Banking sector performance and green growth in China: do education and eco-innovation matter?

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Abstract

China's rapid green growth has resulted in banking sector performance, human capital, and green innovation. This study examines the effect of banking sector performance, education, and green innovation on green growth based in China from 1996 to 2020 by using ARDL. Findings show that banking sector performance (such as market capitalization and banks assets) has significantly enhanced green growth in long-run. The results reveal that education and green innovation foster green growth in China in long-run. We also find short-run market capitalization and education positive effects in green growth. Moreover, in short-run and long-run, trade and renewable energy consumption have a positive effect on green growth. Our empirical consequences provide vital policy implications for promoting green growth in China.

Introduction

Over the past few decades, the world has noticed a continuous rise in the temperature and its detrimental impact on human lives, which has made sustainable development the main goal of the policymakers, governments, civil society, and empirics (IPCC 2018). As a result, the nations are continuously in search of possibilities that can mitigate the effects of climate change. In this regard, the world leaders have signed a Paris Agreement in 2015, the main crux of which is to limit the world temperature below 2 degrees as compared to the pre-industrial level. Similarly, the 2030 Sustainable Development Agenda of the UN also demand that world leaders should take quick action to make the environment better for this and future generations (Organisation for Economic Co-operation and Development—OECD 2020). According to OECD (2020) the developed and developing economy should strive together for attaining Sustainable Development Goals. Though all the countries have made commitments to attain environmentally sustainable economic development their efforts in this direction vary quite enormously.

Given the multi-dimensional nature of the environmental problems and the fact that one environmental strategy can't resolve all the environmental problems which emerge as a result of increasing economic activities, we try to find the factors that can decouple economic growth from CO2 emissions. Such type of economic growth is given the name of green growth, which represents the sustained economic growth that can be attained with the help of more efficient use of natural capital (OECD, 2020). Green growth also represents the country's advancement towards a cleaner environment and sustainable economic development (OECD, 2020). To attain green growth the economies need to use natural resources in a sustainable and efficient manner. The ultimate objective of green growth is to attain economic growth that is more equitable in terms of material benefits and can also preserve the environment for future generations (OECD 2018). The idea of sustainable development i.e., attaining economic growth without compromising on superior environmental standards, calls for the more efficient use of input in the production and manufacturing process that reduces the burden on the environment and also spur economic growth.

Finance is slowly but gradually becoming the main driving force behind the economic development of a nation. A theoretical model proposed by Greenwood and Jovanovic (1990) provided a mechanism that explains the information asymmetries involved in the relationship between financial development and economic growth. They opined that a dynamic and vibrant financial system efficiently controls the issues of adverse selection and moral hazards that emerge due to information asymmetries and direct the funds towards the projects with the highest returns that will positively affect the overall productivity. Similarly, King and Levine (1993) integrated the concept of finance into the endogenous growth model and observed that an efficient financial arrangement help improve productivity and ultimately increases economic growth. Indeed, most of the studies have used banking sectors performance to represent the financial sector development and confirmed the positive impact of banking sector development on economic growth; however, few have also noticed the negative impact of banking sector development on economic development (Aghion et al., 2004 and Ullah et al. 2021). Ruiz (2018) has noticed asymmetric effects of financial development on economic growth; whereas, Asteriou and Spanos (2019) observed that the relationship between banking sector development and economic growth varies before and after the financial crisis.

The importance of financial development in fostering the growth of the economy has encouraged many empirics to analyze whether financial development can also help to decouple economic growth from environmental pollution. Recently, many studies are available that have analyzed the impact of financial development on the economy and confirmed the positive impact of the banking sector and other indicators of financial development on economic growth (Caporale et al., 2015; Tripathy, 2019). However, in recent times, the demand for a better environment has increased manifold, which is based on the more efficient and sustainable use of natural resources while performing economic activities (Longhofer and Jorgenson, 2017).

