

Article

Unraveling the COVID-19 Pandemic's Impact on South Korea's Macroeconomy: Unearthing Novel Transmission Channels within the Energy Sector and Production Technologies

Yugang He 

Department of Chinese Trade and Commerce, Sejong University, Seoul 05006, Republic of Korea;
1293647581@sejong.ac.kr

Abstract: As a consequence of the COVID-19 pandemic, Korea's economy has experienced significant setbacks. Thus, this article examines the implications of the COVID-19 pandemic on Korea's key macroeconomic indicators via the transmission channels of oil prices and production technology. Using Bayesian estimation and impulse response functions for empirical investigation, the results suggest that the COVID-19 pandemic has intensified the reduction in firm production, consumption of oil-based goods, employment, and investment. Increasingly, households rely on non-oil goods rather than oil-based ones. Similarly, the results suggest that the drop in production technology levels brought on by the COVID-19 pandemic has a stronger impact on business output and investment but a lesser influence on household employment. The COVID-19 pandemic has led to a decline in household non-oil consumption as well as household and business consumption of oil-based goods. To sum up, the existing Korean literature on this issue might be improved by including the findings offered in this article.

Keywords: COVID-19 pandemic; macroeconomic indicators; oil price; production technology; Bayesian estimation; impulse response functions



Citation: He, Y. Unraveling the COVID-19 Pandemic's Impact on South Korea's Macroeconomy: Unearthing Novel Transmission Channels within the Energy Sector and Production Technologies. *Energies* **2023**, *16*, 3691. <https://doi.org/10.3390/en16093691>

Academic Editors: Sebastian Saniuk, Piotr Bórawski and Tomasz Rokicki

Received: 31 March 2023

Revised: 22 April 2023

Accepted: 24 April 2023

Published: 25 April 2023



Copyright: © 2023 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The outbreak of COVID-19 has caused a significant setback for the economy throughout the world, and South Korea, being one of the largest economies in Asia, is not an exception to this rule. Due to the COVID-19 pandemic, South Korea's annual GDP growth plummeted to its lowest level in two decades in 2020, at 1.0%. This was mostly attributable to the effect on exports and domestic demand as well as the decline across sectors and services. Specifically, for the industrial sector, Korea's export industry has been severely impacted by interruptions in the global supply chain and a decline in worldwide market demand. Similarly, South Korea's domestic consumer sector has seen a decline in demand owing to the COVID-19 pandemic efforts. Moreover, the COVID-19 pandemic has had a significant influence on the employment market in South Korea. While enterprises have curtailed output owing to the pandemic, some have been compelled to slash wages or lay off employees, resulting in an increase in South Korea's unemployment rate. In 2020, the unemployment rate in South Korea increased from 3.8% to 4.6%. Particularly, the fall in demand induced by the COVID-19 pandemic has exacerbated the rise in unemployment in areas such as service industries and tourism. Likewise, the COVID-19 pandemic has had a substantial effect on South Korean investment. South Korea's overseas investments suffered huge damage because of the COVID-19 pandemic. Due to South Korea's substantial reliance on China, the impact of the pandemic on China's economy has also had a considerable effect on investment and exports in South Korea. Subsequently, COVID-19 has had an effect on South Korea's energy consumption. The bulk of South Korea's energy usage is derived from oil and coal, and the economic slowdown and decreased activity due to the COVID-19 pandemic are among the contributing reasons.

In light of the research background that was mentioned in the previous paragraph, the objective of this article is to investigate the consequences of the COVID-19 pandemic on Korea's fundamental macroeconomic variables through the transmission channels of oil prices and production technology. Our empirical research is based on quarterly data for the consumer price index and gross domestic product in Korea from the first quarter of 2020 to the fourth quarter of 2022. The following are two significant findings that I derived from conducting an experimental investigation using Bayesian estimation and impulse response functions: (1) The COVID-19 pandemic has contributed to a worsening of the drop in firms' production as well as consumption of oil-based products and investment. The consumption of goods that are not based on oil is becoming more important to households as compared to the use of products that are based on oil. Firms are cutting down on output and laying off people in an effort to remain profitable, which is contributing to the rise in the unemployment rate; (2) The fall in production technology levels that was produced by the COVID-19 pandemic has a more substantial impact on firm output and investment, but it has a less significant effect on household employment. In a similar vein, the COVID-19 pandemic caused a drop in manufacturing technology, which in turn led to a decline in home consumption of non-oil-based products as well as a fall in household and firm consumption of oil-based goods.

In contrast, the body of literature that has been produced on the subject in Korea now contains two more contributions as a result of this article. In point of fact, the COVID-19 pandemic has had an impact, although an indirect one, on the operation of the macroeconomy. The first lesson that this study adds is evidence that the COVID-19 pandemic has an effect on the primary macroeconomic indicators of Korea via the transmission channel of the price of oil. The second takeaway from this research is proof that the COVID-19 pandemic has an influence on the major macroeconomic indicators of Korea through the transmission channel of production technology. To summarize, the body of Korean scholarly work that already exists on the subject may be strengthened by the addition of the two contributions that are presented in this article.

