list of requirements that we settled on: *I* is equal to 1, … , 100, and represents the daily returns of the four most important assets traded on the market in the past. The index portfolio should have a greater expected return given that it entails a lower level of risk in comparison to the portfolio that we are looking for. After keeping the portfolio for a total of twenty business days, we will then sell it. We start from scratch and then optimize based on the most recent specifications, all in an effort to eliminate the possibility of incurring any transaction fees. The results of our investigation are presented in the table below. The market index was higher for 8 of the intervals, while it was down for 7 of the intervals. In each of those time periods, the disparities between the two investment portfolios amounted to less than one percent. It is important to include the following additional information: At the beginning of 2010, a total of 100 USD was invested in the index portfolio; in comparison, the VaR portfolio's investment amounted to slightly more than 146.78 USD as of the end of 2020. When we say this, we are not really intending to imply that the optimized portfolio provides decision-makers with crucial information; however, we may come to the conclusion that the optimized portfolio will include information that is valuable to decision-makers.

Figure 1. Indexes of the period 2010–2020



4.4. Incorporating financial development in growth regressions

At this point in our project, we are validating the financial model's (FM) proposed numbers by making minor changes to certain of the economic variables. The use of these parameters is especially critical, as they are not semantine province rules and are commonly accepted as conditions. To eliminate confusion, companies may employ contemporary predictive algorithms, as well as financial goods and diversified financial products, to offer accurate and precise assessments of those aspects. This study gives supply chain managers information that may be used to analyze how network changes occur if there are significant changes in economic activity. Weighted average cost of capital (WACC) is an essential financial measure, to say the least. The investment capital parameter reflects the value of both loans and equity. The costs to borrow can be influenced by the company, while the equity costs are based on market conditions. An important financial indicator is net profit after taxes (NOPAT). This percentage is affected by a company's credit policy, however, this influence is not unique. Which percentage of the market will be that will be decided by market conditions. An important financial factor impacting the wealth of a business is its tax rate. When corporations "campaign" for regulations, or price the triangle through offshore firms, they can adjust the tax rate percent. The credit markets ultimately define long-term interest rates (LTR) and short-term rates (STR). The financial model's reaction is seen in Figure 2. We have kept this transit brief because we are not reporting the passage of the product from one node to the other. Only the economic value added (EVA) index varies with WACC, LTR, and STR.

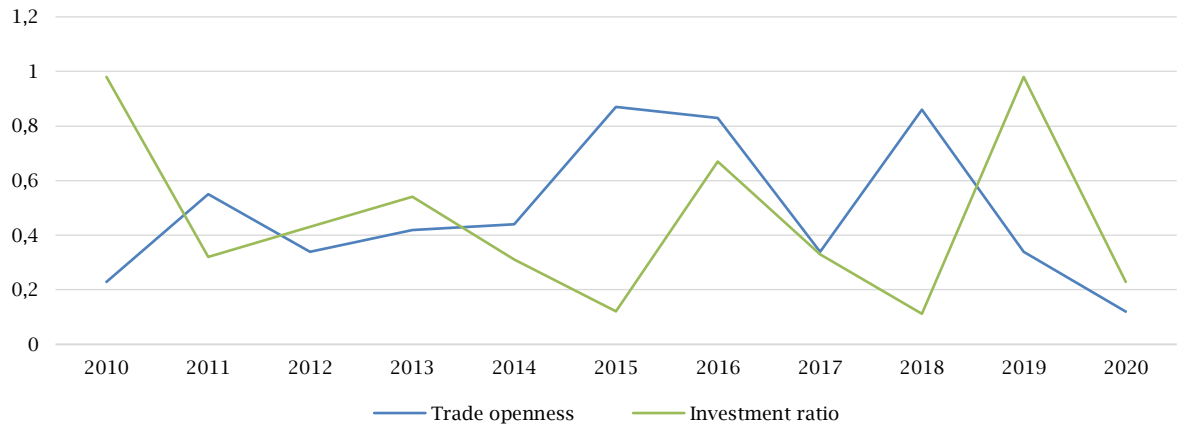
4.5. Linear effects on the finance growth

When the variable of interest has different coefficients below and above a specific threshold, threshold models are able to capture the linear effects that can emerge as a result of this difference. For example, the effect of the financial sector may be contingent on the value of another variable, such as the level of economic development. In these kinds of models, the value of the threshold is arrived at endogenously by the use of a grid search. In this study, a grid search is performed with step sizes of 6% of the distribution in order to find the value of the threshold variable that results in the smallest sum of squared residuals from the estimated two-regime model. The steps in this search are 1% of the distribution. The grid search begins at 23% of the distribution and continues until it reaches 33% of the distribution in order to ensure that a sufficient number of observations fall into each regime.

$$Y = \beta + \sum X1 - 10 + \sum \delta + C \quad (5)$$

where,
β: Trade openness;
δ: Investment ratio;
C: Constant.

