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Impact of COVID-19 on environmental regulation and economic growth in China: A Way forward for green economic recovery

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ABSTRACT

The COVID-19 pandemic has caused turmoil in every aspect of life and may be prevalent for years. Therefore, this study aimed to determine whether the pandemic reflects oil prices in China. We utilized a model to simulate and examine the energy, economic, and environmental effects of COVID-19, which affects a wide range of industries and households. The impact of the pandemic is considered in terms of customer expectations and factor input changes. Based on these changes, we find that factor input changes are the primary cause of the economic recession. We further find a parallel relationship between CO2 emissions and economic downturn. In addition, a reduction in transportation has significantly influenced the Gross Domestic product (GDP), which plunged during the pandemic period by 0.49%. Transportation negatively influences industrial production, railway sector, and air transportation by 10.17%, 1.76%, and 1.53%, respectively. Based on these findings, this study proposes important policy implications.

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1. Introduction

SARS-CoV-2 is a novel coronavirus strain responsible for the acute viral infection known as COVID-19. On March 11, 2020, the World Health Organization (WHO) declared that the disease had reached pandemic levels. Fear caused by the virus had a significantly negative impact on every aspect of society. This further caused a steady decline in the sustainability of the economy over the long run. The spillover model analyzes and conducts simulations on the effects of pandemics and rising oil costs on various enterprises and households in China. Several COVID-19 studies incorporate energy and economic inputs to decouple the influences on a country's infection rate, mortality rate, and increase in gross domestic product (GDP) (Sheng, 2020). The low-carbon economy saw crude oil prices decline by 66% globally. However, due to the COVID-19 pandemic, worldwide carbon emissions have decreased (Mohsin et al., 2022). This is understandable in light of the present economic depression. Pandemics' severe impacts on world oil prices have a dual influence on 75% of the economy, particularly in emerging economies. Another way to mitigate this impact is to adjust the price differential between fossil fuels and renewable fuels (for example, by raising the carbon tax) and provide inhabitants with adequate tax credits (IMF, 2012).

Furthermore, COVID-19 policies have been implemented for environmental protection. First, the analysis reveals that a fall in transportation demand substantially affects China's macroeconomy. The GDP fell sharply during the pandemic, decreasing by 0.51%. Second, all modes of transportation and life growth are inextricably linked (Shah et al., 2019).

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List of the main Nomenclature

COVID-19	Corona Virus Disease 2019
WHO	World Health Organization
OPEC	Organization of Petroleum Exporting Countries
CIF	Cost Insurance and Freight computable
GEG	General equilibrium
GDP	Gross Domestic Product
CIOT	China Input–Output Table
SAM	Social Accounting Matrix
TFP	Total Factor Productivity
AEEI	Autonomous Energy Efficiency Improvement
PFP	Proactive Fiscal Policy

The spread of the virus slowed the output across the board. The road transport industry saw the most significant drop in production (10.17%), followed by the railway sector (1.76%) and the air transport sector (1.76%); daily cases effects declined global transport by 1.66%. In addition to transportation, the service sector is also experiencing a downturn. Finally, investing in transportation infrastructure may help the economy grow and create employment. Furthermore, rail transportation is more cost-effective than road and air transportation. These statistics demonstrate the economic impact of a considerable decrease in transportation usage (Zhang et al., 2021).

This study was conducted in three stages. Stage 1 falls are primarily caused by a rebound in crude oil prices following the initial spike (Agyekum et al., 2021). Indeed, Organization of the Petroleum Exporting Countries (OPEC) members began lowering output towards the end of the year, and oil prices rose as the year progressed. In Stage 2, COVID-19 triggered an oil price decrease in late March 2020. Based on COVID-19 data from the Ministry of Public Safety traffic management, road traffic plummeted considerably during the Chinese New Year. At the same time, the collapse of a significant airline had a significant impact on the global aviation business. Road traffic dropped by more than 80%, notably on the sixth day after the Chinese New Year vacation. China's oil consumption and worldwide demand for aviation fuel fell considerably in the near term because of the outbreak, significantly influencing global supply and demand for crude oil. In Stage 3, on March 6, oil consumption dropped dramatically because of the economic pressures brought on by the worldwide pandemic. The data from the world bank shows the OPEC+ "failure" generated a significant mismatch between present petroleum supply and demand and expectations.

The pandemic concerning global issues in the first half of 2020 started to be realized (Xiuzhen et al., 2022). On the other hand, the Chinese government was streaked after investing in the US stock market, and oil prices fluctuated. China's apparent consumption in 2019 suggests that it is now 72.6% dependent on imported crude oil. Primary domestic crude oil production costs more than $50 per barrel with a reserve of less than 11 years. The outcomes of these investigations have led to several issues. China's international oil prices are decreasing, which will help future oil and gas enterprises. Moreover, the COVID-19 impact is significant enough; it can cascade on financial markets and the entire economy (Ullah et al., 2020). China's local governments and policymakers face obstacles in developing, designing, and managing the present energy system and progressively transitioning it to an innovative and sustainable model using a holistic thinking paradigm.

This study examined the energy, economic, and environmental effects of COVID-19, both positive and negative, on the world economy and environment beginning in 2020. This mechanism has not yet been studied during the pandemic. Therefore, this is the first study to explore such a mechanism to understand the growing impact of Covid-19 on oil prices, transportation, and household families. The COVID-19 pandemic has reduced financial growth and energy demands. Owing to the decrease in the pandemic, the demand for global oil increased, which aided the drop in oil prices. Perhaps the energy intensity index will increase in the next two years. While not very helpful for low-carbon development, this study evaluates the impact and response to the COVID-19 pandemic. In our findings, reducing production factors is the main reason pandemics negatively impact the economy. As a result, safe and proactive work and the resumption of production will significantly affect reductions; falling oil prices may have a short-term effect. Low-carbon policy instruments such as carbon taxes must be used to achieve a long-term decline. Thus, a carbon tax cycle must be created to counteract the detrimental impact of taxes on social welfare. The remainder of the paper is structured as follows. Section 2 presents the relevant literature and theoretical background. Section 3 presents the methodology and data. The empirical analysis and conclusions, including policy implications, are presented in Sections 4 and 5, respectively.

2. Literature review

Social scholars have rarely researched the interconnected mechanisms of energy, economy, and environment during the time of COVID-19 (Organization, 2020). COVID-19 is widely acknowledged to have an enormous negative economic impact by lowering energy costs and carbon dioxide emissions (Mohsin et al., 2022). According to the Umair and Dilanchiev (2022) the virus significantly impacted the transportation industry. In addition, the air quality suffered because of the blockage. COVID-19 control is costly but required (Song et al., 2021). It has been shown to improve air quality. Using pandemic-related objectives to accomplish sustainable development goals, is risky (Darling et al., 2022). The most effective and realistic strategy for a pandemic is to work online to reduce turnover. New modes of working and living, institutional reforms, new technologies, and reintegration can open new doors to the world (Baldwin and Tomiura, 2020). However, new processes that require powerful hardware and software support may fall disproportionately in developing and emerging economies (Maithya et al., 2022).