The remainder of the paper is structured as follows: Section 2 examines the relevant prior literature; Section 3 presents the model; Section 4 evaluates and analyzes the results; and Section 5 presents the conclusions gained from the research.

2. Literature Review

In order to offer an objective theoretical foundation for the work that will be outlined in this article, a review of the existing body of literature will be conducted. As a result of the global spread of the COVID-19 pandemic, city closures, travel restrictions, and severe security measures have been implemented in several countries. Undoubtedly, numerous economic activities would be impacted.

The COVID-19 pandemic has precipitated a severe decline in the world economy, particularly in the crude oil market. Fluctuations in oil prices not only influence the financial condition of oil-producing and exporting nations but also have a significant effect on energy use and economic development in consuming nations. Antonakakis et al. [1] investigated the effect of oil prices on energy goods, stock markets, currency rates, and bond markets during the COVID-19 pandemic using the time-varying parameter vector autoregressive approach. They discovered that shifts in the oil prices brought on by the COVID-19 pandemic were responsible for causing significant swings in energy consumption and the financial markets. Additionally, Yamacli and Yamacli [2] found similar results. Creti et al. [3] investigated how the COVID-19 pandemic affected the oil and stock markets. They observed a link between the COVID-19 decrease in oil prices and the volatility of the stock market by using the dynamic conditional correlation GARCH approach. This might imply that the influence of oil price volatility on the macroeconomy might be more complicated than previously imagined. In particular, Wang et al. [4] investigated how fluctuations in the price of oil affected employment in the industrial sector throughout the COVID-19 pandemic. They discovered that a rise in the price of oil had a detrimental effect

on employment in the manufacturing sector. Razmi and Razmi [5] developed a simple open economy model in order to investigate the effect that the COVID-19 pandemic and variations in oil prices had on overall macroeconomic shifts. They discovered that the spike in the price of oil had a detrimental effect on economic production and employment, particularly in nations that are heavily dependent on exports. Moreover, He and Zhang [6], Cui et al. [7], Wang et al. [8], Zhang et al. [9], Mzoughi et al. [10], and He and Zhang [11] were in agreement with these arguments.

In Korea, the COVID-19 pandemic has had a significant impact on a variety of facets of daily life. In order to halt the spread of COVID-19, it has become necessary for certain individuals to conduct their jobs from inside the confines of their own homes rather than in traditional settings such as factories or offices. Therefore, He [12] evaluated the effects of the COVID-19 pandemic on South Korea's macroeconomy through the home production pathway. Utilizing the impulse response function, he discovered that as a result of a home productivity shock, market goods consumption, total production, market work hours, investment, and capital all decreased, whilst home work hours, wages, home goods consumption, and transfer payments all rose. Subsequently, in the same case, He and Wang [13] observed that the pandemic caused by COVID-19 had a large impact on Korea's main macroeconomic indicators in the near term, but that its effects were not significant at all in the long run. As a result, the overall demand in Korea was lower than it had been before the COVID-19 outbreak. It was most evident in the reduced desire for consumption and investment. Concurrently, this had the effect of putting further pressure on inflation as well as unemployment. In addition, using a multi-criterion decision-making technique, Zhao et al. [14] assessed the severity of the pandemic's effects on the financial markets of industrialized as well as emerging nations. They concluded that the impact of the COVID-19 pandemic on financial markets varied across industrialized and developing countries. The COVID-19 pandemic had a greater impact on the financial markets of industrialized nations via supply reduction and economic instability. For developing countries, the three most notable implications of the COVID-19 pandemic on financial markets were positivity and preconceptions, shifts in consumer behaviors, and the bandwagon effect. Similarly, Bouzgarrou et al. [15], Wang et al. [16], Walmsley et al. [17], Bairoliya and İmrohoroglu [18], Gonçalves and Moro [19], and Shen and Pan [20] acknowledged the validity of these points of contention.

The requirements for the study that will be conducted in this paper have been established by a recent review of the relevant literature. The COVID-19 pandemic has important repercussions for South Korea's economy on a macro level. This article investigates the influence of the COVID-19 pandemic on the macroeconomy of South Korea via two channels: fluctuations in the price of oil and changes in production technology. These findings are compared with the conclusions supplied by the current literature. I believe that the insights offered in this work have the potential to improve the current body of literature.

