The Onus on Coal Consumption and the "Beautiful China Initiative": Policy and Economic Implications

Economic Implications

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Abstract

China's need for rapid economic growth and its hunger for natural resources bring significant challenges to its economic and policy vision of sustainability, social stability, and economic development. The Beautiful China Initiative plans to bring sustainable development for the country to fulfill the United Nations 2030 Agenda for Sustainable Development Goals. The Chinese authorities are expected to reconsider traditional economic policy models to integrate environmental protection while ensuring that their economy proliferates. The shift from a traditional and heavy coal-dependent economy towards greener energy and a sustainable economic model brings additional challenges to China. This article seeks to examine causality patterns between economic growth and fossil fuels energy consumption through the analysis of coal consumption and carbon dioxide emissions policies using an Autoregressive Distributed Lag Model. This makes the Beautiful China Initiative move even more challenging and with several national and international economic policy implications.

Keywords: Beautiful China Initiative; Coal Dependency; Green Development, Economic Policy

Introduction

Humanity is facing survival needs and growing inequalities hat force to reconsider their economic growth, current development and future sustainability. The global economic model is deeply ingrained in the principles and paradigms that guide global capitalism and the globalisation process, contributing to developing a chronic tension between economic development, environmental sustainability, and human survival (Eriksen, 2016). Within these very challenging times, it is of interest to examine how China is addressing economic growth amidst mounting pressures to align with climate goals. China is signalled as the country with the highest pollution levels globally and a heavy reliance on coal to address its energy needs. At the same time, China is viewed as one of the countries that have engaged with the most ferocious approach against pollution, seeking to combat the effects of climate change (Yan and Spangenberg 2018). In addition, on the recent Glasgow COP 26, China and the United States finally engaged in public commitment through a joint declaration that intended to show compromise on reducing global emissions so that climate goals are not put at risk (US-China joint Glasgow Declaration 2021). However, as COP26 agreed on new climate rules, China weakened its position on the coal pledge as countries sought to strengthen their commitments to phase out fossil fuels (Hook et al. 2021). Egypt's COP 27 meeting did not end with a strong compromise, and China role and stance in climate change diplomacy remains blurry. China

endorses the work being done to establish a fund on "loss and damage" to help poor countries to pay climate change consequences, which was one of the main stalled points in the talks (Spring, 2022). As China continues to be the second-largest total emitter in history and still being counted as a “developing country” by the UN; how this should be articulated needs to be further cleared. (The Economist 2022).

China sustains itself on a fragile international socio-political equilibrium between cooperating and engaging in international environmental diplomacy through its Beautiful China Initiative and *"ecological civilisation"* philosophy and keeping its economic development. The Chinese economic growth has inflicted significant damage to its environment, leading to air, water, and soil pollution and the associated negative spillover effects on public health. To correct the inflicted damage, Chinese authorities have been challenged to rethink their economic growth model so that they can achieve a number of sustainable and socio-economic developmental goals (Sun and Zhou 2017). As such, China has embarked upon a challenging quest to integrate more sustainable economic growth metrics to become an industrialised and developed nation guided by the principles associated with economic sustainability. The core elements of the required change are based on social demands and on raising environmental awareness levels. The main drivers of a shift in this direction can be found in the following: the country's insecurity towards its future fossil energy supply; widespread pollution associated with an energy model strongly connected to fossil fuels; acute water shortages; and a significantly polluted soil. Damages have been caused by the intensive exploitation of coal resources in the country in general and in the Northern region in particular (Zeng et al. 2019). Another aspect that needs assessment relates to the rising economic costs of dealing with environmental damage and public health issues that can threaten future economic growth prospects.

Over the past few decades, China's energy needs and energy consumption patterns have multiplied due to its fast economic development pace. The Chinese energy sector relies heavily on coal, and the Chinese coal dependency outweighs by far that of other countries when assessing their energy models. But, the transition towards more sustainable energy sources requires significant investment, a large innovative effort, and local government authorities' collaboration and cooperation to implement the required changes. It is important to consider that China's coal reserves are abundant and that coal remains the cheapest energy resource worldwide. Consequently, a significant challenge emerges as many local governments and industries have a strong reliance on coal, and as such, they still favour the usage and exploitation of this resource. Coal remains a relatively inexpensive energy source that enables the creation and sustainability of employment levels, and it helps to materialise short-term benefits associated with a continuous and very much needed economic growth pattern. On a positive front, research findings suggest that renewable energies are becoming increasingly cheaper. An IRENA (2020) report indicates that in 2019 renewable energies managed to achieve lower power costs compared with the most affordable new coal plants. The Chinese authorities face a dilemma as local governments' involvement is needed to progress with the necessary changes. However, short-term goals appear to dominate, and the prospects for long-term investment and long-term economic and sustainability goals do not seem to align with current developmental needs. Furthermore, the local authorities might not have the needed resources to engage in developing alternative energies. They cannot wait for innovations to occur, as the short-term goals remain a priority and need to be met. The Chinese government has identified very ambitious targets for the development of renewable energy and nuclear power. However, the demand for fossil fuels is still enormous. China is now a net importer of

fossil fuels, which adds further complications to its desirable shift towards an energy model less reliant on fossil fuels.

