CHAPTER II
LITERATURE REVIEW, RESEARCH FRAMEWORK, AND HYPOTHESES

2.1 Theoretical Framework

Theoretical frameworks provide a comprehensive perspective on a research problem by explaining the underlying assumptions, concepts, and relationships that guide the study. This study, the study analyses the relationships between financial literacy, financial inclusion, climate change, economic growth, FinTech adoption, and financial stability in SSA countries. To achieve this objective, a combination of grand theories, middle-range theories, and applied theories were used. The grand theory is the development finance theory. This theory provides a broad understanding of the political, social, and economic factors that shape the development of sub-Saharan African countries and helps explain the macro-level dynamics that affect financial stability. For the middle-range theories, we will use general system theory, financial inclusion theory, and social learning theory. These theories can help us understand the micro-level dynamics that shape the behaviour of individuals and organizations in the financial sector. The study also uses the FinTech adoption theory, climate change adaptation theory and innovation diffusion theory as applied theories. These theories provide a comprehensive framework for analyzing the complex relationships between financial literacy, financial inclusion, climate change, economic growth, FinTech adoption, financial development, regulatory requirements, and financial stability in SSA countries.

2.1.1 Grand theory

Grand theories provide a broad understanding of the underlying social, economic, and political factors that shape the development of societies. In this study, we will employ development finance theory.

2.1.1.1 Development Finance Theory

Development finance theory has been a subject of interest for scholars and researchers aiming to understand the role of money in economic development, especially in low- and middle-income countries. Rather than a singular, widely accepted theory, development finance theory encompasses a range of concepts and viewpoints from various sources. Since the 1970s, scholars like Arthur Lewis and W. Arthur Lewis have been key proponents of this idea, highlighting the importance of mobilizing savings and investments to facilitate capital accumulation and growth(Lewis, 1984). Structuralist and dependency theorists, including Raul Prebisch, underscored the detrimental effects of exploitative commercial relationships and unequal exchange on development during the period spanning the 1960s to the 1980s (Prebisch, 1961). They provided backing for governmental initiatives and actions aimed at reducing dependence on external entities. In contrast, market-oriented philosophers, including Douglass North and Ronald McKinnon, have emphasised the significance of financial liberalisation, efficient markets, and robust institutions for economic development since the 1980s(McKinnon, 2010).

The stated research objectives are consistent with the foundational principles of development finance theory. Objective 1 underscores the criticality of financial inclusion in fostering economic expansion. Particularly in Sub-Saharan Africa, where a significant number of individuals lack access to conventional financial services, this study investigates the potential of FinTech to enhance financial inclusion. Objectives 2, 3, and 4 examine the complex interrelationship between financial inclusion, climate change, and financial stability, emphasising the criticality of integrating environmental considerations into financial institutions to guarantee their long-term viability.

The fifth objective of this study is to examine the impact of regulatory quality and financial development on the relationship between financial stability and economic growth. This aligns with the theoretical emphasis on the necessity of establishing a financially stable and efficient system to support long-term economic progress. Although it offers practical frameworks for understanding financial systems and their influence on development, development finance theory has its own set of constraints. The concept might oversimplify intricate subjects and disregard crucial elements such as social structures and political institutions. Certain theoretical concepts might lack robust empirical support and necessitate additional inquiry to validate their applicability to specific contexts.

Numerous studies have examined the impact of various aspects of financial systems on development using development finance theory.

The correlation between financial development and economic growth in multiple countries was the subject of an empirical investigation by Beck, Demirgüç-Kunt, et al. (2003). Building on concepts from development finance theory, Honohan (2007) underscores the importance of financial inclusion in the context of poverty reduction and economic empowerment. Beck (2020) and Demirguc-Kunt et al. (2022) have examined the impact of financial inclusion initiatives on poverty reduction and economic growth in emergent nations using development finance theory. The research underscores the criticality of expanding financial service accessibility, strengthening regulatory structures, and promoting inclusive finance policies to foster sustainable development outcomes. Bekele (2024) examine the potential of financial inclusion to enhance climate change adaptation and resilience in developing countries. The research demonstrates the potential efficacy of development finance theory in addressing substantial challenges faced by economies in Sub-Saharan Africa and other comparable areas.

The development finance theory provides a comprehensive structure for understanding the intricate workings of financial systems and how they influence the expansion of the economy(Levine, 1997). One of its notable attributes is its ability to offer a holistic perspective that considers various factors influencing financial outcomes, including institutional structures, policy measures, and socioeconomic conditions. By examining the interplay between money, economic growth, and development outcomes, the theory offers valuable perspectives on strategies to promote sustainable and equitable development.

Furthermore, development finance theory is subject to specific limitations. A notable limitation of this approach is its tendency to disregard the heterogeneity of financial systems and the numerous socio-economic contexts in which they operate. The theory's potential failure to sufficiently account for the unique challenges and opportunities faced by different regions or countries could lead to errors or oversimplifications when implemented(Gomes & Gubareva, 2021; Mercure et al., 2016). Some critics argue that development finance theory might oversimplify complex issues and fail to consider the impact of non-financial factors such as cultural practices, political institutions, and social norms on development outcomes(Marszałek & Szarzec, 2023).

Despite its limitations, the theory of development finance has been widely applied in policymaking and research to address a variety of development issues (Zeitz, 2021). Its importance extends beyond scholarly circles, influencing tangible endeavours to promote worldwide financial inclusion, stability, and sustainable development. Theoretically, the relationships between finance, economic expansion, and development are explicable through the lens of this theory. It guides the formulation of policies, programmes, and interventions that effectively advance the goals of sustainable and inclusive development.

Particularly in low and middle-income countries, such as those in Sub-Saharan Africa, development finance theory offers valuable insights into how financing could facilitate economic growth. By scrutinising the interconnections among financial inclusion, FinTech adoption, climate change, financial stability, and economic growth, this theory provides an all-encompassing structure for comprehending the intricate workings of financial systems and the resulting impacts on development outcomes. The theory's concepts and insights remain highly pertinent and applicable to contemporary development concerns, notwithstanding its inherent limitations. They exert a significant impact on research, policy formulation, and practical endeavours that aim to advance sustainable and equitable development on a global scale.

2.1.2 Middle Range Theory

Middle-range theories help to identify and explain the specific mechanisms and processes that link financial literacy, financial inclusion, climate change, economic growth, and financial stability in sub-Saharan African countries. By focusing on specific aspects of these constructs, middle-range theories can help to identify the key drivers and outcomes of these relationships and guide future research and policy interventions.

2.1.2.1General system theory

Ludwig von Bertalanffy developed General Systems Theory (GST) in the 1950s as a fundamental foundation for understanding complex systems across many disciplines (von Bertalanffy, 1972). This viewpoint sees systems as interconnected entities with emergent properties, focusing on the relationships between components and the system as a whole. While lacking a broadly agreed theory, General Systems Theory provides a strong framework for analysing events by studying interdependencies and interactions within systems(Mele et al., 2010). The intricate interplay between financial inclusion, FinTech adoption, climate change, financial stability, and economic growth in Sub-Saharan Africa makes the consideration of GST very relevant for the proposed study.

The GST emphasises understanding systems as unified entities rather than separate elements (Pokharna & Bobra, 2016). This aligns with the research's goal of examining the complex connections between many factors, recognising their mutual reliance within the broader financial environment. When examining how FinTech adoption might affect the relationship between financial literacy and financial inclusion, it is crucial to consider the overall financial landscape and how it interacts with social, technological, and regulatory factors.

The major strength of General Systems Theory (GST) is its capacity to capture emergent features that result from interactions among separate components at the systemic level(Rousseau, 2018). This concept highlights the need to recognise the possibility of synergistic effects and unexpected consequences while studying the connection between climate change, FinTech adoption, financial inclusion, and FinTech adoption within the study's scope. By identifying the emerging traits of the financial system, the research may improve its capacity to anticipate and address prospective challenges and opportunities in achieving sustainable development outcomes.

Furthermore, the incorporation of open systems emphasised by the GST highlights the interconnectedness between regional financial institutions and global economic and environmental processes (Bashan & Kordova, 2021). This is particularly important for the Sub-Saharan Africa area because of its vulnerability to environmental pressures and foreign disruptions. The study may better assess the adaptation and resilience of regional financial systems to climate change and economic volatility by considering the socio-economic environment of the area and external influences.

Additionally, the GST highlights emergent qualities, which are traits shown by the total system that cannot be predicted by its components (Turner & Baker, 2019). This concept acknowledges the potential for unforeseen consequences and synergistic effects when examining the interplay of several aspects including financial technology, global warming, and financial stability within the scope of this study. This study aims to improve its understanding of the complex processes that impact financial inclusion and sustainability in the Sub-Saharan African area by identifying emergent phenomena at the systemic level.

GST recognises systems as dynamic and open entities that may interact with their environment (Van Assche et al., 2019). This aligns with the research's focus on Sub-Saharan Africa, which has unique challenges and opportunities related to economic development, climate change, and financial access. The study may analyse the interconnectedness between regional financial systems and global economic and environmental dynamics more precisely by considering the socio-economic context of the area and external elements that may influence it.

While GST has some benefits for studying complex systems, it also has several limitations. This technique lacks prescriptive advice and clarity since it just provides a framework for study without offering tested hypotheses or real answers (Van Assche et al., 2019). Furthermore, striving for a thorough understanding might sometimes hinder the capacity to identify and measure the exact effects of certain components in complex systems. Despite its shortcomings, the numerous applications and emphasis on interdependence make GST a great tool for analysing complex processes.

Several research across many disciplines, including public policy, ecology, and management, have used GST. The General System theory has been implemented to analyse the interconnectedness of financial institutions, markets, and laws in the financial systems(Aprile et al., 2023). It has been used to study the impact of financial inclusion on reducing poverty and promoting economic growth, as well as the ability of financial innovation to address social and environmental challenges. Allen et al. (2005) performed research using the GST to investigate the complex relationship among financial inclusion, poverty, and economic progress in emerging countries. Advocates support several measures aimed at addressing broader social and economic disparities, highlighting the need of understanding systemic factors that lead to financial exclusion.

The suggested study examines interactions, making General Systems Theory a valuable framework for understanding. This research aims to gain deeper insights into how the implementation of FinTech, economic growth, and financial stability in SSA can promote financial inclusion and address challenges related to climate change by considering various interconnected factors. Despite some limitations in specificity and testability, GST is a valuable framework for analysing complex systems in financial development and sustainability due to its ability to promote comprehensive understanding and exploration of emergent properties.

2.1.2.2. Financial inclusion theory

The theory of financial inclusion is a detailed paradigm that scrutinises the tenuous correlation between the availability of financial services and the welfare of both individuals and society at large. While lacking a unified theory, it comprises numerous perspectives developed by influential philosophers over an extended period of time. During the 1970s, McKinnon and Shaw emphasised the critical significance of financial access as a catalyst for investment, savings stimulation, and economic growth(Pagano, 1993). Financial exclusion, according to their argument, impedes progress and perpetuates destitution. Developing economists such as Beck et al. (2010) and Levine (2005) provided empirical evidence in the 1990s that established a correlation between financial inclusion and the alleviation of poverty, improvement of livelihoods, and expansion of economic opportunities. For both individuals and businesses, their research highlighted the significance of formal financial services like credit, deposits, and insurance.

Scholars who emphasised social and financial inclusion, including Birkenmaier et al. (2019), expanded the definition of financial inclusion beyond access to financial services in the 2000s and beyond. The authors emphasised the importance of consumer protection measures, financial competency, and responsible financial products in advancing truly inclusive financial systems. This broader perspective acknowledges that inclusion should encompass not only access but also ensure that individuals are equipped with the necessary knowledge and assets to effectively manage their finances and achieve their financial goals.

The direct correlation between the financial inclusion theory and the research objectives of the proposed study establishes its obvious significance. Objective 1, which investigates the impact of FinTech adoption on the relationship between financial literacy and financial inclusion, is consistent with the access and capacity emphasis of the theory. Enhancing users' financial literacy and comprehension of these emerging technologies is crucial for the success of FinTech, which aims to expand access to financial services. Objectives 2 and 4 examine the interrelationships among climate change, FinTech adoption, and financial stability, highlighting the theory's emphasis on the broader ramifications of financial inclusion. The availability of appropriate financial products and a stable financial system may empower communities and individuals to adapt to climate-related disruptions and increase their resilience.

