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THE EFFECTS OF GREEN FINANCE ON EMPLOYMENT IN DEVELOPING COUNTRIES: THE ROLE OF HUMAN CAPITAL DEVELOPMENT

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BY

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A final year project submitted in partial fulfilment of the requirement for the degree of

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DECLARATION

We hereby declare that:

(1) This undergraduate FYP is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this FYP has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the FYP.

(4) The word count of this research report is 10454 words.

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LIST OF ABBREVIATIONS

GNI	Gross National Income
EMP	Employment
GF	Green Finance
HCD	Human Capital Development
HDI	Human Development Index
RE	Renewable Energy
ET	Energy Transition
FDI	Foreign Direct Investment
PG	Population Growth
ILO	International Labour Organization
UNDP	United Nations Development Programme
WDI	World Development Indicators
GHG	Greenhouse Gas
UMIC	Upper-Middle-Income Countries
LMIC	Lower-Middle-Income Countries
LIC	Low-Income Countries
R&D	Research and Development
GFIRPZ	Green Finance Innovation and Reform Pilot Zones
CB	Central Bank
UNFCCC	United Nations Framework Convention on Climate Change
SMEs	Small and Medium-sized Enterprises
IV	Independent Variable
DV	Dependent Variable

SDGs	Sustainable Development Goals
OLI	Ownership, Location, and Internalization
MNE	Multinational Enterprises
CO_2	Carbon Dioxide
ADB	Asian Development Bank
GEF	Global Environment Facility
DEA	Data Envelopment Analysis
GMM	Generalized Method of Moments

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PREFACE

This research project was submitted to meet the undergraduate requirement of the Bachelor of Economics (Hons) Financial Economics at Universiti Tunku Abdul Rahman (UTAR). Dr. Chen Fanyu is the supervisor of this undergraduate research. The topic of this study is *"The Effects of Green Finance on Employment in Developing Countries: The Role of Human Capital Development"*. This research was written by Khaw Bei Yee, Khor Xuan De, and Tammy Loh Ren Ling with reference to multiple academic sources, databases, and empirical evidence from international organizations and past studies conducted by other researchers.

The research topic was chosen due to the increasing importance of balancing climate change pressures with sustainable job creation in developing countries. Despite the global promotion of green finance as a driver of clean energy investment and growth, the employment effects remain mixed and often underexplored, particularly in low- and high-HDI developing nations. This sparks the interest in studying how human capital development moderates the relationship between green finance and employment outcomes. The aim of this study is to provide insights that may guide policymakers, financial institutions, and development agencies in designing integrated strategies that promote both environmental sustainability and inclusive economic growth.

In this research, green finance (GF) is measured by international financial flows to developing countries supporting clean energy R&D and renewable energy production. Employment (EMP) is proxied by wage and salaried workers as a share of total employment, while human capital development (HCD) is represented by the Human Development Index (HDI). Four control variables are also included which are renewable energy consumption (REN), energy transition (CAP),

population growth (PG), and foreign direct investment (FDI) in order to ensure robustness of the empirical analysis. With that, this study employs a two-step System GMM approach on a 15-year panel dataset covering 88 developing countries, providing comparative results across low-HDI and high-HDI groups. The findings are expected to help readers gain a clearer understanding of how green finance, when complemented by human capital, can influence sustainable employment generation in developing economies.

ABSTRACT

Developing countries face climate pressures alongside persistent socioeconomic challenges, making green adoption strategies such as green finance essential for sustainable employment creation. Yet, high unemployment and underemployment remain unresolved, job displacement due to rapid digitalization and artificial intelligence, while the transition from fossil fuels to low-carbon industries raises questions about net job outcomes due to limited resources, skills gaps, and uneven growth and inclusivity. This study investigates how green finance influences employment in 88 developing countries from 2008 to 2022, emphasizing the moderating role of human capital development (HCD). Using a dynamic panel approach with two-step System GMM, the results reveal that green finance generally enhances employment, and its effects are amplified when combined with higher levels of HCD. However, contrasts emerge across HDI groups: in low-HDI countries, green finance alone exerts negative employment effects but becomes strongly positive when interacted with HCD; however, in high-HDI countries, green finance shows no significant impact, reflecting structural maturity and capital-intensive transitions. These findings underscore that without sufficient skills and education development; green finance cannot deliver inclusive job growth. Policy implications highlight the need for targeted vocational training, skills-upgrading programs, and complementary institutional reforms to maximize the socioeconomic and environmental benefits of green investments in resource-constrained contexts.

CHAPTER 1: INTRODUCTION

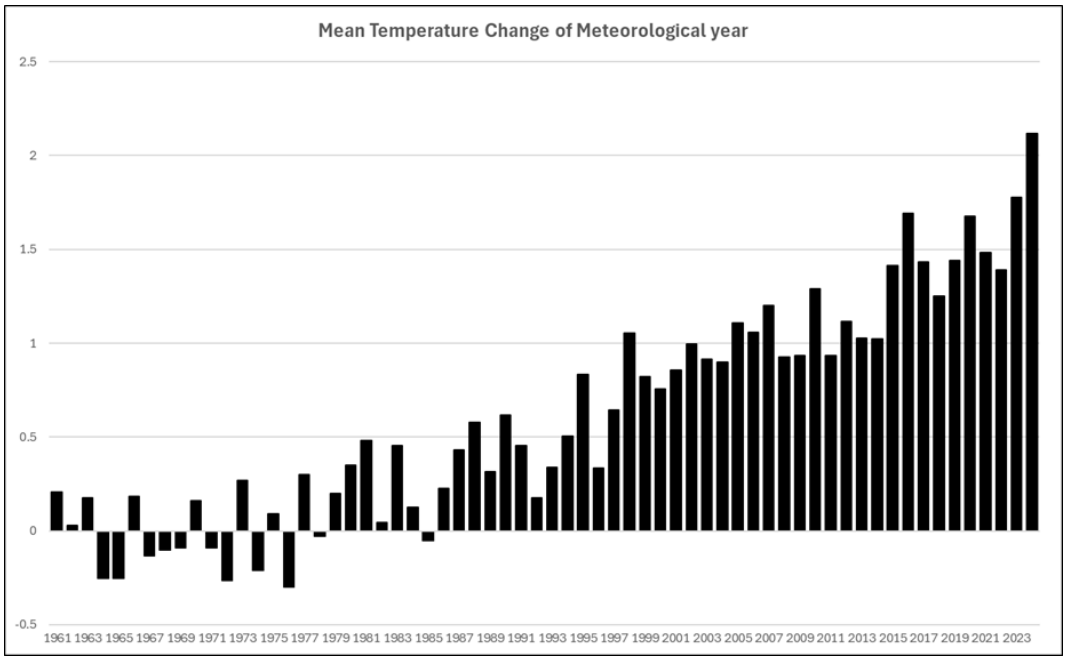
1.1 Research Background

1.1.1 Employment

Employment, as defined by World Bank Group, refers to those aged 15 and above who, during a short overtime , were engaged in the production of goods or offering services for compensation or profit, regardless of whether they put in at least one hour of work or were temporarily away from their jobs due to leave or work schedule arrangements. According to ILO (2015), developing countries are often marked by the presence of both formal and informal types of employment within their labour markets. Employment is a key indicator of overall economic stability and development potential to measure economic performance and shows how well an economy can generate and maintain productive jobs. Besides, improved employment will increase the well-being and living quality of people through consistent incomes. However, employment is vulnerable, especially in developing countries, as it can easily be affected by shock events like COVID-19.

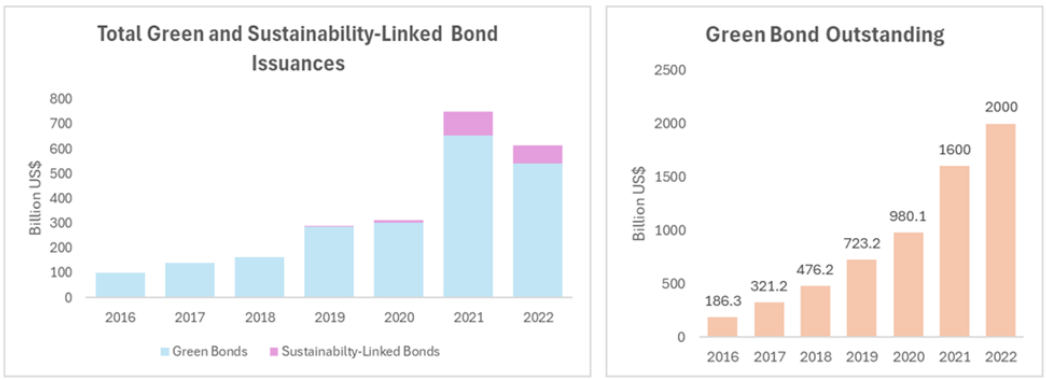
1.1.2 Green Finance

Figure 1.1.2.1



Source: IMF

Figure 1.1.2.2



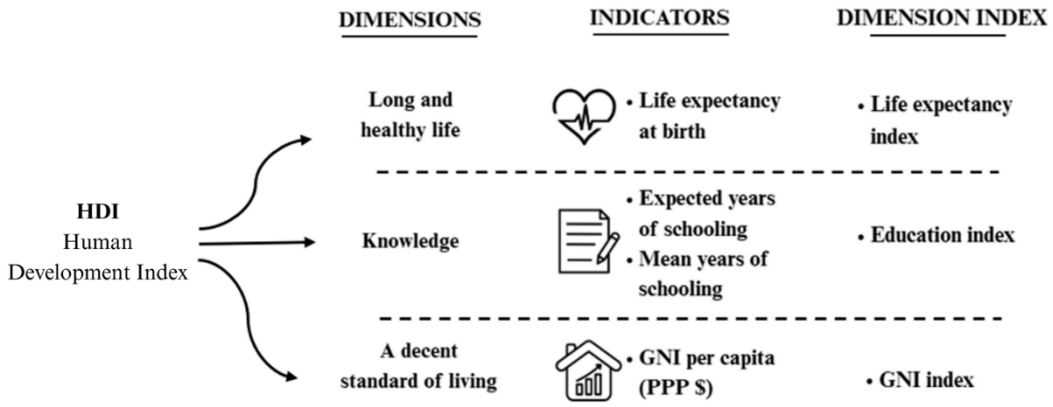
Source: IMF

Figure 1.1.2.1 shows that the mean temperature around the world is rising, and here is where green finance (GF) plays an important role. GF is defined as any structured financial activities related to environmental benefits and creation for a better

