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DOES DIGITAL FINANCE AND FINANCIAL INCLUSION STRENGTHEN ENVIRONMENTAL SUSTAINABILITY: EVIDENCE FROM ASIA

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ABSTRACT
Digital finance and financial inclusion are considered to be significant development strategies in many economies. Promoting both of these strategies helps increase environmental sustainability. Access to financing improves people's ability to engage in economic activities that degrade the environment. The goal of this research is to look at the impact of digital finance and financial inclusion on environmental sustainability in a few emerging Asian countries. From 2015 through 2021, the research study used quantitative secondary annual data acquired from World Development Indicators provided by the World Bank. The study's dependent variable is environmental sustainability, as measured by carbon dioxide emissions (CO2-EMS), and the independent variables are mobile money transactions (MMT), automated teller machines (ATMs), financial institution's branches (FIB), and deposit accounts (DACC). The study also used some control variables, like population growth (POPG), industrialization (IND), and financial literacy (FL). The panel data from ten Asian nations was analyzed by using a fixed- or random-effects model. The outcomes revealed that mobile money transactions (MMT), automated teller machines (ATMs), and financial institution's branches (FIB) have a significant negative relationship with CO2-EMS, whereas deposit accounts (DACC) have a significant positive association with CO2-EMS. The study has significant implications for countries seeking to improve their overall energy efficiency, thereby reducing environmental degradation. Countries should modernize technology and implement improved environmental practices to help improve environmental sustainability. In order to attain economic success and environmental sustainability, policymakers should develop policies that increase digital financial inclusion.

Keywords: Digital finance, financial inclusion, mobile money transactions, financial literacy, environmental sustainability.

INTRODUCTION
The financial sector is considered to be an important component, and it plays an important role in a country's growth and development (Le et al., 2019). According to the United Nations, globally, there are roughly three billion people who are not able to access the services, such as financial services, provided by any financial institution like banks, insurance companies, leasing companies, etc. for the purpose of sending and receiving any amount of money or completing a formal financial transaction remotely or internationally (Chibba, 2009). In the larger framework of inclusive development, financial inclusion's purpose is to provide easy access to financial services to all segments of society; its basic aim is to reduce the level of poverty and inequality, respectively; it is considered an important segment of the Millennium Development Goals (MDGs). According to research, FI is a big economic development catalyst (Acheampong, 2019;

Claessens, 2006). When we discuss FI, we basically discuss the variety of financial services provided to every member of society according to their needs and requirements at an affordable, reasonable cost. For example, giving them the opportunity to open an account and execute a financial transaction for sending money, receiving money, saving money, etc. is one of the most important priorities of effective FI (Demirguc-Kunt et al., 2017). Later on, FI entails using insurance products to help consumers reduce financial risks like fire, flood, and crop damage, in addition to gaining access to various financial services offered by various financial companies or institutions, respectively.

The ideas of financial inclusion (FI) and digital financial inclusion (DFI) are similar; FI's extension phase is where advanced technology is being considered. In this light, DFI has recently been viewed as a transformative force capable of bringing about significant change in the financial systems of all countries that provide these services through their financial institutions (Ozili, 2018). Along with social isolation and containment measures, the recent COVID-19 pandemic era has enabled people to use more digital financial services, such as buying, selling, online bill payments, and sending or receiving money, via their Android devices or computers provided by various companies. It means that digital finance also helps promote FI in economies. The basic aim is to provide customers with the ability to complete transactions by sitting in a comfortable zone, which is also beneficial to service providers (Klapper, 2017). Governments benefit from digital banking, along with the fact that it provides a way to increase overall expenses and helps increase financial or digital transactions (Manyika et al., 2016). In order to benefit from digital financial services offered by financial institutions, the first step is to open a formal account with any financial institution in order to execute a transaction for sending and receiving money (Demirguc-Kunt et al., 2017). Later on, FI means not just employing insurance products to mitigate financial risks such as crop loss, fire, and flood, but also having access to sufficient finance from recognized financial institutions (Demirguc-Kunt et al., 2017). Additionally, farmers who had access to accounts saved more money, which enhanced agricultural productivity and household expenditures. A process known as financial inclusion is one that "notes an increase in quantity, quality, and efficiency of financial intermediary services that helps improve lives, encourage possibilities, and strengthen economies" (Babajide et al., 2015). According to Babajide et al. (2015), this allows companies and individuals to make their investments more productive.

