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Financial development, industrial structure and environmental sustainability: new evidence from Japan

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ABSTRACT

Considering the significant importance of environmental sustainability, it is vital to understand the determinants of environmental sustainability and to draw the policy implications for a sustainable environment. This paper examines the impacts of financial development and industrial structure on environmental sustainability in China from 1995 to 2020 using the A.R.D.L. approach. The result indicates that financial development negatively impacts CO_2 emissions and greenhouse gas emissions in the long-run. The impact of industrial structure is also enormous. The results also suggest that industrial structure negatively impacts environmental sustainability by decreasing CO_2 emissions and greenhouse gas emissions in the long-run. While Internet development accelerates environmental sustainability in Japan in the long run, economic development and energy negatively impact environmental sustainability in the long run. The findings of this study add to the current literature and provide some significant policy implications for improving environmental sustainability.

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1. Introduction

In the opinion of welfare economists, financial development in the form of financial markets and institutions is crucial for human development (Fergusson, 2006; Xu et al., 2022) also, it highlights the importance of financial development for human and environmental health. Financial development and industrial structure are important for environmental sustainability (Ielasi et al., 2018; Ji et al., 2021; Wang et al., 2020). Previous studies associate the role of financial market development and industrialisation with the economic growth perspective, but recent studies observed that economic growth provides a temporary upsurge in environmental performance (Ferrat et al., 2022; Hmaittane et al., 2019; Kollamparambil, 2020; Umar et al., 2022) also denoted

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that increase in income level raises the happiness level of individuals, and the upsurge in income growth enables households to use carbon-free goods. Subsequently, the enhancement in people's income levels results in improvements of public health, environmental health and sanitation (Campbell-Lendrum & Corvalán, 2007; Hanjra et al., 2012) denoted that environmental sustainability is not attached to an increase in income level. Furthermore, it is stated that no long-run association exists between income level and environmental sustainability (Feroz et al., 2021). However, it is argued that human satisfaction mainly depends on household circumstances, marital status, employment, environment and health (Mirowsky & Ross, 2017). Additionally, Alola et al. (2019) indicated that income enhances life satisfaction but does not improve environmental sustainability.

Helliwell and Huang (2008) reported that health quality, environmental health, decent living styles, and education are the fundamental determinants of human well-being and life satisfaction. Masud et al. (2018) argued that environmental quality is the most important determinant of human development in any society. Hutton and Chase (2016) and Zhao et al. (2022) reported that any society's human development includes providing good quality social services such as education, sanitation, health care, a clean environment, and drinking water. All these determinants of human development tend to improve society's overall public health outcomes. Subsequently, it can be stated that good quality environmental health is a key determinant of a healthy society. Hence, considering environmental health determinants has become a fundamental issue for any economy on several grounds. Environmental health plays a significant role in the development of a healthy society. Literature disclosed that basic indicators of environmental quality are CO_2 emissions and G.H.G. emissions. Moreover, the environmental quality flourishes based on the level of CO_2 emissions and G.H.G. emissions. Thus, it is fundamental to explore the determinants of environmental health.

In this perspective, financial development is considered an important determinant of environmental health that improves environmental health through various channels (Chen et al., 2022; Lv & Li, 2021; Su et al., 2022). Firstly, financial development affects environmental health through the channel of income effect. The income effect demonstrates that financial development stimulates economic output and industrialisation. The growth of economic activities and industrialisation trigger employment opportunities and raise the income level of households. The rise in income enables households to save money and to spend more on advanced technology-related goods that enhance environmental performance. Secondly, financial development affects human and environmental health through the channel of education. The education effect demonstrates that easy access to financial resources enables a household to spend more money to attain a better education. It subsequently increases their skills which help in getting better employment opportunities. With better education and income, people become more environmentally conscious, improving environmental outcomes. Thirdly, financial development improves environmental health through the channel of energy sector development. The energy sector development affects households' behaviour as they prefer to use more advanced goods in houses that generate relatively less pollution, hence improving environmental sustainability (Muhammad et al., 2022; Saidi & Mbarek, 2017; Yuan et al., 2022). Lastly, financial development enhances environmental health through the infrastructure development effect. This effect reveals that it stimulates economic output that helps construct environment care infrastructure by supporting private and public investments due to easy access to financial services (Berger, 2022; Vandermeulen et al., 2011).