Apart from the relationship between financial development and economic growth, another important relationship that has grabbed the attention of the empirics is the link between environmental innovation and environmental pollution (Ullah et al. 2021 and Usman et al. 2021). It is widely recognized that an improvement in environment-related technologies, on one side, increase the productive capacity of the economy; on the other side, help the economy to produce a wide variety of environmentally friendly products and services that exert less burden on the environment and decouple economic growth from CO2 emissions. However, technological innovation has a dual impact on environmental quality and productivity (Yang et al. 2021). On one side, it saves human and material resources by improving the efficiency of producers and manufacturers, thereby decreasing the prices of the goods produced and raising their demand as well (Zeng et al. 2010 and Ullah et al. 2019). On the other hand, the rebound effect also plays its part and causes the demand for natural resources to rise (Herring and Roy 2007). At the same time, two different phenomena, "brown technology" and "pseudo-innovation", also appear, which suggest that firms and businesses purposefully use a low level of outdated technology that help them to attain the scale effect but don't allow them to contribute to the overall target of green growth. Further, education can also contribute to achieving the target of sustainable development goals and help to decouple economic growth from CO2 emissions. Education is the most important factor in the development of human capital, which is used as input in the production function. Promoting human capital and using the production techniques that are driven by human capital instead of physical capital can promote economic growth without exacerbating the environmental problem (Li & Ullah 2021). Hence, we can't predict the impact of banking sector performance, education, and eco-innovation on green growth; therefore, banking sector performance, education, eco-innovation, and green growth relationship should be explored in detail and this study is an effort in this direction.

Model And Methods

King and Levine (1993) incorporated financial sector development into the endogenous growth model and observed that the financial sector is playing a crucial role in improving the firm's productivity, which will help to achieve sustainable economic development in the economy. In the literature, many studies such as Wachtel (2001), Caporale et al. (2015), and Tripathy (2019) have examined the link between financial development and economic growth. In this study, we have modified their models a bit and replaced economic growth with green growth, and tried to observe whether banking sector development help to attain green growth or not. Therefore, we have developed the following long-run model.

$$\mathrm{GG_t} = \mu_0 + \mu_1\mathrm{BSP_t} + \mu_2\mathrm{Education_t} + \mu_3\mathrm{GI_t} + \mu_4\mathrm{REC_t} + \mu_5\mathrm{Trade_t} + \epsilon_t (1)$$

In the above specification (1), the green growth (GG) is determined by the banking sector performance (BSP), average years of schooling (Education), green innovations (GI), renewable energy consumption (REC), Trade, and random error term (ϵ_t). However, Eq. (1) is a long-run model and only provides us with the long-run estimates, but we are also interested in the short-run estimates. Hence, we have redefined Eq. (1) into the error correction format is presented below:

$$\Delta\mathrm{GG_t} = \mu_0 + \sum_{k=1}^{n}\beta_{1k}\Delta\mathrm{GG_{t-k}} + \sum_{k=0}^{n}\beta_{2k}\Delta\mathrm{BSP_{t-k}} + \sum_{k=1}^{n}\beta_{3k}\Delta\mathrm{Education_{t-k}} + \sum_{k=0}^{n}\beta_{4k}\Delta\mathrm{GI_{t-k}} + \sum_{k=1}^{n}\beta_{5k}\Delta\mathrm{REC_{t-k}} + \sum_{k=1}^{n}\beta_{6k}\Delta\mathrm{Tra}$$
(2)

Specification (2) can now be called as ARDL model of Pesaran et al. (2001), which provides us with both short and long-run estimates simultaneously. The short-run results can be derived from the coefficients that are connected to first-difference variables, and the long-run results can be interpreted from the coefficients $\mu_2 - \mu_6$ normalized on μ_1. However, in time series analysis, the long-run results are considered spurious unless we find cointegration between them. To that end, Pesaran et al. (2001) proposed a bounds F-test, which confirms the joint significance of lagged level variables if the calculated value is greater than the tabulated value. Moreover, an alternative test is known as the error correction (ECM_{t-1}) test, which approves the cointegration if the estimate of ECM_{t-1} is negatively significant. Another advantage of this model is that we don't need to check the stationary of the variables because it can deal with I(0) and I(1) variables at the same time. Further, this model can produce efficient results in the case of a small sample size (Panopoulou & Pittis, 2004). Last but not least, this model allows us to include the dynamic process in the short-run, which highlights feedback effect if any, and control endogeneity and multicollinearity (Bahamani-Oskooee et al. 2020).