The key objectives in this paper are to offer a critical assessment of and a contribution to the extant literature on China's progression towards a green energy model through the economic evaluation of the current country's coal dependency. The central research question examines long-run and causal dynamics that help bring further insights into the contribution of fossil fuels to economic growth with the support of the Autoregressive Distributed Lag Model. It is essential to emphasise China's heavy dependence on coal, which remains the cheapest energy resource and still dominates China's energy model. After discussing China's fuel dependence and the concept of China's *"ecological civilisation"* and the *"Beautiful China Initiative,"* the paper will discuss the economic growth/environment relationship from both an analytical and empirical viewpoint, offering avenues in terms of policy implications. A final section will conclude the analysis.

An Entangled Context: China's Fossil Fuel Dependence

Over the past decades, China's fast economic development model, based on cheap fossil fuel, has contributed to increasing pollution levels. Zhang et al. (2017) highlight how China's energy demands have reached unprecedented levels caused by the high-speed of economic development. In particular, air pollution has become increasingly severe, and environmental problems have become a serious area of concern at the global level (Shijin et al. 2019). At the epicentre of the problem, energy consumption, - and especially fossil energy consumption -, is identified as the main source of atmospheric pollutants emissions, directly impacting environmental degradation and aggravating climate change. Over the next few decades, it is expected that China will be driving increasing global energy consumption trends. Dai et al. (2016) argue that environmental destruction and China's limited fossil fuel resource endowment pose growing challenges as China becomes the world's largest energy consumer and producer. The country's large population commands high economic growth and development levels as the Chinese government seeks to reduce the incidence of poverty and avoid the middle-income trap. The country's reliance on coal remains very high, and its oil needs are rising, with nuclear power playing a significant role too. Unlike fossil fuel-fired power plants, nuclear reactors do not produce air pollution or carbon dioxide while operating (EIA 2020). China's coal dependence and rising oil needs will make the country one of the bigger contributors to global growth in CO_2 emissions (Dai et al. 2016). However, current developments are quite worrying as China's energy shortages raise significant doubts about the government's capabilities to curtail its dependency on coal (Shepherd, 2021). In addition, the country's dependence on imported fossil fuels is also another area of major concern; as Chinese energy needs keep increasing, the country needs to secure its energy supply. Therefore, fossil fuel reliance brings significant dilemmas to the Chinese authorities as they are facing economic development problems. The country faces significant obstacles to support economic sustainability due to the country's lack of security of energy supply, pollution, and water scarcity in coal-endowed areas with a systematic impact on the population's health (Shijin et al. 2019). While China is now a leading nation regarding the deployment of green energy technologies, further advances are needed to ensure that the country can "transition" towards a more sustainable energy model that limits and reverts the rising trends of fossil fuel consumption. According to Shijin et al. (2019), China has experienced a change in public awareness regarding the importance of preserving

natural resources and of protecting the environment. This is because the populace has now become aware of the important bottlenecks that restrict China's economic advancement and prevent its alignment with social and environmental goals. Adding complexity to the existing challenges, as the latest Glasgow COP 26 meeting has shown, China is subject to increasing international pressure to control its rising greenhouse gas emissions and reconsider its economic model. Improvements in energy efficiency seem therefore to be the way forward, and efficiency could reduce total energy consumption that could lead to the potential reduction of emission of greenhouse gases and air pollutants while ensuring economic growth.

However, the transition towards a cleaner and low-carbon energy production structure has emerged as a long and costly process. The development of renewable energies requires significant industry restructuring and adjustments. The shift requires significant reform in the existing grid system to facilitate renewable energy penetration and enable the adjustment of both the country's energy sector and its leading manufacturing activities. Therefore, the consolidation of renewable energies as an alternative to fossil fuels is closely linked with massive investment levels in accomplishing long-term goals within an economy (Dai et al., 2016). There is no doubt that renewable energies will play a significant role and that they will generate important positive spillover effects on other sectors and the macroeconomic context. Nevertheless, coal reserves remain very important and firmly embedded in China's national energy strategy, and worldwide (Wu et al. 2017; Wu et al. 2019; Ristovic et al. 2010; Kavouridis and Koukouzas 2008; Yilmaz and Uslu 2007).