environment to mitigate climate risks (World Economic Forum, 2020; International Monetary Fund, 2020). Based on Figure 1.1.2.2 shows that the green funds issued are increasing over the years, indicating that GF has become a trend for institutions to go green. To align with the Paris Agreement 2015, developed and developing countries have actively established green policies to achieve their targets with green financing. Through GF, economic growth can also be improved, which includes employment. This is proven by experts like Almenhali & Nobanee (2021) stated that in the UAE's Green Agenda 2015-2030, the introduction and encouragement of green projects that need financial aid, indicating GF involvement, can lead to a rise in jobs.

1.1.3 Human Capital Development

Figure 1.1.3.1
HDI Dimensions and Indicators



Source: UNDP Human Development Reports (2025)

According to Largin (2024), human capital represents the skills, knowledge, and qualifications that individuals possess, which are considered economic assets. Human capital development is the process of enhancing these attributes to unlock individual potential and improve workplace performance. Although the concept of human capital is clear, measuring it is challenging because individual skills are difficult to observe and standardize across diverse populations and countries.

Based on Figure 1.1.3.1, Human Development Index (HDI) is a composite measure capturing average achievements in three key areas: health, education, and standard of living. It assesses health through life expectancy at birth, education using both the mean years of schooling for adults aged 25 and over and expected years of schooling for children entering school and living standards via the logarithm of GNI per capita. The HDI aggregates these normalized indices by calculating their geometric meaning, providing a standardized way to compare human development outcomes across countries and to challenge how similar income levels can result in varying overall human development.

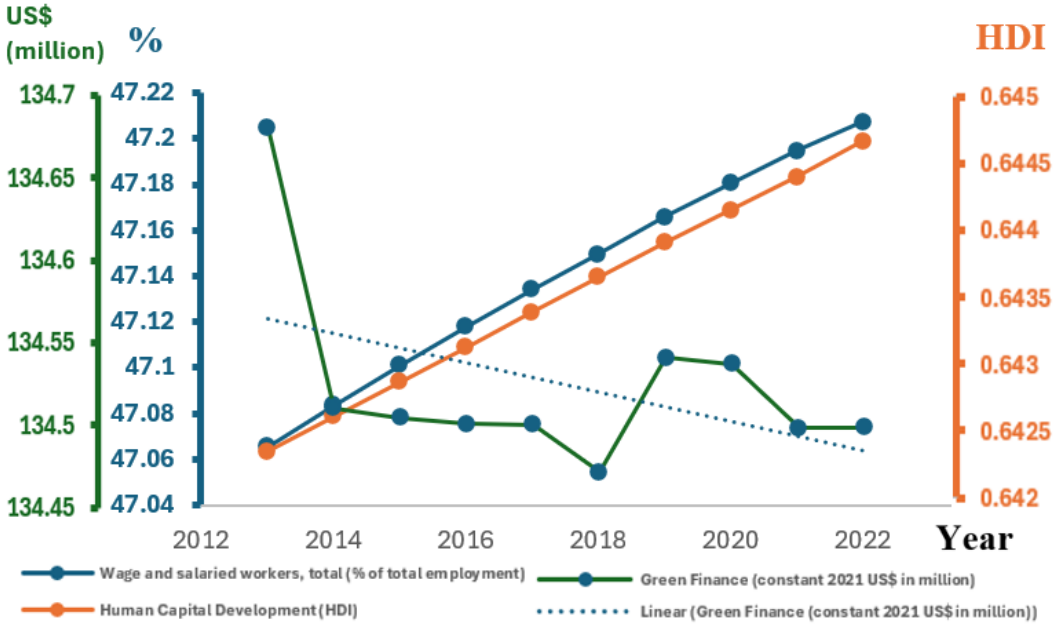
A study from Sodirjonov (2020) emphasized that education is the most important factor of HCD. Education can be understood through a three-stage framework. First, it functions as an economic resource, similar to other productive assets. Second, within the labour market, it serves as a production factor, where workers are selected based on the level and quality of their education to meet the needs of organizations and institutions. Third, the concept of educational potential emerges, reflecting the overall quality and level of education shaped by institutional, organizational, technological, and other influencing factors. Hence, individuals with higher levels of education typically enjoy better job prospects, higher income, and greater productivity.

In short, despite growing investment in human capital development, misalignment with job market needs, unequal access, and institutional weaknesses hinder its impact on sustainable job creation.

1.1.4 Overview of the Trend among Employment, Green Finance and Human Capital Development

Figure 1.1.4.1

Trend among EMP, GF, and HCD in developing countries (2013-2022)



Source: WDI, UNDP, Our World in Data (2025) and author's own calculation

Wage-and-salaried employment edges up almost stable. It starts near 47.06% of total employment in 2013, grows to 47.1% by 2016, and ends around 47.2% in 2022. There is no visible pandemic dip, which points to slow, indicates steady labor-market formalization rather than cyclical. Extrapolating that slope is rising very slowly (about 0.02 percentage points annually), unless stronger reforms make it grow faster.

When GF first initiated, it increased sharply, but decreased drastically in 2014, particularly brought by 2008 financial crisis. Fluctuations seem to be caused by shifting international priorities, or unstable financial flows into green investments, as the emergence and development of green finance as a concept and practice were not fully established in most developing countries (Fu et al., 2023). The trendline

of GF in developing countries demonstrated an overall downward trend from 2013 to 2022, despite considerable fluctuations, implying that, on average, annual flows have not built a durable uptrend. However, post-2020, green finance again began increasing, likely driven by a renewed global commitment to sustainable development initiatives (Xiong et al., 2023).

HCD, measured by the HDI, rises in a near-straight line from roughly 0.642 to 0.645. The smooth climb suggests broad, incremental gains in education, health, and incomes that continued even through 2020 to 2021 with healthcare, and overall quality of life. While continuous progress indicates a reasonable forecast of a growing supply of skilled labour.

In overall, EMP and HCD rise steadily, buy GF is quite volatile, stating that gains in jobs and human capital are driven by structural forces from earlier investments rather than current-year GF volumes.

1.2 Problem Statement

The rapid and advanced growth of digitalization and artificial intelligence (AI) has changed the work structure globally, and people are raising concerns about how these changes could affect jobs. The threat of automation and AI-driven processes had taken over routine and low-skilled jobs, placing workers, especially those with limited digital literacy, inadequate educational backgrounds, and insufficient knowledge, at a competitive disadvantage, particularly in developing countries. Empirical evidence, Wang et al. (2024) shows that the demand for high-skilled labour rises by 0.063% for every unit growth in AI, whereas the low-skilled labour force declines by 0.001%, supported by Giwa and Ngepah (2024), saying a significant negative long-term correlation between AI-adoption and low-skilled employment.

At the same time, climate change and environmental pollution often are the hardest hit by developing countries nowadays, driven largely by an overreliance on fossil fuels, facing hotter temperatures, more extreme weather, fragile infrastructure for proper waste management, and greater health risks, compounded by limited fiscal space (Dayyeh, 2024; Kose et al., 2021). According to Beynon and Edward (2024), high-income countries are responsible for just 29% of GHG emissions in 2022, with UMICs the largest contributor at 48%, LMICs 19%, and LICs less than 4%. In response, global initiatives taken such as the Paris Agreement, under UNFCCC, was signed in 2015 by 196 countries to address long-term goals by limiting global temperature rise to not more than 1.5℃ (Hao & Chen, 2022). However, developing countries still have a hard time balancing their environmental responsibilities with their urgent needs for jobs and money.

Green Finance (GF) has emerged as a potential pathway to address both climate and employment challenges, which is distinct from traditional finance by directing funds specifically to clean-energy R&D, renewable power, and sustainable infrastructure. For example, China's 2017 Green Finance Innovation and Reform Pilot Zone (GFIRPZ) served as a nationwide benchmark, stimulating RE and manufacturing employment (Fu et al., 2024; Ge & Zhi, 2016). However, despite heavy promotion, GF implementation in developing countries shows major gaps. Poor governance, policy instability, and low market awareness have limited its effectiveness in generating stable employment outcomes (Agrawal et al., 2023; World Economic Forum 2024). For instance, Indonesia's 2014–2019 Sustainable Finance Roadmap launched green bonds and lending schemes, yet progress lagged because of low public understanding and persistent capacity-building hurdles. The Covid-19 pandemic caused a sharp drop in jobs and human capital, which further exposed these weaknesses, as governments shifted priorities toward immediate recovery, reducing momentum for green investment.