The biggest and most contentious environmental challenges of our time are climate change and global warming. There is widespread agreement among scientists that the earth's atmosphere and seas are warming due to accumulated CO2-EMS from burning fossil fuels and other human-caused greenhouse gas emissions (Reay et al., 2007; Gök, 2020). Scholars in the fields of science, energy, and the environment have come to an increasing agreement in recent decades about the dangers that climate change poses to human life, human health, and the environment's quality for future generations (Zaidi et al., 2018). Researchers and policymakers have emphasized the importance of reducing greenhouse gas (GHG) emissions, which are believed to be the primary driver of climate change, in order to avoid a global environmental disaster (Mita et al., 2017). Even when population and economic size are taken into account, CO2-EMS from the use of fossil fuels vary greatly between countries (Apergis & Payne, 2009; Koshta et al., 2020). The tremendous climatic change over the past few decades effect the life of humans, animals,and their health around the globe. Because carbon dioxide accounts for 70% of GHG emissions, it is mostly presumed that CO2-EMS is the main component that has become the reason for environmental degradation, along with other gases (hereinafter GHGs) (Sarkodie et al., 2020). Many people believe that GHG levels in the atmosphere will have more than doubled since pre-industrial levels by 2035 (Charfeddine & Kahia, 2019). As a result, global warming may exceed the 2 °C threshold, and if that happens, the world may face various atmospheric changes that may affect the lives of every organism present in this universe (Lu, 2018). The basic aim of this research study is to investigate the impact of digital finance and financial inclusion on environmental sustainability as represented by CO2-EMS in selected Asian countries.

The rest of the papers are arranged in the following sections: Section 2 describes the literature review related to this research topic. Section 3 is related to research methodology, along with data collection and analysis details. Section 4 contains information regarding data analysis and its interpretation. The final section of the research papers discusses the conclusion and recommendations, respectively.

REVIEW OF LITERATURE

The access and availability of financial services to individuals in society is directly related to a country's financial progress (Le et al., 2020; Renzhi & Baek, 2020). Due to the importance of FI and its relationship

with environmental sustainability, various researchers conducted research on this topic by using various techniques and methodologies (Raza et al., 2019; Squalli, 2007).). FI plays an important role in the financial growth and development of any industry, and it also helps reduce poverty in any economy (Anarfo et al., 2019; Sethi & Acharya, 2018). Boutabba et al. (2014) try to determine the long-run equilibrium causal relationship by using FI, financial development, CO2_EMS, trade openness, economic growth, and energy in the Indian economy by using annual data from 1971-2008. The findings of the study show that there is a significant relationship between FI and CO2-EMS in India. In the case of Pakistan, Baig and Baig (2020) determine a co-integrated relationship by using energy consumption, population growth, GDP per capita, and CO2-EMS. The study applied the ARDL method to determine the relationship between variables by using annual data from 1970–2010. The outcome of the study revealed that CO2-EMS has a bidirectional causal relationship with population growth; likewise, GDP per capita and energy consumption have a unidirectional causal relationship with CO2-EMS. Khan et al. (2020) revealed that in Pakistan, energy usage has a significant relationship with CO2-EMS by using the ARDL method. Isk et al. (2019) find the effect of real GDP, population, and financial literacy on renewable energy by using data from 10 US states.

Ding et al. (2022) collect data from 30 Chinese provinces from 2011 to 2019. The study used a spatial econometric model and panel data econometric techniques. The dependent variable of the study is CO2-EMS and is used as a proxy for environmental sustainability, whereas the two important independent variables are digital finance and environmental legislation. The findings of the study revealed that there is a significant relationship between selected variables, and digital finance is considered an important variable that helps in improving and achieving environmental sustainability. Zhao et al. (2021) determine the relationship between debt capital finance and CO2-EMS by using balanced panel data for China from 2011–2018. The findings of the study showed that digital finances strongly influence CO2-EMS in a selected country. The study has important policy implications for promoting digital finance in order to reduce CO2 emissions. Zaidi et al. (2021) investigate the dynamic relationships between FI, energy use, and CO2-EMS by using annual panel data collected for 23 OECD nations from 2004–2017. This study employs the (Dynamic) Common Correlated Effects Estimator technique, also called CS-ARDL, to examine long-run connections. The findings of the study revealed that there is a strong link between FI, energy usage, and CO2-EMS in selected economies. Based on literature review the study develop following hypothesis.