Industrialisation also enhances economic output by stimulating production activity and employment generation (Ullah et al., 2019, 2020). The strong industrial structure results in the improvement of economic growth. It enhances the productive efficiency of goods and significantly reduces unemployment. Employment generation and higher levels of productivity of goods and services increase the income levels of individuals, which in turn enhance human well-being and environmental health (Evans et al., 2017). It is argued that industrialisation enables people to spend more income on their livelihood through the channel of employment generation and increased income level, hence improving environmental health (Godil et al., 2021). Literature reveals that upgrading the industrial structure is important for stimulating economic development and improving the quality of life and environmental health (Liang & Yang, 2019). Industrial structure development enhances economic development and transforms the employment structure. Industrial structure development affects almost every segment of society, including human health and environmental quality (Ma et al., 2022). Thus, it is argued that a strong association exists between industrial structure and environmental health. Industrial structure development inevitably changes the employment structure that upgrades people's incomes. Hence their living standards and environmental quality improvement. The previous literature does not find Japan's financial development, industrial structure, and environmental sustainability nexus.

Existing empirical studies have investigated the impact of social and economic determinants on the environmental performance of various economies. However, there is a lack of empirical evidence considering the impact of financial development and industrial structure development on environmental sustainability. Hence, it is fundamental to define the impact of financial development and industrial structure development on environmental performance. Therefore, it is fundamental to understand empirically and theoretically the importance of financial development and industrial structure development on environmental sustainability in the case of Japan. Japan is the most industrialised economy. Japan achieved sustained economic growth through industrialisation. For these reasons, we have selected Japan for empirical analysis. Thus, our study adopts the A.R.D.L. approach to obtain the long-run and short-run impact of financial development and industrial structure development on environmental sustainability from 1995 to 2020. This study also provides estimates for the short-run. Based on the findings, this study will suggest policy implications that simultaneously upgrade Japan's financial, industrial, and environmental sectors.

The rest of this work comprises the following parts: Section 2 is the model and methods. In Section 3, results and discussion have been made. And Section 4 contain conclusion and implications.

2. Model and methods

The study focuses on the effects of financial development and industrial structure on the environmental sustainability of the Japanese nation. Following the literature (Feng

& Wu, 2022; Lv & Li, 2021), we have developed the subsequent empirical model:

$$EP_t = \alpha_0 + \alpha_1 FD_t + \alpha_2 IS_t + \alpha_3 GDP_t + \alpha_4 EC_t + \alpha_5 Internet_t + \mu_t \quad (1)$$

where environmental pollution (EP_t) is a function of financial development (FD_t), industrial structure (IS), gross domestic product (GDP_t), energy consumption (EC_t), Internet users ($Internet_t$) and randomly distributed error term (μ_t). One of the study's contributions is that it focuses on short- and long-run estimates. Therefore, we express the above long-run model in the form of error correction, as shown below:

$$\begin{aligned}\Delta EP_t = {} & \gamma + \sum_{p=1}^{n1} \gamma_{1p}\ \Delta EP_{t-p} + \sum_{P=0}^{n2} \gamma_{2p}\ \Delta FD_{t-p} + \sum_{p=0}^{n3} \gamma_{3p}\ \Delta IS_{t-p} + \sum_{p=0}^{n4} \gamma_{4p}\ \Delta GDP_{t-p} \\ & + \sum_{p=0}^{n5} \gamma_{5p}\ \Delta EC_{t-p} + \sum_{p=0}^{n6} \gamma_{6p}\ \Delta Internet_{t-p} + \pi_1 EP_{t-1} + \pi_2 FD_{t-1} + \pi_3 IS_{t-1} \\ & + \pi_4 GDP_{t-1} + \pi_5 EC_{t-1} + \pi_6 Internet_{t-1} + \lambda.ECM_{t-1} + \mu_t\end{aligned} \quad (2)$$

Pesaran et al. (2001) used the above error correction specification in producing the famous bounds testing approach to cointegration, also known as the A.R.D.L. model. The advantage of the A.R.D.L. approach is that it can incorporate a mixture of level and first difference stationary series in the regression process. Another benefit of the A.R.D.L. technique is that it provides long-run and short-run simultaneously. Moreover, the A.R.D.L. technique also handles the problem of a small number of observations and provides unbiased and efficient results (Majeed et al., 2021). While previous traditional cointegration methods ignore the short-run (Bahmani-Oskooee et al., 2020), A.R.D.L. provides long-run and short-run simultaneously. Finally, this method can also deal with the issues of endogeneity and serial correlation by adding a short-term dynamic adjustment process to the empirical model (Gao et al., 2022; Usman et al., 2021).