China has been continuously called to order by the international community and by civil society for its pollutant emissions. As such, a global approach to deal with climate change challenges is needed as individual efforts are not enough to address the sustainability problem. Fuel substitution appears as a potential energy policy instrument that can enable the transition towards sustainable development. According to Bloch et al. (2015), in order to make progress on the environmental front, there is a need to encourage and foster the substitution of fossil fuels for renewable energies. In particular, the transition from coal to alternative energy resources is very much needed as coal is identified as the energy resource that has the most detrimental impact on the environment. Therefore, if coal consumption is discouraged by introducing policies that prevent its usage and eliminate its advantage as the "cheapest" energy resource, faster progress could be made. As a result, there would be more possibilities of transitioning to alternative energy resources and shifting from coal energy-driven models towards greener alternatives that enable a stronger and united impact on carbon dioxide emissions. Therefore, a global environmental approach that seeks to encourage cooperation and collaboration among countries is very much needed, but is it at all realistic? The global 2020 health crisis along with the unclear results of the COP26 have clearly shown that global leaders find it difficult to unite fronts and efforts to deal with a massive health issue. This suggests that international engagement and collaboration expectations to deal with climate change problems are quite over-rated.

For the above-mentioned reasons and despite the fact that China's renewable energy portfolio is quite diverse, including hydropower, wind power, solar power, biomass power, and other renewable energies, coal still remains the dominant energy resource. In 2018, raw coal output accounted for 69.3 per cent of China's total primary energy production. In addition, there are concerns regarding rising trends towards oil consumption. As the country shifts from coal to oil, this might perpetuate its over-dependence on fossil energy, thereby mitigating the solution to

greenhouse emissions. In order to deal with the intense conflict between rapid economic growth and excessive CO_2 emissions, the government and the local authorities will need to develop and exploit their renewable energy resources. The critical issue to consider at this juncture is the strategic approach towards a gradual transition that does not harm the fundamental economic basis of a coal-driven economy (Zhang et al. 2017). Furthermore, the sustainability of Chinese coal cities is critical to the country's socio-economic development and energy security (Zeng et al. 2017). This reality adds further complexities to the country's vision to move towards an environmentally friendly energy model that might marginalise coal (Zeng et al. 2019). The current reliance on coal is not, nevertheless, only China's problem. The global economy shows a significant dependency on coal through consumption activities from developed economies that import products from countries like China. Activities such as basic fuel energy consumption in less developed economies and capital formation are just some examples of the global reliance on coal that accounts for 60 per cent of total strategic resource consumption (Zeng et al. 2019; Wu and Chen 2018). According to Wu and Chen (2018), coal usage in households' consumption has been neglected in a context where coal consumption has been traditionally connected with the electricity industry's needs. As such, coal consumption patterns across different economic players emerges as an area of concern as it has become a controversial issue that requires further attention.

A Shifting Environmental Policy? China's "Ecological Civilisation" and the "Beautiful China Initiative"

President Hu Jintao had first endorsed the concept of "ecological civilisation" in 2007, and since then, the concept has developed into a central framework on the green rhetoric of the Chinese Communist Party (Goron 2018). According to Hansen and Liu (2018: 322), the adoption of the "ecological civilisation" view as enshrined in the Party ideology in 2007, was a sign of the political leaders' acknowledgement of heavy costs associated with China's economic miracle. An increasing number of Chinese citizens are questioning the impact of fast economic growth on their health and the quality of their environment. China's "ecological civilisation" concept emerged as an ideological framework with origins in the late 1980s when the term "ecology" was introduced as part of the government's guidelines on environmental policy, specifically in ecological agriculture. The term "ecological civilisation" gained momentum among academic writers by the end of the millennium. But more recently, the rise in environmental consciousness among ordinary citizens has led to a necessary political response that seeks to bring harmony within the political party. It tries to find a balance between economic development and the need to protect the environment (Schmitt 2018). As part of the 15th Party Congress agenda in September 1997, it was listed that "the huge environmental and resource pressures caused by population growth and economic development" are surging as major difficulties for the nation eager to appease environmental concerns within a challenging economic landscape (Meng 2012). The concept of "ecological civilisation" gained further importance in Government circles with the 17th National Party Congress Report (N.P.C 2007: 15-21). The 18th National Party Congress delivered on 8 November 2012 introduced the term "eco-civilisation". During the Third Plenary Session of the 18th Central Committee in 2013, President Xi started to acknowledge the importance and the need to solve the existing contradictions between economic development goals and their impact on the environment (Marinelli 2018).