H1: Digital finance and environmental sustainability (CO2-EMS) have a significant relationship.

H2: Digital financial inclusion and environmental sustainability (CO2-EMS) have a significant relationship.

Research Framework

The primary objective of the study is to determine the impact of digital finance and financial inclusion in promoting environmental sustainability (C02-EMS) in selected Asian economies. CO2-EMS was employed as a dependent variable in this study, and mobile money transactions (MMT), automated teller machines (ATMs), financial institution's branches (FIB), and deposit accounts (DACC) were used as independent variables. The study also used some control variables, like population growth (POPG), industrialization (IND), and financial literacy (FL). Figure 1 depicts a complete study framework generated from a literature review, which shows dependent variables, independent variables, and control variables.

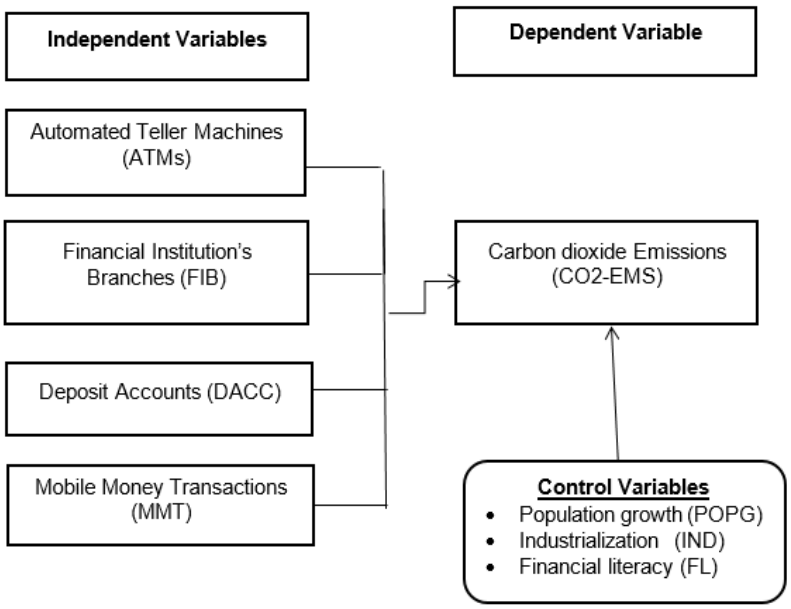

Figure 1: Research Framework

METHODOLOGY

Research population, Sampling, Variables and Data

In this research we used the panel data from 2015 to 2021; we collect data from 10 developing countries. The study used CO2-EMS as dependent variables whereas, independent variables used are mobile money transactions (MMT), automated teller machines (ATMs), and financial institution's branches (FIB), deposit accounts (DACC). The study also used some control variables, like population growth (POPG), industrialization (IND), and financial literacy (FL). The data has been collected from WDI which is called as World Development Indicators managed by the World Bank. In our model we use an annual balanced panel data for 10 developing countries. The countries included are: Pakistan, India, Indonesia, Malaysia, Philippines, Singapore, Vietnam, Brunei Darussalam, Thailand and Cambodia.

Descriptive Statistics

Descriptive analysis is a useful research technique. It can help with a variety of investigations, both descriptive and causal in nature. The data's central tendency and measure of dispersion were determined using descriptive statistics. Descriptive statistics are concise descriptive coefficients that summaries a particular data collection, which can represent the whole set or its sub part that is about its population and sample. Descriptive statistics are commonly used to offer a quantitative examination of data in a straightforward manner.

Fixed Effect Method

For our analysis, we'll employ a fixed or random effect model. To determine if fixed effect is suitable for our analytic technique or not, the Hausman test will be employed.