Although the COVID-19 pandemic has resulted in severe economic losses, emission reductions are insufficient (Ren et al., 2022). People's income and costs are reduced due to foreclosure techniques, influencing companies' and other citizens' incomes. Consequently, the entire economy may be sent into a tailspin (Mohsin et al., 2022). An extensive study has been conducted to estimate the economic impact of the pandemic. We examine COVID-19's influence on China's macroeconomic and agri-food sectors. The pandemic has had an impact on carbon dioxide emissions. However, this effect is negligible (Mohsin et al., 2021). Carbon dioxide emissions are expected to rise over the next two years. The investigation will occur from March 2020 to August 2020, coinciding with the first wave of the COVID-19 pandemic. Some academics have examined the impact of pandemics. Dilanchiev and Taktakishvili (2022) exemplify this. The econometric model examines the influence of the Belgian economy on carbon dioxide emissions.

However, this study did not consider the influence of oil prices on carbon dioxide emissions. The falling oil prices caused a wave of economic instability in April 2020. Sharif et al. (2020) estimated Australia's trajectory toward lowering emissions, boosting GDP, and expanding employment using an alternate (econometric) model. To encourage economic recovery, they advocate tax cuts and mixed laundering policies. However, this analysis obscures the government's burden. As most econometric models disregard the consequences of fiscal deficits, almost all the models reach the same conclusion. Tax cuts and strategies can boost economic growth and enhance people's lives. However, the model does not account for the impact of an expansionary fiscal policy, which may distort the model and its suggestions. Coibion et al. (2020). China's biggest, second-largest, and most diminutive trading partners. This study addresses literature gaps and provides policy implications for the COVID-19 situation in China and other countries.

Some scholars have also been interested in the consequences of fluctuations. According to Daniel (2020), the dynamic growth of the world oil market remained a concern throughout the 2008 global financial crisis, and equities and commodities in the financial market were influenced by global pricing. Although this study focuses on declining oil prices, their influence on energy surges cannot be overlooked. When oil prices fall, how people use and store them is the first thing that changes. The COVID-19 pandemic lowered oil consumption by raising prices, as demonstrated in Section 2. Long-term impact and reaction are the primary subjects of this study. As previously mentioned, certain conclusions need to be discussed further, and some sources examine the influence in countries other than China. Further, this study tries to fill the knowledge vacuum by assessing the overall impact of the COVID-19 pandemic in the context of China's recession.

According to neoclassical economic theory, a prolonged period of rapid development over the long term requires an equally rapid increase in total-factor output. It is widely agreed that investments in transportation infrastructure are crucial to long-term economic growth because they affect total factor output growth across three key dimensions: technological sophistication, allocation effectiveness, and economies of scale. Specifically, transportation infrastructure development helps to encourage and grow inter-regional exchanges of individuals and products, pushing the spread of information and technology, optimizing resource allocation, and fostering market expansion and economic agglomeration.

However, transportation restriction regulations were considered the most popular tools for pandemic control and prevention in China during the COVID-19 outbreak, which reduced transportation facilities and ultimately caused an economic downturn. However, tourism and airlines have remained stable. Using quantitative cross-sector analysis, researchers have found that traffic control regulations significantly impact the tourism sector. Marek (2021), Romagosa (2020), and Jones et al. (2017) are only a few of the studies that have looked at the topic of sustainable tourism development during an epidemic (2020). In addition, Liu et al. (2020) examine the aviation sector's development following traffic limits by estimating the volatility of stock indices in Chinese Airport Shipping set at the industry and business levels.

In addition, the sustainable development problems of international trade and supply chains posed by transportation constraints during the COVID-19 pandemic were significant. According to Kumar et al. (2020), the breakdown of transportation linkages and distribution systems among suppliers, manufacturers, and customers poses a threat to sustainable production methods. Food distribution networks have suffered the most. According to research by Narasimha et al. (2021), the marine industry is responsible for 90% of the affected worldwide commerce. Shipping and border delays, as a direct result of traffic limitations, have caused a considerable increase in trade expenses and significantly affected international commerce.

Considering this evidence, we stress that transportation constraints negatively influence economic recovery. The existing literature considers this component to be one of the fundamental drivers of the pandemic. Transportation should be analyzed separately as an economic element. There are conflicting findings regarding the influence of transportation systems on economic development. Thus, we propose using traffic limitations to examine the impact of transportation on economic recovery. China has 34 states which are interrelated; therefore, regional peculiarities must be considered when studying the effects of enormous transportation limitations.

2.1. Theoretical background

At present, short- and long-term oil price volatility and the impact of COVID-19 affects the Chinese economy (Organization, 2020). The influence of pandemics on energy consumption is an underlying background pattern in the medium- and long-term. Meanwhile, due to market share conflicts among (OPEC + nations), crude oil prices will have decreased dramatically in the near future. Renewable energy development will significantly influence a country's health and environmental issues and decrease the motivating energy demand. However, its overall influence on society's productivity is uncertain.

On the other hand, pandemics rapidly impact company productivity, restricting home consumption and, as a result, the primary energy of CO_2 emissions and social output. These two factors have an impact on China's economy. The government and private sector, influencing energy prices and even pandemics, adequately respond to second, afflicted economies. For example, falling oil prices benefit strategic oil reserves and temporarily raise oil prices. The expanding economic effects of the pandemic will require governments to balance these effects with recessive forces. It adds to the medical equipment production capacity and the worldwide prevention and management of pandemics.

On the other hand, the retrograde steps and the COVID-19 pandemic are still unknown. Despite the government's efforts, the number of infected people progressively tracks logistical functions but with some ambiguity. The threat of viral mutations and the requirement of governments to balance economic and epidemiological pressures have prompted these concerns. Consequently, the price of crude oil fluctuated dramatically. The first question is how the extent and length of the outbreak would affect the economy and energy consumption. The second question is how much OPEC + capacity will expand or decrease in a given situation and how large a production gap will result. The oil prices were also affected. This study employs an econometric model to analyze the influence of these critical events, volatility and COVID-19, in the Chinese economy in 2020, based on the explanation above. The Pandemic can be simulated and analyzed. The Chinese economy has boomed. Savings, energy usage, and carbon dioxide emissions were all considered in this model.

We create precise assumptions for these two events–people's buying power, raw material pricing and output, and international trade–to study further and explain which sectors of the Chinese economy are affected. Governments generally favor the former when balancing stability, economics, and ecology (Froneman, 2013; Wang and Wang, 2020; Wang and Zhi, 2016). This research benefits from climate change and renewable energy sources (RES), but other concerns might not be as strong as stability in the post-COVID-19 age. In particular, carbon emissions decreased with time. As a result, COVID-19 is one of the most significant roadblocks to low-carbon development. Furthermore, because of the fall, the cost of replacing fossil fuels is lower than that of renewables, posing a significant impediment to low-carbon growth. As a result, it is vital to re-evaluate the effectiveness of low-carbon growth policies, such as renewable energy finance.

3. Data and methodology

3.1. Analyses using three leading indicators (1. Energy 2. Economic 3. Environmental)

Econometric models are frequently used to examine the impact of policies and events. This study employs the econometric model of China's energy-economic-environmental analysis. It enables us to swiftly assess a simulated event's environmental, energy, and economic consequences (Dixon and Rimmer, 2016). Moreover, the Leontief function of inputs and intermediate components is the most fundamental feature of production technology (excluding energy inputs). Factorial input is blended with labor input (KE input; a set of capital and energy inputs). The inflow (KE) function of capital and energy inflows utilizes a constant elasticity of substitution (CES). Use the combined electricity and fossil fuel (ESC) option to represent overall energy intake. The CES function breaks fossil fuels into primary and refined petroleum. The nesting model for the significant fossil energy input ray and the nonsolid energy input ray is identical to the primary fossil energy input ray nesting model. Thermal and nonthermal electricity generation are intertwined in the production of electricity.