The term "eco-civilisation" considers the environmental conditions and the need for balanced and sustainable development that are relevant aspects presented in the report. However, some conflicts are surrounding the concept, and its "real environmental impact" as economic development emerges as a dominant force. Despite the rhetoric, there is some degree of systematic prioritisation in favour of economic growth and development objectives over environmental protection, which reveals the gap between the official discourse on climate change and the real actions to deal with the problem. Therefore, an appropriate balance between economic growth and environmental protection requires an environmental law framework, a culture of environmental protection, and a focus on resolving air, water, and soil pollution, as well as promoting the harmonious economic development between individuals, society, and nature (Pan 2003, Pan 2013). According to Schmitt (2018), China's "ecological civilisation" approach is grounded on the Chinese Communist Party's interpretation of sustainability. Within this context, sustainability is defined according to the three pillars: social, economic, and environmental - pillars that are subject to different interpretations depending on the political context of a given country that is shaped by views, ideologies, and visions of their political leaders (Goodland 1995; Scoones 2016; Purvis et al. 2019; MERICS 2021). In this regard, environmental politics differentiates China's efforts to change its energy future. Its future is grounded on an energy framework that has been cemented on fossil fuels with a towering presence in global coal markets (Rajmil et al 2020).

As hinted at above, the country's global economic role and its environmental footprint are a critical area of concern with the depletion of resources and the continuous loss of biodiversity accelerating at the world level. China's vision of ecological civilisation is in conflict with its reliance on the exploitation and usage of coal resources. In addition, International Diplomacy is mounting its pressures on countries to adopt the 2030 UN Agenda Development Goals as the main international framework for environmental and energy policies, significantly impacting China. As a reaction and related to China's ecological civilization appears the "Beautiful China Initiative" (BCI) that embraces the concept of sustainability and takes into a further stage the country's long-term policy to transition towards a greener economy with the support of a sustainable energy model. BCI is a phased strategic plan for China to implement the construction of ecological civilization, promote the country's sustainable development, and improve the ability and quality of sustainable development. This is also the core goal of China to achieve high-quality development. It includes two aspects: broad sense ("big BCI") and narrow sense ("small BCI") (Fang et al. 2020: 693).

However, despite international enthusiasm on China's unexpected engagement in the last COP 26 meeting, coal remains as China's primary energy resource, with a share of coal in total energy use reaching 61.83% in 2017, well above the world average (Wu and Chen 2018; B.P. Statistical Review of World Energy 2017). Geall and Ely (2018: 1190) state that: "China is abandoning the concept of regarding economic growth as the only criterion in government performance assessment." However, China's coal consumption from 1998 to 2020 amounted to 82.3 exajoules, and by 2020 China consolidates as the world's largest coal consumer with 54 percent of coal consumption (Statista 2021). The Chinese authorities have indicated that they are in the process of aligning their targets, policies, assessments, rewards, and fines to meet the requirements of the "ecological civilisation" and "the Beautiful China initiative "policy framework. However, recent developments in the country towards increasing levels of coal production cast serious doubts on the country's alignment to international climate goals (Early 2021; Hook et al. 2021). The social awareness of air pollution dangers has led to significant

questioning of the country's economic model as the causes of greenhouse gases and pollutants are becoming a major area of concern (Hansen and Liu 2017). The connection between households' consumption, air pollution, and coal consumption at the domestic level has become under increasing scrutiny. The usage of solid fuels such as coal or wood for cooking and heating purposes at the domestic level appears to be part of the problem. While the outcome and policy results of COP 26 are still uncertain, meanwhile and according to the WHO (2022), some 4.2 million deaths occur every year due to exposure to air pollution.

Economic Growth and the Environment

The 2015 Paris agreement has outlined the importance of "limiting global warming to well below 2 degrees […] Celsius compared to pre-industrial levels" (UN Paris Agreement 2015). Quite worryingly, countries' commitments are not enabling them to meet the 2-degrees Celsius target (WHO 20122). According to Leahy (2019), most countries cannot meet climate change goals, with largest emitters showing signs of increasing patterns in their emissions. The Paris Agreement has not yet succeeded in changing the behaviour of the most polluting countries in the world. Given its large population and the need for continuous economic growth in the context of limited natural resources, China is identified as a central economic player to achieve greenhouse gas emissions reductions (Geall and Ely 2018; Nature 2021)). The country needs to reconsider its economic growth model, whereas new growth measures need to be devised, agreed upon, and implemented globally. Measuring GDP is subject to significant criticisms due to the assumption that the exploitation of natural resources (as inputs in the production process) is computed totally as a positive outcome. Within this traditional national accounts logic, the high costs of environmental degradation and deteriorating human health are neglected. In short, economic externalities' and their long-term implications are overlooked from the measurement of growth, posing a challenge to sustainability. Over more than three decades, the Chinese economy has registered strong annual growth rates with a yearly average of around 9.8 percent. However, the year 2012 brought a significant shift to China's economic growth trend. The Global Economic and Financial Crisis contributed to unveil that China's prolonged period of high-speed economic growth was not sustainable. The Chinese society and the global community started to demand changes as unprecedented ecological pressures and environmental constraints emerged. There has been rising awareness of the seriousness of related environmental problems due to economic activity, and finally, the connection between human survival and economic sustainability was acknowledged. The new situation has forced the Chinese leaders to turn their attention towards the importance of rebalancing China's economic model. Sustainable growth and the "new normal" with new economic developmental patterns have been considered (Lin 2011). The situation has become more delicate by the limitation of economic resources.