A critical barrier lies in human capital development (HCD). While human development index (HDI) has gradually improved, the pandemic exposed the fragility of education and health infrastructures. As developing countries transition toward green industries, without adequate skills and training, workers in developing countries have a hard time adjusting to the needs of green industries. This limits the job growth that GF could bring. Attempts have been made to address these issues through previous policies in Indonesia, China, Mongolia, and Brazil (UNEP, 2015; Campos, 2025; SBFN, 2022; Costa, 2024), but structural barriers, including inadequate financial literacy, informal economic sectors, and short-term financial market focus, have constrained employment outcomes (Jing et al., 2023).

In conclusion, the core problem in this research seeks to address whether developing countries, across different HDI levels, can achieve a significant and sustainable increase in employment through GF investments, and how HCD strengthens this relationship. Addressing this research gap is essential not only for maximizing the effectiveness and sustainability of green finance initiatives but also for advancing inclusive labour market development and achieving broader socio-economic and environmental goals in developing countries.

1.3 Research Questions

1. Does green finance have a positive impact on employment in developing countries?
2. Does human capital development positively moderate the relationship between green finance and employment in developing countries?
3. Does green finance have a positive effect on employment in both low-HDI and high-HDI developing countries?
4. Does human capital development play a role in moderating the relationship between green finance and employment in both low-HDI and high-HDI developing countries?

1.4 Research Objectives

1.4.1 General Objectives

This study aims to assess how GF influences employment outcomes, whether its relationships are positive, negative, or non-existent in developing countries, including low-HDI and high-HDI developing countries. It will further examine HCD as an intermediary variable to determine if workforce skills and education can strengthen or even reverse the initial relationship between green finance and employment.

1.4.2 Specific Objectives

1. To investigate the positive effects of green finance on employment in developing countries.
2. To examine whether human capital development positively moderates the relationship between green finance and employment in developing countries.
3. To investigate the positive effects of green finance on employment in both low-HDI and high-HDI developing countries.
4. To evaluate whether human capital development strengthens the positive impact of green finance on employment in both low-HDI and high-HDI developing countries.

1.5 Significance of Study

This study examines the relationship between GF and employment, as well as GF and HCD on employment in developing countries, consisting low-HDI and high-HDI developing countries. The list of low HDI (<0.550), high HDI (0.700-0.799), and the developing countries is based on 2022 HDI values of United Nations

Development Programme (UNDP), which stated in Appendix 1 (UNDP, 2025). Besides, researchers and environmentalists can use this study as a reference to provide further useful and practical studies. Impacts of GF on the overall employment of developing countries will provide a clearer, more policy-relevant assessment of sustainable investments and be more politically persuasive, as employment statistics by industry or skill level are more readily available and consistent to be compared across countries.

For Ministries of Labour, Human Resources, and Finance, this study will offer concrete guidance on designing integrated green-growth strategies. For instance, a ministry might learn that simply issuing green bonds is not enough, without parallel investments in vocational training for labourers, the full employment potential of those bonds will go unrealised.

By examining how GF paired with HCD drives employment, this study supports SDG 7 (Affordable and Clean Energy), SDG 4 (Quality Education), and SDG 13 (Climate Action) by identifying the policy levers that align clean-energy investment, workforce skills, and climate resilience in developing countries. In many countries, opportunities for green finance are potentially commercially viable, but inadequate owing to barriers in demand or supply.

However, while global studies often report a positive correlation between green finance and employment, few studies examine how local policy frameworks, credit constraints, and educational systems mediate this relationship. Besides, high unemployment and underemployment rates persist, and the transition from fossil fuels to low-carbon industries raises questions about net employment effects. Hence, by quantifying the interaction effect of HCD on GF investments, this study aims to bridge a critical gap in the literature on evaluating how green finance can drive employment when coupled with HCD as the moderator in developing countries, consisting of low-HDI and high-HDI developing countries.

1.6 Scope of Study

This study aims to determine the relationship between GF, HCD, and EMP. It analyses the trends of employment across 88 selected developing countries, including 20 each for low HDI and high HDI developing countries, which are also based on gross national income (GNI) per capita over 15 years from 2008 to 2022, indicating a panel data analysis. This research reviews global case studies to show how different HDI countries deploy green finance, both with and without strong human capital to drive sustainable employment and also amplify green finance's impact, creating jobs that boost innovation and international competitiveness in the long term.

CHAPTER 2: LITERATURE REVIEW

2.1 Review of Theories and Concepts

2.1.1 Human Capital Theory (HCT)

Gary Becker's 1964 book "HCT" is considered a classic in the field of economics (Na, 2012). According to Wuttaphan (2017), the importance of HCT is widely acknowledged for enhancing organisational performance. Organisations depend on the skills, knowledge, and abilities of their employees as essential elements for generating value. Human capital can be developed through various means such as education, training, health improvements, and migration. These paths enable individuals to acquire competencies, expertise, and capabilities in diverse ways. This theory becomes particularly applicable in the context of GF. As the global economy moves toward sustainability, renewable energy and energy efficiency demand new skill sets. These sectors often require technical expertise,

environmental literacy, and innovation capacity. However, the workforce in many developing countries could not be prepared to handle these demands. For example, Ritter (2017) stated that insufficient government involvement hinders efforts to invest in human capital, posing a significant challenge for many developing countries.

Therefore, GF is important in this context, which supports initiatives that develop human capital as well as financially supporting environmentally sustainable projects because those projects often require skilled workforce. Based on Fu et al. (2024), GF policies encourage enterprises to adopt environmentally sustainable technologies and upgrade equipment for boosting production efficiency. These advancements drive innovation. Crucially, such green transitions require skilled workforce, particularly engineers and R&D professionals to develop, implement, and manage new technologies. In high-tech manufacturing sectors, where the demand for innovation is high, GF support enables continuous technological upgrading, further reinforcing the need for highly skilled talent to sustain and grow green projects.

Samiullah (2014) concluded that improvements in a country's health and education sectors are linked to lower unemployment rates. In the case of Pakistan, better education and physical well-being equip individuals with the skills and capacity to participate more actively in the labour market, thereby reducing unemployment. By making investments in the development of human capital, nations can generate new employment opportunities (Nguyen et al., 2024). This not only reduces structural unemployment but also drives innovation, increases productivity, meanwhile ensures a more stable and sustainable labour market.

2.1.2 Keynesian Theory of Employment

The Keynesian Theory of Employment was proposed by John Maynard Keynes in 1936 in his book, The General Theory of Employment, Interest, and Money (Hicks, 1936). The main concept is that employment and income level are affected by the overall aggregate demand. In short, if individuals, firms and governments' spending and consumption are low, many will lose jobs because the firms' demand for labour for production decreases. In addition, the multiplier effect mentioned, which refers to the idea that there is an increase in initial spending or investment by one, the overall income and employment will increase more than one (Pigou, 1936). Essentially, this indicates that more spending and investments lead to more demand and production needed, followed by an increase in employment, showing that initial finance or investments can be snowballed into larger-valued economic growth and job gains.

In this research, this theory can be linked to our main IV, GF and DV, employment, to analyse the relationship between both. Theoretically, we hypothesise that an increase in GF that leads to green investments can affect employment more by multiplying the impacts. As a support, O'Callaghan et al. (2022) came out with a study, claiming that green investments created more employment opportunities and delivered a higher multiplier effect, with evidence. Besides, this theory can be linked to the control variables, FDI and RE. Similarly, like GF, FDI, and RE are assumed to impact employment positively.

2.1.3 Dunning's Ownership, Location, and Internalization (OLI) Paradigm

Dunning's Ownership, Location, and Internalization (OLI) Paradigm, formerly known as the Eclectic (OLI) Paradigm, was first formulated by John Dunning in

1976 and demonstrates a unified framework to explain why and where firms undertake foreign production (Dunning, 1988). Dunning observed that U.S. affiliates in the U.K. outperformed local competitors, not because they were inherently superior, but due to three key advantages: ownership, location, and internalization (Sharmiladevi, 2017). This theory can be used to explain the relationship between FDI, GF, and employment.

According to the OLI paradigm, FDI flows hinge on a host country's location advantages such as market size and openness, infrastructure quality, labour conditions, institutional strength, and policy stability, making investments highly sensitive to its macroeconomic and regulatory environment (Julio & Yook, 2016). According to Shear et al. (2023), the theory holds that MNEs invest in higher risk developing countries because they believe they can manage those risks.

Studies by several developing countries have used the OLI paradigm to reveal how GF and FDI can catalyse job creation by leveraging each of its three pillars. In Vietnam, Anh et al. (2021) showed that foreign investors' technology and capital (Ownership), host-country incentives (Location), and subsidiary hiring (Internalization) directly reduce poverty through new jobs, contributing up to 60% of poverty reduction. Liu & Lu (2011) found that Chinese firms' overseas investments boost service-sector employment by repatriating profits and expanding domestic staffing. In post-conflict Ukraine, Nasrulddin (2024) argued that tailored green-finance zones enhance Location advantages, attracting labour-intensive renewable projects and generating significant employment in reconstruction efforts.

Hence, by leveraging GF mechanisms to enhance OLI advantages, developing countries can attract higher volumes of quality FDI into their green sectors, turning financial flows into sustainable jobs, from project engineering and construction to operations, maintenance, and innovation.

2.2 Empirical Review

2.2.1 Different Definitions of Employment, Green Finance, and Human Capital Development

The concepts of employment, green finance, and human capital development are multifaceted and have been defined differently by various scholars and institutions across diverse economic and developmental frameworks. These varying definitions reflect the wide range of perspectives and contextual interpretations that shape how each term is understood and applied. Gaining insight into these differing definitions is crucial for comprehending the broader challenges and opportunities associated with sustainable development. By exploring these key concepts from multiple viewpoints, this section aims to provide a more comprehensive understanding of how they are conceptualized and interconnected in shaping economic transformation and inclusive growth.