Aligned with the theory's recognition of the broader ecosystem's influence on financial inclusion, Objective 5 investigates how regulatory quality and financial development moderate the relationship between financial stability and economic growth. A sophisticated and effectively administered financial system has the potential to foster ethical financial inclusion practices and contribute to sustainable economic growth. Alongside its merits, financial inclusion theory also possesses certain limitations. The document's content might be deficient in specifics regarding the financial services that are optimal for particular circumstances and individuals. The assessment of the impact of financial inclusion on economic development and poverty reduction is challenging due to the presence of numerous confounding variables.

Several studies have employed financial inclusion theory to investigate various aspects of financial systems and the resulting impacts on individuals and communities. Highlighting the significance of financial inclusion in stimulating economic activity, Beck, Demirguc-Kunt, et al. (2003) conducted an empirical investigation into the relationship between financial development and economic growth. In support of economic growth, their research demonstrated that a sophisticated financial system characterised by broad financial inclusion is conducive to progress. They demonstrated that increased availability of financial services, including banking and credit, correlates with higher levels of investment, entrepreneurship, and total economic activity by analysing data from multiple countries.

Honohan (2008) emphasised the criticality of financial inclusion in fostering economic empowerment and alleviating poverty, drawing upon the foundations of financial inclusion theory. Honohan illustrated the potential for empowering marginalised communities, particularly those living in poverty, through the provision of financial services and increased accessibility to empirical data and case studies. Financial inclusion may assist individuals in escaping cycles of poverty, amassing assets, and improving their economic well-being as a whole by providing avenues for saving, borrowing, and investing.

Kuada (2019) examined the potential contribution of financial inclusion to the attainment of multiple Sustainable Development Goals (SDGs), including but not limited to climate action, poverty alleviation, and gender parity. The study placed particular emphasis on how financial inclusion can have a substantial impact on sustainable development through its facilitation of access to financial services, support for small enterprises, and empowerment of women. Buchenau et al. propose that by integrating financial inclusion into broader development policies, governments could utilise finance to achieve a multitude of Sustainable Development Goals (SDGs). This strategy can facilitate sustainable and inclusive development on a global scale. Moreover, numerous other scholars have employed financial inclusion theory to examine the ramifications of diverse facets of financial systems on social welfare.

In their comprehensive field study, Morduch and Rutherford (2003) investigated the effects of microfinance organisations on the financial inclusion of low-income families. The study presented novel findings regarding the potential of microfinance initiatives to foster community and individual empowerment, thereby illustrating the profound influence that inclusive financial services can have. In their study, Johnson and Rogaly (1997) examined the socioeconomic ramifications of informal money practices within marginalised regions of developing countries. They investigated the intricate workings of informal financial networks and how they assist those who are not members of official financial systems in gaining access to savings and loan opportunities through qualitative research. The research underscored the importance of recognising and leveraging existing informal systems to promote social cohesion and financial inclusion.

Comparing the institutional and legal frameworks that either facilitate or hinder access to financial services, Allen et al. (2014) conducted a comparative analysis of financial inclusion policies and initiatives in multiple nations. They identified effective strategies and recommendations for promoting financial inclusion, emphasising the importance of government, financial institutions, and civil society organisation collaboration. The study placed great importance on the importance of inclusive policies in creating an environment that facilitates the success of financial inclusion initiatives and enables marginalised communities to participate. The concept of financial inclusion has been instrumental in informing policy and research endeavours aimed at promoting sustainable and equitable financial systems worldwide. Empirical analysis, case studies, and policy evaluations have collectively demonstrated that financial inclusion possesses the capacity to empower individuals, mitigate poverty, and foster broader development goals. Policymakers have the potential to foster a more equitable and prosperous future for all by integrating financial inclusion into all-encompassing development initiatives and policies.

2.1.2.3 Social learning theory

Institutionalised in the 1960s, Albert Bandura's social learning theory posits that learning transcends individual experiences and occurs through observation, imitation, and modelling of the attitudes, behaviours, and emotions of others(Bandura, 2001). The aforementioned theory furnishes an invaluable conceptual structure for understanding the proposed research, which investigates the influence of multiple variables on climate change awareness and financial inclusion in Sub-Saharan Africa. The fundamental concept of observational learning aligns perfectly with the objective of the study, which is to investigate the influence of community leaders and social networks on financial literacy, FinTech adoption, and climate change awareness of citizens(Soutter et al., 2019). The act of observing individuals adeptly navigate financial systems or embrace environmentally sustainable practices may serve as a source of inspiration for those who observe. Consider a hypothetical society in which individuals are motivated to explore FinTech independently by the success of their peers who utilise mobile banking. The endorsement of sustainable practices, such as rainwater collection, by community leaders has the potential to inspire and encourage others to adopt comparable actions, thereby fostering a collective endeavour to increase environmental consciousness.

This study investigates the potential of social incentives, monetary rewards, and community recognition to encourage climate-conscious behaviours and financial inclusion through the application of modelling principles. Per to social learning theory, highlighting the positive outcomes of particular activities may encourage dissemination through social interactions(Salomon & Perkins, 1998). Suggest a financial literacy initiative that provides participants with incentives to complete courses, thereby enhancing their comprehension and serving as a model for others to follow. Communities that publicly recognise individuals who embrace sustainable practices may generate a cascading effect, motivating others to adopt the same practices.

This study is aligned with social learning theory when self-efficacy is considered (Bandura, 1986). This concept underscores the significant relationship between an individual's confidence in their ability to execute a particular behaviour and their propensity to engage in it. The objective of this study is to investigate the influence of social interactions and community support on the financial confidence and adoption of sustainable behaviours of individuals. Observing individuals adeptly administer financial systems or embrace environmentally sustainable practices may bolster individuals' self-efficacy and inspire a greater sense of empowerment to engage in analogous conduct. Envision an initiative for peer-to-peer financial literacy in which participants encourage and support one another, fostering a collective sense of confidence in effectively overseeing their financial resources.

In multiple ways, social learning theory offers valuable insights that apply to the proposed study. The text examines how knowledge of finance, acceptability of financial technology (FinTech), and awareness of climate change increase through community observation and social interactions(Allen et al., 2021). This data could potentially inform the formulation of approaches that leverage social networks and influential members of the community to promote environmentally and financially responsible behaviours. The concept facilitates the development of effective behaviour modification strategies through an understanding of the factors that influence individuals' propensity to imitate and adopt novel behaviours. This may encompass the incorporation of elements such as social modelling, positive reinforcement, and peer support and mentoring to bolster self-efficacy. In the diverse cultural milieu of Sub-Saharan Africa, social learning theory acknowledges the significance of cultural influences and social norms in shaping the conduct of individuals. By considering these factors, it is possible to tailor interventions in a manner that is culturally sensitive and effective in promoting behaviour modification among local communities.

Although social learning theory possesses a robust framework, it is not without its limitations. Its detractors argue that it inadequately accounts for the influence of cognitive variables and human agency on behaviour. Furthermore, it failed to fully comprehend the complexities of power structures and social dynamics within communities, factors that could potentially influence the adoption of novel practices (Cornish, 2017; Rosenthal & Zimmerman, 2014). Despite their limitations, several studies have utilised social learning theory to comprehend and promote various behaviours. Scholarly investigations have indicated that financial education initiatives delivered through social networks or peer learning may exhibit greater efficacy than traditional classroom-based approaches(Kaiser & Menkhoff, 2022). By utilising community leaders and role models, social marketing initiatives have effectively promoted sustainable behaviours such as energy conservation and waste reduction.

The application of social learning theory to the examination of climate change awareness, financial inclusion, and FinTech adoption in Sub-Saharan Africa is highly beneficial(Siano et al., 2020). By analysing the influence of social norms, self-efficacy, observation, and modelling, the research may yield more profound insights into how individuals acquire and assimilate new behaviours in their social environments. This understanding could potentially facilitate the development of effective interventions that promote environmentally and financially responsible behaviours, ultimately resulting in a more sustainable and equitable future for the region.

2.1.3 Applied Theory

Applied theories refer to those used to guide practical applications or interventions in real-world contexts. In this study, two applied theories were used to guide the analysis of the relationship between FinTech adoption, financial literacy, financial inclusion, climate change, economic growth, and financial stability in SSA countries. FinTech adoption theory, climate change adaptation theory and innovation diffusion theory will be employed as applied theories in the current study.

2.1.3.1 FinTech adoption theory

While FinTech adoption theory encompasses multiple perspectives that analyse the factors influencing the decisions of individuals and organisations to adopt financial innovations, it remains an interdisciplinary and non-coherent framework. The incorporation of this diverse framework is critical for the proposed research, which examines the potential impact of FinTech implementation on financial inclusion in sub-Saharan Africa. Several fundamental concepts endorse FinTech adoption theory, each of which provides valuable insights for scholarly investigation. Developed in 1989 by Davis et al., the Technology Acceptance Model (TAM) emphasises the importance of perceived utility and perceived simplicity of use(Davis, 1989). This study aims to examine the discrepancies in perspectives among various socioeconomic groups and populations in Sub-Saharan Africa. By highlighting the benefits of FinTech to diverse user demographics and addressing specific usability concerns, these data may ultimately contribute to the promotion of wider adoption.

To highlight elements including relative benefit, compatibility, complexity, trialability, and observability, Rogers (2003) developed Innovation Diffusion Theory (IDT)(Sahin, 2006). The objective of this study is to investigate the influence of these factors on the level of FinTech adoption within the diverse cultural contexts of Sub-Saharan Africa. This understanding could facilitate the development of approaches to enhance trialability through targeted awareness campaigns, reduce perceived complexity through user education, and improve compatibility with current practices. Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT), which builds upon the TAM and IDT by incorporating performance expectation, effort expectancy, social influence, and enabling circumstances. The initiative examines the effects of infrastructure and support system accessibility, cultural values, and social norms on the adoption of financial technology in SSA. Understanding these variables can facilitate the customisation of interventions that leverage social influence, address infrastructural limitations, and offer crucial support to foster greater acceptance.

In multiple respects, FinTech adoption theory offers valuable insights that inform the proposed research. Initially, it aids in identifying the primary determinants that either promote or hinder the adoption of FinTech solutions by individuals and organisations(Roh et al., 2023). These data could potentially inform the development of targeted initiatives that eliminate specific barriers and leverage facilitators to promote FinTech's wider adoption, thus contributing to the improvement of financial inclusion. This concept emphasises the importance of designing with the user in mind. By analysing user perceptions, needs, and preferences to ensure cultural sensitivity, usability, and effective resolution of challenges, this research intends to inform the development of FinTech solutions in sub-Saharan Africa. The adoption of a user-centred approach facilitates the promotion of the effective adoption of FinTech products and increases trust and engagement.

The application of FinTech adoption theory could perhaps aid in the formulation of regulatory and policy frameworks. Policymakers and regulators can establish legislation and regulatory frameworks that foster responsible FinTech innovation, facilitate adoption, and mitigate risks by understanding the factors that influence adoption(Feyen et al., 2023). This will ensure that advancements in Financial Technology (FinTech) positively influence both economic growth and financial inclusion in the sub-Saharan African region.
The adoption hypothesis of FinTech has numerous advantages. The analysis is comprehensive, incorporating multiple perspectives to offer a holistic understanding of adoption behaviour. Significant empirical research supports the notion that this applies to a variety of contexts, including sub-Saharan Africa.

In addition, it offers pragmatic concepts for developing interventions, implementing solutions with the user in mind, and shaping policy decisions. However, this theory has some limitations. This could potentially be context-dependent, disregarding the nuances that contribute to diverse cultural backgrounds and evolving technological landscapes. Furthermore, the theory may overemphasise specific components while neglecting broader cultural and institutional factors that influence adoption such as financial literacy levels, infrastructure, and legislation. The concept focuses primarily on adoption decisions, ignoring the long-lasting effects of FinTech usage on individuals, organisations, and society.