Coal has been quite dominant in China's energy model due to poor storage infrastructures for oil and gas energy resources; this has led to an excessive use of coal that has contributed to exacerbating environmental problems within the country and at the global level (Chai et al. 2019; Zhang et al. 2018; Lin and Zhu 2017). Recent research studies suggest that greenhouse emissions and smoke have become quite severe in China (Chang et al. 2019; Zhang et al. 2019; Lin et al. 2016; Lin et al. 2017). Current carbon reduction trends might not be sufficient to enable a significant reduction in the country's coal dependency with no major impact on the reduction of carbon dioxide emissions (Yu et al. 2018). Wu et al. (2019) found that increases in electricity demand have driven the use of coal and of crude oil. Li et al. (2018) indicate that

thermal power dominates China's power generation structure, which is a large CO2 emitter. To add further challenges, the country's national energy security has been identified as crucial due to its external dependence and overreliance on fossil fuels to sustain its vast population (Ji and Zhang 2019). Some interesting research findings reveal that Mainland China is the largest coal user in the world; however its household consumption only represents a quarter of the patterns registered in the United States, and it does not exceed the levels in the United Kingdom, a country that is viewed as a leading economy in efforts to move away from coal usage (Wu and Chen 2018). In the 18th and 19th centuries when the world was immersed in its Industrial Revolution, there was wide exploitation and extensive use of coal resources worldwide. During that period, coal was used to fuel new industries and to support the intensive period of technological transformation due to its low costs and wide availability; these features remain very important at the global level, and they add significant constraints to the transition towards renewable energies (B.P. Energy Outlook 2035, 2017). Noteworthy, the United States' coal consumption has increased as the country is the world's leading importer of coal, of which non-coal products dominate the country's indirect energy imports due to its high dependence on products made in China. On the other hand, China is signalled as the leading coal exporter. The globalisation process and the development of international trade relationships have led to the successful transfer of natural resource-based production systems (with the associated negative impacts on the environment) to middle- and low-income foreign regions and countries (Holland et al. 2015; Peters and Hertwich 2006). Relatively high levels of carbon content characterise coal production, and its consumption is regarded as the leading source of anthropogenic greenhouse gas emissions contributing to global warming (Chandran and Tang 2013). But, beyond the many climate change concerns, there are additional areas that require urgent attention. Earth systems scientists highlight the risks and other biophysical changes that are pushing human development towards dangerous tipping points. According to the IEA (2016), government policies aiming to reduce domestic coal consumption has reached levels that were once unimaginable, but China's efforts to bring alternatives to its energy portfolio are not sufficient, as the country keeps investing in coal exploitation at home, and it has an active approach in financing fossil-fuelled power overseas (Economy 1997: 2017).

The latest COP 26 conference did end with a formal joint declaration between China and the US. These two major global economies reinforced the Paris agreement seeking to take further steps on their commitment to reduce their dependence on fossil fuels. "Both countries will work cooperatively to complete at COP 26 the implementing arrangements ("rulebook") for Articles 6 and 13 of the Paris Agreement, as well as common time frames for NDCs "(U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s)". In other words, the COP 26 did reinforce both global pressure on China to shift towards a green transition and a "Beautiful China" and its national attachment to the international diplomacy negotiating frameworks. In addition, COP 27 did fail to proper address the climate change consequences.The political dimension of the enormous physical impacts of climate change became very clear at COP 27. In this occasion, there was a strong focus on loss and damage. By contrast, adaptation to climate-related environmental change as well as international climate finance for adaptation have fallen short (Feist and Geden, 2023).