Data

The study is exploring the impact of banking sector performance, education, and eco-innovation on green growth of China for the period 1996–2020. Table 1 is displaying the information regarding abbreviations of variables, definitions, and descriptive statistics. In this study, green growth is determined by environmentally adjusted multifactor productivity. For measuring banking sector performance, the study has used three proxies namely market capitalization (excluding top 10 companies to total market capitalization), bank assets (deposit money bank assets as percent of GDP), and bank return on assets (in percent after-tax). Average years of schooling are taken to measure education. Eco-innovation is determined by patent applications as percent of GDP. Besides focused variables, trade as percent of GDP and renewable energy consumption are taken as control variables. The required data for empirical investigation have been sourced from the OECD, IMF, EIA, and World Bank.

Table 1
Definitions and data description

Variables	Definitions	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
GG	Environmentally adjusted multifactor productivity	8.864	8.615	13.134	7.103	1.298	1.825	6.620
MC	Market capitalization excluding top 10 companies to total market capitalization (%)	76.61	76.14	93.36	60.59	8.650	0.230	2.356
BA	Deposit money banks assets to GDP (%)	124.9	120.3	174.5	82.39	23.64	0.485	2.606
ROA	Bank return on assets (%, after tax)	0.940	0.978	1.545	0.431	0.332	0.110	2.307
EDUCATION	Average years of schooling	11.81	12.15	14.60	9.200	1.890	-0.107	1.468
GI	Patent applications, total (residents and non-residents)	12.40	12.49	14.24	10.03	1.360	-0.189	1.777
TRADE	Trade (% of GDP)	45.28	43.82	64.47	32.42	10.12	0.539	2.026
REC	Total energy consumption from nuclear, renewables, and other (quad Btu)	1.614	1.604	2.797	0.523	0.798	0.006	1.519

Results And Discussion

To explore the unit root properties of data, DG-GLS and PP tests have been employed. The outcomes of both DF-GLS test and PP test are given in Table 2. The findings of GF-GLS unit root test report that green growth, return on assets, and renewable energy consumption are integrated at I(0), while market capitalization, bank assets, education, green innovation, and trade are integrated at I(1). The findings of PP unit root test report that green growth and return on asset are integrated at I(0) while market capitalization, bank assets, education, green innovation, trade, and renewable energy consumption are integrated at I(1). The findings of both unit root tests proved that the pre-condition to adopt ARDL approach has been fulfilled. Thus, our study is confident in adopting ARDL approach for making empirical inferences. Table 3 presents the short-run and long-run coefficient estimates of all three ARDL models.

Table 2
DF-GLS and PP unit root tests

	DF-GLS			**PP**		
	I(0)	**I(1)**	**Decision**	**I(0)**	**I(1)**	**Decision**
GG	-2.587**		**I(0)**	-2.654*		**I(0)**
MC	-1.025	-4.658***	**I(1)**	-1.121	-4.587***	**I(1)**
BA	-0.455	-3.158***	**I(1)**	-0.325	-3.258**	**I(1)**
ROA	-2.154**		**I(0)**	-2.658*		**I(0)**
Education	-0.452	-2.758***	**I(1)**	-0.123	-3.012**	**I(1)**
GI	0.254	-4.253***	**I(1)**	-2.234	-4.654***	**I(1)**
Trade	-1.456	-4.562***	**I(1)**	-1.425	-3.201**	**I(1)**
REC	-2.754***		**I(0)**	-0.754	-3.988***	**I(1)**
Note: ***p < 0.01; **p < 0.05; *p < 0.1						