Several studies have utilised FinTech adoption theory to effectively comprehend and improve financial inclusion in a variety of contexts. Akhtar et al. (2019) investigated the adoption of mobile banking in China through the use of UTAUT, with an emphasis on the importance of perceived simplicity of use, performance expectation, and social impact. Sarmah et al. (2021) examined the adoption of mobile wallets in India using the Technology Adoption Model (TAM). The research emphasised the significance of perceived usability and ease of implementation when it comes to allaying concerns regarding security. The research findings demonstrate the flexibility of FinTech adoption theory and its potential utility in formulating approaches to promote financial inclusion in sub-Saharan Africa through the ethical adoption of FinTech. By applying Fintech adoption theory to the proposed research, it is possible to gain a deeper understanding of the variables that influence Fintech adoption in sub-Saharan Africa. Furthermore, it endeavours to develop efficacious approaches that promote financial inclusion by employing responsible and inclusive advancements in FinTech.

2.1.3.2 Climate Change Adaptation Theory

The climate change adaptation theory is a relatively new field of study that has emerged in response to the growing need to address the impacts of climate change. The theory is centred around the idea that societies and ecosystems must adapt to the changes brought about by global warming and climate change to mitigate the potential negative consequences (Wittneben et al., 2012). Climate Change

Adaptation Theory proposes that climate change is an inevitable and permanent phenomenon that requires societies and ecosystems to adapt to minimize its negative impacts. The theory recognizes that global warming and climate change are not only environmental issues but also social, economic, and political issues that require collective action at all levels of society. Therefore, adaptation to climate change requires the integration of scientific knowledge, technology, policies, and institutions to enable effective planning, decision-making, and action (Brulle & Dunlap, 2015; Kelly & Adger, 2000).

The theory of climate change adaptation has been discussed since the early 1980s, and several scholars have contributed to the development of the theory over the years. For instance, in 1999, Adger and Kelly (1999) proposed the concept of social vulnerability to climate change, which emphasizes the importance of understanding the social and institutional factors that shape vulnerability to climate change. Similarly, Yohe et al. (2004) argued that adaptation to climate change requires a shift from reactive to proactive responses, which involves integrating climate change risks into planning and decision-making processes. The core principles of climate change adaptation theory revolve around the recognition of the need for resilience and the ability to adapt in the face of changing climatic conditions (Berrang-Ford et al., 2011). The theory posits that adaptation measures must be integrated into all aspects of society, including economic, social, and environmental systems (Smit & Wandel, 2006). It also recognizes the importance of local and indigenous knowledge in the development of adaptation strategies (Adger et al., 2003).

Previous studies have utilized climate change adaptation theory to analyze a wide range of phenomena, including the impacts of climate change on agriculture, water resources, and human health. For example, a study by Seo and Mendelsohn (2008) used the theory to analyze the potential impact of climate change on agriculture in the United States. Other studies have applied climate change adaptation theory to examine the effects of global warming on water resources. For instance, Farzaneh et al. (2021) used the theory to explore the potential impacts of climate change on water resources in a semi-arid region in Iran. Another study by Uddin et al. (2020) applied the theory to analyze the adaptation strategies used by communities in the face of water scarcity caused by climate change in Bangladesh. Additionally, climate change adaptation theory has been used to analyze the impact of climate change on human health. For example, a study by Turner et al. (2017) used the theory to assess the health risks associated with climate change in the United States.

In the current study, climate change adaptation theory is relevant to the research question of how FinTech adoption can mediate the relationship between financial literacy, financial inclusion, climate change, economic growth, and financial stability in sub-Saharan African countries. The theory is used to understand the potential impact of climate change on the economic and social systems of the region and to develop adaptation strategies that are integrated into the FinTech adoption process.

Climate change adaptation theory is closely related to other theories used in the current study, such as innovation diffusion theory. The two theories can be used together to analyse the potential barriers to the diffusion of FinTech innovations in the region that are related to climate change adaptation, such as infrastructure constraints and access to finance. For example, infrastructure constraints may limit the ability of FinTech companies to provide services in certain areas, while lack of access to finance may limit the ability of individuals and businesses to adopt and utilize FinTech innovations to adapt to the impacts of climate change. The integration of climate change adaptation theory and innovation diffusion theory has been applied in various previous studies. For instance, a study by Cerveny et al. (2016) applied both theories to analyse the potential for sustainable water use in the context of climate change adaptation in urban areas. The study found that the diffusion of sustainable water use practices was influenced by factors such as perceived benefits and costs, social norms, and the availability of information and resources.

Climate change adaptation theory provides a valuable framework for understanding the potential impacts of climate change on economic and social systems, and for developing adaptation strategies that are integrated into the FinTech adoption process. The theory is relevant to the current study as it is used to understand the potential impacts of climate change on the economic and social systems of sub-Saharan African countries and to develop adaptation strategies that are integrated into the FinTech adoption process.

2.1.3.3 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB), developed by Icek Ajzen in 1991, is widely recognised as a key paradigm for understanding and predicting human behaviours and intentions(Ajzen, 1991). Intentionality is considered the primary factor in understanding human behaviour. Three crucial aspects impact these intentions:

An individual's "attitude" refers to their feelings towards certain conduct, which may be either good or negative(Ajzen, 2014; Feather, 2021). The proposed study on climate action and financial inclusion in SSA strongly depends on the viewpoints of the participants about these concepts. Individuals with a positive outlook on the future of currency and the environment are more inclined to use financial technology solutions and contribute to mitigating climate change. To influence people's opinions, one might initiate an educational campaign emphasising the benefits of sustainable living and financial inclusion.

Subjective Norm refers to the level of societal influence that a person perceives while deciding how to behave(Al-Swidi et al., 2014). Social norms, the behaviour of influential figures in society, and the influence of friends and family all impact individuals' spending patterns and their environmental consciousness. Individuals are more likely to adopt sustainable habits or appropriate money management when they perceive significant public pressure to do so. Community engagement projects may help shift cultural norms around money and the environment by promoting honest discourse, showcasing good role models who practice sustainable living and smart financial management, and mobilising the community to support these causes.

Perceived behavioural control refers to an individual's confidence in their ability to do a certain activity(Ajzen, 2002). This study may include factors such as knowledge of FinTech technology, financial resources, and the perceived ease of adopting sustainable practices. Individuals are more likely to engage in climate-friendly actions or practise effective financial management when they believe they possess the necessary information and resources. Interventions such as financial literacy training increased accessibility to FinTech solutions, and guidance on everyday sustainability practices may enhance individuals' views of their behavioural control. The TPB offers valuable information for the next research in several ways. The TPB can shed light on the factors influencing people's decisions to act on climate change and financial inclusion by studying the aspects that affect their intentions(Faisal et al., 2020).

By understanding the factors that impact attitudes, social norms, and perceived behavioural control, more efficient interventions can be developed to assist individuals in changing their behaviour positively. The TPB provides a framework for identifying the specific psychological factors that influence behaviour while designing treatments. Interventions might include awareness programmes aimed at promoting sustainable practices and improving financial literacy. Address cultural norms by initiating community engagement activities that promote frugal spending and environmentally conscious behaviours. Empower individuals by providing them with information and resources such as financial literacy training, access to FinTech solutions, and guides on sustainable living(Danladi et al., 2023). The Theory of Planned Behaviour emphasises the importance of subjective standards and highlights the need to consider social elements and cultural contexts in treatment development. By ensuring that projects are respectful of local customs and values in Sub-Saharan Africa, we can enhance participation and effectiveness.

The TPB is well-supported by empirical evidence and is known for its simplicity. This well-established theory has shown high predictability in understanding and interpreting human conduct via comprehensive testing across many demographics and activities. Due to its extensive research, scholars and professionals may rely on the theory's precision and practicality. Besides, TPB offers practical insights for creating interventions. The theory provides a detailed framework for examining the factors that influence individuals' intentions to engage in certain activities by pinpointing the primary drivers of behaviour, which include attitudes, subjective norms, and perceived behavioural control(Wu & Chiang, 2023). The flexibility of the TPB enhances its use across many contexts and activities. Researchers may customise their studies and therapies by modifying and implementing the theory to various scenarios and demographics.

The research focuses on climate action and financial inclusion in Sub-Saharan Africa, showcasing the Theory of Planned Behaviour as a versatile framework capable of addressing the complexities of these issues and directing personalised strategies for behaviour modification.

It is crucial to remember that the TPB has both advantages and constraints. The primary limitation is its restricted focus on superficial psychological processes. Attitudes, social norms, and a feeling of control are recognised as direct influences on conduct in the theory(Ajzen & Fishbein, 2000). However, it may not fully consider the intricate cognitive and psychological mechanisms involved. This absence may lead to oversimplified replies without subtlety due to a limited understanding of conduct. The TPB's perspective on social repercussions via subjective norms may oversimplify the complex network of power and influence present in each society(Ceglia et al., 2015). Social norms may be influenced by intricate social, cultural, and historical factors that may not necessarily align with theoretical explanations. Interventions based only on subjective criteria may be unproductive if they fail to address the systemic barriers that influence behaviour(Johnston & Klandermans, 2013). Emotions have a part in shaping intentions and behaviours, which the TPB may not fully consider since it focuses more on cognitive factors. The TPB disregards emotions, despite their crucial role in behaviour and decision-making. Failure to include emotional variables in the theory might result in therapies that lack emotional resonance and provide an inadequate understanding of conduct.

The TPB is widely used to explain and promote a diverse array of behaviours in many contexts. Extensive research in financial behaviour has used the TPB to predict individuals' saving, investing, and debt management tendencies, Ajzen (1991) research demonstrated that the TPB effectively predicts individuals' intentions to save money and their subsequent saving actions. Studies conducted by Sheeran (2002) and Hagger et al. (2015) demonstrated that the TPB was effective in forecasting individuals' financial decision-making and investment actions. The TPB has been significant in the study of environmental behaviour by clarifying the factors that drive individuals to adopt sustainable practices.

Studies by Bamberg and Möser (2007) and Kaiser et al. (1999) have used the Theory of Planned Behaviour (TPB) to investigate individuals' intentions and behaviours related to recycling, reducing energy usage, and using environmentally friendly products. The Theory of Planned Behaviour (TPB) is important for promoting environmental sustainability since research has shown that attitudes, subjective standards, and perceived behavioural control significantly influence people's intentions to engage in pro-environmental actions.

Furthermore, the TPB has been widely used in health behaviour research and promotion. Godin and Kok (1996) and Armitage and Conner (2001) conducted research using the Theory of Planned Behaviour (TPB) to predict individuals' behaviours and intentions related to exercise, healthy eating, and medication adherence. Studies indicate that the Theory of Planned Behaviour (TPB) may be effective in promoting positive health results by demonstrating that attitudes, subjective norms, and perceived behavioural control play significant roles in health-related activities.

TPB's cross-cultural validity and adaptability are supported by further data from its use in other socioeconomic and cultural contexts. Research worldwide has shown the validity and use of the TPB for many individuals, indicating the accuracy of its fundamental principles. Fishbein and Ajzen (2011) used the Theory of Planned Behaviour (TPB) to forecast behaviours such as condom usage, smoking cessation, and dietary decisions in cross-cultural research, demonstrating consistent intention-behaviour relationships.

Additionally, the TPB has played a significant role in influencing and guiding initiatives aimed at changing people's conduct in light of important societal problems. For instance, TPB-based interventions have effectively boosted the use of financial services in disadvantaged regions and enhanced saving habits among individuals with low incomes in the context of financial inclusion (Magendans, 2014). The treatments have enhanced individuals' financial independence by targeting the key behavioural factors identified by the Theory of Planned Behaviour. These elements include individuals' saving attitudes, society's financial standards, and their sense of autonomy in financial decision-making.

Similarly, interventions using the Theory of Planned Behaviour (TPB) have successfully decreased environmental impact and promoted the adoption of eco-friendly habits in the realm of environmental sustainability (Moore & Boldero, 2017). These interventions have promoted environmental stewardship and improved individual behaviour by addressing perspectives on conservation importance, societal expectations for eco-friendly practices, and individuals' perceived ability to impact environmental outcomes through their actions. Environmental advocacy campaigns have used TPB results to motivate diverse populations to participate in activities such as recycling, energy efficiency, and utilising public transport.