The latter includes hydropower and other renewable energy sources such as nuclear, wind, and solar. All of these were based on a function (ESC). According to an econometric model, the functional plasticity (ESC) of primitive fossil energy sources has been discovered in the energy conversion sector, such as the conversion of electricity and oil (Dixon et al., 2013). It is zero. Leonchev's production technique, not production technology, is responsible for most fossil fuel buildup in the energy processing business. The national production of production blocks provide company income and is connected to the balance between income and expenditure blocks. It also connects the transaction blocks to the blocks.

Companies must determine their product market share in domestic and international markets. The intake of coal, crude oil, and natural gas, when multiplied by the carbon dioxide emission factor, equals emissions. These primary fossil fuel inputs are the glue that holds the production in the energy environment. Further, we used an econometric model, which often presumes that items made in the same industry are comparable and consistent. Incorporating this assumption directly into the model makes it difficult to account for simultaneous imports and exports of identical goods. However, both imports and exports occur within the same nation. The Armington hypothesis is included in this analysis, as in another econometric model. The Armington hypothesis states that a model's inhabitants and companies do not directly consume or use native or imported goods.

Domestic products equal to Armington products created from imported items and are consumed domestically using the CES manufacturing function (Dixon et al., 2010). This model also implies that producers must compute the supply share in the home and international markets. It is essential to offer items according to the target market criteria and transport them to both markets. The Constant Conversion Elasticity (CET) function explains the conversion process in this article. The econometric model included a single nation, several sectors, and multiple families. The world is considered to be a distinct economic unit. Applying a multiregional empirical model allows enterprises and individuals to access more information. Because this study focuses primarily on the overall impact in China, the single-regional econometric model is better than the multiregional econometric model. The aggregate of all home activities is known as household consumption (or the consumption of amino products). In a commodity market such as this, market equilibrium is required. As a result, commodities connect the international trade macroeconomic blockade and the macroeconomic blockade of shutting and clearing markets. Because consumption is the total personal consumption and seller's revenue, it is connected to the income–expenditure block. A trade surplus is created when imports and exports balance. This macro-closure issue involves the relationship between macro-closures and market clearing. The equilibrium block depicts economic interactions between a society's economic units. Governments, national enterprises, urban and rural people, and other sectors perform the economy's primary functions.

Entities, except the government want to maximize earnings. Businesses strive for maximum profit, and two types of inhabitants strive for maximum profit as well. As a result, this study analyzes the maximizing behavior of economic agents and determines their behavioral preferences. Businesses encourages residents to work and invest money. Consumption, savings, and direct taxes are part of the family's income. The proceeds from a company's asset sale are used to buy intermediate inputs, pay employees' wages, pay indirect taxes, and save money. The authority makes money by charging direct and indirect taxes, and customs fees and spends it on consumption, savings, and government remittances. Products created in other nations are supplied by foreign enterprises to people, corporations, and governments in the United States.

International corporations purchase local goods and pay customs fees. The discrepancy between income and spending represents a trade deficit. This block illustrates the entire cash flow between organizations and the connection between income and costs. This block links all blocks except the energy environment block. Most of these have already been mentioned, such as linkages to production and trading blocks, macro closures, and market-clearing blocks. A balanced budget is a prerequisite for macroeconomic closure. As a result, government actions affect not only this sector but also macroeconomic closure and market clearing. The Energy environment component relates the energy input and output data to information on actual energy usage in the company to assess the relationship between energy consumption and CO_2 emissions. The Fujimori technique (Baldwin and Tomiura, 2020; Bollain-Parra et al., 2021; Newton et al., 2021). The transitional energy input from the input–output sheet is linked to the actual energy consumption using a linear equation. The carbon dioxide emissions related to energy use can be calculated using the carbon dioxide emission factor. As this study does not explain carbon costs, this block is related to production blocks.

This study focuses on three balance rules from macroeconomic closures: state budget balance, trade balance, and the balance between investments and savings. The revenue and cost blocks define these three principles; thus, they are not repeated here. All savings are converted into investments in this paradigm, and the overall investment equals the total endogenous savings. Consequently, this strategy is predicated on cost reduction. Market regulation is a model that represents the supply and demand balance across all marketplaces. Two compensation criteria were developed for this post. One is commodity market clearing, wherein inhabitants and the government employ all amino compounds for consumption, savings, and intermediate investments. Second is the liquidation of the object market. The influx of labor and capital into society equals the income from work and the capital of urban and rural people in a particular period.

3.2. Indicators and data

The Social Accounting Matrix (SAM) is created using the Input-Output(I/O) Table 1. I/O table is a major data source for the econometric model. To research energy issues, an energy balance graphic was created. The Chinese Statistical Yearbook provides data for this table. The (CO_2) emissions discussed are exclusively due to energy expenditure, biological respiration, microbial degradation, and carbon sinks compared to the 2019 Global Carbon Balance. According to the announcement, land and marine bases were not covered. Emissions from the 139 carbon dioxide divisions were reorganized into 19 new divisions. In this study, the classification of rural and urban households was different.

3.3. Empirical model

Following Baldwin and Tomiura (2020), it was found that the Covid-19 impacts on energy, economy, and environment for capital depreciation, use present capital, depreciation rate, and equity investment; four variables are modeled as follows:

$$\text{Capital stock}_{\text{it}} = \text{f}\,(CI_{it}, \text{SAM}_{it}, GF_{it}, W_i) \tag{1}$$

$$\text{Capital depreciation}_{\text{it}} = \alpha_{1it} GF_{it} + \alpha_{2it} CI_{it} + \alpha_{3it} NFE_{it} + W_i + u_{it} \tag{2}$$

where the dependent variable for a country is the subscript $i(i = 1, 2, \ldots, N)$ and i indicates the time $t(t = 1, 2, \ldots, T)$ in Eq. (2), where u is a stochastic random expression: The set of Chinese input–output table variables is given as, where W_i the country fixed effect is $\mu_{i,t}$ and is the error term.

Table 1
Selected indicators.
Source: Authors compilation.

No	Variable type	Variable description
1	Input	Capital depreciation
2	Input	Capital stock
3	Control	AEEI
4	Output	Equity investment

We selected China for the empirical estimation of the econometric model based on data availability and policy of using a balanced panel. Although measurement units explain the variables more, the balancing approach causes a few issues, such as eliminating personal effects due to the contrast method. Second, when the time variable "T" presents a significant problem, the instrumental variable strengthens the poor instrument problem. Considering the first distinction between the one-step system, cointegration, the two systems–casual collaboration–have a negative relationship. The cointegration estimator provides more resources for improved performance. Restricted data and a lack of observations on emerging countries form part of this study's significant constraints (i.e., panel imbalance). Second, in the data sample, China had net capital accumulation, population increase, and technology development. Capital amortization equals capital expenditure and selected indicators in Table 1.