The equation is:

$$CO2 - EMS_{it} = \alpha + \beta_{1MMT_{it}} + \beta_{2ATM_{it}} + \beta_{3FIB_{it}} + \beta_{4DACC_{it}} + \beta_{5POPG_{it}} + \beta_{6IND_{it}} + \beta_{7FLit} + \varepsilon_{it}$$

Where $CO2_{it}$ represents CO2-EMS of the specific country i in period t, mobile money transactions (MMT), automated teller machines (ATMs), and financial institution's branches (FIB), deposit accounts (DACC). The study also used some control variables, like population growth (POPG), industrialization (IND), and financial literacy (FL), β_1 to β_7 be the estimated parameters and ε_{it} is disturbance term.

DATA ANALYSIS AND FINDINGS

Descriptive Statistics

he summary of data used in the study is represented by descriptive statistics. The present research study used two measures that is measure of central tendency and measure of dispersion in a given data set. Each descriptive statistic distils a large amount of data into a more concise summary. Table 1 displays descriptive information for each variable

Table No. 1: Descriptive Statistics of the Variable

	Mean	Maximum	Minimum	Std. Dev.	Observations
CO2-EMS	2.938743	7.927126	0.131695	2.72	70
MMT	8045.371	31315.01	15.13	8903	70
ATM	46.15133	117.7917	0.917248	37.3	70
FIB	10.2183	19.14044	1.873467	4.14	70
DACC	1558.646	7955.706	30.97359	1731	70
POPG	1.364757	3.077054	0.089252	0.69	70
IND	30.61192	40.84134	10.05187	8.29	70
FL	0.951924	1.03738	0.58382	0.12	70

Table 1 shows the result of summary measures, including the number of observations, their mean value, minimum value, maximum value, and standard deviation. The table indicates that there were 70 observations in total. According to Table 1's findings, CO2-EMS has a mean value of 2.938743, which is located between 0.131695 and 7.927126 and has a standard deviation of 2.72. The result for ATM data shows a mean value of 46.15133, which is an average value. The range of the ATM data shows 0.917248 and 117.7917 values, respectively. The data shows that the standard deviation is 37.2, which shows a deviation from the mean of the sample. The result for FIB data shows a mean value of 10.2183, which is an average value. The range of the FIB data shows 1.873467 and 19.14044 values, respectively. The data shows that the standard deviation is 4.14, which shows the deviation from the mean of the sample. The result for DACC data shows a mean value of 1558.646, which is an average value. The range of the DACC data shows 30.97359 and 7955.706 values, respectively. The data shows that the standard deviation is 1731, which shows the deviation from the mean of the sample. The result for MMT data shows a mean value of 804.55.371, which is an average value. The range of the MMT data shows 15.13 and 31315.01 values, respectively. The data show that the standard deviation is 8903. This represents the sample's deviation from the mean.

Panel Unit Root Test

The panel unit root test has been used to determine the stationary and non-stationary nature of the selected data. This research study specifically used two famous unit root tests. The first one is the ADF (Dickey & Fuller, 1979) and the second one is the PP (Phillips & Perron, 1988) tests, respectively. The basic aim is to determine the status of null hypothesis of a unit root for selected individual series. The condition is that if the p-value is less than 5% or 1%, it means that the data is stationary and has no unit root problem, and vice versa. Table 2 represents the outcome or findings obtained from both tests.

Table No. 2: Unit Root Analysis of Variables

Variables	Statistic		Probability	Order of Integration
CO2-EMS	ADF	-13.6775	0.0000	I(1)
	PP	-8.17886	0.0000	I(1)
ATM	ADF	-7.49597	0.0000	I(1)
	PP	-8.1577	0.0000	I(1)
FIB	ADF	-6.28177	0.0000	I(1)
	PP	-8.35552	0.0000	I(1)
DACC	ADF	-7.38761	0.0000	I(1)
	PP	-7.34322	0.0000	I(1)
MMT	ADF	-8.06803	0.0000	I(1)
	PP	-8.13454	0.0000	I(1)
POPG	ADF	-8.88219	0.0000	I(1)
	PP	-9.04924	0.0000	I(1)
IND	ADF	-8.38116	0.0000	I(1)
	PP	-8.38116	0.0000	I(1)
FL	ADF	-8.99065	0.0000	I(1)
	PP	-8.99065	0.0000	I(1)

Table 2 shows the statistic values and probability of each test for the sample period 2015-2021. The outcome of this test shows that all selected variables used in the study satisfy the properties of unit

root test at the level of first difference. The order of integration for all the variables is 1(1) respectively.