Table 2.2.1

Definitions of Employment

Researchers	Definitions
Nguyen et al. (2024)	Defines employment is measured by the employment-to-population ratio, indicating how effectively a country's labour market utilizes its working-age population.
Peckham et al. (2019)	Employment describes a formal agreement between an employer and an employee.

Table 2.2.2

Definitions of Green Finance

Researchers	Definitions
Berensmann and Lindenberg (2016)	GF refers to positive transformation in the global economy's move toward sustainability by supporting both public and private green investments, as well as policies that promote environmentally friendly initiatives.
Palmaccio et al. (2023)	GF broadly refers to financial activities and related institutional and market systems that contribute both directly and indirectly to advancing the SDGs, aiming to foster resilient, sustainable, equitable, and inclusive economic growth.

Table 2.2.3

Definitions of Human Capital Development

Researchers	Definitions
Odia et al. (2024)	HCD involves enhancing the quantity and quality of individuals equipped with the education, skills, and experience necessary to drive a nation's economic growth and development.
Shavkun and Dybchinska (2022)	HCD relies on an effective management culture that ensures the necessary material and technical

	support to foster strong work ethics and enhance productivity.

Each definition offers valuable insights into how employment, GF, and HCD is perceived and measured across different economic systems, institutional frameworks, and cultural contexts. Incorporating these diverse perspectives into research and policymaking is essential for formulating comprehensive and effective strategies that reflect the realities of developing countries.

2.2.2 Green Finance and Employment

Green Finance (GF) is a fund to generate environmental benefits through financial activities related to sustainable ecological conservation, while the idea originated in the European and Western regions. It aims to boost firms and enterprises to mitigate climate change issues by funding R&D development, clean technologies, or green projects (Woode, 2024). The concept is also introduced to achieve a sustainable green economy by innovating green financial tools such as green debts, green bonds, etc and fund them into the operations while ensuring sustainability (Ouyang et al., 2023). As GF is prevalent, there are more green funds or bonds, and debts provided by organisations or parties globally. One of them is the Asian Development Bank (ADB), who give out loans and grants for sustainable, resilient growth. Based on ADB, they collaborate with the Global Environment Facility (GEF), that established to tackle environmental issues since the 1990s, while approximately $135.1 billion was given out by GEF to fund more than 5000 projects in 170 countries (Breezy, 2024).

From the perspective of employment, numbers of studies states that GF has significant potential to increase job opportunities. The statement is supported by various researchers, saying that GF enhance job creation (Bowen & Kuralbayeva,

2015; Falcone & Sica, 2019). Furthermore, researchers from China also reviewed the green finance reform and innovation pilot zones that encourage GF. Fu et al. (2024) stated that the GF related pilot zones did have a positive impact on employment in the manufacturing industry. While some found that pilot zones have different results, at the city level (optimistic), but firm level (adverse) (Xin et al., 2024). Besides, Liu and Wang (2023) discovered that the GF policy has a larger impact on jobs in green industries compared to polluting industries. Therefore, based on the past and recent findings, most GF have positive impacts towards employment, but vary depending on external factors like geographical, geopolitical, etc.

2.2.3 Green Finance, Human Capital Development and Employment

GF is seen as a potential option to help developing countries target sustainable development at less cost in terms of economic decline, despite the uncertainties, such as HCD and the inconsistency of policies. Many research studies agree that there is a positive relationship among GF, HCD and employment in developing countries.

According to Feng et al. (2022), the study uses data envelopment analysis (DEA) and system Generalized Method of Moments (GMM) techniques to analyse panel data from 2008 to 2018 in selected Belt and Road Initiative (BRI) countries which are caused by the lack of series government policies, demonstrates that public expenditure on human capital and renewable energy leads to labour production. Besides, Aqib and Zaman (2023) use robust regression, Granger causality, and impulse-response analysis on Pakistan's 1975 to 2020 data to show that R&D and tech investments cut CO_2 emissions and raise life expectancy and school enrolment, while growth fuels both emissions and human-capital gains. Yet, they caution that without stronger education, health, and labour-market policies, these environmental and human-capital improvements will not translate into lasting job growth.

Recent studies show that strong human capital amplifies GF's job creation effects, as Tufail et al. (2024) use a difference-in-differences approach on China's pilot zones to find a 5% to 7 % larger increase in manufacturing and services employment with higher education and health indices. Fu et al. (2024b) report that each US $1 million of green bonds yields 8 to 10 new jobs on average, rising to 12 to 15 jobs in countries above the median for literacy rates and vocational training. Sahoo & Dash (2024), using system-GMM across 56 emerging economies 2000 to 2021, showing that green credit and bond volumes significantly boost industrial and service employment where workforce skill levels are high.

Nevertheless, employment will decrease if green finance is implemented in weak human capital countries. As shown by studies, Gong and Wang (2024) showed that in China's forestry sector, GF only boosts productivity and jobs creation once average education exceeds 5.87 years, but if below that threshold, more green funding has no benefit and can even react negatively. Nguyen et al. (2024) studied 52 countries from 2005 to 2019 and found that without supporting green-energy production policies and the skilled labour they demanded, GF tends to hinder employment, meaning low human capital can turn green investments into job and economic setbacks. Moreover, Jawadi et al. (2024) apply system-GMM to 30 emerging economies and find that green credit and bond volumes positively impact employment only in countries above the median HDI but have a statistically insignificant effect in lower-HDI countries.

Although GF expanded during this period, its effect on employment creation was inconsistent, considering the availability of skilled labour related to GF. GF typically correlates with increased employment, but it becomes no effect if human capital is weak. The are mixed relationships of GF, HCD and employment and need to be clarified to ensure sustainability.

2.2.4 Controlled Variables

The involvement of control variables in this study is crucial to capturing the broader economic and social factors influencing employment in developing countries. By accounting for relevant influences, the analysis provides a more accurate and realistic understanding of employment dynamics. Control variables such as renewable energy (RE), energy transition (ET), population growth (PG), and foreign direct investment (FDI) are included for their potential impact on labour market outcomes, ensuring a more robust and comprehensive assessment.

Firstly, RE plays an important role in employment in the context of GF. As many researchers have found, there is a positive relationship between RE consumption and EMP (Hernandez-Cortes and Mathes, 2023; Moummy et al., 2021; Khobai et al., 2020). Secondly, ET is the transformation from fossil fuel-based to zero-carbon renewables like wind, solar, hydro, biomass, etc, to reduce climate change issues such as CO2 emissions (IRENA, 2025). Based on major past studies, ET and EMP have a positive relationship where an increase in ET or clean energy production, EMP will increase (Zhang et al., 2024). However, some did find that there is a negative relationship between them due to different geographical and industry factors (Ju et al., 2022). Thirdly, PG can affect the employment level, assuming that an increase in population leads to an increase in the labour force at a constant rate based on the Solow Growth Model theory. Major previous findings have resulted positive relationship between PG and employment (Baht et al., 2022; Haider et al., 2023). Yet, there are some that found PG and EMP have a negative relationship due to over high PG and low EMP rate, especially in the Middle East and North Africa (Haririan et al., 2010). Lastly, FDI stands for Foreign Direct Investment, which happens when foreign investors, firms, and governmental institutions invest and own a stake in ownership in a foreign company or project (Hayes, 2024). Based on the studies reviewed, mostly stated that FDI and EMP have a positive relationship (Irpan et al., 2016; Rong et al., 2020; Nguyen et al., 2024). However, there is an

exception: researchers found that FDI might hurt EMP in the short term and benefit in the long term (Jude & Silaghi, 2015).

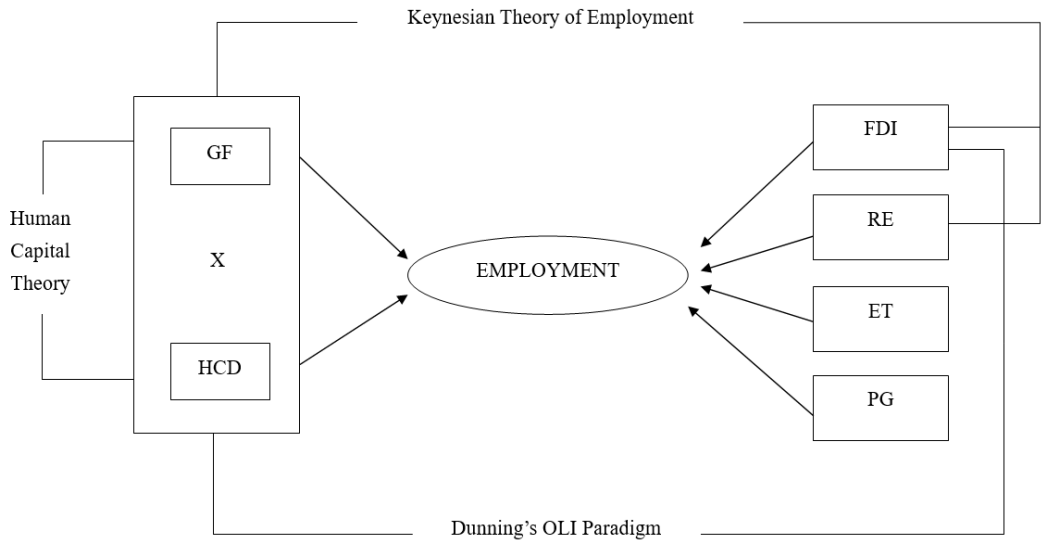
2.3 Theoretical Framework

2.3.1 Conceptual Framework

Figure 2.3.1.1 illustrates this research's conceptual framework which explores the relationship between GF and EMP in developing countries, emphasizing the interaction term of HCD. The framework also includes four control variables, aligning with the theories and concepts, that may independently impact employment outcomes.