This study explores the impact of financial development and industrial structure on environmental sustainability in the case of Japan for the period 1995 to 2020. Table 1 contains detailed information regarding descriptive statistics, definitions, and symbols of variables to be used in the analysis. Environmental sustainability is measured through two indicators: CO_2 emissions in kilotons and total greenhouse gas emissions. Financial development is measured through domestic credit provided by the financial sector as a percent of G.D.P. The industrial structure is measured by the ratio of the output of tertiary industry to secondary industry. The study has used G.D.P. per capita at constant 2015 US$, energy use as a kg of oil equivalent per capita, and Internet users as a percent of the population as control variables. The World Bank has scrutinised the required data. Data description covers the period from 1995 to 2020 for Japan. The mean of CO_2, G.H.G., F.D., I.S., G.D.P., E.C. and Internet are 13.98 kt, 14.05 kt, 2.489%, 0.307, 4.519 US$, 3.579 kg, 61.67%, respectively.

Table 1. Data description and definitions.

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Definitions
CO_2	13.98	13.97	14.04	13.89	0.036	−0.392	3.112	0.679	0.712	CO_2 emissions (kt)
GHGs	14.05	14.05	14.11	13.97	0.033	−0.651	3.543	2.157	0.340	Total greenhouse gas emissions (kt of CO_2 equivalent)
FD	2.489	2.470	2.590	2.419	0.045	0.461	2.170	1.667	0.434	Domestic credit provided by financial sector (% of GDP)
ISU	0.307	0.303	0.371	0.265	0.031	0.702	2.569	2.336	0.311	Ratio of output of tertiary industry to secondary industry
GDP	4.519	4.519	4.561	4.480	0.024	0.145	1.890	1.427	0.490	GDP per capita (constant 2015 US$)
EC	3.579	3.593	3.611	3.535	0.028	−0.323	1.359	3.368	0.186	Energy use (kg of oil equivalent per capita)
Internet	61.67	74.85	93.18	1.594	30.98	−0.754	2.131	3.285	0.194	Individuals using the Internet (% of the population)

Source: Author's Estimation.

3. Results and discussion

Before processing for empirical exercise, it is necessary to confirm the unit root properties of selected variables. To perform this task, we decided to use three-unit root tests, namely D.F.-G.L.S., P.P., and A.D.F. unit root tests, and the obtained results are given in Table 2. The results of the D.F.-G.L.S. test reveal that only the Internet is stationary at level, and the rest of the variables are stationary at first. The results of the P.P. test display that the Internet is a level stationary variable, and the remaining variables are first difference stationary. The findings of A.D.F. tests show similar results as we found in previous tests. Our study employed the A.R.D.L. approach for empirical tasks based on the unit root test findings. Table 3 contains the short and long-run coefficient estimates of environmental pollution. Two separate regressions have been done based on two proxy measures of environmental pollution.

In the long-run, findings demonstrate that financial development exerts a significant and negative effect on CO_2 emissions and G.H.G. emissions. It reveals that an

Table 2. Unit root testing.

	DF-GLS		PP		ADF	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
CO_2	−0.298	−1.879*	−1.023	−4.325***	−1.905	−5.998***
GHGs	−0.201	−2.694***	−0.987	−2.654*	−1.602	−4.302***
FD	0.512	−4.320***	1.021	−4.112***	0.421	−4.012***
ISU	−1.023	−5.657***	−1.754	−5.324***	−1.578	−5.785***
GDP	−0.954	−4.023***	−1.452	−4.255***	−1.425	−4.546***
EC	0.345	−4.321***	−0.475	−4.325***	−0.452	−4.325***
Internet	−1.703*		−3.321**		−3.274**	

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Author's Estimation.