Economic Analysis & Policy Implications

The economic analysis seeks to identify any causality patterns between economic growth and fossil fuels energy consumption through the analysis of coal consumption and carbon dioxide

emissions. The relationship can be formulated as follows: $GDP_t = f(CC_t, CO2; FFEC)$, where the GDP stands for China's real GDP per capita in time t, CC_t is China's coal energy consumption, $CO2$ represents China's carbon dioxide emissions and FFEC accounts for fossil fuels energy consumption. The study employs annual data over the period 1971–2017, drawn from the available DataStream database and limited to 2017 due to data availability. The functional log specification is used as it yields better results than the linear functional form. The study is supported by the implementation of the ARDL bounds testing approach to cointegration developed by Pesaran et al. (2001) to examine the existence of long-run relationships between the variables as this model works particularly well in the context of a small sample size.1 Further advantages associated with this test relate to consistent estimates of the long-run coefficients that are asymptotically normal irrespective of whether the underlying regressors are I(1) or I(0). The equations below outline the models used to support this study.

$$\Delta GDP_t = \alpha_{10} + \sum_{i=1}^{p} \beta_{11} \Delta Y_{t-i} + \sum_{i=0}^{q} \gamma_{12} \Delta CC_{t-i} + \sum_{i=0}^{r} \delta_{13} \Delta CO2_{t-i} + \lambda_{14} GDP_{t-1} + \lambda_{15} FFEC_{t-1} + \lambda_{16} CO2_{t-1} + \theta_{17} T + \varepsilon_{1t} \quad (1)$$

$$\Delta CC_t = \alpha_{20} + \sum_{i=1}^{p} \beta_{21} CC_{t-i} + \sum_{i=0}^{q} \gamma_{22} \Delta GDP_{t-i} + \sum_{i=0}^{r} \delta_{23} \Delta CO2_{t-i} + \lambda_{24} GDP_{t-1} + \lambda_{25} FFEC_{t-1} + \lambda_{26} CO2_{t-1} + \theta_{27} T + \varepsilon_{2t} \quad (2)$$

$$\Delta CO2_t = \alpha_{30} + \sum_{i=1}^{p} \beta_{31} \Delta CO2_{t-i} + \sum_{i=0}^{q} \gamma_{32} \Delta GDP_{t-i} + \sum_{i=0}^{r} \delta_{33} \Delta CC_{t-i} + \lambda_{34} GDP_{t-1} + \lambda_{35} FFEC_{t-1} + \lambda_{36} CO2_{t-1} + \theta_{37} T + \varepsilon_{3t} \quad (3)$$

[1] According to Pesaran and Shin (1999), simulation results show that the ARDL is superior and delivers consistent results for even a small sample.

If there is evidence of a long-run relationship between the variables presented in the equations above, the study requires the estimation of the Error Correction Model as outlined in equations 4 to 6 below.

$$\Delta GDP_t = \omega_{10} + \sum_{i=1}^{p} \emptyset_{11} \Delta GDP_{t-i} + \sum_{i=0}^{q} \theta_{12} \Delta CC_{t-i} + \sum_{i=0}^{r} \tau_{13} \Delta CO2_{t-i} + \rho_{14} ECM_{t-1} + \mu_{1t} \quad (4)$$

$$\Delta CC_t = \omega_{20} + \sum_{i=1}^{p} \emptyset_{21} CC_{t-i} + \sum_{i=0}^{q} \theta_{22} \Delta GDP_{t-i} + \sum_{i=0}^{r} \tau_{23} \Delta CO2_{t-i} + \rho_{24} ECM_{t-1} + \mu_{2t} \quad (5)$$

$$\Delta CO2_t = \omega_{30} + \sum_{i=1}^{p} \emptyset_{31} \Delta CO2_{t-i} + \sum_{i=0}^{q} \theta_{32} \Delta GDP_{t-i} + \sum_{i=0}^{r} \tau_{33} \Delta CC_{t-i} + \rho_{34} ECM_{t-1} + \mu_{3t} \quad (6)$$

Stationarity tests are implemented to identify the variables in level of integration as the ARDL bound testing for cointegration becomes inappropriate if any series is identified as integrated processes of order 2, or I(2) processes. Prior to implementing the unit root tests for the identified variables, the adequacy of the logarithmic transformation of each of the variables was also considered. Three unit root tests were implemented: the Augmented Dickey-Fuller (ADF), Phillips Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) to examine stationarity properties that characterise the time-series data under study. The chosen stationarity tests were applied to identify the series level of integration. In addition, a VAR (Vector Autoregressive framework) model was implemented to determine the optimal number of lags. The AIC information criteria was the preferred option as it is considered the optimal criteria when dealing with small samples. Stationarity testing indicates that none of the series under study are an I(2) process and as such Pesaran et al. (2001) is appropriate. The main research findings are summarised in the tables 1 and 2 below.