Public health practitioners have widely used the Theory of Planned Behaviour (TPB) to tackle many health-related behaviours, including sickness management, treatment adherence, and preventive health practices. The TPB has implemented programmes that have improved health outcomes and reduced healthcare costs by promoting healthier lifestyles, adherence to medical treatments, and engagement in disease prevention activities. These interventions have enhanced individuals' capacity to regulate their health by addressing cultural norms around health practices, perceived autonomy over health decisions, and attitudes towards health behaviours (Paul et al., 2022).

TPB has played a vital role in broadening our understanding of human behaviour and informing strategies to promote positive behaviour modifications across many settings. The TPB has developed effective strategies for addressing many social challenges such as public health promotion, financial inclusion, and environmental sustainability by analysing key behavioural elements and providing a framework for developing solutions. The continued research and actual use of the TPB principles may significantly aid in creating a healthier, more equal, and more sustainable society. The theory's ability to produce meaningful and enduring changes in behaviour is a vital asset in this effort.

2.2 Literature Review

SSA countries are facing challenges in achieving financial inclusion, promoting financial literacy, and ensuring economic stability and development, while also dealing with concerns about climate change. The adoption of FinTech is seen as a potential solution to these challenges, as governments and financial institutions increasingly rely on digital solutions to drive economic development, enhance financial inclusion and literacy, and address the impacts of climate change. This literature review aims to provide a comprehensive overview of key concepts related to financial inclusion, financial literacy, climate change, economic development, financial stability, and the adoption of FinTech in Sub-Saharan Africa. By analyzing existing research, the review seeks to identify gaps in knowledge and contribute to the advancement of theory in this field.

The review will delve into different aspects of the topic in separate sections. The conceptual review will explain fundamental concepts and theories relevant to the subject matter, while the prior studies section will examine existing research on the interplay between these variables in Sub-Saharan African countries. The section on theoretical foundations will establish the conceptual basis for the research, and the hypothesis formulation section will outline the specific hypotheses to be investigated.

2.2.1 Conceptual review

2.2.1.1 Financial literacy

Financial literacy refers to the ability to understand and effectively manage one's finances. A lack of financial knowledge can lead to a cascade of negative consequences, as demonstrated by Jennah (2022) who found a correlation between low financial literacy and imprudent financial decisions like excessive borrowing, substantial debt accumulation, and insufficient savings. It comprises the knowledge and skills necessary for effective debt management, budgeting, saving, investing, and comprehending financial products and services (Huang et al., 2023). Financial literacy has become increasingly significant on a global scale in recent years, as numerous countries recognise its contribution to the promotion of economic growth and financial stability (Van Nguyen et al., 2022b). The escalating intricacy of financial products and services, coupled with the growing importance of financial decision-making in everyday existence, has elevated the global significance of financial literacy (Atkinson & Messy, 2020). According to research, a lack of financial knowledge may lead to imprudent financial decisions, including excessive borrowing, the accumulation of substantial debt, and insufficient savings (Jennah, 2022). To improve the financial literacy of their populations, numerous nations have implemented financial education programmes (Graña-Alvarez et al., 2024).

The significance of financial literacy in Africa is increasing in tandem with the region's integration into the global economy. The lack of adequate financial literacy in Africa is hindering the region's advancements towards achieving its goals of poverty reduction and economic growth (World Bank, 2021). In Africa, a dearth of financial literacy has resulted in inadequate levels of financial inclusion, which presents a significant impediment to economic development and growth, according to the AfDB (World Bank, 2021). SSA faces unique challenges in its pursuit of financial literacy improvement due to its diverse populace, inadequate financial infrastructure, and low levels of financial inclusion (Wealth & Svotwa, 2023). However, several endeavours have been undertaken to augment financial literacy in the region. The Mobile Money for the Poor (MM4P) initiative, initiated by the United Nations Capital Development Fund (UNCDF), aims to promote financial inclusion and enhance financial literacy through the utilisation of mobile technologies (Mahomed, 2022).

Credit card utilisation, financial consciousness, and financial decision-making are a few of the financial literacy topics covered in the research. An abundance of research underscores the criticality of financial literacy and education in empowering individuals to make informed decisions regarding their finances (Karakara et al., 2021). According to a study by Yan et al. (2021), there was a negative correlation between credit card debt and university students' financial literacy. Shanmugam et al. (2023) emphasize the importance of employing standardized measures to accurately assess financial literacy across diverse populations. To make informed financial decisions, numeracy, defined as the ability to comprehend and apply numbers, is crucial (Desai et al., 2023).

Byegon (2020) conducted an extensive international study on financial literacy, which unveiled that it is generally deficient in several countries, irrespective of their degree of progress. This highlights the imperative to improve financial literacy worldwide. Mohandas (2022) employed a causal research design to investigate the impact of financial education interventions on financial knowledge and behaviour. The findings revealed that such programs are effective in fostering positive financial practices and enhancing financial literacy. Financial education programmes are effective in fostering positive financial practices and enhancing financial knowledge, according to the findings of these studies (Muchandigona & Kalema, 2022). In addition to the studies, several others have investigated the influence of financial literacy on a variety of finances. Dube and Asthana (2023) postulate financially literate individuals are more likely to understand the benefits of long-term saving and make informed investment decisions, potentially leading to greater financial security in retirement.

Irrinki et al. (2023) found that there exists a positive correlation between financial literacy and both asset accumulation and fortune. Additionally, financial literacy has a substantial impact on financial decision-making. A study conducted by de Bassa Scheresberg et al. (2015) revealed a positive correlation between financial literacy, self-assurance in making financial decisions, and the propensity to seek assistance with financial matters. Inadequate financial literacy is associated with greater financial hardship and diminished financial well-being (Saif et al., 2022). An understanding of finances is vital when it comes to entrepreneurship. Anshika and Singla (2022) posit that in sub-Saharan Africa, an advantageous correlation exists between entrepreneurial performance and financial literacy. Munyuki and Jonah (2021) discovered a positive relationship between financial literacy and the likelihood of initiating a business venture and securing loans.

There exists a robust relationship between financial literacy and both economic prosperity and stability. Inadequate financial literacy may lead to imprudent financial decisions, resulting in economic underachievement and financial insecurity, according to research (Susan, 2020; Widati et al., 2023). There is a nexus between inadequate financial literacy and increased debt and financial hardship (Hemed, 2022b). On the contrary, an increased level of financial literacy has the potential to promote economic growth and stability. Financial education may enhance financial well-being and financial decision-making (Mawad et al., 2022). Moreover, interventions in financial education have the potential to bolster economic development by fostering entrepreneurialism and enhancing financial literacy (Soomro et al., 2024).

The efficient functioning of financial systems, which is essential for economic development, is contingent upon financial literacy (Graña-Alvarez et al., 2024). Tsouli (2022) identified an inverse relationship between economic development and financial inclusion, which includes access to financial services and financial literacy. Improving financial literacy is of the utmost importance in sub-Saharan Africa to foster economic development and ensure financial stability. In sub-Saharan Africa, Dissanayake et al. (2023) discovered a positive correlation between entrepreneurial performance and financial literacy. A positive relationship exists, according to Klapper and Lusardi (2020), between financial literacy and credit accessibility in Zimbabwe, which is crucial for the expansion and employment generation of small and medium-sized enterprises (SMEs). The study demonstrates the criticality of financial literacy in promoting economic growth, financial inclusion, and financial stability. It is essential to improve financial literacy in sub-Saharan Africa to promote economic development and alleviate destitution in the region (Klapper & Lusardi, 2020).

To combat financial illiteracy in SSA, a comprehensive approach involving technological advancements, educational programs, and regulatory policies is necessary (Boldar et al., 2022a). Tailoring financial literacy initiatives to suit the socio-economic contexts of individual nations is crucial, considering factors like cultural norms, technological access, and literacy levels (Yan et al., 2021). Leveraging digital platforms and innovative educational tools can enhance the effectiveness and reach of financial literacy programs, especially in rural areas with limited access to traditional educational institutions (Wealth & Svotwa, 2023). Enhancing financial literacy not only benefits individuals and businesses but also has broader economic implications. Hasan et al. (2023) noted that financial literacy empowers individuals to make informed investment decisions, leading to increased capital formation and liquidity in financial markets. This, in turn, fosters economic growth and strengthens the financial system's resilience against external shocks.

Moreover, improved financial literacy can lead to a more informed and responsible consumer base, reducing susceptibility to fraudulent schemes and exploitative financial practices that target vulnerable populations (Kass-Hanna et al., 2022). Promoting financial prudence through literacy initiatives can enhance the financial system's stability, mitigating risks associated with market volatility and instability. The positive impacts of financial literacy extend to various sectors such as infrastructure, healthcare, and education (Thakur & Gautam, 2023). As individuals enhance their financial management skills, they can allocate resources towards human capital development, including healthcare and education, essential for sustained economic growth and societal progress (Mose & Thomi, 2021). Increased financial literacy can also help governments secure funding for infrastructure projects, facilitating investments in utilities, transport, and telecommunications critical for economic productivity and connectivity. Investing in financial literacy in SSA is essential for ensuring prosperity and sustainable development in the region. By promoting financial literacy among the general population, policymakers can create opportunities for inclusive development, poverty alleviation, and resilience-building, leading to a more prosperous and secure future for future generations.

2.2.1.2 Financial inclusion

Financial inclusion pertains to the provision of a diverse array of financial services to all individuals and enterprises, with a particular emphasis on those that are unbanked or underbanked (Gao et al., 2024). Financial inclusion is considered a key driver of sustainable development. Ozili (2024) argues that by enabling individuals and businesses to access financial services, financial inclusion empowers them to participate more effectively in the economy, manage their finances efficiently, and invest in their futures. This can lead to poverty reduction, increased economic growth, and overall societal well-being. Globally, several countries have taken steps to promote financial inclusion. For example, India launched the Pradhan Mantri Jan Dhan Yojana program in 2014, which aimed to provide every household in the country with a bank account, while in Kenya, the mobile payment system M-Pesa has been successful in promoting financial inclusion, especially among the rural population (Omwansa & Sullivan, 2012; Xia & Huang, 2023).

In SSA, financial inclusion is particularly important as the region has a large unbanked population. According to the World Bank Group (2022), only 43% of adults in SSA have a bank account, compared to the global average of 69%

However, several initiatives have been launched to promote financial inclusion in the region, such as mobile money platforms and digital financial services. Understanding the challenges and opportunities surrounding financial inclusion in SSA is particularly relevant to research on improving financial literacy in the region. Since financial literacy is a key driver of financial inclusion, effective interventions to enhance financial knowledge and skills can contribute significantly to increasing access to financial services in SSA. For example, Tanzania has launched a national financial inclusion strategy to promote financial access and literacy (Yan et al., 2021). Studies have found that financial inclusion can promote economic growth by providing access to credit and financial services, which can help SMEs grow and create jobs (Demirgüç-Kunt & Klapper, 2013; Redford & Verhoef, 2022). Furthermore, financial inclusion can also promote poverty reduction by enabling individuals to save and invest in education, health, and other essential needs (Bui & Luong, 2023; Ssewamala et al., 2016). Financial inclusion provides individuals and businesses with the tools they need to participate more actively in the economy. Access to credit, for example, enables SMEs to invest in growth, create jobs, and contribute to economic development (Demirgüç-Kunt & Klapper, 2013). Additionally, financial inclusion allows individuals to save for the future, invest in education and skills training, and become more productive members of the workforce, ultimately leading to higher economic growth (Bui & Luong, 2023).

Several studies have examined the relationship between financial inclusion and economic growth. For example, Lusardi and Mitchell (2011), Mushtaq et al. (2023) and Lin et al. (2023) opine that individuals with higher levels of financial literacy are more likely to plan and save for retirement, invest in the stock market, and have greater financial well-being. These behaviours can contribute to economic growth by increasing savings and investment in the economy. Furthermore, Beck et al. (2015) and Xia and Huang (2023) posit that financial inclusion is positively related to entrepreneurship, which is an important driver of economic growth. The authors suggest that financial inclusion can lead to better decision-making, risk assessment, and financial management, which are essential for entrepreneurial success.