3.3.1. Levin, Lin, and Chu (LLC) unit root test

Several pooled panel unit root tests with different specifications were produced to evaluate individual-specific intercepts and time trends. Although the intercept and trend may vary across individual sequences, their test imposes uniformity on the autoregressive coefficient, which indicates the presence or absence of a unit root issue. The following steps show that the LLC unit root test uses Augmented Dickey Fuller (ADF) regression to investigate the unit root hypothesis. We apply the ADF regression separately for all of China.

$$\Delta \mathrm{y}_{\mathrm{i,t}} = \alpha_{\mathrm{i}} + \mathrm{p}_{\mathrm{i}}\mathrm{y}_{\mathrm{it-1}} + \sum_{\mathrm{j=1}}^{\mathrm{p_i}} \alpha_{\mathrm{i,j}} \Delta \mathrm{y}_{\mathrm{i,t-j}} + \varepsilon_{\mathrm{i,j}} \tag{3}$$

Specific countries are allowed to use lag order p_i. Having allowed the full lag order, following this, the t-statistics for ij b is used to decide whether a smaller lag order is desired. This is how the appropriate lag period is determined.

The residuals from running two different regressions are saved

$$\tilde{\eta}_{\mathrm{it}}, \Rightarrow \tilde{\mu}_{\mathrm{i,t-1}} \Delta \mathrm{y}_{\mathrm{i,t}} = \eta_{\mathrm{i}} + \sum_{\mathrm{j=1}}^{\mathrm{p_i}} \mathrm{y}_{\mathrm{i,t-j}} \Delta \mathrm{y}_{\mathrm{i,t-j}} + \eta_{\mathrm{i,t}} \Rightarrow \tilde{\eta}_{\mathrm{it}} \tag{4}$$

$$\mathrm{y}_{\mathrm{i,t-1}}. = \partial_{\mathrm{i}} + \sum_{\mathrm{j=1}}^{\mathrm{p_i}} \mathrm{l}_{\mathrm{i,t-j}} \Delta \mathrm{y}_{\mathrm{i,t-j}} + \mu_{\mathrm{i,t}} \Rightarrow \tilde{\mu}_{\mathrm{i,t-1}} \tag{5}$$

The LLC method indicates that the errors are standardized use the ADF theorem to regress capital accumulation, population increases, and technology development. Capital amortization equals capital expenditure.

$$\tilde{\eta}_{\mathrm{it}} = \frac{\tilde{\eta}_{\mathrm{it}}}{\hat{\sigma}_{ei}}, \tilde{\eta}_{\mathrm{it-1}} = \frac{\tilde{\eta}_{\mathrm{it-1}}}{\hat{\sigma}_{ei}} \tag{6}$$

Eq. (5) measures the statistical panel test using a regression for capital accumulation, population increase, and technology development. Capital amortization equals capital expenditure.

$$\tilde{\eta}_{\mathrm{it}} = \alpha \tilde{\eta}_{\mathrm{i,t-1}} + v_{i,t} \tag{7}$$

H_0 Is the null hypothesis $(\mathrm{p}_1 \ldots\ldots = \cdots ..\mathrm{p}_{\mathrm{n}} = \mathrm{p} = 0)$, and H_{a} *the* alternative hypothesis is $(p_1 \ldots\ldots equel\ to \ldots..p_n = p =< 0)$.

3.3.2. Panel test

A panel unit root test was conducted on a homogeneous panel. The ADF test is adapted to individual series, allowing each series to have short-run dynamics. However, the mathematical mean of different COVID-19 cases was used in the overall t-test. Assume $(\mathrm{AEEI}_{ti}, EC_{ti})$, that the ADF can describe a string (without a trend).

$$\Delta \mathrm{x}_{\mathrm{i,t}} = \overline{\omega}\mathrm{j} + \overline{\omega}\mathrm{ix}_{\mathrm{i,t-1}} + \sum_{\mathrm{j=1}}^{\mathrm{p_i}} \varnothing_{\mathrm{i,j}} \Delta \mathrm{x}_{\mathrm{i,t-j}} + \nu_{\mathrm{i,t}} \tag{8}$$

The ADF test has specific modification lags for each nation; in multiple measurements, the expressions $E(t_T)$ and $var(t_T)$ are followed by the tabulated values of the corresponding group averages, such as $E(t_T, P_i)$ and $var(t_T, P_i)$, respectively.

Table 2
Indicators of Capital stock and AEEI econometric model.

Indicator's description	Depreciation rate	Capital stock	AEEI
Agriculture_forestry_animal_husbandry and fishery sector	5.0%	4516	2.5%
Industries of mining activities and cleaning	6.2%	1550	0.6%
Exploitation of petroleum	6.5%	1174	0.6%
Exploration of natural gas	6.5%	263	0.6%
Chemicals made from refined oil	6.5%	1353	0.6%
Smelting and rolling of metals	5.5%	6364	1.5%
Products made of metal	5.5%	7085	2.5%
Thermal energy production	5.5%	1527	2.0%
generation of hydropower	4.8%	6423	2.5%
Generation of wind energy	4.8%	2029	2.5%
Nuclear generation	4.8%	500	3.5%
Solar energy production	4.8%	156	2.8%
Transportation, warehousing, and postal services are all part of the transportation, warehousing, and postal services	4.8%	29	3.5%
Real estate construction, lodging, and catering	5.2%	9654	3.3%
a different industry	5.5%	2993	0.6%
Services sector	4.5%	38,443	2.3%

Notes: The capital stock is expressed in billions (CNY in 2018).

Under its alternative hypothesis, IPS testing enables capital accumulation, population increases, and technological development. Capital amortization equals capital expenditure, and the value $\overline{\omega}i$. This is much more critical and efficient than a single time series test.

3.4. Selected variables

The three selected variables of the model dynamics discussed in this study are capital accumulation, population increase, and technological development. Capital amortization equals capital expenditure. Using the perpetual inventory technique, capital depreciation was calculated. The present capital, depreciation rate, and equity investment was used to obtain the capital depreciation. The capital amortization rates are listed in Table 2.

The Econometric model estimation using these variables and their description, including (1) The Autonomous Energy Efficiency Improvement (AEEI) and (2) the Total Factor Productivity (TFP) parameter, is a critical component for the dynamics of the econometric model. Several econometric models use the GDP as the leading indicator and TFP endogenous variables to estimate AEEI and TFP. This approach can accurately replicate the model's GDP results in real GDP; nevertheless, this method often assumes that each industry's total productivity is equal. This research aims to differentiate various growth stages of industries. Hence, an annual direct exogenous index (AEEI) was constructed along with relevant literature, information matrix, heterozygous anomaly tree, and unusual kurtosis decomposition tests. Equal variances are rejected, as is aberrant asymmetry/kurtosis. This mistake indicates that the constant variance is improper. The statistical significance of individual coefficient values was calculated using significant standard errors to account for variability. Quantitative regression was used to re-evaluate the underlying model in the presence of petroleum manipulation.

3.5. Contributions of the paper

The effects of the COVID-19 pandemic on the price of oil volatility on primary energy, economy, and environment indicators are studied using the same reference model. The findings of this study reveal that the pandemic's destructive economic impact outweighs its negative influence on environment and energy indicators. The pandemic is a significant impediment to expanding renewable energy (RE). Falling oil costs have a substantial influence on renewables compared with fossil fuels. Therefore, China's RE growth must continue after and during the pandemic.

(1) The study's conclusion highlights the significance of returning to work and cautions that reducing carbon emissions by 2020 will be due to the collapse of the economy, not technical advancement. As a result, it is becoming increasingly vital in the post-COVID-19 era to apply a zero-carbon policy and prevent the unrestrained growth of fossil fuel energy from oil.