Figure 2. Investigation of trade openness to investment ratio



5. CONCLUSION

Using linear programming (LP) methodology, this research investigates what role the effects of fluctuating oil prices have played in the expansion of the economy. It was done by employing a method known as linear programming to estimate the effects that changes in the price of oil have had on the economy. The LP model has been presented with the assistance of the data that was gathered for the product example. The optimal values for the quality of a selection of bicycle quality features have been identified with the help of optimization tools. These features include: A study into convergence was carried out so that the findings of the linear programming could be validated. This was done so that the conclusions could be drawn from the programming. For each of the four most essential criteria, calculations have been done using growth regressions that take into account trends in financial markets. These calculations cover the time span from 2010 to 2020. The analyses of regression that were described earlier have been carried out. In addition to this, the linear repercussions within the finance-growth basis do not accord with the static model that has been generated suitably. This is an important point to keep in mind. These discoveries have been brought up in past

conversations. In order to validate the suggested model, a cost-benefit analysis was carried out on particular qualitative features of the crude oil. This was done in order to ensure that the model might be successfully applied in the future. The model that is presented in this article takes into account not only the happiness of the consumers but also the contentment of the manufacturer with the prices that are attached to the goods. This model takes into account both the happiness of the consumers and the contentment of the manufacturer. The enjoyment of the customers as well as the fulfilment of the needs of the business that made the product is taken into account by this approach.

By following these recommendations, future research can build upon the findings of this study and further enhance our understanding of the relationship between oil price volatility and economic development.

1. *Monitor and analyze oil price fluctuations:* Continuously track and analyze oil price trends and their impact on the economy. This will help in understanding the dynamics and identifying potential opportunities or challenges arising from changing oil prices.

2. *Enhance the linear programming model:* Improve and refine the linear programming model used in this research by incorporating additional relevant variables and refining the optimization techniques. This will ensure the model's accuracy and effectiveness in estimating the effects of oil price changes on the economy.

3. *Expand the scope of analysis:* Consider expanding the time span of the analysis beyond 2010–2020 to capture longer-term trends and fluctuations in oil prices. This broader perspective will provide a more comprehensive understanding of the relationship between oil prices and economic expansion.

4. *Validate the model with real-world data:* Conduct further cost-benefit analyses and validate the suggested model using real-world data on qualitative features of crude oil. This will help assess the model's applicability and reliability, enabling its successful implementation in future scenarios.

5. *Consider stakeholder perspectives:* Take into account the viewpoints and needs of both consumers and manufacturers when analyzing the impact of oil price volatility on the economy. A more comprehensive understanding of the consequences will be provided, as a result, of this, and it will also guarantee that the model takes into account the interests and satisfaction of all important stakeholders.