Regarding financial stability, Christelis et al. (2016) intimate that financial inclusion is positively related to financial stability. The authors argue that individuals with higher levels of financial literacy are more likely to make informed financial decisions, avoid excessive debt, and avoid financial shocks, which can contribute to financial stability at the individual and systemic levels. Moreover, Klapper and Panos (2011) and Oanh (2023) stated that financial inclusion is positively related to the use of formal financial services, such as bank accounts, which can contribute to financial stability by reducing reliance on informal and potentially risky financial services. Financial inclusion empowers individuals to make informed financial decisions and manage their finances more effectively. This can lead to reduced reliance on risky informal financial products and debt, ultimately contributing to greater financial stability at the individual level (Christelis et al., 2016). Furthermore, by promoting the use of formal financial services, financial inclusion strengthens the financial system as a whole, reducing risks associated with widespread reliance on informal financial arrangements (Klapper and Panos, 2011).

The link between financial literacy and economic growth, financial stability, and the use of formal financial services has significant implications for developing countries. Studies have shown that financial inclusion is positively associated with economic growth and financial stability (Zetzsche & Buckley, 2019). For instance, greater financial inclusion is linked to higher levels of entrepreneurship, innovation, and investment in SMEs (Beck et al., 2015; Klapper et al., 2015). SMEs are a key driver of economic growth in many developing countries, and access to finance is a critical factor for their success.

Furthermore, financial inclusion is associated with improved financial decision-making, including better savings behaviour, lower levels of debt, and higher rates of participation in formal financial services. For example, Van Rooij et al. (2011) revealed that individuals with higher access to financial inclusion were more likely to use formal financial services, such as bank accounts and insurance. In developing countries, particularly in Asia and Africa, the low levels of financial literacy and financial inclusion pose significant challenges to sustainable economic development. In these regions, many individuals lack access to formal financial services, and they rely on informal sources of finance, such as family and friends, moneylenders, and savings groups. Informal finance can be costly, unreliable, and limited in scope, and it can impede economic growth and poverty reduction (Andarsari & Ningtyas, 2019).

Promoting financial literacy is essential for improving financial inclusion, which in turn can contribute to sustainable economic development and poverty reduction. Several studies have examined the effectiveness of financial inclusion interventions in developing countries, including Asia and Africa. These interventions range from financial education programs in schools to community-based financial literacy initiatives and digital financial inclusion tools. Aduda and Kalunda (2012) evaluated the impact of a financial education program in Kenya and found that it led to improved financial knowledge and behaviour among participants. Similarly, Alam et al. (2018) assessed the effectiveness of a community-based financial literacy program in Bangladesh and found that it increased financial literacy and promoted the use of formal financial services.

Studies have shown that traditional financial institutions and formal services play a crucial role in enabling individuals to manage their finances efficiently, save money, and invest in their futures (Malik et al., 2022). However, limited access to essential financial products, such as mortgages, insurance, and pensions, can significantly disadvantage marginalized groups. This lack of access restricts their ability to invest in housing, protect their assets, and plan for retirement, ultimately hindering their economic mobility and progress (Mogaji et al., 2021). This disparity in access to financial services between different segments of the population is a growing concern for policymakers and stakeholders, particularly in developing countries. Geographical limitations, particularly the concentration of financial services in urban areas, pose a significant challenge to financial inclusion efforts (Haridh, 2022). Rural and remote communities often face difficulties in accessing banking services due to the lack of physical branches in their areas (Khelifa, 2023). This limited presence of traditional banking institutions in rural regions further exacerbates the financial exclusion of low-income individuals and SMEs (Elouardighi & Oubejja, 2023).

Additionally, the lack of financial literacy in marginalized communities contributes to the reluctance of individuals to engage with formal financial institutions (Saluja et al., 2023). Financial education efforts are often inadequate, leading to a lack of understanding of banking services and hindering the adoption of these services by those in need. Moreover, the stringent requirements and regulations imposed by traditional banking institutions, such as collateral prerequisites for loans, create barriers for economically disadvantaged individuals to access essential financial services (Ghosh & Chaudhury, 2019). While mobile financial transactions have the potential to bridge the gap in financial inclusion, recent policy decisions, such as the imposition of fees on mobile money transactions by the Tanzanian government, have raised concerns (Elouardighi & Oubejja, 2023). These fees, aimed at increasing government revenue, may impede efforts to promote financial inclusion and limit access to mobile financial services for low-income individuals (Siano et al., 2020; Xu, 2020).

2.2.1.3 Climate change

Climate change is a phenomenon that refers to the long-term alteration of the Earth's climate, primarily due to human activities such as the burning of fossil fuels and deforestation (Nda et al., 2018). The Earth's climate is changing at an unprecedented rate, leading to rising temperatures, sea-level rise, and extreme weather events such as floods, droughts, and hurricanes. Climate change is a global issue that affects all countries, but some regions, including Asia, Africa, and sub-Saharan Africa (SSA), are more vulnerable to its effects due to their dependence on natural resources and low levels of economic development (Cianconi et al., 2020). The relevance of climate change to theories of the study such as financial stability, financial literacy, financial inclusion, and economic growth cannot be overstated. Climate change has significant implications for financial stability, as it poses risks to financial institutions and markets. For example, natural disasters such as floods and hurricanes can damage infrastructure and disrupt economic activity, leading to losses for financial institutions and investors. Climate change can also lead to changes in asset values, such as the devaluation of fossil fuel assets (Cianconi et al., 2020).

Financial literacy and financial inclusion are critical in addressing the challenges of climate change. Financial literacy can help individuals and businesses make informed decisions about investing in sustainable technologies and managing climate risks (Gabor & Brooks, 2017). Financial inclusion can help ensure that vulnerable communities have access to financial services that can help them adapt to the effects of climate change. For example, in Bangladesh, microfinance institutions have played a crucial role in providing loans to farmers to invest in climate-resilient crops and technologies (Ahmed, 2009; Bouraima et al., 2024). Climate change also has implications for economic growth, as it can lead to lower productivity and increased costs. However, addressing climate change can also create opportunities for economic growth, such as the development of renewable energy and sustainable infrastructure. Several countries, including China and India, have made significant investments in renewable energy, which has led to job creation and economic growth (Bhattacharya et al., 2016).

Another approach to financing climate change adaptation and mitigation efforts is through green bonds. Green bonds are fixed-income securities that are specifically designed to finance projects with environmental benefits, including climate change mitigation and adaptation. The market for green bonds has grown significantly in recent years, with issuance increasing from $3 billion in 2012 to over $269 billion in 2020 (Bond, 2021). However, despite these efforts, the financing gap for climate change adaptation and mitigation remains significant, particularly in developing countries. According to the UN, developing countries require an estimated $70-100 billion per year to finance climate change mitigation and adaptation efforts, but current levels of funding fall far short of this (United Nations, 2017).

Moreover, climate change can have significant economic impacts, including increased frequency and severity of natural disasters, rising sea levels, and changes in agricultural productivity. These impacts can in turn affect financial stability, particularly in countries that are heavily dependent on agriculture or have significant exposure to natural disasters (Alrteimei et al., 2022). Addressing climate change requires significant investments in climate change mitigation and adaptation efforts. These investments can be financed through a range of mechanisms, including public financing, private financing, and international climate finance. Financial literacy and financial inclusion are therefore critical for ensuring that individuals and businesses can access the financial services they need to invest in climate change mitigation and adaptation efforts (Ozili, 2018). Climate change and efforts to address it can also have implications for economic growth. While the transition to a low-carbon economy may require significant investments in the short term, it can also create new opportunities for growth and job creation in sectors such as renewable energy and energy efficiency (Kalafatis, 2018).

Previous studies have explored the link between climate change and financial stability, financial literacy, financial inclusion, and economic growth. These studies have shown that climate change poses significant risks to financial stability, as it can lead to physical and transition risks that affect financial institutions, markets, and the economy as a whole. In terms of financial literacy, several studies have highlighted the need for greater financial education and awareness of climate change risks and opportunities. For example, a study by Beck (2020) found that individuals with higher levels of financial literacy were more likely to engage in environmentally sustainable behaviours and invest in green financial products.

Financial inclusion can also play a role in promoting climate change resilience and adaptation. A study by Nuruzzaman et al. (2024) and Schicks (2014) found that microfinance institutions in Bangladesh were able to promote climate change resilience among their clients by providing access to credit for climate-smart investments. Moreover, several studies have explored the link between climate change and economic growth. For example, a study by Acemoglu et al. (2012) found that climate change can lead to lower levels of productivity and economic growth, especially in agriculture-dependent economies.

In terms of policies, several countries have taken steps to address climate change risks and promote sustainable finance. For example, the European Union has developed a sustainable finance taxonomy to promote environmentally sustainable investments, while China has launched a green finance initiative to support low-carbon and environmentally friendly projects. In SSA, climate change risks are particularly acute, as the region is highly vulnerable to the impacts of climate change, such as droughts and floods. However, there have been several initiatives to promote climate change resilience and adaptation, such as the African Risk Capacity, a specialized agency of the African Union that provides weather-based insurance to African countries (Dikau & Volz, 2018; Lee, 2020; Nyasimi et al., 2014).

Thus, climate change is a complex and pressing global challenge that requires significant investments in climate change mitigation and adaptation efforts. Financing these efforts will require a range of financing mechanisms, including public financing, private financing, and international climate finance. Financial literacy and financial inclusion are critical for ensuring that individuals and businesses can access the financial services they need to invest in these efforts, while financial stability and economic growth are also linked to efforts to address climate change (Bellon & Massetti, 2022; Okereke et al., 2012).

2.2.1.4 Economic growth

Economic growth refers to the increase in the production of goods and services in an economy over a specific period. It is often measured by the Gross Domestic Product (GDP) of a country. Economic growth is crucial for the development of a country, as it leads to increased employment opportunities, higher standards of living, and reduced poverty rates. Globally, there have been significant differences in economic growth rates among countries. For example, Asian countries such as China and India have experienced rapid economic growth in recent years, with average annual growth rates of over 6% and 7%, respectively (World Bank Group, 2022). In contrast, many SSA countries have struggled to achieve sustained economic growth, with average growth rates of less than 3% (World Bank, 2021).

Financial stability is essential for promoting economic growth as it ensures that financial intermediaries such as banks can provide credit and other financial services to individuals and businesses. Studies have found that financial stability can promote economic growth by reducing the likelihood of financial crises and improving the efficiency of financial intermediation (Beck & Levine, 2004). Financial literacy is also crucial for economic growth. It can promote economic growth by encouraging individuals to save and invest in productive activities and by improving the effectiveness of financial intermediation. Studies have found that higher levels of financial literacy are associated with increased savings rates, improved financial decision-making, and better investment outcomes (Lusardi & Mitchell, 2014; Qiao et al., 2023).

Financial inclusion is also critical for economic growth, particularly in SSA countries, where a significant proportion of the population remains unbanked. Financial inclusion can promote economic growth by increasing access to credit and other financial services, which can help SMEs grow and create jobs (Chinoda & Kapingura, 2023; Demirgüç-Kunt & Klapper, 2013). Additionally, financial inclusion can enable individuals to save and invest in education, health, and other essential needs, leading to poverty reduction and improved living standards. Finally, climate change is also increasingly recognized as a significant factor that can affect economic growth. The impacts of climate change, such as natural disasters and extreme weather events, can lead to significant economic losses, particularly in developing countries that are vulnerable to the effects of climate change (Raihan et al., 2022). In response, many countries have developed policies to mitigate the effects of climate change, such as transitioning to renewable energy sources and promoting sustainable economic growth (Connor, 2015).

Beck et al. (2013) and Ndombi Avouba et al. (2023) reported that financial inclusion can help promote financial stability by reducing the likelihood of banking crises. Similarly, Carletti et al. (2013) stated that financial literacy can help promote financial stability by improving the quality of financial decision-making and reducing the likelihood of financial distress. In terms of economic growth, studies have shown that it can also affect financial stability. For example, As reported by Beck et al. (2013) and Chinoda and Kapingura (2023), higher economic growth rates are associated with lower banking crises. However, the relationship between economic growth and financial stability may not always be straightforward, as high economic growth rates can also lead to excessive risk-taking and financial instability, as seen in the 2008 global financial crisis.