The long-run findings display that market capitalization and bank assets report a significant and positive impact on green growth, but the impact of return on asset is statistically insignificant on green growth. It infers that market capitalization and bank assets can be adopted as policy tools to enhance green growth in China. The long-run coefficient estimates reveal that 1 percent surge in market capitalization and bank assets increases green growth by 0.214 percent and 0.129 percent, respectively. This finding is also backed by Zhou et al. (2021), who noted that banking institutions and the stock market play a key role in green growth. The finding infers that banking sector performance improves green investment by increasing renewable energy consumption, which in turn increases green growth. Our findings also suggest that the banking sector is strengthened credit markets by stimulating renewable energy consumption and green investment. This finding is also supported by Amuakwa-Mensah & Nässtrröm (2022). Our finding is also consistent with Cao et al. (2021), who noted that the banking sector has significantly caused green growth. Findings also suggest that banking sector finance affects green growth mainly through green innovation. The banking sector can accelerate green productivity by mitigating carbon emissions in China. A similar finding is also reported by Li & Liao (2020). Normally banking sector promotes green growth by mobilizing savings, allocating green resources, and diversifying risks. This means the banking sector is the core tool of green growth.

The role of education is positive in determining the green growth in China as shown by the significant and positive coefficient estimate of education in all three models. It is shown that 1 percent rise in education level brings an increase in green growth by 1.188 percent in the market capitalization model, 1.254 percent in bank assets model, and 1.100 percent in the return on assets model in the long-run. This finding is also consistent with previous studies (Hao et al. 2021 and Wang et al. 2021), which noted that human capital has significant effects on green growth. Finding suggests that human capital is an important source of environmental quality by enhancing energy efficiency in the production process and production methods. This also means that human capital increases new pollution-free production methods and technologies in production processes. High levels of firm human capital can significantly reduce environmental costs, which in turn increase green productivity. Moreover, human capital may also improve skill, knowledge, and awareness of eco-friendly technologies, which is helpful in increasing CO2 emissions.

Green innovation has a significant and positive effect on green growth in two models in the long-run. It is found that 1 percent rise in green innovations tends in improve green growth by 2.178 percent in the bank assets model and 1.510 percent in the return on assets model. This finding is also supported by Talebzadehhosseini & Garibay (2022), who infers that green innovation is a crucial factor that fosters green growth in OECD regions. These outcomes are also similar to the earlier findings of Wang et al. (2021); Cao et al. (2021); Wang et al. (2021), they argued that green innovation enhances green growth by reducing demand-based and production-based emissions. Green innovation plays an effective role in green growth in the digital era by promoting energy efficiency.

Trade variable is significantly and positively attached with green growth in all three models in the long-run. It can be seen that 1 percent rise in trade results in improving green growth by 0.142 percent in the market capitalization model, 0.189 percent in the bank asset model, and 0.102 percent in the return on asset model in the long-run. Renewable energy consumption is positively associated with green growth in the long-run in all three models. It is shown that 1 percent intensification in renewable energy consumption improves green growth by 2.495 percent in the market capitalization model, 1.693 percent in bank assets model, and 1.355 percent in return on asset model in the long-run.

Table 3
Short and long-run estimates of green growth

Variable	Coefficient	t-Stat	Coefficient	t-Stat	Coefficient	t-Stat
Short-run						
MC	0.036*	1.728				
MC(-1)	0.015*	1.707				
MC(-2)	0.097	1.345				
BA			0.051	0.960		
BA(-1)			0.164***	3.099		
ROA					0.025	0.012
ROA(-1)					0.237	0.727
ROA(-2)					1.014	1.507
EDUCATION	1.671	1.448	1.744**	2.152	1.458*	1.706
EDUCATION(-1)	0.675	1.567	1.159*	1.857	0.929**	2.197
EDUCATION(-2)			0.846**	2.588	0.614	1.145
GI	1.960	0.633	1.682	1.094	1.999	0.577
GI(-1)	1.552	0.577	1.621	1.483	1.160	0.325
GI(-2)	0.874	1.265			1.905	1.733
TRADE	0.066	0.682	0.159***	2.848	0.086	0.728
TRADE(-1)	0.113	0.710	0.163**	2.176	0.025	0.270
REC	0.438	0.042	0.837***	4.096	0.534**	2.164
REC(-1)	0.361	1.088				
Long-run						
MC	0.214***	3.053				
BA			0.129***	4.066		
ROA					0.420	0.215
EDUCATION	1.188**	2.473	1.254***	3.547	1.100**	2.082
GI	2.217	1.060	2.178*	1.859	1.510*	1.870
TRADE	0.142*	1.680	0.189***	5.907	0.102***	2.678
REC	2.495**	2.062	1.693***	4.437	1.355**	2.072
C	11.10**	1.987	8.359	0.924	4.346*	1.779
Diagnostics						
F-test	4.788***		9.356***		2.758	
ECM(-1)*	-0.602***	6.448	-0.669***	10.18	-0.532***	6.212
LM	0.854		0.587		1.254	
BP	1.175		1.002		0.257	
RESET	1.257		1.165		1.004	
CUSUM	S		S		S	
CUSUM-sq	S		S		S	
Note: ***p < 0.01; **p < 0.05; *p < 0.1						