Figure 2.3.1.1

Conceptual Framework



Human Capital Theory aligns with the context of GF, where HCD moderates the relationship to influence employment outcomes. In addition, the Keynesian Theory of Employment emphasizes how GF and its interaction with HCD contribute to

employment, alongside factors such as FDI and RE. Meanwhile, Dunning's OLI Paradigm highlights how the interaction of GF and HCD, together with FDI, shapes employment dynamics.

2.4 Hypotheses Development

This section presents the hypothesis development to explore the relationship between independent variables, the interaction term, and employment in developing countries. These hypotheses offer testable predictions and also findings from major studies that guide the study's empirical analysis. It aims to clarify how GF initiatives positively impact EMP outcomes, particularly when moderated by HCD.

H_1: There is a significantly positive significant relationship between green finance and employment in developing countries.

H_2: There is a significantly positive significant relationship between green finance and employment with human capital development as the moderator in developing countries.

H_3: There is a significantly positive significant relationship between green finance and employment in both low-HDI and high-HDI developing countries.

H_4: There is a significantly positive significant relationship between green finance and employment with human capital development as the moderator in both low-HDI and high-HDI developing countries.

2.5 Research Gap

Although prior researchers have widely explored the role of green finance in promoting the relationship between green finance and economic growth (Soundarrajan & Vivek, 2016; Yin & Xu, 2021; Xu et al., 2023), and the relationship between green finance and environmental sustainability (Wei et al., 2023; Sharif et al., 2024; Teng et al., 2024), its direct impact on employment remains underexplored. Most studies either measure short-term job creation effects of GF or investigate how enhancements in HCD such as education and health will expand employment opportunities. However, few have analyzed the interactive effect of HCD on the GF-employment relationship in developing countries, despite evidence that weak HCD can diminish the benefits of green investment. For instance, Gong and Wang (2024) found that in China's forestry sector, GF only enhances employment once a threshold level of human capital is reached. Furthermore, GF policies in developing countries often lack long-term consistency, producing volatile outcomes (Fu et al., 2024b; Sahoo & Dash 2024). Short-lived stimulus can increase temporary hiring, but without integrated HCD, vocational training, education reforms, and health investments, job creation tends to decrease, leaving economies vulnerable to policy volatility and global economic shocks such as the global financial crisis, climate change or the Covid-19 pandemic. Besides, labors in low-HDI developing countries frequently lack the absorptive capacity to take advantage of green investment opportunities, leaving GF's employment effects neutral or insignificant, whereas stronger HCD in higher-HDI developing countries, founded by existing studies has been shown to amplify GF's impact (Rao et al., 2023). Lastly, there is not much comparative evidence across different HDI groups because most empirical studies are limited to individual countries or regional cases.

Hence, addressing these gaps by studying past and recent studies from diverse researchers, this study seeks to fill these gaps by modelling the interaction between GF and HCD on employment using a 15-year panel broader dataset of developing countries, with a comparative focus on low and high-HDI developing countries. By

incorporating control variables such as renewable energy, energy transition, FDI inflows, and population growth, the analysis captures structural conditions shaping the GF-EMP relationship. By doing so, our research may clarify whether strong HCD amplifies the employment effects of GF or whether weak HCD reverses their relationship. Unlike previous studies that isolate the effects of GF or HCD individually, this study provides not only an overview but a comparative and integrative approach to understanding how labour market readiness mediates the success of GF in generating jobs. Furthermore, the findings from our study aim to provide policymakers with clearer guidance on aligning GF instruments with HCD strategies to foster sustainable and inclusive employment growth in diverse developing countries.

CHAPTER 3: METHODOLOGY

3.1 Research Design

This study investigates how green finance (GF) influences employment in developing countries and whether human capital development (HCD) moderates that effect. Our main independent variable is GF, with HCD entered both directly and as an interaction term (GF × HCD) to capture effects on employment. We also include four control variables, which are renewable energy (RE), energy transition (ET), population growth (PG), and foreign direct investment (FDI), all of which the literature identifies as key determinants of labour-market outcomes. Our dataset covers 88 selected developing economies over 15 years (2008–2022) and relies exclusively on secondary data from WDI, UNDP, Our World in Data, and IRENA. The purpose of this chapter is to provide an overview of the data sources and econometrics methods to gather and analyse the data, ensuring it aligns with the research objectives. Referring to the Appendix 2, it shows the list of countries selected in our study.

3.2 Empirical Model

This study proposes an empirical framework linking employment to green finance (GF) and human capital development (HCD) by estimating a log-linear panel-data model with an explicit interaction term (GF×HCD). By taking natural logs, each coefficient represents elasticity, so a 1 % change in a regressor leads to a β % change in employment, while including both GF and HCD allows us to test how workforce skills moderate the impact of green finance on job creation. We address endogeneity and the inherently slow adjustment of employment by using a dynamic panel model, system GMM, improving the reliability of our results.

Our dynamic empirical model, which includes a lagged dependent variable, where the impact of GF on employment in developing countries, can be signified below:

$$\ln EMP_{it} = \alpha_0 + \emptyset lnEMP_{i,t-1} + \alpha_1 \ln GF_{it} + \alpha_2 \ln HCD_{it} + \alpha_3 \ln REN_{it} + \alpha_4 \ln CAP_{it} + \alpha_5 \ln PG_{it} + \alpha_6 \ln FDI_{it} + \varepsilon_{it}$$

Equation 1

where α is the developing countries, after introducing human capital development as a moderator of GF and employment, the dynamic panel model is expressed as follows:

$$\ln EMP_{it} = \alpha_0 + \emptyset lnEMP_{i,t-1} + \alpha_1 \ln GF_{it} + \alpha_2 \ln HCD_{it} + \alpha_3 (lnGF_{it}\ x\ lnHCD_{it}) + \alpha_4 \ln REN_{it} + \alpha_5 \ln CAP_{it} + \alpha_6 \ln PG_{it} + \alpha_7 \ln FDI_{it} + \varepsilon_{it}$$

Equation 2

**where i in Equation 1 and 2 refers to the selected 88 developing countries*

where β are the low-HDI developing countries, the relationship with GF and employment is expressed as follows:

$$\ln EMP_{it} = \beta_0 + \emptyset lnEMP_{i,t-1} + \beta_1 \ln GF_{it} + \beta_2 \ln HCD_{it} + \beta_3 \ln REN_{it} + \beta_4 \ln CAP_{it} + \beta_5 \ln PG_{it} + \beta_6 \ln FDI_{it} + \varepsilon_{it}$$

Equation 3

to test whether human capital development will amplify or reverse the effect of GF on employment in low-HDI developing countries, it can be expressed as follows:

$$\ln EMP_{it} = \beta_0 + \emptyset lnEMP_{i,t-1} + \beta_1 \ln GF_{it} + \beta_2 \ln HCD_{it} + \beta_3 (lnGF_{it}\ x\ lnHCD_{it}) + \beta_4 \ln REN_{it} + \beta_5 \ln CAP_{it} + \beta_6 \ln PG_{it} + \beta_7 \ln FDI_{it} + \varepsilon_{it}$$

Equation 4

**where i in Equation 3 and 4 refers to the 20 low-HDI developing countries*

where γ are the high-HDI developing countries, the relationship with GF and employment is expressed as follows:

$$\ln EMP_{it} = \gamma_0 + \emptyset lnEMP_{i,t-1} + \gamma_1 \ln GF_{it} + \gamma_2 \ln HCD_{it} + \gamma_3 \ln REN_{it} + \gamma_4 \ln CAP_{it} + \gamma_5 \ln PG_{it} + \gamma_6 \ln FDI_{it} + \varepsilon_{it}$$

Equation 5

to examine the relationship between GF and employment in high-HDI developing countries, with human capital development as an interaction term, it can be expressed as follows:

$$\ln EMP_{it} = \gamma + \emptyset lnEMP_{i,t-1} + \gamma_1 \ln GF_{it} + \gamma_2 \ln HCD_{it} + \gamma_3 (lnGF_{it}\ x\ lnHCD_{it}) + \gamma_4 \ln REN_{it} + \gamma_5 \ln CAP_{it} + \gamma_6 \ln PG_{it} + \gamma_7 \ln FDI_{it} + \varepsilon_{it}$$

Equation 6

**where i in Equation 5 and 6 refers to the 20 high-HDI developing countries*

Where,

EMP_{it} = Wage and salaried workers in country i, at time t

$EMP_{i,t-1}$ = lagged wage and salaried workers in country i, at time t

GF_{it} = green finance volume in country i, at time t

HCD_{it} = human capital development (HDI), an interaction term in country i, at time t

REN_{it} = renewable energy consumption (% in total) in country i, at time t

CAP_{it} = installed renewable capacity (MW) in country i, at time t

PG_{it} = annual population growth (%) in country i, at time t

FDI_{it} = net FDI inflows (% of GDP) in country i, at time t

ε_{it} = error term

ln = natural logarithm

t = 2008, 2009, 2010, …, 2022

Blundell and Bond (1998) demonstrate that using lagged dependent variables such as lagged employment as instruments within their System GMM framework helps mitigate endogeneity, corrects bias from serial correlation, and remains robust to heteroskedasticity in dynamic panel data models. Thus, our equation forms with EMP, lagged EMP, GF, HCD, REN, CAP, PG, FDI similar to Jing et al. (2023). By including these control variables in our log-linear specification, we make our estimates more reliable as each term captures a key determinant of employment that the literature consistently identifies, helping to mitigate omitted-variable bias and influence employment significantly in the long run.