Furthermore, Ahmad and Satrovic (2023) investigated the relationship between mobile money, telecommunications, and economic development across 146 countries over a twenty-two-year period. They found that mobile money positively influenced economic growth, particularly in countries with high mobile phone usage. Ali et al. (2020) focused on the Islamic Development Bank member countries and identified a significant positive correlation between economic development and financial inclusion, as measured by the financial inclusion index. Ameraldo et al. (2019) studied 55 member nations of the Organisation of Islamic Cooperation (OIC) and found that financial inclusion had a positive impact on GDP growth. Granger causality tests supported the notion that financial inclusion is a critical determinant of economic growth in OIC nations.

Singh and Ghosh (2021) analyzed the impact of financial inclusion on economic development in India from 2014 to 2019. They observed an equilibrium relationship between economic activity and financial inclusion, noting structural changes post-demonetization. Sharma and Jain (2021) examined data from 2004 to 2021 in India and found a robust correlation between GDP and various aspects of financial inclusion, including a unidirectional relationship between deposit/loan accounts and GDP. Van et al. (2021) studied economic development and financial inclusion, noting a stronger correlation in low-income countries with limited financial inclusion.

Emara and El Said (2021) explored the relationship between financial inclusion, governance, and economic development in the Middle East and North Africa region using data from 44 countries between 1990 and 2018. Their study, employing the GMM dynamic panel model, revealed a positive impact of financial inclusion on GDP per capita. They highlighted the importance of factors like political stability, corruption control, and judicial independence in determining the extent of this impact.

Thus, these studies collectively emphasize the significant role of financial inclusion in fostering economic development. They highlight how mobile money, telecommunications, and financial inclusion indices positively influence GDP growth in various regions (Emara & El Said, 2021; Nandru & Rentala, 2020). The findings underscore the bidirectional relationship between economic development and financial inclusion, indicating that as financial inclusion increases, economic growth follows suit. Additionally, the studies shed light on the importance of governance factors in amplifying the impact of financial inclusion on economic development, suggesting that a conducive governance environment is crucial for maximizing the benefits of financial inclusion initiatives.

2.2.1.5 Financial stability

Financial stability refers to the condition in which the financial system of a country can perform its core functions effectively without being disrupted by shocks or crises (Jungo et al., 2022). It is an essential element for sustained economic growth and development, as it ensures the availability of credit and financial services to individuals and businesses. Financial stability has been a major concern for policymakers and researchers globally, particularly in the aftermath of the global financial crisis of 2008 (Banna & Alam, 2021a). Several countries have implemented policies and regulations to enhance financial stability. For instance, after the 1997 Asian financial crisis, many countries in the region implemented macroprudential policies to strengthen their financial systems and reduce the likelihood of future crises (Claessens et al., 2012).

In Africa, several countries have taken steps to enhance financial stability. For example, after experiencing banking sector weaknesses, Nigeria launched its Financial System Strategy 2020 program, which aims to create a more stable and inclusive financial system (Lawal et al., 2018). In addition, the Central Bank of Kenya has implemented measures such as capital adequacy requirements and stress tests to promote financial stability (World Bank, 2021). The importance of financial stability is closely linked to the theories of the study, particularly those related to economic growth and financial inclusion. Studies have shown that financial instability can negatively affect economic growth.

Claessens et al. (2008) analyzed the impact of banking crises on economic growth in a sample of over 100 countries between 1970 and 2004. They found that banking crises can have severe and long-lasting effects on economic growth, with a decline in output growth of up to 2% per year for several years following a crisis. On average, they estimated that banking crises reduced economic growth by 1.5% per year. Similarly, Demirgüç-Kunt and Detragiache (2005) analyzed the impact of financial crises on economic growth in a sample of over 100 countries between 1960 and 2001. They found that financial crises can have significant and persistent effects on economic growth, with a decline in output growth of 1.2% per year over a ten-year period following a crisis. They also found that the negative impact of financial crises on economic growth is more severe in countries with weak institutional frameworks and low levels of financial development(Dwyer et al., 2013; Funke et al., 2016).

These studies highlight the importance of financial stability in promoting sustainable economic growth and development. Financial crises can have severe and long-lasting effects on the economy, and reducing the likelihood of such crises is crucial for promoting economic stability and prosperity. Therefore, policymakers should prioritize promoting financial stability and implementing effective measures to mitigate the risks of financial instability (Demertzis et al., 2019; Maimbo et al., 2011). Furthermore, financial stability is also closely linked to financial literacy and financial inclusion. By enhancing financial literacy and promoting financial inclusion, individuals and businesses are better equipped to make informed financial decisions, which can help to reduce the likelihood of financial instability. In addition, a stable financial system can also facilitate greater financial inclusion, as it provides a foundation for the delivery of financial services to underserved populations (Yan et al., 2021). Financial stability is also relevant to the issue of climate change. The financial sector plays a crucial role in the transition to a low-carbon economy, and financial stability is necessary to support this transition. The World Bank (2016) highlighted the risks associated with climate change to financial stability and the need for financial institutions to assess and manage these risks.

Other studies on financial stability such as a study by Laeven and Valencia (2012) highlight the importance of financial stability for promoting income equality. Their findings suggest that banking crises can exacerbate income inequality by disproportionately affecting the poor and middle class. This underscores the need for effective measures to prevent and mitigate the risks of financial crises, such as strengthening regulatory oversight and risk management practices in financial institutions. Also, a study by Levine (2005) provides further support for the importance of financial stability and development for sustainable economic growth. His findings suggest that countries with more developed financial systems tend to experience faster economic growth, highlighting the need for policies that promote financial stability and development. This can include measures such as improving access to financial services, strengthening regulatory frameworks, and promoting financial literacy.

Moreover, the model of financial contagion developed by Borio et al. (2023) highlights the risks posed by the spread of financial distress from one institution to another. Their findings suggest that financial contagion can be a significant driver of financial instability, emphasizing the importance of measures to prevent and contain the spread of financial distress. This can include measures such as enhancing risk management practices in financial institutions, improving transparency in financial markets, and strengthening regulatory oversight. Gorton and Metrick (2012) provide insights into the factors that contributed to the global financial crisis of 2008-2009. Their findings suggest that excessive risk-taking by financial institutions, lax regulatory oversight, and the securitization of subprime mortgages were among the key drivers of the crisis. This highlights the need for measures to improve risk management practices, enhance regulatory oversight, and promote responsible lending practices.

Taken together, these studies underscore the importance of financial stability for sustainable economic growth and development. Effective measures to promote financial stability can help to prevent financial crises, promote income equality, and support sustainable economic growth. This can include a range of policy measures, such as enhancing regulatory oversight, promoting financial literacy, improving risk management practices, and developing more resilient financial systems.

2.2.1.6 FinTech adoption

Financial technology, or FinTech, refers to the use of technology to improve and automate financial services, including banking, insurance, and investment management (Huarng & Yu, 2022). FinTech has rapidly transformed the financial industry, enabling businesses and individuals to access financial services more efficiently and at lower costs (D. W. Arner et al., 2020). FinTech has emerged as a disruptive force in the financial industry, challenging traditional business models and increasing competition. FinTech companies typically leverage new technologies, such as mobile apps, artificial intelligence, and blockchain, to provide innovative financial products and services (Chen Zheng & Zhiyue Sun, 2023). For example, mobile banking apps allow customers to perform banking transactions and access financial information using their smartphones, while robo-advisors use algorithms to provide investment advice and portfolio management services (Leong & Sung, 2018).

FinTech has the potential to democratize access to financial services, particularly in developing countries and underserved communities. By leveraging mobile technology and digital platforms, FinTech companies can provide financial services to people who are unbanked or underbanked, helping to promote financial inclusion (D. Salampasis & A.-L. Mention, 2018). According to a report by the World Bank (2021), FinTech can also enhance financial stability and reduce systemic risks by improving the efficiency and transparency of financial systems. FinTech can help to reduce information asymmetry, increase market efficiency, and enable better risk management, which can ultimately contribute to a more stable financial system (Xu et al., 2021).

The emergence of FinTech has brought about numerous benefits to the financial industry, including increased efficiency, convenience, accessibility, and affordability. FinTech innovations have enabled financial institutions to streamline their operations, reduce costs, and offer a wider range of products and services to customers. At the same time, FinTech has provided consumers with greater access to financial services and products, as well as more control over their finances (Mavlutova et al., 2021). However, the adoption of FinTech is not without its challenges. One of the main challenges is the potential for FinTech to widen the digital divide, as individuals without access to technology or digital literacy may be left behind. Additionally, there are concerns regarding data privacy, cybersecurity, and financial stability, as the rapid pace of innovation may outpace regulatory oversight (Douglas W Arner et al., 2020).

Despite these challenges, the adoption of FinTech is expected to continue growing, driven by increasing demand for digital financial services, advancements in technology, and favourable regulatory policies. World Bank Group (2022) reported that the global FinTech market is projected to reach a value of $310 billion by 2022, with digital payments, personal finance, and insurance being among the top sectors driving growth. As a result of its potential to disrupt traditional financial services, FinTech has attracted significant interest from investors and policymakers alike. In recent years, there has been a surge in FinTech start-ups offering a wide range of services, from payment processing and online lending to financial advice and wealth management. Furthermore, Huong et al. (2021) posit that FinTech adoption has increased significantly in recent years, with over 64% of the global population adopting FinTech solutions. The report further states that China has the highest FinTech adoption rate at 87%, followed by India at 87%, and the United Kingdom at 71%.

In Africa and Sub-Saharan Africa (SSA), FinTech adoption is also gaining momentum. A study by Fernando (2019) found that FinTech adoption has the potential to enhance financial inclusion in Africa by providing access to financial services and products to underserved populations. Countries such as Kenya and Nigeria have emerged as FinTech hubs in SSA, with mobile money services such as M-Pesa and Paga gaining widespread adoption (Demirgüç-Kunt et al., 2022). As FinTech solutions facilitate access to financial services and products, they can enhance financial literacy and inclusion, which in turn can promote financial stability. For instance, in a study by Agénor et al. (2020), FinTech adoption was found to be positively associated with financial inclusion, which can help to reduce the likelihood of financial instability.

Additionally, FinTech solutions can support the transition to a low-carbon economy, thereby promoting financial stability in the face of climate change. For example, blockchain-based solutions can be used to track carbon emissions, while green bonds can provide a source of funding for sustainable projects(Cen & He, 2018). The growth of FinTech has also spurred innovation in traditional financial institutions, with many banks and other financial firms investing heavily in technology to improve their services and stay competitive in the rapidly evolving financial landscape (Anagnostopoulos, 2018). While the potential benefits of FinTech are clear, there are also concerns about its impact on financial stability and consumer protection. Regulators around the world are grappling with how to balance the need to encourage innovation and competition in financial services with the need to protect consumers and maintain financial stability (Michaels & Homer, 2018).

FinTech has also had a significant impact on financial inclusion, as it has enabled the provision of financial services to underserved populations. For example, mobile banking platforms and digital wallets have made it easier and more affordable for people to access basic financial services such as savings, payments, and remittances (Daniel Makina, 2019). FinTech has also facilitated the growth of alternative lending platforms, which provide credit to individuals and small businesses that may have difficulty obtaining loans from traditional financial institutions (Stijn Claessens et al., 2018).

2.2.1.7 Financial development

The financial system in SSA plays a crucial role in promoting economic growth, reducing poverty, and enhancing resilience in the region (Ofori-Acquah et al., 2023). Financial depth, access, efficiency, and stability are key components that need to be addressed to achieve sustainable development goals. Financial depth, which refers to the size and sustainability of the financial system relative to the economy, is lacking in SSA (Khan et al., 2019). This hinders credit accessibility for individuals and businesses, limiting investment opportunities and economic growth. Research by Demirgüç-Kunt et al. (2022) highlights the strong correlation between financial depth and economic advancement, emphasizing the need to address this deficiency in SSA. The financial focuses on reducing costs related to information acquisition, contract enforcement, and transaction execution to encourage the development of diverse financial contracts, markets, and intermediaries. The five essential functions of the financial system include facilitating the exchange of goods and services, providing information on investments, overseeing investments and corporate governance, facilitating risk management, and mobilizing savings (Appiah et al., 2023).