(2) Carbon taxes and other zero-carbon level policies in China may effectively address low energy prices in the long run, but their impact on consumers must be addressed. In response to these two issues, this study recommends several counter measures. Use the recycling method if necessary. Another technique is required to restore factor-taking to normal and return to work securely during the COVID-19 pandemic. This is the best and only adequate method to reduce the adverse economic impacts of the pandemic.

Table 3
Socio-economic impact of transportation during the COVID-19 pandemic.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
GDP	−0.22%	−0.51%	−0.37%	−0.39%	−0.28%
Stock	−0.33%	−0.70%	−0.52%	−0.44%	−0.50%
Depletion	−0.32%	−0.80%	−0.59%	−0.53%	−0.39%
Service	−0.20%	−0.45%	−0.41%	−0.31%	−0.50%
Goods Import	−0.30%	−0.40%	−0.31%	−0.41%	−5.40%
Export Goods	−0.9%	−0.19%	−0.28%	−0.21%	−0.77%

Table 4
Results of a simulation of the economic impact of transportation investments.
Source: Author calculation.

	Model 1	Model 2	Model 3
GDP	0.30%	0.09%	0.16%
Consumption	0.20%	0.13%	0.10%
Labor demand	0.21%	0.09%	0.11%
Agriculture, forestry, animal husbandry and fishery	0.02%	0.09%	0.02%
Mining and Dressing	0.09%	−0.09%	−0.05%
Manufacturing	0.55%	0.31%	0.16%
Electricity, heat, gas and water production and supply industry	0.31%	0.04%	0.17%
Building industry	0.19%	0.03%	0.06%
Service industry	0.20%	0.09%	0.20%
Railway transport	5.70%	0.04%	−0.27%
Road transport	0.19%	3.10%	0.20%
Air transport	−0.04%	0.09%	7.60%

4. Empirical results and discussion

4.1. Socioeconomic impact during the COVID-19 pandemic

The socioeconomic impact of transportation used during the COVID-19 pandemic is shown in Table 3, representing China's macroeconomic performance, which is significantly impacted by reducing transportation costs. Based on the findings of each simulation, Table 3 lists the macroeconomic impacts of transportation usage.

This study focusses on analyzing the fluctuation in transportation consumption at the commencement of the COVID-19 pandemic In the first stage GDP decreased by 0.18%; whereas in Phase 2 it was most severe, with the GDP decreasing by 0.49%. Between the second and fifth stage, consumption decreased by 0.75%, 0.51%, 0.46%, and 0.43%, respectively. More specifically, in the third stage, the GDP fell by 0.35%, followed by 0.31% in the fourth and 0.31% in the fifth stage, respectively. The decrease was approximately 0.22% at each stage. Consumption was the macroeconomic variable with the most significant negative influence. Owing to decreased transportation demand and the COVID-19 pandemic, consumption plummeted.

Furthermore, a reduction in transportation significantly influenced imports and exports, with imports having the most significant impact. The decrease in transportation demand had a severely detrimental impact on the economy throughout the pandemic. The decline in transportation demand had the biggest impact on the economy during the pandemic's most effective variables affecting China's GDP. Potential changes in energy consumption include the exchange rate, energy consumption structure, and carbon dioxide emissions. Moreover, other activities are inextricably linked to the transportation sector. The influence of transportation usage on many sectors, including agriculture, mining, manufacturing, power, heating, water, natural gas production and supply, construction and services, rail, road, and air transportation, is described in this section. The simulation findings reveal that each sector's production decreases when traffic demand decreases, as shown in Table 4. As a result, transportation consumption affects productivity at every stage of life. To address the COVID-19 scarcity caused by the pandemic, the government and transportation organizations have expanded their spending in the transportation sector. For example, transportation capital investment increased by 9.8% to 2.51 trillion yuan in the first three quarters of 2020. As a result, utilize econometric simulations are used to assess the economic benefits of transportation infrastructure investments based on changes in transportation investments. Train, road, and air travel are the three forms of transportation discussed expressly. It is assumed that the rate of investment increase is the same for all forms of transportation. The simulation results are presented in Table 4.

Table 4 shows the results of a simulation of the economic impact of transportation investments.

The findings suggest that rail, road, and aviation infrastructure improvements can boost GDP growth. When compared the simulation results for the three modes of transportation, indicated that rail investments influence GDP growth. A 10% increase in railway infrastructure investment would boost GDP by 0.2%. Compared with the other two means of transportation, it dramatically influences household expenditure and employment. Increased investment in transportation

Table 5
Quantile regression of the impact of supply chain performance in China.

Impact of:	Aggregate supply chain			Supply chain input			Supply chain output		
	−5.1	−5.2	−5.3	−5.4	−5.5	−5.6	−5.7	−5.8	−5.9
Quantile:	Q25	Q50	Q75	Q25	Q50	Q75	Q25	Q50	Q75
SClogistics	0.018***	0.003	−0.005						
	−0.004	−0.004	−0.004						
SCinput				0.012***	−0.001	−0.006			
				−0.004	−0.003	−0.004			
SCoutput							0.017***	0.003	0.002
							−0.004	−0.004	−0.005
GDP(*t* − 1)	−0.017**(0.004)	−0.09***	−0.009**	−0.020***	−0.010***	−0.007*	−0.020***	−0.0098***	−0.008***
		−0.004	−0.004	−0.003	−0.004	−0.004	−0.005	−0.004	−0.004
INVESTMENT	0.019***	0.020***	0.020***	0.019***	0.020***	0.020***	0.019***	0.015***	0.0189***
	−0.007	−0.004	−0.01	−0.007	−0.006	−0.006	−0.01	−0.005	−0.006
Employment Growth	0.290***	0.190***	0.129	0.270***	0.189***	0.14	0.269***	0.200***	0.106
	−0.01	−0.079	−0.079	−0.089	−0.069	−0.089	(0.99.9)	−0.079	−0.079
Human Capital Index (HCI)	0.020***	0.0099***	0.010***	0.009***	0.009***	0.010***	0.020***	0.010***	0.006
	−0.01	−0.006	−0.005	−0.006	−0.005	−0.004	−0.007	−0.005	−0.005
Land Locked Countries	0.002	0.0099	0.00099	0.003	0.0009	0.003	0.002	0.002	0.005
	−0.005	−0.004	−0.004	−0.003	−0.005	−0.005	−0.005	−0.005	−0.005
H_0:Q25 = Q50 = Q75		7.89***			10.20***			4.89***	
(Logistics measure)		[0.000]			[0.000]			[0.009]	
Observations	513	513	513	513	513	513	513	513	513
Pseudo R-squared	0.145	0.163	0.178	0.134	0.163	0.181	0.145	0.163	0.177

Notes: Asterisks indicate the following degrees of significance. Author calculation.
*p0.1.
**p0.05.
***p0.01.

infrastructure may increase labor demand. In Scenario 1, labor demand rises by 0.18%, 0.06% in Scenario 2, and 0.09% in Scenario 3. and Investments in the transportation infrastructure can boost consumer spending. As transportation infrastructure investments rise, the value of consumption and labor demand increase.

4.2. Quantile regression of the impact of supply chain

Table 5, Quantile regression of the impact of the supply chain; additionally, concurrent economic development and supply network logistical performance might influence supply chain performance. As a result, this endogeneity is explained in Table 5 by calculating the Although a fixed term is included, it is omitted. In brackets, typical bootstrap mistakes (100 duplicates) are listed. Q25 denotes the twenty-fifth percentile, Q50 the fiftieth (middle) percentile, and Q75 the seventieth percentile.