3.3 Data Collection and Description

For our data, we use selected 88 developing countries that include low, medium, high and very high-HDI countries, while the developing countries which defined by IMF are countries whose standard of living, income, economic and industrial development remain more or less below average as they are categorized based on the country's population, GNI per capita, human development index and human asset index (WorldData.info, 2025). Furthermore, the HDI categorization is based on gross national income (GNI) per capita, life expectancy at birth, expected years of schooling, and mean years of schooling, where high HDI is between 0.700 and 0.799, whereby index below 0.550 is grouped as low HDI countries.

Table 3.3.1

Proxy Used for Each Variable

Acronym	Variable	Proxy used	Source of data
EMP	Employment	Wage and salaried workers, total (% of total employment)	WDI*
GF	Green Finance	International financial flows to developing	Our World in Data

		countries in support of clean energy R&D and renewable energy production, including in hybrid systems (millions of constant 2021 United States dollars)	
HCD	Human Capital Development	Human Development Index (HDI)	UNDP**
REN	Renewable Energy	Renewable Energy Consumption (% of total final energy consumption)	WDI*
CAP	Energy Transition	Electricity Installed Capacity on Renewable Sources (MW)	IRENA***
PG	Population Growth	Population Growth (annual %)	WDI*
FDI	Foreign Direct Investment	Foreign direct investment, net inflows (% of GDP)	WDI*

**WDI (World Development Indicators)*

***UNDP (United Nations Development Programme)*

****IRENA (International Renewable Energy Agency)*

Key datasets include economic and employment indicators from WDI, human capital measures from UNDP, environmental and energy statistics from Our World in Data and IRENA. By integrating these data into a panel-data framework, we can assess how GF, and the interaction effect with HCD on employment over time. All of the data for these variables are obtained from reliable international sources to guarantee reliability and consistency.

Our DV in this research, employment is measured using total wage and salaried workers (% of total employment). This indicator calculates the percentage of employed people who are paid in wages and salaries, expressed as a percentage of all employment. A higher employment ratio implies greater economic activity and social inclusion. This indicator is sourced from WDI provided by the World Bank.

GF is our research IV. It is represented by international financial flows to developing countries in support of clean energy R&D, and renewable energy production, including hybrid systems. GF indicates international financial flows that are specifically directed toward environmental sustainability. This proxy, expressed in millions of constant 2021 U.S. dollars, is obtained from Our World in Data.

HCD is considered a key factor that can influence the effectiveness of GF in generating employment, hence it stands for the research's interaction term. It is measured using the HDI. Data is obtained from UNDP. HDI is a composite indicator combining metrics of knowledge (education), health (life expectancy), and standard of living (per capita income). A higher HDI reflects a more skilled, healthy, and productive workforce, which can better absorb and benefit from green investments. Alterations in capital inputs, such as human capital, are interconnected with the process of economic growth (Barro, 2013).

To separate the effect of GF and account for other determinants of employment, there are four control variables included in the model. Firstly, renewable energy. Measured by renewable energy consumption as a percentage of total final energy consumption, this variable captures the extent to which a country relies on renewable sources for its energy needs. Jaiswal et al. (2022) stated that renewable energy consumption promotes economic growth and ensures sustainable green energy sources for the future. Data in our research is sourced from WDI.

Secondly, energy transition. Energy transition is assessed through the electricity installed capacity from renewable sources (measured in megawatts, MW). This indicator reflects a country's progress in shifting from conventional energy to renewable energy sources. Data is provided by the IRENA. According to UNDP (2024), with an emphasis on lowering reliance on fossil fuels and giving renewable energy priority, the energy transition signifies a substantial shift in the ways that energy is produced, distributed, and used. The goal of this transition to sustainable energy is to combat climate change and improve long-term sustainable development by reshaping the global energy environment.

Thirdly, population growth. The annual percentage growth of the population is included in investigating the demographic pressure on the labour market. The data are sourced from the WDI. Population growth is known as the gap between birth and death rates (excluding migration), the 20th century worldwide population expansion can be attributed to both decreasing rates of death and improvements in healthcare (Bloom & Canning, 2008).

Lastly, FDI, measured by net inflows as a percentage of GDP, reflects the degree of international investment in a country. The data are sourced from the WDI. Ali et al. (2023) highlighted that FDI has been a major force behind company expansion and cross-border knowledge sharing over the last thirty years, particularly in developing countries. FDI plays an important role in promoting economic development by providing capital, cutting-edge technologies, and management expertise. Additionally, it promotes the spread of technology, builds labour skills, integrates international trade, boosts competition, and helps businesses grow.

3.4 Model Estimation

3.4.1 Limitations of Pooled Ordinary Least Squares, Fixed Effect Model & Random Effect Model

Static estimators, POLS, FEM, and REM, fail to deliver consistent estimates in the dynamic panel data. This can be further explained that POLS ignores unobserved, time-invariant heterogeneity, producing biased coefficients when country-specific factors influence both employment and GF. Furthermore, FEM controls for time-invariant heterogeneity but suffers from the Nickell (1981) bias where the lagged dependent variable is correlated with the error term when T is finite, leading to downward-biased estimates of persistence. Besides, REM assumes that these unobserved effects are orthogonal, statistically independent to all regressors. These static estimators produce biased and inconsistent coefficients in the presence of a lagged dependent variable and endogenous regressors, causing them cannot handle dynamic panel data model due to biases unless it has very long panel data. Hence, GMM is critical to be employed in this study.

3.4.2 Generalized Method of Moments (GMM)

GMM, consisting of System GMM and Difference GMM, orthogonality conditions are moment conditions that specify how expected values of certain products of variables should be zero, given the true parameter values. Some advantages of using GMM are that it can correct for unobserved heterogeneity and omitted variable bias.

3.4.2.1 Blundell and Bond (1998) System GMM

System GMM is critical to employ in this study, as it addresses the limitations of Difference GMM by capturing and resolving issues related to endogeneity, persistence, and individual-specific effects. System GMM (SGMM) is a dynamic-

panel estimator introduced by Blundell and Bond (1998) as an extension of the difference GMM approach of Arellano and Bond (1991), using both lagged levels and lagged differences as instruments, strengthening identification and reducing finite-sample bias. It simultaneously estimates two equations, which are a first-difference equation that instruments change in the dependent and endogenous regressors with their lagged levels, and a level equation that instruments levels with lagged first differences. It also corrects the Nickell bias arising from including a lagged dependent variable in FEM and addresses simultaneity or omitted-variable endogeneity in regressors where independent variables correlated with the error term.

3.4.2.2 One-Step SGMM Estimation

One-step system GMM uses a simple, pre-specified weighting matrix to solve the dynamic panel's moment conditions, yielding consistent but not fully efficient parameter estimates. It provides robust standard errors immediately under arbitrary heteroskedasticity, and its residuals feed into the construction of the optimal weighting matrix that underlies the more efficient two-step system GMM estimation.

3.4.2.3 Two-Step SGMM Estimation

The two-step system GMM estimator refines the one-step by using its residuals to form an empirical covariance matrix of the moment conditions, which then serves as an optimal weighting matrix in a second minimization. This second-order transformation applies "forward orthogonal deviations", meaning instead of subtracting the previous observations of a variable from its current value, the two-step SGMM model subtracts the average of all future available observations of a particular variable (Roodman, 2009). Besides, researchers can prevent unnecessary data loss by using this method (Ullah et al., 2018a).

3.4.2.4 Two-Step SGMM with Robust Standard Error

The use of robust standard errors addresses potential issues of heteroskedasticity and autocorrelation in the error terms, which can bias the standard errors in small samples. Hence, a procedure advocated by Windmeijer (2005) employed it to adjust for the downward bias that can arise when using many instruments in panels of moderate length.

3.4.3 SGMM Postestimation Test

3.4.3.1 Sargan Test

The Sargan test or J-test, a test used for overidentifying restrictions, where more instruments than endogenous variables. Failure to reject the null hypothesis, when p-value is greater than alpha value (0.01/ 0.05/ 0.10), would imply that the instruments are valid and the model is correctly specified, which are not correlated with the error term (Boonyanet et al., 2024).

3.4.4 Autocorrelation Test

Autocorrelation is also a common problem in data analysis, including panel data. In our study, we want to see that the errors of the panel data are independent and are not correlated with other errors over time. Therefore, we also employed serial correlation test, AR(1) and AR(2).

3.4.4.1 Serial Correlation Test, AR(1) & AR(2) Tests

This is another test to examine the presence of autocorrelation in our model. AR(1) is used to test first-order serial correlation, while AR(2) is used for second-order serial correlation testing. The null hypothesis of both is that there is no AR(1) and AR(2) in differenced residuals. So, to obtain optimistic results, we want to reject AR (1) and do not reject AR (2) at the 1%/ 5%/ 10% significance level.

CHAPTER 4:

RESULT INTERPRETATION AND DISCUSSIONS

4.1 Result interpretation

Our study implemented a panel data set of developing countries over 15 years, from 2008 to 2022, including 20 developing countries, each for the low and high HDI, which were selected based on the criteria of WDI and the data availability for our study. Whereby, all the variables which are employment (EMP), green finance (GF), population growth (PG), foreign direct investment (FDI), energy transition (CAP), renewable energy (RE), with the interactive term, human capital development (HCD), that included in our study, are summarised in Table *3.3.1* in terms of the sources, measurements and proxies used.