3. Model

3.1. Household

Suppose there is a paradigmatic household that epitomizes the traits of all households within the contemporary economic landscape, thereby serving as an archetypal illustration of household behavior. In the ensuing exposition, we meticulously engineer a utility function encapsulating constant relative risk aversion (CRRA) to portray the preferences of such a household. The CRRA utility function, extensively employed in modern economics, represents a category of utility functions that manifest risk aversion in decision making, with the degree of risk aversion remaining invariant across varying levels of wealth [21]. In the following form, we construct the constant relative risk aversion utility function:

$$U = E_t \left\{ \sum_{t=0}^{\infty} \beta^t \left[\frac{(C_t^\alpha E C_t^{1-\alpha})^{1-\sigma}}{1-\sigma} - \mu \frac{L_t^{1+n}}{1+n} \right] \right\}, \quad (1)$$

where U indicates the constant relative risk aversion utility function; E indicates the expectation operator; β indicates the discount factor; C indicates the non-oil consumer goods; EC indicates the oil-based consumer goods; α indicates the weighted value between non-oil consumer goods and oil-based consumer goods; σ indicates the relative risk aversion elasticity of consumption; L indicates the labor; n indicates the reciprocal elasticity of labor supply; and μ indicates the weighted value of labor relative to consumption. Meanwhile, the following is a description of the budget constraints faced by a typical household:

$$C_t + B_{t+1} + P_t EC_t = (1 + R_t)B_t + W_t L_t, \quad (2)$$

where B indicates the domestic one-period risk-free nominal bonds (in this study, we postulate an incomplete asset market framework. Furthermore, households are presumed not to possess any foreign assets or liabilities, further simplifying the economic landscape under examination); P denotes the oil price level; R indicates the (gross) nominal interest rate; and W indicates the wage. In addition, when Equations (1) and (2) are coupled, the first-order conditions of a typical household are provided as follows:

$$\mu L_t^n = W_t C_t^{\alpha(1-\sigma)-1} E C_t^{(1-\alpha)(1-\sigma)}, \quad (3)$$

$$C_t^{\alpha(1-\sigma)-1} E C_t^{(1-\alpha)(1-\sigma)} P_t = C_t^{\alpha(1-\sigma)-1} E C_t^{(1-\alpha)(1-\sigma)-1}, \quad (4)$$

$$C_t^{\alpha(1-\sigma)-1} E C_t^{(1-\alpha)(1-\sigma)} = \beta E_t [C_t^{\alpha(1-\sigma)-1} E C_t^{(1-\alpha)(1-\sigma)} (1 + R_t)], \quad (5)$$

where $\lim_{t \rightarrow \infty} E_t \beta^{t+j} \lambda_{t+j} B_{t+j} = 0$; λ indicates the Lagrange multiplier.

3.2. Firm

Suppose a market environment is characterized by the prevalence of perfect competition. In this context, an exemplary firm is one that actively partakes in production undertakings, harnessing domestic capital and labor in tandem with petroleum-derived raw materials. Concurrently, it is posited that such a prototypical firm orchestrates its production processes by employing the framework of a Cobb–Douglas production function [22]. It is seen from the following:

$$Y_t = A_t K_t^\gamma L_t^\zeta (P_t EC_t)^{1-\gamma-\zeta}, \quad (6)$$

where A indicates productivity, a variable that can be interpreted as the level of general knowledge about the “art” of production available in an economy; Y indicates the output; γ indicates the elasticity of the level of production with respect to capital; ζ indicates the elasticity of the level of production with respect to labor; and $1 - \gamma - \zeta$ indicates the elasticity of the level of production with respect to oil raw materials. Drawing inspiration from Equation (6) and building upon the groundwork laid by Amiri et al. [23], this article incorporates an oil price shock into the analysis. This shock is postulated to adhere to an autoregressive (AR) process of order 1. The representation of this phenomenon is delineated as follows:

$$\log P_{t+1} = (1 - \rho) \log \tilde{P} + \rho \log P_t + e_t, \quad (7)$$

where ρ indicates the autoregressive parameter of petroleum price; $\tilde{P}$ indicates the steady-state value of oil price; $e_t \sim N(0, \sigma_p)$. Then, the formula for firms’ capital accumulation is as follows:

$$K_{t+1} = I_t + (1 - \delta)K_t, \quad (8)$$

where I indicates the investment. The first-order conditions of a representative firm are stated as follows when Equations (6) and (8) are combined:

$$r_t = \gamma A_t K_t^{\gamma-1} L_t^\zeta (P_t EC_t)^{1-\gamma-\zeta} - \delta, \quad (9)$$

$$W_t = \zeta A_t K_t^\gamma L_t^{\zeta-1} (P_t E C_t)^{1-\gamma-\zeta}, \quad (10)$$