Table 1: Unit Root tests

Variables	**ADF**		**PP**		**KPSS**	
	Levels	1st Differences	Levels	1st Differences	Levels	1st Differences
GDP	-0.594(0.8612)	-2.7914(0.0685)	10.213(1.000)	-4.464(0.000)	0.7684(0.739)	0.1989(0.7390)
Coal Consumption	-2.1309 (0.2339)	--5.064 (0.0001)	1.7630(0.999)	-5.1083(0.0001)	0.8768 (0.7390)	0.3612(0.7390)

CO2 Emissions	1.6232 (0.9993)	-3.214(0.0262)	0.9857(0.9958)	-3.223(0.025)	0.7964(0.7390)	0.0960(0.7390)

*The values in brackets are p-values in the case of the ADF and PP tests and critical values for the KPSS. The outcomes show that the series are I(1) processes across the chosen unit root tests.

Table 2: Cointegration and Diagnostic Tests

Bounds testing to cointegration			**Diagnostic Tests**		
Variables	Optimal lag	F-statistics	Serial correlation	Heterokedasticity	Normality
GDP (Yt)	(2,3,2)	4.087(C)	1.7089(0.119)	1.2897(0.2830)	0.258(0.8787)
Coal Consumption	(4,0,1)	3.58(C)	0.9131(0.4125)	1.171(0.3472)	5.5607(0.0620)
CO2 Emissions	(1,2,1)	3.10 (I)	0.7152(0.498)	0.691(0.709)	0.5670(0.7531)

*1%significance level; **5% significance level, ***10% significance level; I(inconclusive) as the F-Statistic fall between the low and upper bounds. C(cointegration) the F-statistic is above the upper bound.

The cointegration outcomes show evidence of a long-run relationship when GDP and Coal consumption are dependent variables; there is no long-run association in the case where carbon dioxide emissions is the dependent variable, and the results are inconclusive in the ramining cases. The diagnostic tests indicate the presence of heteroskedasticity only in the case of equation 1 when GDP is the dependent variable indicating robustness on the outcomes of the implemented models. In addition, causality dynamics is explored in Table 3.

Table 3 : Short-term Dynamics - Causality

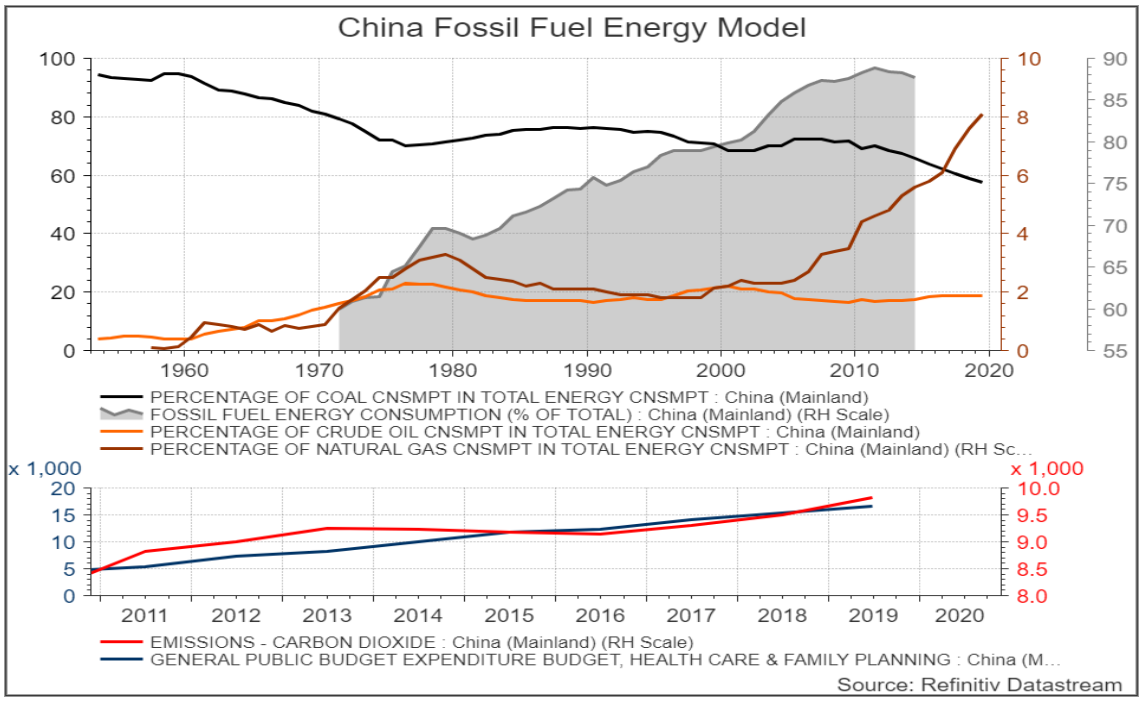
	Direction of Causality			
	Short run			Long run
Variables	ΔGDP	ΔCoal Consumption	ΔCO2 Emissions	E.C.M.
ΔGDP (ΔYt)	0.390(0.008)	0.8116(0.007)	-0.3100(0.0224)**	-0.06008(0.000)*
ΔCoal Consumption	-0.03562(0.4678)	-0.2134(0.0576)***	0.1841(0.0000)*	-0.7735(0.000)*
ΔCO2 Emissions	0.4379(0.0023)	0.9500(0.0026)*	0.1841(0.0000)*	--0.4553(0.008)