The descriptive statistics of all the variables are listed in Table 4.1.1. The mean ranking from highest to lowest is from GF, CAP, RE, FDI, PG and HCD. The minimum value for GF is 9.2103, and the maximum value is 22.3230, while the average value is equal to 16.1397 with a standard deviation of 3.114. For EMP, the biggest value is 4.5664, and the lowest value is 2.1865, with the mean, 3.7050 and the standard deviation, 0.5813. For the interactive term, HCD, the values are -0.4591(Mean), 0.1981 (Std dev), -1.030 (Min.) and -0.1404 (Max).

Table 4.1.1: Descriptive Statistics Summary

Notes: EMP refers to employment, GF represents green finance, HCD is human capital development, REN equals to renewable energy, CAP is energy transition, PG refers to population growth, and FDI is foreign direct investment.

Variable	Obs	Mean	Std Dev.	Min	Max
lnEMP	1320	3.7050	0.5813	2.1865	4.5664
lnGF	1320	16.1397	3.1147	9.2103	22.3230
lnHCD	1318	-0.4591	0.1981	-1.0300	-0.1404
lnREN	1320	3.1865	1.2867	-2.3026	4.5747
lnCAP	1300	6.2055	2.8646	-6.9078	13.9606
lnPG	1320	1.3027	0.4035	-2.2911	2.5644
lnFDI	1320	2.1012	0.4483	-1.93	4.6853

Table 4.1.2 shows the correlation between green finance and employment with the interactive term, HCD. Significantly, GF (- 0.1756) has the strongest correlation with employment, and the weakest is PG (0.0115). Among the variables, only HCD and PG are positively correlated with the dependent variable, employment.

Table 4.1.2: Correlation

Notes: This table reports the correlation coefficient between the variables of the research. All variables are defined in Table 1, while the "ln" before variable notations represents that the variables are in natural logarithm form.

Variable	***lnEMP***	***lnGF***	***lnHCD***	***lnREN***	***lnCAP***	***lnPG***	***lnFDI***
lnEMP	1.000						
lnGF	-0.1756	1.000					
lnHCD	0.0578	0.1114	1.000				
lnREN	-0.0744	0.0936	-0.3955	1.000			
lnCAP	-0.1184	0.3506	0.3638	0.0087	1.000		
lnPG	0.0115	0.0035	0.2628	-0.0683	0.1219	1.000	
lnFDI	-0.063	0.0493	-0.1275	0.0629	-0.0728	0.0151	1.000

4.2 Empirical Findings

The results obtained from the employed estimation of equation *1,2,3,4,5,6* using the 2-Step SGMM model are reported clearly in Table 4.2.1, where "$lnEMP_{i,t-1}$", represents the lagged dependent variable (lagged employment rate). Whereby, Models 1 (without HCD) and 2 (with HCD) are the models involving developing countries, one with an interactive term and the other without. For Models 3 (without HCD) and 4 (with HCD), they focus on low-HDI developing countries, one with an interactive term and the other without. For Models 5 (without HCD) and 6 (with HCD), they involved high-HDI developing countries, one with an interactive term and one without it.

Through the table, we can observe that the developing countries, GF play a significant role in improving employment positively, at 0.0002%, at 1% significance level, respectively (Model 1), indicating that if there is a 1% increase in GF, on average, employment will increase by 0.0002% in developing countries, holding other variables constant. While the interaction of GF and HCD will enlarge the effect of GF more significantly towards EMP on average at 0.0022% (Model 2). Besides, in Model 1 and Model 2, all control variables are significantly positive towards employment at 1% significance level, which aligns with the theories, which are Human Capital Theory, Keynesian Theory of Employment, and Dunning's Ownership, Location, and Internalization Paradigm. Besides, these align with other authors' findings that there is a positive relationship between GF and EMP with HCD (Sahoo & Dash, 2024; Tufail et al., 2024). While employment can be improved by green finance, with HCD, as green jobs require high skills (OECD, 2010).

Then, focus on Model 3 and Model 4, which consist of 20 low-HDI developing countries. For Model 3, the results show that GF is negative and statistically significant in affecting employment in low-HDI countries, with a coefficient of -

0.0013. This suggests that the increased utilization and investment in green activities can negatively impact job opportunities. When there is a 1% increase in GF, on average, employment will decrease 0.0013% in low-HDI countries, holding other variables constant. For control variables, there are only energy transition and FDI have significant relationship with employment. Similar evidence is reported in Africa, where green innovation has been found to have negative effect on industrialization due to high initial investment costs, limited infrastructure, and human capital constraints (Nchofoung et al., 2024). Since industrialization is a major pathway for employment generation in developing economies, this finding indirectly supports the result that GF alone, without sufficient supporting capacity, may not lead to employment growth in low-HDI developing countries. Whereas Model 4 incorporates the interaction of HCD with GF. The result shows positive and statistically significant, which means that employment is positively impacted by GF when accompanied by improvements in HCD. When there is 1% increase in GF interact with HCD, on average, employment will increase by 0.1922%, holding other variables constant. This result contrasts with the study of Jawadi et al. (2024). When GF is accompanied by HCD, its effect on employment becomes favorable in low-HDI developing countries. The presence of a skilled and educated workforce allows economies to better absorb and benefit from green investments. Whereas for control variables, FDI shows a positive significant in Models 3 and 4, but energy transition shows a statistically negative effect.

Furthermore, Model 5 and Model 6, which study the 20 high-HDI developing countries, show results that all variables indicate insignificant relationships with employment except the control variable, which is PG. PG shows a positive and significant relationship with EMP. In Models 5 and 6, when there is a 1% increase in PG, on average, EMP will increase 0.0103% and 0.1111% respectively, holding other variables constant. Compared with Models 5 and 6, PG increases in a positive percentage even more after interacting with HCD. The results of these models demonstrated a sharp contrast with theories. In Model 5, results showing insignificant relationships between GF and employment, do not align with several authors (Bowen & Kuralbayeva, 2015; Falcone & Sica, 2019), stating GF has

significant potential in increasing job opportunities. Even after interacting with HCD in Model 6, results remain showing insignificant relationships which are not align with several authors showing positive significant relationships (Tufail et al., 2024; Fu et al., 2024b; Sahoo & Dash, 2024). However, our results may be explained by a few reasons. Studies from high-HDI developing countries, Peru and Brazil, stated that GF may have insignificant effects on service and construction sector employment due to high capital investment projects like wind farms and hydro dams (Pécastaing et al., 2018; Mori-Clement & Bednar-Friedl, 2018), indicating the emphasize of capital intensive compared to labour intensive. However, in China, it shows no obvious change in green industry headcount to increase the lowly-skilled labour (Liu & Wang, 2023). This is probably high-HDI economies have mature growth and smaller multipliers as the output gap is smaller and supply chains are efficient.

Besides, the estimated models are properly defined because they pass all three post estimation specification tests. The Sargan test failed to reject the over-identification restriction of null hypothesis at p-value > 0.05 as it would suggest the validity of the chosen instruments using two-step estimator (Boonyanet et al., 2024), ranging between 0.1 to 0.3 of our results, and hence adequate specification of the model. Similarly, based on the theory, the serial correlation test of the disturbances Arellano and Bond (1991), the AR(1) test result shows a rejection of null hypothesis of the absence of the first order serial correlation and tends not to reject the null hypothesis of second order serial correlation AR(2), indicating model is correctly specified as it validate the use of lagged levels as instruments.

In addition, in our study, we excluded the Two-Step System GMM with Robust Standard Error testing since we have a solid and well-weighted diagnosis checking through AR tests and Sargan test. This is supported by past researchers' studies who used two-step system GMM (Yitayaw, Mogess, et al., 2022; Jiang & Khan, 2022; Farzana et al., 2024). Whereby, instrument proliferation risks are crucial for our study as our study's and additional lags and variants may invalidate the Sargan test.

As the sample size is small with a limited time span (T=15 years) and 20 countries in low and high-HDI developing countries each (N=20), limited number of groups in our estimations we prefer to use two-step system GMM estimation, supported by Berk et al. (2018). Based on Roodman (2009), he stated that overflowing instruments can cause overfitting in variables and weaken the validity of tests, which might occur during testing. Hence, our study addresses this by restricting the number of instruments (number of instruments < number of groups) and using the Sargan test to verify validity and reliable results.

In summary, our study first found that GF positively affects employment in the developing countries. After GF interacts with HCD, the employment impact of GF is amplified positively in these countries. However, if the countries are to be compared between the low and high-HDI categories, there is a sharp contrast in the effects between the two groups of countries. In low-HDI countries, GF exhibits a statistically significant relationship with employment, though its direct effect is negative. When combined with HCD, GF becomes a positive driver of employment. In contrast, the results for high HDI countries reveal an insignificant relationship between GF and employment, and even after interacting with HCD, thus, with only population growth showing a significant positive effect.

