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Article

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Financial Inclusion, Digital Financial Inclusion and Air Quality: Evidence from Asian Countries

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ABSTRACT

Financial inclusion enables greater access to financial resources and facilitates green energy investments, thus emerging as a potential avenue to mitigate pollution. However, the relationship between financial inclusion and environmental impact is complex, with arguments both for and against its positive effects. This study aims to examine the impact of financial inclusion and digital financial inclusion on air quality in thirteen selected Asian countries. The dependent variables used in this study was the air quality index. The independent variables were financial inclusion, digital financial inclusion, population growth, net trade of goods and services and gross domestic product (GDP). The findings showed that the proxies of financial inclusion had mix effects on air quality, while a higher level of digital financial inclusion led to a better air quality in Asian countries. This study also revealed that population growth and GDP may somehow affect the air quality of Asian countries as well. These results suggest that Asian countries with lower level of financial inclusion and digital financial inclusion need to improve their citizen's access to financial resources. Several policies shall be implemented to enhance the level of financial inclusion and the air quality.

Keywords: Financial Inclusion, Digital Financial Inclusion, Air Quality
JEL Classifications: O16, Q53

1. INTRODUCTION

Industrialization has spread across the globe, yielding numerous positive outcomes, such as a surge in economic growth, productivity, and employment opportunities. On the contrary, it has also brought significant strain on the environment and led to the pressing issue of air pollution (Teng and He, 2020). Air pollution has also emerged as a critical global environmental concern, posing significant threats to human health. For instance, the air pollution The World Health Organization (WHO)[1] reported that nearly all the global population are exposed to the poor-quality air. Meanwhile, various studies have demonstrated that air pollution brings different diseases to humans, such as respiratory diseases, cardiovascular diseases, and non-communicable diseases (Mannucci et al., 2015; Qin et al., 2017; Matsebula and Sheefeni, 2022; Nambie et al., 2023; Qamruzzaman, 2023). Nevertheless, air pollution is no longer an urban-only issue in Asia, as agricultural burning and forest fires are impacting many parts of Asia (Faulder, 2021). Notably, the rapid economic growth in Asia also contributed to the increase in the emissions of primary pollutants over the past 5 decades (Kurokawa and Ohara, 2020).

1 https://www.who.int/news/item/04-04-2022-billions-of-people-still-breathe-unhealthy-air-new-who-data

Despite this, technological advancement allows individuals to check the air quality index (AQI) through the Internet and mobile apps. Indirectly, such data may help individuals raise their awareness about protecting the environment. Researchers have also focused on exploring the causes of air pollution and revealed that air quality can be improved through several factors such as green innovation (Dong et al., 2023) and political cycle (Shao and Chou, 2023). Several solutions have been proposed to reduce air pollution, such as using electric vehicles, walking, and cycling (Johansson et al., 2017). Meanwhile, Riley et al. (2021) stressed that more attention should be paid in changing the behaviors of the public and enhance their awareness. Yet, changing the public's behaviors is not an easy task as it requires addressing deeply ingrained habits, societal norms, and perceptual barriers.

However, *financial inclusion* (FI) may somehow play an important role in reducing pollution (Wen et al., 2022). Wider access to financial resources also facilitates firm's and individual's accessibility to competitive financial frameworks, thereby rendering green energy investments more attainable (Chaudhry et al., 2021). At the same time, the financial sector should also promote the advantages of using green technologies in economic activities. In contrast, Zhao et al. (2021) argued that FI allows the firms to increase their production, causing degradation to the environment. Notably, technological advancement also revolutionizes the traditional finance to digital finance, providing various forms of financial services to support pollution mitigation. Digital finance also proven to help the boost up the Chinese corporate's environmental, social and governance (ESG) performance, and fasten the modernization for China's industry (Ren et al., 2023a; Ren et al., 2023b). Recently, the concept of "*digital financial inclusion*" (DFI) also slowly become a trendy issue, particularly after the COVID-19 pandemic. DFI also enables many individual accesses to the wider range of financial resources to accomplish their financial requirements in a convenient way (Zheng et al., 2023).

The main gap in the existing research is the lack of a comprehensive view on the impact of financial inclusion and digital financial inclusion on air quality. This, this study addresses the knowledge gap by including the ten selected Asian countries as the sample the study. The main objective of this study is to investigate how the financial inclusion and digital financial inclusion affected the air quality in Asian countries. Section 2 discusses the data and methodology for this study. Section 3 presents the research findings and discussion for the empirical results. Lastly, Section 4 includes the conclusion and recommendation.

2. DATA AND METHODOLOGY

This section discusses the data and methods applied in this study. The data were collected from two different sources – (i) World Health Organization and (ii) World Bank. Table 1 presents the sources of data for various variables. This study employed the annual data spanning the period from 2012 to 2019. The dependent variable used in this study was AQI (proxy for *air pollution*). Meanwhile, the independent variables used in this study were ATMs per 100,000 adults (*financial inclusion*) and commercial banks branches per 100,000 adults (*financial inclusion*), mobile cellular subscription (*digital financial inclusion*), individual using the internet as a percentage of population (*digital financial inclusion*), population growth, net trade of goods, and gross domestic product (GDP).

Next, this study applied the panel data analysis to investigate the impact of financial inclusion and digital financial inclusion on the air pollution in Asian countries.

$$AQI_{i,t} = ATM_{i,t} + CB_{i,t} + MC_{i,t} + Internet_{i,t} + Population_{i,t} + Trade_{i,t} + GDP_{i,t}$$

Breusch-Pagan LM test and Hausman test were employed in this study to confirm the suitability of the random effect model and fixed effect model. Lastly, this study performed the diagnostic checks for issue of multicollinearity, heteroscedasticity, and serial correlation.