3.3. COVID-19 Pandemic

Nakamura et al. [24] and Farhi and Gabaix [25] claimed that the influence of catastrophic events on the macroeconomy was distributed with regard to manufacturing technology and oil price; this means that they came to the conclusion that catastrophic events would not only influence the allocation of human resources, patent technology, and other intangible assets, but would also lead to sweeping changes in oil supply and demand, which would have an influence on oil prices. According to the information presented in this article, the COVID-19 pandemic is a catastrophic event that will have an effect on the production technology and energy prices in Korea. It is seen from the following:

$$\log P_{t+1} = (1 - \phi_1)(1 - \rho_1) \log \tilde{P} + \rho_1 \log P_t + e_{1t}, \quad (11)$$

$$\log A_{t+1} = (1 - \phi_2)(1 - \rho_2) \log \tilde{A} + \rho_2 \log A_t + e_{2t}, \quad (12)$$

where ϕ_1 indicates the change proportion of energy price; ϕ_2 indicates the change proportion of production technology.

3.4. Market Clearing Condition

The condition of the market clearing results in the following:

$$Y_t = C_t + I_t + P_t E C_t, \quad (13)$$

4. Results

4.1. Parameter Calibration and Parameter Estimation

The parameters used in this study were obtained from two distinct sources: one was culled from the existing authoritative literature in South Korea, and the other was produced using South Korean data and Bayesian estimation. With regard to parameter calibration, following Adeiza et al. [26], the depreciation rate is 0.025. Following Zhang et al. [27], the weighted value of labor relative to consumption is 0.2 ($\mu = 0.2$). Following Chan [28] and Warwick McKibbin [29], the weighted value between general consumption goods and petroleum consumption goods is 0.75 ($\alpha = 0.75$). Following Amiri [23], the discount factor is 0.98 ($\beta = 0.98$). Regarding Bayesian estimation, this article uses the quarterly data of the Korean consumer price index and gross domestic product from quarter 1, 2020, to quarter 4, 2022. This was the time of the COVID-19 pandemic, which was the primary driver in our choice to concentrate on this time period. According to Shah and Garg [30], Hou et al. [31], Castelnovo [32], and Doojav [33], the consumer price index and gross domestic product are both detrended via the Hodrick–Prescott filter, leaving just the cyclical components. The results of Bayesian estimation are shown in Table 1.

Table 1. Results of Bayesian estimation.

Parameter	Definition	Prior Mean	Posterior Mean	Confidence Interval	Distribution	Posterior Distribution
α	Relative risk aversion elasticity of consumption	1	0.926	[0.863, 1.382]	Gamma	0.23
n	Reciprocal elasticity of labor supply	2	2.767	[2.019, 3.125]	Gamma	0.3
γ	Elasticity of the level of production with respect to capital	0.5	0.468	[0.317, 0.533]	Beta	0.3
ζ	Elasticity of the level of production with respect to labor	0.4	0.445	[0.384, 0.489]	Beta	0.3
ρ_1	Autoregressive parameter of energy price shock	0.5	0.614	[0.554, 0.786]	Beta	0.25
e_1	Error of energy price shock	0.5	0.495	[0.187, 0.832]	Inverse-gamma	0.2
ρ_2	Autoregressive parameter of technology shock	0.75	0.95	[0.932, 0.984]	Beta	0.1
e_2	Error of technology shock	0.71	0.772	[0.667, 0.876]	Inverse-gamma	0.2

4.2. Effect of COVID-19 Pandemic on Korean Key Macroeconomic Variables via the Oil Price

This subsection aims to examine the impact of oil price shock on Korea's key macroeconomic variables, including output, employment, investment, household non-oil goods consumption, firm oil-based goods consumption, and household oil-based goods consumption. The results of the impulse response function are shown in Figure 1.