Hausman Test

Hausman test has been used when we want to determine which method that is fixed effect model or a random effect model is appropriate for data analysis. The null hypothesis demonstrates that REM is appropriate, whereas the alternative hypothesis supports FEM. The underlying premise of REM is that unobserved effects and independent variables do not correlate. The Hausman test finds if the said assumption is violated or not. This test is required prior to regression since it allows for the selection of an appropriate model for regression analysis. The Hausman test results are presented in Table 3. The p-value is less that 5% so it means that the fixed effect model is appropriate for data analysis in this research study.

Table No. 3: Hausman Test

Test Summary	**Chi-Sq. Statistic**	**Chi-Sq. d.f.**	**Prob.**
Cross-section random	8377.713765	9	0

Fixed Effect Model

To pick between random effects and fixed effects, we first apply the Hausman test to the set of variables. A statistical model called a fixed effects model uses fixed or non-random model parameters. The following table summarizes our empirical research on the key variables affecting the degree of financial inclusion in emerging nations. Heteroscedasticity, autocorrelation, and horizontal cross-section dependence issues are present in our model. The results obtained from the fixed effect model for selected variables are presented in Table 4.

Table No. 4: Fixed Effect Result

Dependent Variable	**Independent Variables**	**Coefficients**	**P-value**
CO2-EMS	ATM	-0.01592**	0.0151
	FIB	-0.0487**	0.0398
	DACC	0.00002*	0.0975
	MMT	-0.000007**	0.0178
	POPG	0.047333	0.7102
	IND	0.008103	0.3742
	FL	0.215037	0.879
	C	1.837337	0.1735
	R-squared	0.998878	
	F-statistics	2522.054	
	Prob(F-statistic)	0.0000	

According to table 4, the finding of fixed effect model indicates that DACC 0.00002 (p = 0.0975) is positively significant to the CO2-EMS. The table shows that ATM -0.01592 (p = 0.0151), FIB -0.0487 (p = 0.0398) and MMT -0.000007 (p = 0.0178) are negatively significant to the CO2-EMS. As a conclusion, the variable DACC is positively significant, showing that increases in DACC will cause increases in CO2-EMS. In contrast, ATM, FIB, and MMT are negatively significant for CO2-EMS. This may lead to the conclusion that ATM, FIB, and MMT will cause a decrease in CO2-EMS.

CONCLUSION AND IMPLICATIONS

Inclusion of the financial sector is crucial for development. Individuals' access to financial services in society contributes to the country's economic development. Various studies have been conducted in the literature to investigate the impact of financial inclusion on CO2-EMS, but there are still many gaps that must be filled before more comprehensive research can be conducted in this area. This research study specifically tries to examine the impact of digital finance and financial inclusion on environmental sustainability proxies by CO-EMS in selected Asian economies. The relationship between CO2-EMS, digital finance, deposit accounts, financial institution branches, ATMs, IND, POPG, and FL for the 10 developing nations between 2015 and 2021 is examined in this article. The findings demonstrate that most of the independent variables are important in improving environmental sustainability in selected economies. The development of nations seems to overlook the usage of environmentally friendly technologies.

In a more precise manner, policymakers should promote financial inclusion and access to finance. Countries in the region must work together to synchronize financial inclusion programmes with

environmental regulations. The region that has promoted international cooperation on climate change the most is Europe. In light of the anticipated findings, this study suggests some important policy recommendations, such as the necessity for financial institutions to make sure that their funding is allocated to environmentally favorable projects rather than going toward the manufacturing of dirty commodities. Additionally, the governments of these nations should launch environmentally beneficial initiatives by offering low-interest financing and by setting up a robust check and balance mechanism.

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