The short-run findings of all three models display that market capitalization reports a significant and positive impact on green growth while bank assets and return on assets report a statistically insignificant impact on green growth. In the short-run, education is positively and significantly associated with green growth in two models. However, green innovations report a statistically insignificant effect on green growth in all three models. In the short-run, trade reports a significant and positive effect on green growth in one model only. However, renewable energy consumption reports a significant and positive influence on green growth in two models in the short-run. The findings of diagnostic tests are reported in the lower panel of Table 3. It is found that there exists long-run relationship among variables in all three models as reported by the results of F-statistics and ECM test. LM test and BP test reports that no issue of serial correlation and heteroskedasticity is found in all three models. All the models are correctly specified as reported by the coefficient estimates of Ramsey RESET tests. The findings of CUSUM and CUSUM-sq tests report that stability condition holds in all three models. Causality results of China are signified in Table 4. Findings show that unidirectional causality is running between MC and GG, BA and GG. Further, the results also reveal that unidirectional causal nexus exists from education to green growth. The results show no causality between ROA and green growth, green innovation and green growth.

Table 4
Causality test results of China

Null Hypothesis:	F-Statistic	Prob.	Null Hypothesis:	F-Statistic	Prob.	Null Hypothesis:	F-Statistic	Prob.
MC → GG	5.108	0.009	BA → GG	5.994	0.005	ROA → GG	1.045	0.373
GG → MC	1.488	0.250	GG → BA	1.429	0.266	GG → ROA	0.182	0.835
EDUCATION → GG	2.546	0.087	EDUCATION → GG	2.546	0.087	EDUCATION → GG	2.546	0.087
GG → EDUCATION	0.212	0.887	GG → EDUCATION	0.212	0.887	GG → EDUCATION	0.212	0.887
GI → GG	0.011	0.989	GI → GG	0.011	0.989	GI → GG	0.011	0.989
GG → GI	0.093	0.912	GG → GI	0.093	0.912	GG → GI	0.093	0.912
TRADE → GG	4.418	0.029	TRADE → GG	4.418	0.029	TRADE → GG	4.418	0.029
GG → TRADE	3.060	0.073	GG → TRADE	3.060	0.073	GG → TRADE	3.060	0.073
RE → GG	1.386	0.277	RE → GG	1.386	0.277	RE → GG	1.386	0.277
GG → RE	0.686	0.517	GG → RE	0.686	0.517	GG → RE	0.686	0.517
EDUCATION → MC	1.745	0.205	EDUCATION → BA	2.735	0.093	EDUCATION → ROA	6.991	0.006
MC → EDUCATION	0.189	0.830	BA → EDUCATION	0.705	0.508	ROA → EDUCATION	1.210	0.323
GI → MC	1.760	0.202	GI → BA	1.736	0.206	GI → ROA	5.564	0.014
MC → GI	0.063	0.940	BA → GI	1.309	0.296	ROA → GI	3.641	0.048
TRADE → MC	2.066	0.157	TRADE → BA	3.929	0.040	TRADE → ROA	3.328	0.060
MC → TRADE	0.241	0.788	BA → TRADE	0.443	0.650	ROA → TRADE	3.867	0.041
RE → MC	1.468	0.258	RE → BA	2.739	0.093	RE → ROA	5.875	0.012
MC → RE	2.704	0.096	BA → RE	1.211	0.322	ROA → RE	0.078	0.926
GI → EDUCATION	1.629	0.225	GI → EDUCATION	1.629	0.225	GI → EDUCATION	1.629	0.225
EDUCATION → GI	3.119	0.070	EDUCATION → GI	3.119	0.070	EDUCATION → GI	3.119	0.070
TRADE → EDUCATION	2.035	0.161	TRADE → EDUCATION	2.035	0.161	TRADE → EDUCATION	2.035	0.161
EDUCATION → TRADE	1.235	0.316	EDUCATION → TRADE	1.235	0.316	EDUCATION → TRADE	1.235	0.316
RE → EDUCATION	0.597	0.562	RE → EDUCATION	0.597	0.562	RE → EDUCATION	0.597	0.562
EDUCATION → RE	6.750	0.007	EDUCATION → RE	6.750	0.007	EDUCATION → RE	6.750	0.007
TRADE → GI	0.219	0.806	TRADE → GI	0.219	0.806	TRADE → GI	0.219	0.806
GI → TRADE	0.697	0.512	GI → TRADE	0.697	0.512	GI → TRADE	0.697	0.512
RE → GI	2.187	0.143	RE → GI	2.187	0.143	RE → GI	2.187	0.143
GI → RE	2.095	0.154	GI → RE	2.095	0.154	GI → RE	2.095	0.154
RE → TRADE	0.822	0.456	RE → TRADE	0.822	0.456	RE → TRADE	0.822	0.456
TRADE → RE	3.303	0.061	TRADE → RE	3.303	0.061	TRADE → RE	3.303	0.061
Note: ***p < 0.01; **p < 0.05; *p < 0.1								