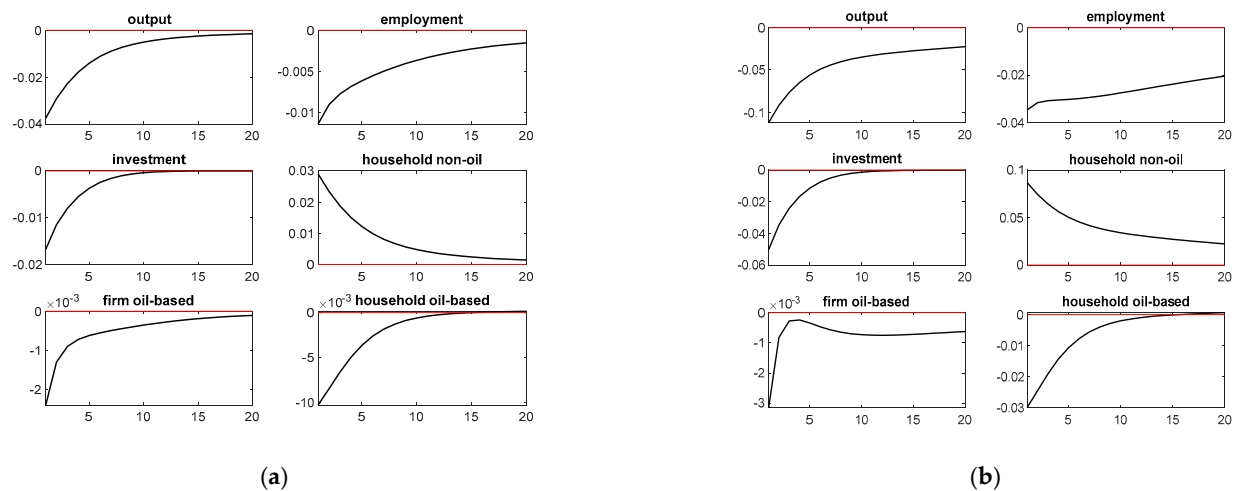


Figure 1. Effect of COVID-19 pandemic on Korean key macroeconomic variables via oil price. (a) The simulation does not consider the COVID-19 Pandemic; (b) the simulation considers the COVID-19 Pandemic.

As seen in Panel (a) of Figure 1, a positive oil price shock decreases firm output, consumption of oil-based goods, and investment. The reasoning for this conclusion is that an increase in the price of energy leads to an increase in the firm's manufacturing expenditures as well as a decrease in the firm's demand for oil-based goods. Meanwhile, when a firm's marginal expenses exceed its marginal revenues, the firm is forced to reduce both its production and its investment. Equally, as a consequence of a positive oil price shock, the consumption of oil-based goods by households decreased, while the consumption of non-oil goods by households increased. The explanation for this is that increased energy prices have resulted in a decrease in household demand for goods that are based on oil, which has, in turn, resulted in an indirect increase in household consumption of goods that are not dependent on oil. Moreover, a positive oil price shock decreases employment. One of the reasons is that increased production costs are directly proportional to increasing oil prices. In order to return to regular business operations, firms will need to reduce the size of their firms.

Then, we turn to the analysis of the results in Panel (b) of Figure 1. Panel (b) examines the impact that the COVID-19 pandemic has had on South Korea's macroeconomy, notably focusing on how the price of oil has changed as a result of the pandemic. According to information provided by the South Korean Statistical Office, the price of petroleum products in South Korea rose by 31.2% compared to the same month last year. Gasoline (27.4%), diesel (37.9%), and kerosene (47.1%) each contributed 1.32 percentage points to the overall price increase of 4.1% during the beginning of the COVID-19 pandemic. The price of crude oil has a strong influence on the cost of producing industrial products. The rise in the price of raw materials has a direct and proportionate impact on the total cost of manufacturing. Because of this, the price of industrial goods such as oil has increased by 6.9%. Using Equation (11), we can vary ϕ_1 to a range of values to indicate the influence of the COVID-19 pandemic on oil prices in Korea. In Panel (a), the value of ϕ_1 is zero. In Panel (b), the value of ϕ_1 is set to 0.5. According to our findings in Panel (b), the COVID-19 pandemic has worsened the reduction in business production, consumption of oil-based goods, and investment. The reason for this is that the COVID-19 pandemic has led to an

increase in the shortage of oil supply in Korea, and as a result, the price of domestic oil in Korea has continued to rise, which in turn causes the cost of production for Korean businesses to rise. Similarly, households are increasingly reliant on the consumption of non-oil goods as opposed to oil-based goods. In an effort to remain afloat, firms have reduced output and laid off employees, contributing to a rise in unemployment. Furthermore, the conclusions of this subsection are consistent with the macroeconomic performance of Korea in the actual world. This may also help mitigate the widespread impact of the COVID-19 outbreak on the Korean economy.

4.3. Effect of COVID-19 Pandemic on Korean Key Macroeconomic Variables via Production Technology

The purpose of this subsection is to investigate the effect that the COVID-19 pandemic has had on South Korea's macroeconomy, specifically with regard to production technology. The results of the impulse response function are shown in Figure 2.