Financial access encompasses the availability of a wide range of financial services (World Bank Group, 2022). Many people in SSA, especially in rural areas, lack access to formal financial institutions, perpetuating poverty and limiting economic opportunities. The World Bank's Findex Database shows that only 43% of the population in SSA has a formal financial account, well below the global average (World Bank Group, 2022). Financial efficiency is essential for effective resource allocation and reducing transaction costs. Inefficient loan distribution, high-interest rates, and limited competition among financial institutions in SSA hinder economic progress. Research by Cohen and Dijkman (2022) supports the idea that improving financial efficiency can stimulate economic growth by facilitating investment and resource allocation. Financial stability is crucial for withstanding disruptions and crises. Weak regulatory frameworks and fragile financial institutions in SSA pose significant threats to financial stability, potentially hindering economic growth and leading to systemic crises. The aftermath of the 2008 global financial crisis highlighted the importance of robust financial stability institutions in fostering resilience (Bull & Klapper, 2023).

Informal financial institutions, such as moneylenders, exacerbate financial marginalization and exploit rural communities in SSA (Coffie & Hongjiang, 2023). Regulatory deficiencies, weak legal systems, and inadequate property rights further hinder financial progress and participation in the formal financial system (Mlachila & Ouedraogo, 2020). To address these challenges, a holistic approach is needed, incorporating technological advancements, legislative reforms, and improved financial literacy (Hunjra et al., 2021). Capacity-building programs for financial institutions can enhance efficiency and risk management. The adoption of mobile banking, agent banking, and microfinance initiatives can boost financial inclusion (Ahiadorme, 2022). Strengthening financial education programs and implementing regulatory frameworks that promote competition and stability can empower individuals and drive financial development in SSA (Cicchiello et al., 2021).

Furthermore, financial development is vital for economic growth as it attracts foreign capital, optimizes capital allocation, accumulates funds, advances technology, increases savings rates, mobilizes savings, and generates investment information (Abeka et al., 2021). Countries with sophisticated financial systems tend to experience more rapid and consistent economic growth, indicating a strong relationship between financial development and economic advancement. Financial development also plays a role in reducing poverty and inequality by increasing access to capital for disadvantaged individuals, promoting risk management, and supporting investments in SMEs (Giordino & Revello, 2023). Effective financial development requires not only the presence of financial infrastructure and intermediaries but also robust regulations to govern and supervise the sector (K. Molefhi, 2019). The global financial crisis highlighted the importance of adequate regulations in fostering financial growth and ensuring positive economic outcomes.

The crisis led to a revaluation of traditional financial sector policies and emphasized the need for sustainable development approaches (Akbalik & Ozkan, 2017; Kaur, 2023b).

Assessing financial development is crucial for understanding its impact on economic growth and poverty reduction (Tsouli, 2022). Evaluating financial development can be challenging due to its complexity, but empirical research often relies on quantitative indicators such as the assets-to-GDP ratio of financial institutions, liabilities-to-GDP ratio of liquid assets, and deposits-to-GDP ratio (Appiah et al., 2023; Hussain & Rasheed, 2023). The Global Financial Development Report by the World Bank provides valuable statistics and analysis on financial development worldwide, aiding in policy evaluation and decision-making (Demirguc-Kunt et al., 2022; World Bank Group, 2022).

2.2.1.8 Regulatory quality

Regulatory quality is of the utmost importance in modern society, influencing the efficiency, justice, and safety of numerous industries (Gichuru & Namada, 2022). Regulatory requirements are obligations established by industry associations or governing bodies that prescribe specific conduct, behaviours, or benchmarks that must be adhered to by individuals, businesses, or entities (World Bank Group, 2022). The mandates encompass a multitude of objectives, including the protection of public health and safety, the encouragement of equitable competition, the preservation of market stability and integrity, and the promotion of ethical conduct across various industries (Falchetta et al., 2021). Regulatory regulations establish benchmarks for workplace safety, environmental protection, and product quality, thereby serving as safeguards for public health and safety (Asongu & Odhiambo, 2021). Governing bodies establish regulations and legislation to mitigate risks and safeguard the welfare of individuals and communities (Asongu & Odhiambo, 2021).

Also, regulatory frameworks are of paramount importance in fostering equitable competition through the establishment of level playing fields, prohibition of unethical business practices, preservation of transparency, and discouragement of anti-competitive conduct; thus, they cultivate a conducive environment for the prosperity of enterprises (Ofoeda et al., 2024). Regulatory standards play a pivotal role in upholding the integrity and stability of markets, with particular emphasis on the financial sector. These laws aid in risk mitigation, fraud prevention, and consumer confidence. To foster conscientious corporate conduct, safeguard stakeholder interests, and instil trust in organisational procedures, regulatory frameworks across various sectors tackle ethical concerns (Ofoeda et al., 2024).

Moreover, they are multifaceted, manifesting in various formats including but not limited to laws, statutes, rules, directives, standards, codes of practice, licences, and permits (Shavshukov & Zhuravleva, 2023). Every form possesses distinct objectives, ranging from legally binding obligations to sector-specific benchmarks that aim to promote ethical and consistent conduct among stakeholders. Regulatory requirements are subject to the influence of various factors, the most significant of which is the level of risk associated with specific enterprises or activities (Shavshukov & Zhuravleva, 2023). Certain industries are frequently subject to more stringent regulations to effectively mitigate potential hazards that may jeopardise public health, safety, or the environment. Additionally, advancements in technology, regional collaboration, financial considerations, cultural trends, and the increasing interconnectedness of global markets all exert substantial influence on regulatory frameworks, necessitating adaptability and cooperation (Ofoeda et al., 2024).

Besides, regulatory guidelines are of paramount importance; however, they are not without their drawbacks. Constantly striving to strike a balance between innovation and regulation is the risk that excessive regulations will stifle the former and impede economic expansion (Bekana, 2023). The regulatory burden, comprising complex and all-encompassing regulations that impose significant financial obligations and administrative impediments, impedes industrial progress and economic activity (Karikari et al., 2023). Effective rule enforcement necessitates robust systems and resources to ensure adherence, particularly in rapidly evolving domains where enforcement may encounter challenges in keeping pace with technological advancements (Bekana, 2023).

Also, stakeholders must give precedence to agility and adaptation to effectively address regulatory challenges. Facilitating the alignment of regulatory requirements with technological advancements and societal needs through the implementation of regulatory flexibility and innovation could aid in resolving the tension between regulation and innovation (Li et al., 2023). Furthermore, by streamlining and optimising regulatory processes, organisations and individuals may experience a reduction in workload, which can improve efficiency and facilitate compliance (Xu et al., 2021). Effective collaboration with stakeholders representing diverse sectors is imperative in the development and implementation of adaptable regulatory frameworks that strike a harmonious equilibrium between regulatory oversight and economic dynamism (Li et al., 2023).

Procedures for enforcement are indispensable for preserving the integrity and efficacy of regulatory obligations (Abrahams et al., 2024). By incorporating technology, data analytics, and risk-based approaches, regulatory bodies can potentially enhance the effectiveness and efficiency of enforcement measures. This would enable more prudent resource allocation and a concentration on sectors with elevated risk (Abrahams et al., 2024). Incentives, education, and awareness campaigns that promote compliance may inspire stakeholders to adhere to regulations voluntarily, thereby bolstering enforcement efforts and fostering responsible conduct (Levi-Faur, 2023). Regulatory authorities can enhance public trust in regulatory frameworks and deter non-compliance through the establishment of robust enforcement capacities and the promotion of a compliance-oriented culture. This will enhance the effectiveness of regulatory obligations in achieving their objectives (Gichuru & Namada, 2022).

Developments such as globalisation, sustainability, and digitization will have an impact on regulatory standards in the future (Teichmann et al., 2023). The implementation of regulatory technology (RegTech) solutions has the potential to facilitate cross-border regulatory harmonisation and enhance regulatory transparency, efficiency, and compliance monitoring (Teichmann et al., 2023). Moreover, the incorporation of sustainability considerations into regulatory frameworks could potentially promote ethical conduct among corporations, mitigate environmental risks, and facilitate the achievement of global sustainability goals (Migliorelli, 2021). Policymakers, regulators, and industry stakeholders may collaborate to address emerging challenges and capitalise on prospects to efficiently administer regulatory obligations and establish environments that foster sustainable development, innovation, and inclusive growth (Migliorelli, 2021).

2.2.2 Previous research

2.2.2.1 Financial literacy and financial inclusion

The importance of financial inclusion and financial literacy in driving economic development and societal progress is widely recognized by the global community (Boldar et al., 2022b). Financial inclusion, as defined by the World Bank, involves providing a wide range of financial services to individuals and businesses to help them manage risks and seize opportunities (Prameswari et al., 2023). This includes traditional services like savings accounts and credit facilities, as well as modern options such as microinsurance and digital payments. Financial literacy is crucial in promoting responsible financial behaviour and informed decision-making, covering topics like budgeting, saving, investing, and managing debt (Desai et al., 2023). These elements are essential for empowering individuals to navigate the complexities of the financial landscape and improve their overall financial well-being.

The relationship between financial literacy and financial inclusion is well-documented in the literature, with numerous studies highlighting a positive correlation between the two concepts (Widati et al., 2023). Financial literacy plays a crucial role in enabling individuals to effectively navigate and utilize a range of financial products and services, empowering them to make informed decisions aligned with their financial goals (Chhatoi & Sahoo, 2023). Financial inclusion initiatives are instrumental in advancing financial literacy by providing individuals with practical opportunities to engage with financial services and enhance their money management skills (Kobugabe & Rwakihembo, 2022). This relationship is particularly significant in efforts to improve socioeconomic status and financial well-being, especially among disadvantaged populations (Tsouli, 2022).

The impact of financial literacy and financial inclusion extends beyond individual empowerment to broader societal benefits, such as poverty reduction and equitable economic growth (Nyanzu, 2022). By equipping individuals with essential financial knowledge and skills, societies can help break cycles of poverty and promote economic self-sufficiency (Hemed, 2022a). Furthermore, promoting financial inclusion ensures that marginalized populations have equal access to vital financial services, thereby reducing disparities and promoting social integration (Mishra et al., 2021). Enhancing accessibility to financial services and promoting financial literacy are essential strategies for overcoming systemic barriers to economic empowerment and building more resilient and inclusive societies (Rizwana et al., 2021).

To maximize the benefits of integrating financial literacy and financial inclusion, collaboration among key stakeholders is essential (Mose & Thomi, 2021). International development agencies, governments, financial institutions, and civil society organizations play a crucial role in designing and implementing programs to expand access to financial services and enhance financial literacy (Byegon, 2020). Various interventions, such as educational programs, financial literacy campaigns, regulatory reforms, and innovative fintech solutions, are integral components of these initiatives (Erlanitasari et al., 2020). Leveraging digital platforms and technology can significantly enhance the effectiveness of financial inclusion efforts, particularly in underserved communities lacking access to traditional banking services (Mondal, 2020).

Despite the importance of financial inclusion and financial literacy for economic development, disparities persist across different sectors and regions, exacerbating existing inequalities (Morgan & Long, 2020). Developing countries often lag behind developed nations in terms of financial inclusion and literacy, while certain demographic groups face barriers to accessing financial services or lack essential financial knowledge, leading to ongoing financial exclusion even in more advanced economies (Gupta & Arya, 2020).

In Europe, concerns are raised about the lack of financial knowledge among young individuals, leading to challenges in budgeting, investing, and debt management (Desai et al., 2023). Immigrants face additional hurdles due to language and cultural barriers, making it difficult for them to navigate financial institutions effectively (Lyons et al., 2019). Financial inclusion is a prominent issue affecting rural communities and women, with limited access to banking facilities hindering their ability to save, invest, and access credit. Gender-specific barriers, such as societal norms and legislative restrictions, further exacerbate the financial exclusion of women in the region (Karlovskaya et al., 2022). There is a need for tailored interventions and policies to address the unique challenges faced by different demographic groups, including considerations of socioeconomic status, geography, age, and gender (Desai et al., 2023).

Efforts to improve financial literacy in Europe and promote financial inclusion in Asia may involve targeted educational initiatives, seminars, and digital resources to impart practical financial knowledge and skills (Furrebøe & Nyhus, 2022). Developing new financial products and services tailored to the needs of women and rural populations, as well as expanding banking infrastructure, are suggested strategies to enhance financial inclusion. The study underscores the importance of collaboration among governments, financial institutions, civil society organizations, and international development agencies to address these challenges effectively (Yan et al., 2021). By pooling resources and forming partnerships, stakeholders can enhance the impact and sustainability of programs aimed at promoting financial inclusion and literacy, thereby contributing to more equitable economic development (Mishra et al., 2021).