The progression of GDP under several scenarios for 2020. It is worth noting that all scenarios accounted for the fixed-price value of production in 2012. Changes in the consumption structure have little influence on the economy (up to 0.058%). Another conclusion is that halving China's GDP reduces rather than increases it (0.957%). This is mainly because the domestic oil business was severely harmed. The revenues earned by lower worldwide oil output are insufficient to compensate for local oil industry losses. The impact of COVID-19 on the economy has been demonstrated to be far more extensive than the drop in global oil prices.

We also determined the cause of the economic downturn. The GDP fell by 9.431% under the COVID scenario. The rates of change for the supply and consumption sides of the economy were 9.484% and +0.058%, respectively. In other words, item procurement has become a major issue for the Chinese economy. These findings also explain why the Chinese government encourages enterprises to return to work and produce.

4.3. Post-COVID-19 commodity market

The findings reveal that COVID-19 has a modest influence on commodity prices, with most commodities experiencing a decrease of less than 3%. The pandemic will cut commodities prices from 0.49% to 3.03%, regardless of the speculation. Agriculture has been hit the least at 0.49%, while real estate has been hit the most at 3.03%. On the other hand, domestic crude oil prices fell (43.63% to 44.18%) due to declining worldwide crude oil prices and Japan's substantial reliance on foreign petroleum. The price of natural gas fell in tandem with that of oil due to the convergence of production (the decline was approximately 4.18–5.22%). As the primary downstream market for crude oil, the refined oil market is projected to experience a considerable price decline (from 27.61% to 28.37%). Furthermore, downstream users of refined oils, such as chemicals and transportation, benefit from lower prices (7.22%, 8.24%, 7.22%, and 8.32%, respectively).

Unlike commodity prices, COVID-19 and oil prices have impacted industrial production. A strong decline in crude oil prices dramatically reduced domestic crude oil mining sector production (from 63.02% to 66.04%). The substitution effect affects the power generation industry and reduces production (consumption of 0.81% and 2.78% of new cases of coronary pneumonia). The downstream industry will experience a minor increase, while the oil-processing business will see a production spring. These differences in sector performance suggest that a decline in oil prices has a minimal effect on the economy. In contrast, the pandemic's influence on China's whole sector is vast. The outbreak has slowed the growth of several businesses, with losses ranging from 6.99% (hydroelectric power) to 17.24% (housing and food), with transportation, housing, and catering suffering the most. The COVID-19 pandemic has become a key issue impeding economic growth due to a drop in local output.

According to the poll data, COVID-19 significantly reduced residents' purchasing power (from 7.12% to 7.24%), but the sharp drop in oil prices enhanced residents' purchasing power. Inhabitants (Phase 1) Gasoline and diesel costs have plummeted (2.38% to 3.02%) because of the recession, which has benefitted neighbors.

Meanwhile, residents recoup their losses as the cost of all necessary items decreases, enhancing real purchasing power. We can observe that citizens' consumption habits have a minimal effect on purchasing power by separating the effects of the COVID-19 scenario into (CSMP) and (INP) scenarios. The major cause of the loss of buying power caused by pandemics is a drop in income in firms that are not growing. The actual buying power of inhabitants steadily decreased from 4.51% in 2010 to 4.96% in 2020, owing to the negative impact of growing oil costs and the COVID-19 outbreak on residents' purchasing power. Additionally, the import and export patterns of various projects in China are discussed. A steep reduction in Co2 emission will significantly boost crude oil imports, with China's oil exports down by 95.16%, while their levels are already relatively low. Low oil prices have led to increased oil consumption. It also impacts the strategic oil storage strategies of oil-importing countries. In the short term, these actions will increase the demand for oil to some extent, driving up oil prices. Global oil consumption will progressively increase as the pandemic situation improves., Retaining a meagre price for a long duration is difficult. If the outbreak is quelled more successfully than projected, the pace of change in oil imports and exports may be overestimated. However, maintaining ultra-low prices for lengthy periods would likely cause financial issues for other high-cost oil miners, such as US shale oil. This may lead to financial loss or bankruptcy.

Furthermore, the expansion of exports of processed petroleum products may profit from extraordinarily cheap oil prices. In addition to reducing oil prices, research also indicated that the COVID-19 pandemic severely influenced the Chinese economy and negatively impacted international commerce. The imports and exports of key industries were affected (from 5.23% to 21.74%) (from 5.23% to 21.74%). Further, results in many aspects of the primary energy usage in these hypothetical scenarios. Coal, oil, and natural gas accounted for 69.71%, 19.64%, and 4.17%, respectively, of the (BAU) scenario. Renewable energy accounted for 6.47% of the total energy in the (BAU) scenario. The econometric model covers 2012 to 2020 and does not include energy generation as an extrinsic variable or extrinsic renewable subsidy. Instead, the yearly power fluctuations (AEEI) are adjusted such that the output power is somewhat less than the power generation of the scenario (BAU). Thus, COVID-19 may have a positive impact on renewable energy. Renewables accounted for 6.55% of the total energy in the COVID scenario, compared to 6.47% in the (BAU) scenario. This is thought to be because the pandemic made efficient utilization of the components difficult, resulting in lower total energy usage. However, renewable energy sources with superior intelligence and lower marginal costs may reduce the negative impact.

As a result of the COVID-19 pandemic, demand for crude oil is decreasing, lowering its price and providing a wonderful opportunity for the renewable energy industry. However, this pandemic has lowered demand, boosted oil prices, and shifted outcomes. If oil prices fall, oil consumption skyrockets, and the amount of renewable energy increases from 6.47% to 5.38%.

4.4. Evolution of carbon dioxide (CO_2) emissions in China

Table 6 shows the evolution of China's carbon dioxide (CO_2) emissions under various scenarios. The BAU scenario carbon emissions will reach 10.88 billion tonnes by 2020; whereas, the ILO scenario carbon emissions will reach 12.95 billion. Wu et al. (2022) obtained similar results in their investigation. The elimination will increase global carbon emissions by a large magnitude. At the same time, the global energy landscape will shift substantially, significantly lowering the competitiveness of the renewable energy sector. Therefore, climate policies and measures must be considered.

Furthermore, the pandemic has had a considerable influence on reducing carbon emissions. Carbon emissions in the COVID scenario are 9.97 billion tonnes, 8.39% less than the carbon emissions (BAU) scenario. The combined impact of increased oil costs and the COVID-19 pandemic has significantly reduced carbon emissions in many areas. However, even assuming a 50% reduction in 2020, overall energy consumption and carbon emissions might rise due to continued increases in oil imports and processing emissions.

Based on these findings, we determined that the COVID-19 pandemic and its subsequent decline may significantly influence economic growth. Those with long-term goals are less motivated during a recession. In addition, the competitive edge of oil over renewables has improved dramatically. These two events have a significant detrimental effect on low-carbon economies. Carbon strength has increased due to increased fossil fuel usage and decreased GDP. In this light, steps are taken to reduce the severity and economic effects of the pandemic. The first solution for Model 1 estimation in pandemic situations was to increase the cost of fossil fuel consumption. Except for the service sector, all industries are expected to pay 100 yuan per ton of carbon tax. This policy aimed to close the price gap between oil and renewable energy sources.

Table 6
Changes in CO_2 emissions.
Source: Author calculation.