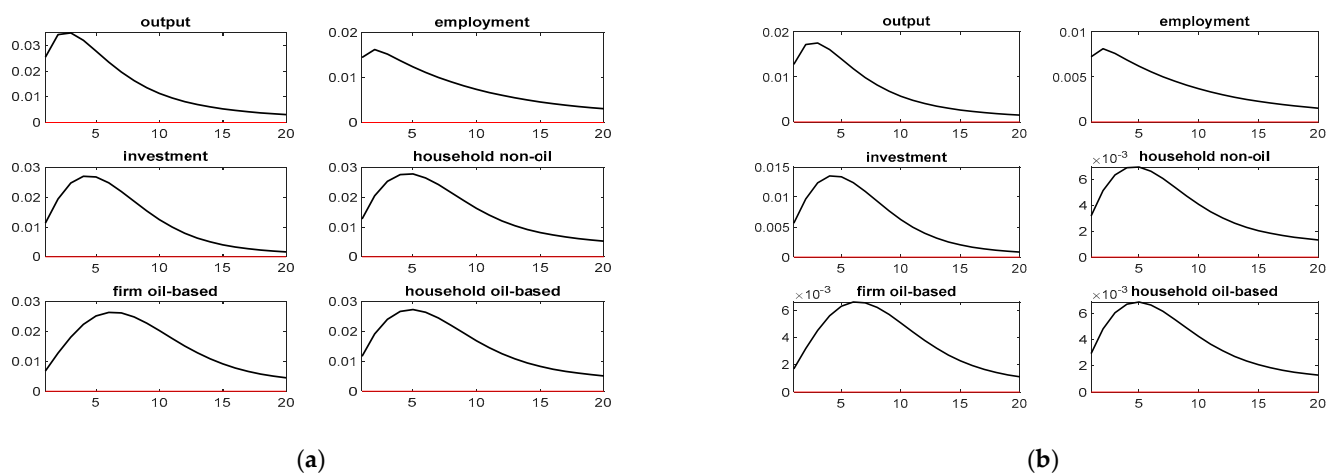


Figure 2. Effect of COVID-19 pandemic on Korean key macroeconomic variables via production technology. (a) The simulation does not consider the COVID-19 pandemic; (b) the simulation considers the COVID-19 pandemic.

As can be seen in Panel (c) of Figure 2, a positive production technology shock causes an increase in firm output as well as investment and firm consumption of oil-based goods. Equally, household non-oil goods consumption, employment, and household oil-based goods consumption increase as a positive effect of production technology shock. In Korea, however, when the COVID-19 pandemic broke out, production technology significantly declined. Using Equation (12), we can assess the effect of the COVID-19 pandemic on production technology in Korea by varying the value of ϕ_2 . In Panel (c), the value of ϕ_2 is zero. In Panel (d), the value of ϕ_2 is set to 0.5. According to our findings in Panel (d), the COVID-19 pandemic has lowered productivity in Korea. The downturn in production technology levels that was brought on by the COVID-19 pandemic has a more noticeable influence on firm output and investment, but it has a comparatively less substantial impact on household employment. Similarly, the decline in production technology due to the COVID-19 pandemic leads to a certain degree of decline in household non-oil consumption and household and firm oil-based goods consumption, which reflects the decline in employment levels of household and the shrinkage of household wealth due to the decline in production technology by firms due to COVID-19 pandemic, which leads to a decline in overall household consumption, while the decline in firms' profit levels leads to a decline in firm oil-based goods consumption.

5. Conclusions

This article examines the impact of the COVID-19 pandemic on key macroeconomic indicators in Korea through the transmission channels of oil prices and production technology. We conduct empirical analysis using quarterly data for the Korean consumer price index and gross domestic product from the first quarter of 2020 to the fourth quarter of 2022. The findings indicate that the COVID-19 pandemic has exacerbated the decline in firm output, oil-based product consumption, and investment. Increasingly, households depend on the consumption of non-oil products as opposed to oil-based products. In an attempt to stay afloat, firms have curtailed production and laid off workers, thus adding to the increase in unemployment. Equally, the findings indicate that the decline in production technology levels caused by the COVID-19 pandemic has a greater effect on firm output and investment, but a less significant impact on household employment. Likewise, the reduction in production technology caused by the COVID-19 pandemic results in a fall in household non-oil consumption and household and firm oil-based goods consumption.

In the context of the empirical study findings presented in this article, several policy implications are outlined. First, because of the negative consequences that limited oil supply has had on the output and investment of Korean firms, those firms need to improve their oil preparation, optimize their industrial structure, and increase the efficiency with which they utilize oil. Second, in spite of the fact that the recent spike in the price of oil has had a negative effect on the consumption of oil-based goods by Korean households, the Korean government needs to increase its stock of related products and work on developing alternatives to oil-based products. Third, due to the fact that uncertainties such as COVID-19 have caused a decline in production technology and have been detrimental to the interests of both firms and households, the government of Korea needs to put appropriate countermeasures in place in advance in order to increase the country's macroeconomic stability.