Conclusion And Implications

The role of the banking sector in the economic development of a nation can't be ignored. To date, many studies have observed the impact of the banking sector's performance on economic growth; however, very few studies have analyzed the impact of banking sector performance on green growth. Green growth refers to economic growth that is achieved through the sustainable and efficient use of natural resources. In other words, the efficient utilization of natural resources helps to decouple economic growth from environmental pollution. Hence, in this analysis, we aim to investigate the impact of the banking sector's performance, education, and eco-innovation on green growth in China over the period 1996–2020.

First of all, we checked whether the variables included in the model are stationary at level or first difference. The DF-GLS and PP test confirm that some of the variables are stationary at the level, and others are stationary at first difference. This helps us to decide about the selection of the econometric model that best suits this type of situation and is known as the ARDL model. Three different variables, such as market capitalization, bank assets, and return on assets, are used to represent the banking sector's performance. Findings of the ARDL model state that market capitalization exerts a positive impact on the green growth in China in the short as well as long run. Similarly, the estimate of banking assets is positively significant in the short and long run, implying that a rise in banking assets causes green growth to rise. However, the estimated coefficients of return on assets are insignificant not only in the short run but in the long run also. On the other hand, the long-run estimates of education, trade, and renewable energy consumption are significant and positive in all three models, whereas the long-run estimates of green innovations are significant only in the second and third models. However, the short-run estimates of these variables are mixed. As far as the causal relationship is concerned, we have not found uni or bidirectional causality between the variables of the banking sector and green growth.

Based on these findings, we have provided some policy suggestions. First of all, our findings imply that an improvement in banking sector performance positively impact the green growth in China; therefore, the policymakers in China should try to further strengthen the role of the banking sector in China that will help to increase the total green productivity and ultimately contribute to the green growth. Further, the banks should increase the return on the asset so that depositors can take benefit from the high return rates and investors can utilize these funds in producing green products. Education can also contribute to the green growth of the economy; hence, the policymakers in China should try to increase the formal literacy rate in China and also try usher in special courses that can promote the production and consumption of green products. In order to promote green innovations, the funds from the banking sector should be directed towards those research and development activities that can spur the process of green innovations in the economy.

Declarations

Ethical Approval: Not applicable

Consent to Participate: I am free to contact any of the people involved in the research to seek further clarification and information

Consent to Publish: Not applicable

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