3. RESULTS AND DISCUSSION

This section discusses the results obtained throughout this study. Table 2 presents the result of correlation analysis. AQI negatively correlated with the proxies of FI (ATM and CB) and DFI (MC and Internet). The proxies of FI (ATM and CB) and DFI (MC and Internet) also positively correlated among each other.

Table 3 presents the estimation results from pooled ordinary least square (OLS), random effect model, and fixed effect model. The Breusch-Pagan LM Test is carried out and confirm that random effect model is an appropriate model. Then, this study carried out the Hausman test to confirm that the fixed effect model is more appropriate than the random effect model. However, the result of diagnostic checking shows that the fixed effect model suffered from heteroskedasticity and serial correlation. To rectify the issue, this study performed the OLS model with roust standard error, and the results were presented in Table 4.

Table 1: Data sources for different variables

Variable	Proxy	Sources
Air pollution	Air quality index (AQI)	World Health Organization
Financial inclusion (FI)	ATMs per 100,000 adults	World Bank Database, World Development Indicators
	Commercial bank branches (per 100,000 adults)	World Bank Database, World Development Indicators
Digital financial inclusion (DFI)	Mobile cellular subscriptions	World Bank Database, World Development Indicators
	Individuals using the Internet (% of population)	World Bank Database, World Development Indicators
Population	Population Growth	World Bank Database, World Development Indicators
Trade	Net Trade of Goods	World Bank Database, World Development Indicators
GDP	Gross Domestic Product	World Bank Database, World Development Indicators

Table 2: Result of correlation analysis

Variable	AQI	ATM	CB	MC	Internet	Population	Trade	GDP
AQI	1							
ATM	−0.2577	1						
CB	−0.1174	0.4102	1					
MC	−0.8966	0.3501	0.1254	1				
Internet	−0.6316	0.6682	0.0548	0.5828	1			
Population	0.3251	−0.5318	0.0150	−0.2359	−0.5431	1		
Trade	−0.7302	0.1047	−0.0238	0.7707	0.4845	0.0283	1	
GDP	0.4920	−0.3061	−0.2779	−0.3915	−0.4520	0.2349	−0.3407	1

AQI refers to Air Quality Index; ATM refers to ATMs per 100,000 adults; CB refers to commercial banks' branches per 100,000 adults, MC refers to mobile cellular subscription; Internet refers to individual using the internet as a percentage of population; Population refers to the population growth; Trade refers to net trade in goods and services; and GDP refers to gross domestic product

Table 3: Results of Pooled OLS estimation, Random Effect Model, Fixed Effect Model and Diagnostic Checking

Variable	OLS		Random		Fixed	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
ATM	0.3356	0.000	−0.0286	0.661	−0.1297	0.043
CB	−0.1624	0.001	−0.0037	0.976	0.1276	0.478
MC	−0.1327	0.000	−0.0036	0.000	−0.0015	0.029
Internet	−0.0081	0.000	−0.0022	0.112	−0.0022	0.042
Population	0.2356	0.000	0.0933	0.051	−0.0140	0.712
Trade	−0.0037	0.396	−0.0012	0.037	0.0019	0.002
GDP	0.0364	0.018	0.0132	0.061	0.0022	0.688
Constant	4.0442	0.000	3.8214	0.000	3.3724	0.000
Breusch-Pagan LM Test	77.84 (0.000)***				-	
Hausman Test	-		222.08 (0.000)***			
Observations	104		104		104	
Multicollinearity	-		-		2.64	
Heteroskedasticity	-		-		73.97 (0.000)***	
Serial Correlation	-		-		15.911 (0.0018)***	

Table 4: Results for OLS with Robust Errors

Variable	Pooled OLS with Robust standard error	
	Coefficient	P-value
ATM	0.3356***	0.000
CB	−0.1624***	0.001
MC	−0.1327***	0.000
Internet	−0.0081***	0.000
Population	0.2356***	0.000
Trade	−0.0037	0.328
GDP	0.0364***	0.005
Constant	4.0442***	0.000

Based on the results in Table 4, there was a mixture of findings for the impact of financial inclusion on the air quality index (AQI). ATM was positively and significantly affected the AQI, whereas CB was negatively and significantly affected the AQI. The results indicated that financial inclusion posed a mixed impact on the air quality of the Asian countries. One possible explanation for these results is the higher number of ATMs may indicate higher level of urbanization, leading to a higher air pollution level. Besides that, the proxies of digital financial inclusion (MC and Internet) were negatively and significantly affected the AQI. The results indicated that higher levels of digital financial inclusion reduce the needs of physical transactions and banks. As a results, it shall lead to a better air quality (lower AQI) in Asian countries. Lastly, both the population growth and FDI also positively and significantly affected the AQI. This result indicated that the higher level of population and FDI shall worsen the air quality (higher AQI) in Asian countries.

4. CONCLUSION AND RECOMMENDATION

This study contributes to existing literatures by investigating the impacts of financial inclusion and digital financial inclusion on the air quality of the Asian countries by using the annual data covering the year 2012 to 2019. This study carried out panel data analysis by including the AQI as the dependent variable. Then, the financial inclusion (ATM and CB), digital financial inclusion (MC and Internet), population growth, GDP, and FDI were used as the independent variables.

The results of the analysis revealed that higher level of digital financial inclusion shall improve the air quality of the Asian countries. This study also recommends the countries with the worst air quality to improve their level of digital financial inclusion. Despite some Asian developed countries did very well in terms of digital financial inclusion, it was very important for the countries to educate their citizen and enhance their awareness towards the issue of air pollution. This study also assists the policymaker to identifying the potential factor that affect the air quality of Asian countries.

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