Did COVID-19 change the decarbonization path? A panel VECM approach

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Overview

During COVID-19 lockdowns and following restrictions imposed by governments, the reduction in many activities reduced global energy demand. The generalized reduction in power and electricity demand in different sectors affected the demand for fossil fuels and oil prices crashed due to the sharp drop in oil demand. However, investment in renewables was more resilient during 2020 than investment in fossil fuels. The exceptional circumstances of 2020 aided the achievement of the renewable energy targets by lowering total energy consumption. The European Union (EU) reached its headline target (20%) for 2020 with a 22.1% share of energy consumed from renewable sources. Overall, renewables saw demand growth of 3% in 2020, renewable capacity additions in 2020 expanded by more than 45% from 2019, with an outstanding 90% rise in global wind capacity additions and a record growth of 23% in new solar PV installations [1].

Even though the impacts of COVID-19 on the global economy are complex and still unfolding, an articulated response could turn this threat into a major opportunity. The volatility in oil prices observed in the last years, together with the unpredictability of the return on investment in fossil fuels, could make renewables more reliable and predominant in the energy mix, and a change in the decarbonization path could be underway. While the positive environmental benefits experienced during the pandemic cannot be explicitly replicated in non-pandemic periods, the motivation and lessons learned have demonstrated a possibility for change [2]. Even though the impacts of COVID-19 on the environment were short-lived, its effects on the energy sector and on the economy might contribute to an acceleration of the clean energy transition. So, one question lingers: will our energy use change due to the pandemic?

This paper investigates the causality between the generation of renewable energy and a set of energy and economic variables for two distinct periods: the first, between 1979 and 2018, i.e., before COVID-19, and the second, between 1981 and 2020, thus, including the pandemic years. The goal of this paper is to assess if the pandemic fundamentally changed the long-run causality relationship among the variables, especially those concerned with the decarbonization transition. To the best of our knowledge, this is the first study dealing with the effects of COVID-19 on the sustainability transition by analyzing the causality of renewables' predominance and a set of energy and economic variables, using an econometric panel vector error correction model (VECM).

Methods

Our data set consists of two balanced panels of five countries (the United States of America, Japan, Germany, Portugal, and Spain) over the two periods previously specified. Taking into consideration the context provided and databases formerly employed in the literature, we selected the following variables of interest: (1) Renewable Energy Consumption (REC), which represents the degree of transition to a clean energy economy and is calculated as the % contribution of renewables to total energy generation [3]; (2) CO2 emissions, which are part of the Greenhouse Gases (GHG) and are used as an indicator of environmental quality [4]; (3) Gross Domestic Product (GDP), a key factor for development, affecting the two previous variables, REC and CO2; (4) Energy Consumption (EUSE), that refers to the use of primary energy before transformation to other end-use fuels; (5) Energy Trade Balance (ETRADE), a proxy for a country's reliance on energy imported; and (6) a variable for crude oil prices (OILP).

Following established procedures in the energy literature (see, for instance, [3][5][6]), we conduct the empirical cointegration and causality analysis in four steps. First, the order of integration of the variables was established. This is an essential first step since cointegration tests are only valid if the variables are integrated of the same order. Accordingly, we tested for a panel unit root to examine the stationarity of the variables in our model. Then, we tested the panel cointegration relationships. This test examines whether a long-run equilibrium relationship exists between the variables when individual variables are non-stationary in nature. Then we calculated short- and long-run relationships among the variables (Granger-causality) using the VECM. The final step was to estimate the long-run elasticities in the cases where Granger-causality has been confirmed using the fully modified OLS (FMOLS) technique.

Results

Since the first two steps are pre-regression tests employed to confirm the stability of data and to confirm the long-run relationship between variables, we will focus on the last two steps herein. The results of the short-run test (Table 1) indicate causality running from GDP and ETRADE to REC in the pre-COVID panel and causality running from GDP and OILP to REC in the COVID panel. Thus, results suggest that short-run causality from ETRADE to REC disappears once we consider the COVID period. In addition, including the pandemic years in the sample makes a short-run causality from OILP to REC significant. The coefficient on the ECT is negative and significant which points to a long-run causality running from the independent variables to the dependent variable for both pre-COVID and COVID panels. In addition, the speed of adjustment toward long-run equilibrium, represented by the Error Correction Term (ECT) differs in weight between the two panels. In fact, the ECT for the pre-pandemic period is higher, indicating a higher speed of adjustment towards the long-term equilibrium. This may be due to the fact that the pandemic created such a shock in the energy and economic system, altering the country’s priorities, that it caused the speed of adjustment to decrease. This decrease in the speed of adjustment can be caused by the increase in adjustment costs or by the fact that the recovery of the energy and economic system depends on something completely exogenous (a pandemic) which made the system more inefficient, staying longer in an unbalanced state.

Table 1 - Short- and long-run Granger causality results (*, **, and *** indicate significance at 10%, 5%, and 1%, respectively).

Dependent Variable	Source of causation (independent variables)					
	Short-run					Long-run
	Δ*ln*CO2	Δ*ln*GDP	Δ*ln*EUSE	Δ*ln*ETRADE	Δ*ln*OILP	ECT
	F-statistics					t-statistics
Pre-COVID (1979-2018) - Δ*ln*REC	0.0214	10.2075***	0.0816	3.4757*	2.2114	-0.0307***
With COVID (1981-2020) - Δ*ln*REC	0.3720	11.5418***	1.1992	2.4474	9.0461***	-0.0188*

As for long-run elasticities, when considering the pre-pandemic period, and holding the other variables fixed, a 1% increase in CO2 will decrease REC by approximately 2.8%. This is an unexpected result, but it might reveal the lack of commitment from economies to decarbonization, following environmental damage and worsening air quality. The same relationship occurs in the panel that considers the COVID period, with a 1% increase of CO2 decreasing REC by approximately 2.0%, less than previously. An increase in EUSE by 1% will increase REC by around 0.49%. Although this impact is positive it reveals the very small presence of renewables in the energy system up until 2019. This relationship is no longer significant once we include the COVID-19 period in the sample. An increase in OILP of 1% will result in an expansion of REC of 0.16% in the pre-pandemic period and 0.19% in the COVID era. Notably, for the panel that considers the pandemic the relationship with GDP is significant. Accordingly, a 1% increase in GDP increases REC by approximately 0.67%.

Conclusions

There is a long-run causality relationship running from economic growth, oil prices, carbon dioxide emissions, energy consumption, and energy trade to renewables consumption, for both the pre-COVID and COVID periods. Yet, the speed of adjustment toward the long-term equilibrium is higher for the pre-pandemic period, suggesting that the pandemic disrupted and shocked the energy and economic system up to a point that the system stays longer in an unbalanced state. This, in turn, presents an opportunity for change, as this unbalanced and delayed return to equilibrium allows to change in the dynamics of the energy system towards more sustainable outcomes. Moreover, since the short-run causality from energy trade to renewables generation disappears once we consider the COVID period, a country's reliance on imported energy no longer Granger causes renewables generation. Thus, countries might invest in renewables despite their energy (in)dependency. Moreover, when including the pandemic years in the models the short-run causality from oil prices to renewables becomes significant, which signals how the instability and volatility of oil markets can disrupt the energy system, especially when it concerns the development and employment of non-fossil fuel energy.

Regarding avenues of future work, since COVID-19 is a fairly new topic there are still few observations available for the pandemic years and afterwards. Accordingly, the panels should be updated as more data becomes available. In addition, a bi-directional short-run causality analysis would enrich this study, as well as considering all the variables as dependent variables, instead of just focusing on renewables consumption as the dependent variable.

References

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