Table 3. Short and long-run estimates of CO_2 and G.H.G.

	CO_2				GHGs			
Variable	Coefficient	Std. Error	t-Statistic	Prob.*	Coefficient	Std. Error	t-Statistic	Prob.*
Short-run								
FD	0.425	0.428	0.995	0.336	0.452	0.388	1.166	0.262
ISU	−0.135**	0.065	−2.018	0.047	−0.116**	0.052	−2.012	0.049
ISU(−1)	−1.076**	0.499	−2.155	0.048	−1.062	0.461	−2.306	0.036
EC	1.159*	0.668	1.734	0.103	0.993*	0.602	1.670	0.009
GDP	0.108	0.817	0.133	0.896	0.054	0.768	0.070	0.945
Internet	−0.108	0.097	−1.123	0.279	−0.109	0.091	−1.204	0.247
Long − run								
FD	−1.611*	0.962	−1.675	0.115	−1.295**	0.652	−1.987	0.063
ISU	−3.112*	1.768	−1.761	0.096	−2.821*	1.708	−1.687	0.101
EC	1.618	1.336	1.211	0.245	1.159*	0.668	1.734	0.103
GDP	1.655**	0.781	2.119	0.049	−1.295**	0.652	−1.987	0.063
Internet	−0.633***	0.215	−2.951	0.010	−0.491**	0.229	−2.144	0.049
C	6.068	9.376	0.647	0.527	9.835	10.503	0.936	0.362
Diagnostics								
F-test	12.20***				5.325***			
ECM(−1)	−0.475***	0.087	−5.460	0.000	−0.459***	0.085	−5.370	0.000
LM	1.203				0.658			
RESET	1.004				0.147			
CUSUM	S				S			
CUSUM-sq	S				S			

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Author's Estimation.

increase in financial development reduces CO_2 emissions and G.H.G. emissions, hence significantly improving environmental sustainability in Japan in the long-run. The coefficient estimates show that a 1% upsurge in financial development reduces CO_2 emissions by 1.611% and G.H.G. emissions by 1.295% in the long-run. Financial development reports a positive association with environmental sustainability as confirmed by the negative impact on CO_2 emission and G.H.G. emission. These findings support (Aluko & Obalade, 2020), who denoted that access to financial services helps improve environmental sustainability due to better availability of funds for the purchase of advanced technologies and clean energy sources; hence, the overall quality of the environment improves. This finding is backed by (Shahbaz et al., 2016), who reported a similar linkage between financial development and the environment by arguing that an increase in environmental quality occurs through the channels of infrastructure, education and G.D.P. per capita.

Moreover, findings demonstrate that industrial structure exerts a significant and negative effect on G.H.G. and CO_2 emissions in the long-run. It reveals that an increase in industrial structure tends to reduce G.H.G. and CO_2 emissions, proving that industrial structure significantly improves environmental outcomes in Japan in the long-run. The coefficient estimates show that a 1% upsurge in industrial structure reduces CO_2 emission by 3.112% and G.H.G. by 2.821%. The industrial structure is positively associated with environmental outcomes, as confirmed by a significant decline in G.H.G. and CO_2 emissions. These results are supported by Ullah et al. (2021). They argued that industrial structure development tends to generate employment opportunities for people and increase incomes of people, thus enabling them to afford good quality appliances for household needs that produce less pollution, hence improving the environmental outcomes.

Energy consumption reports an insignificant effect on CO_2 emission and a significant and positive effect on G.H.G. in the long-run. It shows that an increase in G.D.P. per capita tends to enhance G.H.G. emissions in Japan in the long-run. The coefficient estimates show that a 1% upsurge in energy consumption enhances G.H.G. by 1.159% in the long-run. In the case of control variables, findings demonstrate that G.D.P. per capita reports a significant and positive effect on CO_2 emission and a significant and negative effect on G.H.G. in the long-run. It shows that an increase in G.D.P. per capita tends to enhance carbon pollution in Japan in the long-run. The coefficient estimates show that a 1% upsurge in G.D.P. per capita enhances CO_2 emission by 1.655% and reduces G.H.G. by 1.295% in the long-run. Internet reports significant and negative impacts on G.H.G. and CO_2 emissions in the long-run. Thus, the findings reveal that an increase in energy consumption significantly enhances environmental sustainability in Japan in the long-run. The coefficient estimates show that a 1% rise in Internet use reduces CO_2 emissions by 0.633% and G.H.G. by 0.491%, respectively. Thus, it is concluded that financial development, industrial structure, G.D.P. per capita, energy consumption, and Internet use are proven to be fundamental determinants of environmental sustainability in Japan in the long-run.