Table 4.2.1: Two-Step System GMM Results

*Notes: This table is obtained from Stata results. The value inside the "(.)" is the standard error. ***,**and* represent the significant level at 1%, 5% and 10%, respectively.*

Variable	System GMM	System GMM	System GMM	System GMM	System GMM	System GMM
	Two-step (Model 1)	Two-step (Model 2)	Two-step (Model 3)	Two-step (Model 4)	Two-step (Model 5)	Two-step (Model 6)
$ln\,EMP_{i,t-1}$	0.9440***	0.8865***	0.8648***	0.8649***	0.8267***	0.8257***
	(0.0014)	(0.0028)	(0.0821)	(0.0822)	(0.1059)	(0.1069)
lnGF	0.0002***	0.0011***	-0.0013***	-0.1934***	0.0001	-0.1593
	（0.0000）	(0.0001)	(0.0006)	(0.0499)	（0.0003）	(0.1019)
lnHCD	0.0916***		0.1922***		0.1477	
	（0.0048）		(0.0496)		(0.1039)	
lnGF x lnHCD		0.0022***		0.1922***		0.1593
		(0.0002)		(0.0496)		(0.1019)
lnREN	0.0088***	0.0144***	-0.0116	-0.0116	-0.0018	-0.0015
	（0.0006）	(0.0016)	(0.0159)	(0.0159)	(0.0070)	(0.0069)
lnCAP	0.0041***	0.0010***	-0.0046***	-0.0046***	-0.0018	-0.0021
	（0.0001）	(0.0005)	(0.0012)	(0.0012)	（0.0032）	(0.0033)
lnPG	0.0173***	0.0134***	-0.0045	-0.0045	0.0103**	0.0111**
	（0.0003）	(0.0016)	(0.0061)	(0.0060)	（0.0043）	(0.0044)
lnFDI	0.0087***	0.0145***	0.0069**	0.0071**	0.0032	0.0033
	（0.0005）	(0.0009)	(0.0033)	(0.0033)	（0.0027）	(0.0027)
CONS	0.2110***	0.4737***	0.6645**	0.6643**	0.7564*	0.7655*
	（0.0067）	(0.0123)	(0.3250)	(0.3251)	（0.4550）	(0.4575)
Sargan test	84.41953	84.41951	15.2750	15.2749	14.50756	14.53495
AR(1)	-3.4431***	-3.4431***	-1.7069*	-1.7069*	-2.2697**	-2.2712**
AR(2)	-0.6480	-0.6480	-1.3361	-1.3361	-0.5116	-0.5101

Table 4.2.1: Two-Step System GMM Results (Continued)

Number of Obs	1214	1228	263	263	280	280
Number of groups	87	87	19	19	19	19
Number of instruments	50	50	50	13	13	13

CHAPTER 5:

CONCLUSION AND POLICY IMPLICATION

5.1 Main Findings

Based on this study, we aim to investigate the effects of green finance (GF) brought with human capital development (HCD) towards employment (EMP) in developing countries in terms of overall, high, and low-HDI countries, using the 2-Step System GMM method and panel data over the years, 2008 to 2022. Our study reveals that GF positively affects EMP in developing countries, but differs in low and high-HDI developing countries.

As the world is emphasising a sustainable and green environment, green finance plays a crucial role in it and has been acknowledged by many, including organisations, policymakers, institutions, etc. It is also questionable whether it benefits each country, especially developing ones, in terms of EMP, whereby each differs among HCD, resources and capital availability, labour skill levels, and more. Therefore, researchers and policymakers acknowledged and were attracted to this issue, which is frequently doubted.

Our main results revealed that the impacts brought by GF on EMP are significantly positive in the developing countries, and the positive impacts will be greater with the interaction with HCD. However, when we dive deeper into low and high-HDI countries, we can observe that interactive HCD is significantly important to enlarge the impacts of GF on EMP in low-HDI countries. This implies that HCD plays a crucial role in signifying the effects of GF on employment. Whereby, in high HDI developing countries, GF seems not to be that influential on their EMP, where their HCD level are already mature, well-structured and have limited room to grow. It

plays a limited role in affecting employment and it might lead to undesirable results, which shows no effect even when interacting with HCD.

5.2 Recommendations and Policy Implications

In developing countries, GF shows a positive increase in employment, the percentage of jobs even increases greater when GF interact with HCD, hence, policymakers in these countries may provide more training programs and upskilling initiatives related to the field of IT, engineering and technology to the community to have a better absorption after GF brings in.

Consequently, each policymaker, especially in low-HDI countries, may note that HCD enhancement is crucial in improving employment with the implementation of GF. For example, low-HDI countries' policymakers could consider attracting more green funds to enhance green investments and encourage firms to provide skill training to improve labour quality in renewable energy, like solar power, hydropower, wind power, etc, to increase the impacts of GF towards job opportunities. This initiative can also be achieved by attracting more FDI through incentives or lowering barriers and restrictions, as FDI increases employment even further when interacting with HCD. Thus, only when a project type matches the local conditions, both positive and indirect employment effects may be generated and increase the overall employment in developing countries. As more skills are needed in green industries, workers with lower abilities may face structural unemployment; thus, the government may invest in upgrading the skills of workers in green transformation.

However, high HDI countries are better able to adopt labour-saving innovations with automation, digital monitoring, and AI in energy systems; this implies that, in this group of countries, which the HCD extends, and the level of green finance is relatively mature enough, it will cause no effect on employment as these

investments improve productivity but require relatively few workers. Hence, policymakers' attention is instead suggested to be on population growth, as in model 5, only PG has a positive effect on employment when GF is implemented. According to past studies, researchers stated that PG does help in expanding employment (Baht et al., 2022; Haider et al., 2023). For example, policymakers can give incentives to their people through financial aid or subsidies in medical services, especially for pregnant families, to encourage them to increase the birth rate and allow additional special leave for parents, ensuring time flexibility, in order to increase employment in these countries.

5.3 Limitations and Future Studies

Despite the study's appealing methodology and findings, there are some recommendations for future researchers. Firstly, future studies could incorporate institutional quality as an interaction term with green finance to examine its effect in shaping employment outcomes. While our study focuses on human capital development as an interactive term, institutional quality may influence how green finance translates into employment opportunities. There is empirical evidence that shows that institutional quality has a significant relationship with employment, and it plays an important role in shaping employment dynamics (Savoia et al., 2023). Because it represents how governance and regulatory strength could impact the success of green finance in producing jobs, it is interesting to include institutional quality as an interaction term. This approach would allow a better understanding of the conditions under which green finance contributes most effectively to sustainable job creation, and could get beyond the limitation of our study, which only considers human capital development.

Second, we suggest that future research on the relationship between GF and employment may go beyond linear relationships and consider studying potential nonlinear effects, such as threshold effects, U-shaped effects, or inverted U-curve relationships. As our study is looking at the area of linear estimation, it may not

fully capture the complexity of how green finance impacts employment. Exploring nonlinear relationships could overcome the limitation by providing deeper insights into identifying whether there is an optimal level of green finance that maximizes employment creation, or conversely, whether excessive green finance without sufficient absorptive capacity may hinder job growth.

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Appendices

Appendix 1

Low and High HDI Countries based on HDI 2022

Low HDI Countries	HDI (2022)	High HDI Countries	HDI (2022)
Afghanistan	0.495	Algeria	0.761
Benin	0.512	Armenia	0.799
Burkina Faso	0.457	Bosnia and Herzegovina	0.799
Burundi	0.437	Brazil	0.780
Djibouti	0.510	China	0.796
Guinea	0.498	Colombia	0.782
Guinea-Bissau	0.511	Dominican Republic	0.778
Lesotho	0.547	Ecuador	0.773
Liberia	0.508	Egypt	0.751
Madagascar	0.483	Indonesia	0.726
Malawi	0.513	Jordan	0.751
Mali	0.417	Mexico	0.783
Mauritania	0.548	Mongolia	0.742
Mozambique	0.490	North Macedonia	0.796
Nigeria	0.545	Peru	0.790
Pakistan	0.544	Philippines	0.714
Rwanda	0.546	South Africa	0.737
Senegal	0.526	Sri Lanka	0.777
Tanzania	0.544	Tunisia	0.745
Yemen	0.466	Vietnam	0.764

Appendix 2

List of Countries Selected in Our Study

Afghanistan	Benin	Burkina Faso	Low HDI Developing Countries
Burundi	Djibouti	Guinea	
Guinea-Bissau	Lesotho	Liberia	
Madagascar	Malawi	Mali	
Mauritania	Mozambique	Nigeria	
Pakistan	Rwanda	Senegal	
Tanzania	Yemen		
Angola	Argentina	Azerbaijan	
Bangladesh	Belarus	Bhutan	
Bolivia	Cambodia	Cameroon	
Cabo Verde	Chile	Costa Rica	
Congo, Democratic Republic	El Salvador	Ethiopia	
Fiji	Gabon	Georgia	
Guatemala	Haiti	Honduras	
India	Jamaica	Kazakhstan	
Kenya	Kyrgyzstan	Laos	
Lebanon	Malaysia	Maldives	
Montenegro	Morocco	Namibia	
Nepal	Nicaragua	Panama	
Serbia	Solomon Islands	Sudan	
Tajikistan	Thailand	Tuvalu	
Turkey	Uganda	Ukraine	
Uzbekistan	Vanuatu	Zambia	
Algeria	Armenia	Bosnia and Herzegovina	High HDI Developing Countries
Brazil	China	Colombia	
Dominican Republic	Ecuador	Egypt	
Indonesia	Jordan	Mexico	
Mongolia	North Macedonia	Peru	
Philippines	South Africa	Sri Lanka	
Tunisia	Vietnam		

Appendix 3:

Explanation of Difference GMM

3.7.2.1 Arellano-Bond (1991) Difference GMM

Arellano and Bond (1991) introduced difference GMM (DGMM) to consistently estimate models with both unobserved individual effects and a lagged dependent variable. DGMM works in two steps. Firstly, it eliminates fixed effects by first differencing the model, so that any time-invariant country heterogeneity drops out. Secondly, it helps to instrument the differenced lagged dependent variable or any other endogenous regressors with deeper lags of their own levels, on the logic that those past levels are uncorrelated with the new differenced errors. However, based on Arellano and Bover (1995), this lead to incorrect inferences if the explanatory variables are persistent and the lagged levels of the variables become weak instruments. Instrument proliferation also occur where the number of moment conditions increases as the number of strictly exogenous variables and the number of time series observations increases.