Indicators	M(1)	M(2)	M(3)	M(4)	M(5)	M(6)	M(7)	M(8)	M(9)
GDP	22.9	23.9	22.4	21.3	22.5	23.3	23.5	24.1	24.7
Consumption		16.9	18.3	19.7	17.2	18.3	19.2	19.4	20.1
Labor demand			67.3	56.2	67.3	68.0	68.8	68.5	63.6
Agriculture, forestry, animal husbandry and fishery		5.2	8.5	7.7	7.5	7.5	8.1	8.4	8.6
Mining and Dressing		4.0	2.4	1.7	2.0	2.9	2.8	4.3	3.5
Manufacturing		13.8	28.7	14.8	15.6	14.0	14.0	14.1	13.7
Electricity, heat, gas and water production and supply industry		24.0	24.5	22.2	26.9	28.6	31.2	32.6	30.8
Building industry	13.3	19.2	21.7	19.7	19.3	18.2	17.9	17.5	17.5
Service industry		18.9	18.0	18.8	15.7	14.8	15.2	15.9	16.3
Railway transport		29.3	28.0	26.1	23.2	23.3	23.1	28.0	29.7
Road transport		12.0	10.8	9.4	10.2	11.0	11.3	10.1	11.1
Air transport		34.3	37.8	44.5	29.1	29.1	26.5	29.0	36.6
GDP	35.3	39.8	41.7	40.1	44.8	46.0	43.4	44.2	44.9
Consumption		36.1	36.1	35.2	30.8	30.3	30.5	28.5	27.8
Labor demand		14.1	12.4	14.8	15.9	16.2	16.0	15.4	15.2
Agriculture, forestry, animal husbandry and fishery		33.8	29.0	27.4	25.6	27.1	26.3	25.2	24.7

Table 7
Impacts of countermeasures on model 1 to model 6.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
GDP	0.00%	−8.51%	−10.87%	−10.99%	−7.81%	−6.44%
CO_2 emissions	0.00%	9.90%	0.07%	0.15%	3.77%	8.72%
Rural welfare	0.00%	−5.97%	−8.45%	0.08%	2.70%	6.61%
Urban welfare	0.00%	−.56%	−9.07%	−5.36%	−3.64%	3.55%

However, we believe that carbon taxes would result in poor economic performance and low social welfare under the scenario of the second measure (Model 2). After establishing a tax recovery scheme, households must receive remittances to counteract the negative impact of carbon prices. The transfer amount was the same for all the participants. Model 2 estimates that it mixes scene recycling with new model recycling. The last measure, Model 3, aims to reduce COVID-19's negative economic impact. It is anticipated that all enterprises will decrease their taxes by 10% and embrace more liberal tax strategies. Government expenditure would be increased by approximately 20%, while indirect taxes would be decreased by 10% to help SMEs to respond to the economic crisis created by the pandemic. This is the case for an active fiscal policy being simplified (PFP). Model 3 is a mix of tax cuts and panel model measurements and through model 3 estimation for enterprises in quickly resuming production. Because of the government's strong efforts, it is estimated that 50% of the unemployed have recovered. This scenario considers the increase in available elements and the estimate in Model 4.

The impact of these remedial steps on GDP, CO_2 emissions, and social well-being is summarized in Table 7. The rates of change corresponding to the reference model index are listed in Table 7. Carbon taxes, it turns out, may dramatically cut CO_2 emissions while having no effect on GDP or societal well-being. Tax collection aims to reduce the negative impact on social services. These tax cuts have influenced social welfare significantly, particularly in rural areas. As a result of the extended budget plan, it was discovered that we could not lessen the pandemic's economic burden, but we also had increased carbon emissions. Finally, the negative consequences of COVID-19 can be considerably lessened if authorities attempt to reinstate their jobs. However, reducing the benefits of decreasing carbon tax emissions will be due to financial growth and the revival of the labor market.

4.5. Discussion

In this sub-section, it was found that the pandemic's reduction in carbon dioxide emissions is only brief, owing to a drop in economic activity rather than success in low-carbon policies or activities. Thus, lower oil prices encourage people to use more energy. Additionally, long-term low oil prices may significantly increase emissions (CO_2). Carbon taxes and other emission reduction measures might be valuable tools for addressing low energy prices. However, household costs must be considered, and carbon tax recycling schemes can promote such efforts.

It was found that a decline in the activity or factors of production was the underlying cause of the economic slowdown during the pandemic. As a result, in the post-COVID-19 period, the rapid and secure retrieval of factor inputs is critical. Only in this way can the pandemic's negative economic impact be appropriately reduced. Investments in transportation infrastructure affect the transportation sector's output and that of the non-transport sector. Rail investment considerably influences industrial output growth compared with the other two modes of transportation. The growth of tunnels, axes, and trains during the building phase of railway infrastructure can increase the demand for construction materials, such as reinforced concrete and clay. Simultaneously, locomotive production requires many metalworking machines, handling equipment, motors, and other specialized machinery. According to the survey findings, air transport output falls when railway investment rises, and railway sector production also increases as air transport investment increases. As road investment rises, so does productivity in all modes of transportation. Transportation was critical during the COVID-19 pandemic.

This study examined the patterns in transportation usage during the pandemic and economic ramifications. Transport consumption is declining significantly, hurting GDP, investment, consumption, employment, imports, and exports. According to the model results, COVID-19 is already damaging the Chinese economy's transportation sector, consistent with earlier research. However, changes in the transportation sector, on the other hand, were integrated into their global pandemic shock simulation scenarios, whereas policy simulations, such as infrastructure investments, were ignored. This study constructed five simulation phases based on pandemic conditions to more accurately and intuitively evaluate the economic impact of traffic consumption during different pandemic periods.

This study assessed the impact of the government's economic incentives on transportation by evaluating the government's most ambitious investment programs. The survey's key results are as follows: First, as the pandemic's severity increased, transportation consumption's economic impact became more apparent. Second, in non-transport production, industry and services incur the highest losses and are the most impacted by transportation usage. This highlights the dependence of the economy on transportation demand. Finally, the results of the investment simulation showed that transportation investments might help with economic development and job creation. More importantly, rail transportation is more cost-effective than road and air transportation. To support long-term economic growth, governments must establish investment-friendly climates. Some rules can be implemented based on the initial findings.

First, of the three modes of transportation, road transport significantly reduced usage during the pandemic. It significantly negatively impacts the Chinese economy compared with train and aircraft travel. As a result, the government must take immediate and decisive measures to assist the trucking sector during the pandemic. Open roadways were implemented at the beginning of the pandemic. For example, the provincial government of Jiangsu offers fuel and operational subsidies for urban public, rural passenger, and passenger cab transportation. However, specific relief techniques are only available during the most severe stages of the pandemic. It is known that, the economic turbulence created by increased traffic demand is challenging to recover quickly. Extend the period of the subsidy scheme for road passenger transport businesses and boost subsidies for pandemic prevention and safety inspections in the road passenger transport sector. Second, during the pandemic, the government and transportation must protect public safety while increasing public faith in transportation. When traveling often, caution should be exercised to prevent the transmission of viruses and infections. Zhang et al. (2021) believe that the PASS technique (P: Prepare-Protect-Provision; A: Avoidance-Regulation; S: Shift Participation; S: Alternative Stop) is critical for effective traffic-related pandemic interventions (Zhang et al., 2021). The "avoid coordination" strategy is strongly advised to avoid erroneous information, crowded cars, and activities and excursions that need physical distance.