*1%significance level; **5% significance level, ***10% significance level; Results in brackets report p-values.

The causality results confirm the existence of bidirectional short-run dynamics between the variables with a lack of causal effects between coal consumption and GDP; this is a surprising outcome, as it was expected that coal consumption would impact GDP. However, there is a need to acknowledge that coal consumption dynamics might be better captured by energy markets, and as such, indirect effects to GDP growth from the energy sector should be considered.

The Chinese economy remains heavily reliant on fossil fuel usage, and coal remains the dominant energy resource with almost a 60% share in total energy consumption, followed by oil that captures around 23% of energy consumption with a clear rising trend (see figure 1). Gas consumption is below 10% with a share of around 8% as per data available for the year 2020. It

is essential to highlight that gas consumption patterns have experienced a rise since the late 1990s, where consumption increased from 1.8% registered in 1998 to 7% as per available data in the year 2018 and with further increases in 2020 reaching a share of 8%. While the country is making significant efforts to diversify its energy mix and move towards its vision of an "ecological civilisation", the country's reliance on fossil fuels remains a fact. The current situation raises serious concerns regarding Chinas' ability to introduce the required policies that lead to a shift in its economic growth strategy, compatible with more sustainable goals. Available data from 2010 indicate that carbon dioxide emissions are on the rise as also the country's expenditure budget for health care and family planning.



Source: Authors (2020) Data resourced from Refinitiv Datastream.

Figure 1 Caption: China's Fossil Fuels Dependency
Figure 1 Alt Text: Figure 1 is based in two complementary line graphics, on the upper graphic, line graph plotting the percentage of coal consumption versus crude oil and natural gas consumption. Lower graphic corresponds to the line graph plotting the evolution of Carbon Dioxide emissions versus General Public Budget Expenditure

Conclusions

China's historical reliance on coal to fuel its economic development has had a massive impact on its environmental policies and international diplomacy, and, more recently, a growing impact on the country's public health system has been identified. Recent development from the COP26 and COP 27 meetings suggests the need for serious economic and energy policies that seek to design and develop effective policy measures and interventions that contribute to counteracting the effects of climate change. Overreliance on coal consumption has materialised in the deterioration of air, soil, and water quality with negative long-term spill over effects to its ecosystem However, China is not the only player to be considered when analysing the overexploitation of coal and other natural resources. The globalisation process enabled the

country to benefit from competitive advantages that made its products cheaper than those of its competitors, and it made the country attractive to world investors. To some extent, the behaviour of developed economies in re-locating some of their polluting activities and the drastic change in global consumption patterns have contributed to China's coal dependence. Therefore, environmental degradation needs to be scrutinised at the global level, and international environmental diplomacy is working under this assumption, but pressure does mount on prominent contaminating actors as in the Chinese case.

The Chinese government needs to enable policies that foster the transition towards an economic model that integrates environmentally friendly metrics. To accomplish its "ecological civilisation" vision and to move towards the dream of a "Beautiful China initiative" the nation also requires a significant paradigm shift that could jeopardise years of economic progress and development. The Chinese authorities face tremendous challenges in detaching their growth model from coal. China's hunger for natural resources is challenging its economic vision of sustainability, social stability, and future green economic transition.

While the Chinese leaders dream about a "Beautiful China" that harmoniously integrates economic, social, and environmental goals, they seem to be unable to move away from its historical connection to coal, and as such, the challenges ahead are sizeable. This paper offers interesting evidence on critical challenges faced by China's global leadership as the country faces an enormous development and economic dilemma: how to grow and sustain its international position while adjusting its energy resources model to embrace its political goals and country branding "Beautiful China" strategy. In addition, the 2030 agenda and international diplomacy framework will pay close attention to China's coal dependency mitigation plans. In this sense, future research efforts should explore global fossil fuel consumption patterns to illustrate how other countries adjust their economic models in order to find how they adhere to the climate change international protocols and policies and see how they could affect China's role in the negotiation process.

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