REFERENCES

1. Chen, Y., He, L., Li, J., & Zhang, S. (2018). Multi-criteria design of shale-gas-water supply chains and production systems towards optimal life cycle economics and greenhouse gas emissions under uncertainty. *Computers & Chemical Engineering, 109,* 216–235. https://doi.org/10.1016/j.compchemeng.2017.11.014
2. Coase, R. H. (2019). Economics and contiguous disciplines. In R. H. Coase (Ed.), *The organization and retrieval of economic knowledge* (1st ed., pp. 481–495). Routledge. https://doi.org/10.4324/9780429300769-26
3. Di Somma, M., Graditi, G., Heydarian-Forushani, E., Shafie-khah, M., & Siano, P. (2018). Stochastic optimal scheduling of distributed energy resources with renewables considering economic and environmental aspects. *Renewable Energy, 116*(Part A), 272–287. https://doi.org/10.1016/j.renene.2017.09.074
4. Galbusera, L., & Giannopoulos, G. (2018). On input-output economic models in disaster impact assessment. *International Journal of Disaster Risk Reduction, 30*(Part B), 186–198. https://doi.org/10.1016/j.ijdrr.2018.04.030
5. Garg, J., & Végh, L. A. (2019). A strongly polynomial algorithm for linear exchange markets. In *Proceedings of the 51st Annual ACM SIGACT Symposium on Theory of Computing* (pp. 54–65). Association for Computing Machinery. https://doi.org/10.1145/3313276.3316340
6. Goodarzian, F., Hosseini-Nasab, H., & Fakhrzad, M. B. (2020). A multi-objective sustainable medicine supply chain network design using a novel hybrid multi-objective metaheuristic algorithm. *International Journal of Engineering, 33*(10), 1986–1995. https://doi.org/10.5829/ije.2020.33.10a.17
7. Jarrett, U., Mohaddes, K., & Mohtadi, H. (2019). Oil price volatility, financial institutions and economic growth. *Energy Policy, 126,* 131–144. https://doi.org/10.1016/j.enpol.2018.10.068
8. Khodaei, H., Hajiali, M., Darvishan, A., Sepehr, M., & Ghadimi, N. (2018). Fuzzy-based heat and power hub models for cost-emission operation of an industrial consumer using compromise programming. *Applied Thermal Engineering, 137,* 395–405. https://doi.org/10.1016/j.applthermaleng.2018.04.008
9. Kolotilin, A. (2018). Optimal information disclosure: A linear programming approach. *Theoretical Economics, 13*(2), 607–635. https://doi.org/10.3982/TE1805
10. Malekpoor, H., Chalvatzis, K., Mishra, N., Mehlawat, M. K., Zafirakis, D., & Song, M. (2018). Integrated grey relational analysis and multi objective grey linear programming for sustainable electricity generation planning. *Annals of Operations Research, 269*(1), 475–503. https://doi.org/10.1007/s10479-017-2566-4
11. Markowitz, H. (1952). Portfolio selection. *The Journal of Finance, 7*(1), 77–91. https://doi.org/10.2307/2975974
12. Mo, B., Chen, C., Nie, H., & Jiang, Y. (2019). Visiting effects of crude oil price on economic growth in BRICS countries: Fresh evidence from wavelet-based quantile-on-quantile tests. *Energy, 178,* 234–251. https://doi.org/10.1016/j.energy.2019.04.162
13. Nemati, M., Braun, M., & Tenbohlen, S. (2018). Optimization of unit commitment and economic dispatch in microgrids based on genetic algorithm and mixed integer linear programming. *Applied Energy, 210,* 944–963. https://doi.org/10.1016/j.apenergy.2017.07.007
14. Nordhaus, W. (2019). Climate change: The ultimate challenge for economics. *American Economic Review, 109*(6), 1991–2014. https://doi.org/10.1257/aer.109.6.1991
15. Saeedi, M., Moradi, M., Hosseini, M., Emamifar, A., & Ghadimi, N. (2019). Robust optimization based optimal chiller loading under cooling demand uncertainty. *Applied Thermal Engineering, 148,* 1081–1091. https://doi.org/10.1016/j.applthermaleng.2018.11.122

16. Shuai, H., Fang, J., Ai, X., Tang, Y., Wen, J., & He, H. (2018). Stochastic optimization of economic dispatch for microgrid based on approximate dynamic programming. *IEEE Transactions on Smart Grid, 10*(3), 2440–2452. https://doi.org/10.1109/TSG.2018.2798039
17. Tirkolaee, E. B., Goli, A., & Weber, G. W. (2020). Fuzzy mathematical programming and self-adaptive artificial fish swarm algorithm for just-in-time energy-aware flow shop scheduling problem with outsourcing option. *IEEE Transactions on Fuzzy Systems, 28*(11), 2772–2783. ttps://doi.org/10.1109/TFUZZ.2020.2998174
18. van der Stelt, S., AlSkaif, T., & van Sark, W. (2018). Techno-economic analysis of household and community energy storage for residential prosumers with smart appliances. *Applied Energy, 209,* 266–276. https://doi.org/10.1016/j.apenergy.2017.10.096
19. van Eyden, R., Difeto, M., Gupta, R., & Wohar, M. E. (2019). Oil price volatility and economic growth: Evidence from advanced economies using more than a century's data. *Applied Energy, 233,* 612–621. https://doi.org/10.1016/j.apenergy.2018.10.049
20. Wang, G., Sharma, P., Jain, V., Shukla, A., Shabbir, M. S., Tabash, M. I., & Chawla, C. (2022). The relationship among oil prices volatility, inflation rate, and sustainable economic growth: Evidence from top oil importer and exporter countries. *Resources Policy, 77,* Article 102674. https://doi.org/10.1016/j.resourpol.2022.102674
21. Zhang, S., Liu, L., Zhang, L., Zhuang, Y., & Du, J. (2018). An optimization model for carbon capture utilization and storage supply chain: A case study in Northeastern China. *Applied Energy, 231,* 194–206. https://doi.org/10.1016/j.apenergy.2018.09.129
22. Zhao, J., Liu, S., Zhou, M., Guo, X., & Qi, L. (2018). Modified cuckoo search algorithm to solve economic power dispatch optimization problems. *IEEE/CAA Journal of Automatica Sinica, 5*(4), 794–806. https://doi.org/10 .1109/JAS.2018.7511138