The scenario design of this study was based on various assumptions. Most importantly, the passage of time and the pandemic's impact on the passage of time. China handled the pandemic efficiently in January. The holidays extended to all states after the Chinese New Year. Several bachelor's courses formally and properly began in mid-April. Although the university was not officially established, the employee return rate was high. The SME takeovers in China hit an all-time high of 84%. The impact of the outbreak in China began in January, grew dramatically towards the end of the month, peaked in February, and then progressively faded after March. Some sections might have been affected for a long time, possibly until June. As a result, the impact curve used in this investigation was based on this model.

Furthermore, because the pandemic's long-term worldwide impact is uncertain, this study analyzes the impact of the pandemic on China in 2020. Furthermore, while this research cannot provide precise data forecasts, it identifies differences between adults and minors. The document's COVID-19 pandemic model states that individuals' consumption patterns have shifted and impacted a company's capital and staff. The government wants to make it illegal for certain citizens to stay at home, work or attend meetings. We assume that has halved the examination of the impact of the dropping oil price scenario.

The demand for public transportation, refined oils, housing, restaurants, and real estate declined considerably because of the economic crisis. However, the over 100% cut in lodging and board during the worst months of February had little effect owing to the low demand for public transportation. However, due to the return of labor and manufacturing and the severe pandemic, public transportation is recovering faster than hospitality and food businesses. Simultaneously, the pandemic makes it impossible for many people to work from home or on a flexible schedule (going to the office multiple times instead of 9 a.m. to 5 p.m. on weekdays). Certain parts of the population are stranded in their cities and unable to work. After a protracted pause, the government restarted work and manufacturing with energy, but the pandemic affected the labor supply and capital utilization. As a result, the analysis estimates that the pandemic would have a 30%–20% negative impact on China's labor and capital supply in January and a 50%–40% negative impact in February. Since then, the rebound in jobs and manufacturing has resulted in a swift recovery in supply, with supply shortfalls reducing from 15% to 10% in March to 0% in April. The impact of family consumption and corporate input parameters was considered.

Over the years, the COVID-19 pandemic has lowered China's demand for public transportation, refined oil, housing, food services, and real estate by 20–25 percent, reduced labor supply by around 10%, and increased labor. Capital is offered by approximately 7%. Pandemics have a specific influence on China and must be acknowledged. It is difficult to exhaust theories and precisely quantify the underlying hypotheses because of the ambiguity of the various dimensions. This study assumed the primary pandemic consequences of consumption and supply to ensure the veracity of the results.

Furthermore, the underlying assumptions may have a considerable influence. This is mostly due to the difficulty of simulating human conjecture in the near run and the likelihood of economic "retaliation" in the general equilibrium model. We will need more evidence to support our new assumptions if we focus on these concerns. Consequently, such subjective initiatives were not addressed in this study. Although the importance of influencing the conclusion may be higher than in real life, the link between the scenario and the core logic of the conclusion remains the same. This study aims to conduct a logical analysis and explain the policy's consequences rather than experimentally forecast the percentage of the economy that will produce a pandemic. As a result, dismissing such efforts has no bearing on the results of this study.

5. Conclusion and policy implications

The econometric model is used in this study to examine the impact of two key events: the COVID-19 pandemic and the recession. The customer and the provider assess COVID-19's impact. According to this study, pandemics and dropping prices influence China's economy and emissions. According to these findings, pandemics and oil prices have a wide variety of effects on China's economy and emissions. The connection between these findings and the primary and secondary correlations produced intriguing and valuable information. This drop has neither positive nor dire implications for China, which relies on imported oil. Low oil prices have little influence on GDP compared to the pandemic. Sustained low levels benefit oil processing, transportation, the chemical sector, and Chinese household consumption. The price of a variety of items was reduced by decreasing oil prices. Gasoline and diesel prices have plummeted considerably, increasing the purchasing power of residents. However, domestic crude oil mining firms incur enormous economic losses due to high production costs due to severely low oil prices. The protracted decrease in oil prices may cause many businesses to encounter challenges, including insolvency in the financial markets and economy.

On the other hand, low oil prices increase crude oil speculation and consumption, increasing carbon dioxide emissions in the short run. Low oil prices are also a significant setback for renewable-energy producers. Environmental regulations and policies that encourage low-carbon transitions should be reconsidered. COVID-19 has significantly influenced China's ecosystem and the economy more than previously thought. The outbreak had a modest influence on the population's consumption behavior from a macroeconomic standpoint. This is a shift in how consumption and production are organized. However, under the influence of the pandemic, businesses are "closed", industrial Cadenas ascendants and descendants are "disconnected", and their production factors cannot be transferred effectively to development and production, which is a severe problem. This is why China is attempting to limit citizens' movement and manage their neighborhoods (which may affect residents' consumption habits to some level but may be a promising approach for containing the pandemic to re-establish the industrial chain and utilize production factors). Because some factors of production utilized by enterprises account for a significant portion of the population's income, the economic crisis has resulted in temporary unemployment and a decline in the population's purchasing power. Despite predictions of a substantial reduction, China's worldwide import and export commerce declined sharply, owing to the economy's downward pressure. Simultaneously, the company's energy usage and carbon emissions will be lowered, resulting in considerable reductions in carbon dioxide emissions.

5.1. Policy implications

The overall results significantly influence oil industry output, crude oil imports and exports, and the petrochemical industry more than during the COVID-19 pandemic. Even pandemics can have a significant impact on carbon emissions. China's emissions can climb rather than reduce if they remain low. This is a challenging situation for a country's oil sector. The impact of the COVID-19 pandemic on other industries, notably the service sector, is significantly higher than its impact on the pharmaceutical industry. The influence on overall economic output is far more extensive than the impact on individual economic output. As a result, if the government wants to promote economic growth, it should focus on rebuilding the national industrial chain, ensuring employment, and slowing the migration of large groups. In light of the decline and the global COVID-19 pandemic, this study concludes with the following policy implications for the post-COVID-19 era.

(1) Instead of pursuing a comprehensive, fundamental tax policy, the government should encourage the return of corporate products. The economic loss generated by factor inputs is more significant than that caused by changes in demand structure. The results of this study directly support local production and remanufacturing approaches, including rework, migration, and collection. We can also assist firms by advocating tax reductions and modifying their work habits in various industries. Most businesses experience issues such as sales channel disruptions and supply chain issues. After the restart, particular attention is paid to the supply chain, which is the company's main operation.

(2) Continuous economic turmoil will decline as the pandemic ends. As a result, strict consumption maintains current levels. Retaliation may occur once closed service industries such as tourism and movies reopen. It is critical to stay away from employee meetings. Expanding wholesale, retail, and express delivery in the short and medium terms should help strengthen the "housing economy" and reduce the spread of the pandemic while restoring economic viability.
(3) The government must rethink its low-carbon policy and develop a more stringent carbon reduction strategy. Renewables and electric cars may incur huge losses if the oil prices are too low. Consequently, policies promoting renewable energy must be evaluated. Climate change agreements can be reached only if the economy continues to expand. Reducing emissions during a recession is uncommon.

Crude oil prices rebounded from their decrease because of economic recovery. As a result, the study's findings, which indicate that emissions significantly increase the combined effect of rising oil costs and pandemics CO_2, do not have relevant baselines. However, this study's primary novelty is examining the mechanism and reaction. Additionally, the influence of behavioral changes within the family is mainly represented by assumptions. Therefore, additional observations are required to examine the post-COVID-19 period shifting lifestyles and work patterns comprehensively.

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