In addition, this study does have a few limitations; nonetheless, those considerations put future researchers on the right path for additional exploration since they indicate where more investigation should be focused. First, this article focuses only on Korea as the country to be studied and assessed. In the future, researchers may be inclined to carry out their investigations by taking into consideration a greater range of countries, such as China, the United States, and Europe, which may result in more fascinating conclusions. Second, in this investigation, there are just six macroeconomic indicators that are evaluated; however, future researchers may find a way to improve a more intricate model and explore a larger number of financial indicators, which may result in conclusions that are more comprehensive. Third, the analysis of the impulse response function is the sole method used in this work. The findings presented in this work may serve as a foundation for additional research and analysis by researchers in the future, including variance decomposition and welfare loss. Fourth, intangible assets, via the conduit of production technology, not only exhibit but also engender congruity in the conduct of the two distinct household categories during each discrete period under analysis. This substantiates the paramount significance of intangible assets for households, culminating in employment opportunities in the South Korean context. Consequently, future scholars are advised to bolster intangibles not solely within the technological realm but also within the social sphere, encompassing those South Korean intangible facets that foster cohesion among families and households. Fifth, owing to data availability constraints, this study employs a 12-quarter dataset for Bayesian estimation, which may present challenges in accurately capturing parameter variation. Consequently, to derive more robust and reliable findings, future researchers can adopt alternative, more comprehensive methodologies to revisit and further investigate this subject matter.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available from the authors upon request.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Antonakakis, N.; Cunado, J.; Filis, G.; Gabauer, D.; de Gracia, F.P. Dynamic Connectedness among the Implied Volatilities of Oil Prices and Financial Assets: New Evidence of the COVID-19 Pandemic. *Int. Rev. Econ. Financ.* **2023**, *83*, 114–123. [\[CrossRef\]](#)
2. Yamacli, D.S.; Yamacli, S. Estimation of the Unemployment Rate in Turkey: A Comparison of the ARIMA and Machine Learning Models Including Covid-19 Pandemic Periods. *Heliyon* **2023**, *9*, e12796. [\[CrossRef\]](#)
3. Creti, A.; Joëts, M.; Mignon, V. On the Links between Stock and Commodity Markets' Volatility. *Energy Econ.* **2013**, *37*, 16–28. [\[CrossRef\]](#)
4. Wang, K.-H.; Liu, L.; Li, X.; Oana-Ramona, L. Do Oil Price Shocks Drive Unemployment? Evidence from Russia and Canada. *Energy* **2022**, *253*, 124107. [\[CrossRef\]](#)
5. Razmi, S.F.; Razmi, S.M.J. The Role of Stock Markets in the US, Europe, and China on Oil Prices before and after the COVID-19 Announcement. *Resour. Policy* **2023**, *81*, 103386. [\[CrossRef\]](#)
6. He, Y.; Zhang, Z. Energy and Economic Effects of the COVID-19 Pandemic: Evidence from OECD Countries. *Sustainability* **2022**, *14*, 12043. [\[CrossRef\]](#)
7. Cui, M.; Wong, W.-K.; Wisetsri, W.; Mabrouk, F.; Muda, I.; Li, Z.; Hassan, M. Do Oil, Gold and Metallic Price Volatilities Prove Gold as a Safe Haven during COVID-19 Pandemic? Novel Evidence from COVID-19 Data. *Resour. Policy* **2023**, *80*, 103133. [\[CrossRef\]](#) [\[PubMed\]](#)
8. Wang, J.; Cui, M.; Chang, L. Evaluating Economic Recovery by Measuring the COVID-19 Spillover Impact on Business Practices: Evidence from Asian Markets Intermediaries. *Econ. Chang. Restruct.* **2023**, 1–22. [\[CrossRef\]](#)
9. Zhang, S.; Anser, M.K.; Peng, M.Y.-P.; Chen, C. Visualizing the Sustainable Development Goals and Natural Resource Utilization for Green Economic Recovery after COVID-19 Pandemic. *Resour. Policy* **2023**, *80*, 103182. [\[CrossRef\]](#)
10. Mzoughi, H.; Ghabri, Y.; Guesmi, K. Crude Oil, Crypto-Assets and Dependence: The Impact of the COVID-19 Pandemic. *Int. J. Energy Sect. Manag.* **2023**, *17*, 552–568. [\[CrossRef\]](#)
11. He, Y.; Zhang, Z. Non-Renewable and Renewable Energies, and COVID-19 Pandemic: Do They Matter for China's Environmental Sustainability? *Energies* **2022**, *15*, 7143. [\[CrossRef\]](#)
12. He, Y. Home Production: Does It Matter for the Korean Macroeconomy during the COVID-19 Pandemic? *Mathematics* **2022**, *10*, 2029. [\[CrossRef\]](#)
13. Wang, S.; Gao, H.; Zhou, B. Research on the Dynamic Feedback Mechanism of Fiscal Policy Regulation Under COVID-19: Evidence From China. *Front. Public Health* **2022**, *10*, 931135. [\[CrossRef\]](#) [\[PubMed\]](#)
14. Zhao, L.; Rasoulinezhad, E.; Sarker, T.; Taghizadeh-Hesary, F. Effects of COVID-19 on Global Financial Markets: Evidence from Qualitative Research for Developed and Developing Economies. *Eur. J. Dev. Res.* **2023**, *35*, 148–166. [\[CrossRef\]](#) [\[PubMed\]](#)
15. Bouzgarrou, H.; Ftiti, Z.; Louhichi, W.; Yousfi, M. What Can We Learn About The Market Reaction To Macroeconomic Surprise? Evidence From The COVID-19 Crisis. *Res. Int. Bus. Financ.* **2023**, *64*, 101876. [\[CrossRef\]](#)
16. Wang, X.; Yang, Y.; Tang, M.; Wang, X. The Effect of Macroeconomic Regimes, Uncertainty, and COVID-19 Outcomes on Commodity Price Volatility: Implications for Green Economic Recovery. *Econ. Res.-Ekon. Istraživanja* **2023**, 1–21. [\[CrossRef\]](#)
17. Walmsley, T.; Rose, A.; John, R.; Wei, D.; Hlávka, J.P.; Machado, J.; Byrd, K. Macroeconomic Consequences of the COVID-19 Pandemic. *Econ. Model.* **2023**, *120*, 106147. [\[CrossRef\]](#)
18. Bairoliya, N.; İmrohoroglu, A. Macroeconomic Consequences of Stay-at-Home Policies during the COVID-19 Pandemic. *Eur. Econ. Rev.* **2023**, *152*, 104266. [\[CrossRef\]](#)
19. Gonçalves, H.S.; Moro, S. On the Economic Impacts of COVID-19: A Text Mining Literature Analysis. *Rev. Dev. Econ.* **2023**, *27*, 375–394. [\[CrossRef\]](#)
20. Shen, H.; Pan, Q. Risk Contagion between Commodity Markets and the Macro Economy during COVID-19: Evidence from China. *Sustainability* **2023**, *15*, 66. [\[CrossRef\]](#)
21. Kaplan, G.; Violante, G.L. The Marginal Propensity to Consume in Heterogeneous Agent Models. *Annu. Rev. Econ.* **2022**, *14*, 747–775. [\[CrossRef\]](#)
22. Sun, C.; Xu, Z.; Zheng, H. Green Transformation of the Building Industry and the Government Policy Effects: Policy Simulation Based on the DSGE Model. *Energy* **2023**, *268*, 126721. [\[CrossRef\]](#)
23. Amiri, H.; Sayadi, M.; Mamipour, S. Oil Price Shocks and Macroeconomic Outcomes; Fresh Evidences from a Scenario-Based NK-DSGE Analysis for Oil-Exporting Countries. *Resour. Policy* **2021**, *74*, 102262. [\[CrossRef\]](#)
24. Nakamura, E.; Steinsson, J.; Barro, R.; Ursúa, J. Crises and Recoveries in an Empirical Model of Consumption Disasters. *Am. Econ. J. Macroecon.* **2013**, *5*, 35–74. [\[CrossRef\]](#)