In the short-run, financial development fails to bring any significant change in the short-run CO_2 and G.H.G. emissions, as confirmed by an insignificant coefficient estimate. This implies that environmental sustainability does not significantly respond to industrial structure in the short-run. In contrast, findings show that industrial structure significantly decreases CO_2 and G.H.G. emissions and improves environmental sustainability significantly in Japan. In the case of control variables, findings display that G.D.P. per capita and the Internet fail to report any significant impact on CO_2 and G.H.G. emissions, as displayed by insignificant coefficient estimates of all these variables. At the same time, energy consumption negatively influences CO_2 and G.H.G. emissions in the short term. The lower panel of Table 3 displays the findings of some important diagnostics tests. The F-stat and E.C.M. test findings display that long-run cointegration association exists among variables in both models. No issue of autocorrelation in detected in both models, as confirmed by the findings of the L.M. test. Both the models are correctly specified, as shown by the findings of the Ramsey RESET test. In the end, C.U.S.U.M. and C.U.S.U.M.-sq test findings confirm that the stability condition holds in both models.

4. Conclusion and implications

Health does not only mean physical fitness; indeed, it represents the people's overall condition of physical, mental and social well-being. There is an idiom that health is wealth which is true because a healthy mind and body can participate in wealth-generating activities that can contribute to the affluence of the nation. On the other side, a sick body and mind can become a liability for both family and society. No doubt, a clean environment is a basic need for maintaining health standards in any society. It is widely recognised that financial development has an important role in the economic development of society. Therefore, the link between financial development and the environment cannot be ignored. Similarly, the link between industrial structure and economic development is much debated, but the impact of industrial structure on environmental outcomes is yet to be explored extensively. Consistent with these views, we aim to investigate the impact of financial development and industrial structure on the environmental sustainability of the Japanese people.

To empirically investigate the relationship, we have first checked the stationary of the variables by using D.F.-G.L.S., P.P. and A.D.F. These unit root test results suggest that our variables are either stationary at level or first difference. Hence, we have applied the A.R.D.L. model to deal with the variables of a different order of integration. The long-run estimate of financial development is negative in the CO_2 emissions model and G.H.G. model. Similarly, the long-run estimated coefficient of industrial structure is negatively significant in the CO_2 emission and G.H.G. models. These results imply that a rise in financial development and industrial structure helped improve environmental sustainability in Japan. In the short-run, the estimate of financial development is insignificant and negative in the CO_2 emission model and G.H.G. emission model. However, the short-run estimated coefficient of industrial structure is significantly negative in the CO_2 emission and G.H.G. models.

Based on these findings, we have proposed the following policy suggestions. Policymakers should utilise the financial sector's development to uplift the Japanese society's environmental status. In this regard, policymakers can initiate environmental sustainability programs with the help of financial institutions at a subsidised rate.

Furthermore, the policymakers can induce the financial institutions to provide capital and credit facilities to develop a clean environment infrastructure. On the other side, policymakers must ensure that industries work in accordance with the environmental safety standards devised by the environment ministry. Further, the industries should replace obsolete production techniques with more advanced ones that will help improve the environment and health outcomes. Lastly, the modification of industrial structure can also help the industries to develop more affordable and reliable infrastructure that is relatively less harmful to the environment.

Even though the present study is a most wanted addition to the literature, it still has a few limitations. This analysis is based on a time series setting that suffers from a limited number of observations; hence, the result can be biased. Therefore, pooling data across major economies several times can provide much more efficient results. Similarly, the conclusion drawn from the single has limited implications, and pooling data across major economies can have much more significant implications. In the future, the researchers should focus on the other major economies using panel data analysis.

Disclosure statement

No potential conflict of interest was reported by the authors.

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