25. Farhi, E.; Gabaix, X. Rare Disasters and Exchange Rates. *Q. J. Econ.* **2016**, *131*, 1–52. [[CrossRef](#)]
26. Adeiza, A.; Oye, Q.E.; Alege, P.O. The Macroeconomic Effect of COVID-Induced Economic Policy Uncertainty in Nigeria: A DSGE Approach. *Afr. J. Econ. Manag. Stud.* **2023**, *14*, 106–120. [[CrossRef](#)]
27. Zhang, X.; Zhang, Y.; Zhu, Y. Covid-19 Pandemic, Sustainability of Macroeconomy, and Choice of Monetary Policy Targets: A Nk-Dsge Analysis Based on China. *Sustainability* **2021**, *13*, 3362. [[CrossRef](#)]
28. Chan, Y.T. The Macroeconomic Impacts of the COVID-19 Pandemic: A SIR-DSGE Model Approach. *China Econ. Rev.* **2022**, *71*, 101725. [[CrossRef](#)]
29. McKibbin, W.; Fernando, R. The Global Macroeconomic Impacts of COVID-19: Seven Scenarios. *Asian Econ. Pap.* **2021**, *20*, 1–30. [[CrossRef](#)]
30. Shah, S.A.; Garg, B. Testing Policy Effectiveness during COVID-19: An NK-DSGE Analysis. *J. Asian Econ.* **2023**, *84*, 101577. [[CrossRef](#)]
31. Hou, Z.; Song, Y.; Xin, W. COVID-19 Shocks, Monetary Policy, and Real Estate Price Volatility: Analysis Based on a Dynamic Stochastic General Equilibrium Perspective. *Sci. Program.* **2022**, *2022*, 7625465. [[CrossRef](#)]
32. Castelnovo, E. Uncertainty before and during COVID-19: A Survey. *J. Econ. Surv.* **2022**. [[CrossRef](#)] [[PubMed](#)]
33. Doojav, G.-O. Macroeconomic Effects of COVID-19 in a Commodity-Exporting Economy: Evidence from Mongolia. *Emerg. Mark. Financ. Trade* **2023**, *59*, 1323–1348. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.