The global perspective on financial literacy and inclusion is further supported by studies like that of Chen and Yuan (2021) in Southeast Asia, which investigated the relationship between financial literacy and digital financial inclusion. The research revealed that individuals with higher levels of financial literacy were more likely to utilize digital financial services, highlighting the potential of improving financial literacy to advance digital financial inclusion. Additionally, studies in rural regions, such as the research by Marini et al. (2024)have shown that financial education interventions can lead to increased utilization of formal financial services, such as savings accounts and formal credit, among participants. These findings underscore the positive impact of targeted financial education initiatives on fostering greater financial inclusion in underserved communities.

In the context of Africa, particularly SSA, the input highlights significant challenges in financial inclusion and literacy despite recent advancements in the region(Hofisi, 2023). Data from the World Bank's Findex database indicates that only 44% of individuals in Sub-Saharan Africa have an account with a formal financial institution, which is below the global average of 68%(Ofori-Abebrese et al., 2020). This disparity underscores the urgent need to address barriers to financial inclusion and enhance financial literacy throughout the region to promote economic development and reduce inequalities.

Financial literacy has been identified as a crucial factor influencing individuals' engagement in various financial activities, such as investing, credit card usage, and saving. Studies by Demirgüç-Kunt and Klapper (2012) and Lusardi and Mitchell (2014) have highlighted the positive correlation between financial literacy and prudent financial behaviour. These findings emphasize the importance of financial literacy initiatives in promoting responsible financial conduct, including retirement planning and consistent savings. Moreover, research in African countries, such as Tanzania and Ghana, has demonstrated the significant impact of financial literacy training on enhancing financial inclusion and empowering individuals to make informed financial decisions.

In Africa, studies like that of Lotto (2022) in Tanzania have shown that targeted financial education initiatives can lead to an increase in savings account ownership and the utilization of mobile money services among participants. These findings underscore the potential of financial literacy programs to overcome barriers to financial inclusion and promote fair financial systems within the African context. Similarly, research in Ghana, such as the study by Karakara et al. (2022), has provided compelling evidence of the positive effects of financial literacy initiatives on individuals' credit-seeking behaviour and financial decision-making abilities. By equipping individuals with essential financial knowledge and skills, these programs enable them to improve their financial well-being and navigate financial institutions more effectively, ultimately bridging the gap between financial literacy and financial inclusion in regions with limited access to formal financial services.

The importance of financial literacy in promoting financial inclusion is further exemplified in studies focusing on specific demographics, such as women entrepreneurs and smallholder farmers. Tumba et al. (2022) conducted a study in Nigeria that revealed a positive correlation between increased lending availability for women entrepreneurs and their level of financial literacy, emphasizing the role of financial education in enhancing financial inclusion for marginalized groups. Similarly, Koomson et al. (2023) conducted a study in Ghana that demonstrated the positive impact of financial literacy initiatives on smallholder farmers' access to agricultural credit. By improving farmers' financial literacy, these initiatives led to increased utilization of official agricultural loan services, highlighting the effectiveness of financial education in expanding financial access in rural farming regions.

2.2.2.2 Financial inclusion and climate change

The intricate correlation between climate change and financial inclusion is an intriguing topic that merits further examination. At first inspection, financial inclusion might appear to be beneficial for environmental sustainability; however, the true state of affairs is multifaceted and demanding. By conducting additional research, we can identify potential avenues through which financial inclusion could aid in mitigating and adapting to the effects of climate change, as well as identify the challenges and determinants that insist on resolution. Facilitating the transition to a low-carbon economy, financial inclusion could potentially act as an incentive for environmentally friendly investments. Financial services such as financing and investment products may enable organisations and individuals to invest in renewable energy technology, energy-efficient solutions, and sustainable practices (International Finance Corporation, 2019). Microloans have the potential to assist farmers in the adoption of climate-smart agricultural practices, including the purchase of drought-resistant crops and water-saving irrigation systems, which could reduce greenhouse gas emissions and conserve resources.

In addition to potentially mitigating environmental damage, financial inclusion could reduce dependence on hazardous activities. The provision of alternative sources of income and financial safety nets diminishes the probability that individuals will partake in unsustainable practices, such as deforestation or resource exploitation, in exchange for immediate financial gains (Li & Qamruzzaman, 2023). Micro-entrepreneurship loans have the potential to facilitate the establishment of sustainable enterprises such as organic farming and eco-tourism, thereby promoting responsible resource management and environmental protection (Deyganto, 2023). Financial inclusion not only contributes to the mitigation of adverse consequences but also significantly enhances resilience to the inevitable repercussions of climate change. Severe weather, flooding, and droughts, which are all consequences of climate change, pose substantial financial risks to individuals and society as a whole.

Research by the UNCTAD (2020) indicates that communities and individuals may be better able to withstand financial disruptions if they have access to financial services like microinsurance, savings accounts, and financing for disaster risk. The use of savings accounts permits individuals to amass monetary reserves, which facilitates a more expedited recovery from setbacks. Weather index insurance for farmers and other climate-specific microinsurance products offer financial protection against agricultural failures and animal losses, thereby mitigating the economic repercussions of climate-related catastrophes (Costella & McCord, 2023). Additionally, financial inclusion may facilitate the adoption of agricultural technologies and practices that are climate-smart. Granting financial assistance to farmers could potentially facilitate their acquisition of climate-resilient technologies such as drought-resistant crops, efficient irrigation systems, and other adaptations to changing weather conditions, thereby enabling them to maintain their livelihoods (Ariom et al., 2022).

According to Adhikari and Safaee Chalkasra (2023), climate-focused financial literacy programmes may assist individuals in comprehending climate risks and making informed decisions regarding adaptation strategies, thereby enhancing their resilience to environmental issues. To completely actualize the positive impacts of financial inclusion on climate change, it is imperative to surmount several substantial challenges. Unincorporated into the official financial system is still a significant portion of the global population, particularly in developing countries. This hinders their ability to allocate resources towards sustainable solutions or adapt to the impacts of climate change. The World Bank Group (2022) reports that over 1.7 billion people worldwide lack access to banking services; the majority of these individuals reside in rural areas where infrastructure and financial services are inadequate.

According to Huyer et al. (2021), the exclusion of specific individuals from this environment hinders the acquisition of financial resources that are essential for the development of climate-resilient infrastructure, renewable energy technologies, and sustainable agricultural practices. Ultimately, this impedes their capacity to mitigate the impacts of climate change and adapt to the changing ecological conditions. It is imperative to address the financial inclusion divide through the development of novel financial solutions and the implementation of targeted policies to enable communities and individuals to participate effectively in the fight against climate issues and gain equitable access to benefits as research by Abbass et al. (2022). It is imperative to tailor financial products and services to effectively cater to the distinct needs and vulnerabilities of communities confronted with climate-related perils. It necessitates an in-depth comprehension of the diverse obstacles that different locations and individuals face.

Sheehan et al. (2023), noted development of microinsurance products customised to address climate-related catastrophes, such as droughts or floods, could potentially offer vital economic protection to regions susceptible to such risks. The provision of climate-resilient loans, featuring flexible repayment plans and diminished interest rates, could potentially stimulate the adoption of sustainable business practices, including the financing of renewable energy sources or the installation of water-conserving irrigation systems (Huarng & Yu, 2022). In addition, supporting financial literacy initiatives that prioritise climate adaptation strategies could equip individuals with the knowledge and skills necessary to make informed financial decisions and navigate the complexities of climate-related risks. A universal remedy is insufficient to address the myriad challenges that climate change presents. Effective interventions necessitate customised approaches that attend to the unique susceptibilities and needs of different demographics.

Research by Ofoeda et al. (2024) indicates promoting sound financial inclusion practices and preventing financial services from contributing to environmental damage require regulatory environments that are conducive to these objectives. Insofar as possible, regulations must strike a balance between promoting financial innovation and mitigating the risks associated with greenwashing and unsustainable lending practices. Greenwashing refers to deceitful marketing tactics that falsely represent financial products or services as environmentally friendly, when in fact they are not. Unsustainable financing methods have the potential to inadvertently incentivize environmentally detrimental activities, including deforestation and unsustainable resource exploitation. In addition to protecting consumers and averting financial exclusion resulting from overly stringent restrictions, regulatory frameworks must establish precise criteria for identifying and advocating genuine green financial products (Ofoeda et al., 2024). It is critical to foster collaboration among policymakers, financial institutions, and environmental experts to establish regulatory structures that promote sustainable development and responsible financial inclusion.

Through the adoption of targeted initiatives, innovative financial mechanisms, and advantageous regulatory frameworks, it is possible to empower individuals and communities to engage in endeavours related to climate adaptation and mitigation. This, in turn, will contribute to the development of a future that is both sustainable and resilient for all. Despite not being an exhaustive remedy, financial inclusion is a crucial tool in the fight against climate change. By advocating for environmentally sustainable investments, enhancing resilience, and streamlining risk management processes, it is possible to mitigate the consequences of climate change and facilitate adaptation (Hallegatte et al., 2020). It is critical to confront existing barriers and guarantee ethical implementation to effectively harness the potential of financial inclusion for the benefit of future sustainability.

2.2.2.4 FinTech adoption and climate change

The global financial sector has seen a substantial change in recent years because of the rapid expansion of FinTech. Global concern about climate change has increased, prompting stakeholders to explore sustainable practices in many sectors. There is increasing interest in how the intersection of these two occurrences and the potential effects of FinTech adoption may impact efforts to address and adapt to climate change. Adopting FinTech solutions may significantly impact the environment via several routes. An important aspect is the digitalization of financial services, which eliminates the need for physical infrastructure and paper transactions. The shift to digital platforms in banking operations, such as paperless statements and online transactions, may lead to reduced carbon emissions compared to traditional methods (Hughes et al., 2019). Besides, Sadiq et al. (2024) found that the shift towards online banking and digital transactions can significantly reduce paper usage and associated environmental costs linked to production, transportation, and disposal.

FinTech developments like digital wallets and mobile payment systems help decrease the environmental effect of financial operations by enabling electronic transactions (Dhavamani et al., 2023). Blockchain applications, mobile money, and other advanced financial technologies have the potential to reduce the gap in financial inclusion and empower communities and people vulnerable to the effects of climate change. Damayanti and Wicaksana (2021) found that using financial technology may strengthen the positive relationship between financial literacy and financial inclusion. This might help people in distant areas affected by climate change to easily get important financial services including savings, credit, and insurance.

Mobile money platforms, as demonstrated by research (e.g., Damayanti & Wicaksana, 2021), can empower individuals in remote areas, often disproportionately affected by climate change, to access financial services like savings and credit. This financial inclusion can strengthen their ability to cope with climate shocks and invest in adaptation measures. However, the environmental benefits of adopting FinTech are not unquestionable. The increasing demand for computing power and the growth of data centres supporting digital financial services have raised concerns about carbon emissions and energy use (Wang et al., 2022). The production and disposal of equipment used in FinTech activities contribute to the creation and disposal of electronic waste (Macchiavello & Siri, 2022). Hence, although the integration of FinTech may provide opportunities for environmental sustainability, it is essential to carefully evaluate its broader environmental consequences. FinTech adoption has the potential to enhance resistance to climate change via innovative financial solutions, in addition to its environmental impacts. Utilising FinTech to enhance climate-related insurance and risk management is a key focus area. FinTech platforms may provide tailored risk evaluation and insurance options to enterprises and at-risk populations facing climate-related risks by using sophisticated data analytics and artificial intelligence (Mhlanga, 2023). This phenomenon enhances financial inclusion and strengthens the ability to adapt to climate-related concerns.

Furthermore, FinTech enables the mobilisation of climate funds and promotes sustainable investment. FinTech enables the redistribution of money to ecologically friendly initiatives and projects via the use of green bonds, crowdfunding platforms, and blockchain-based finance (Suryanto et al., 2022). Moreover, FinTech platforms like green bonds and crowdfunding leverage technology to connect investors with environmentally friendly projects. This transparency and accessibility, as highlighted by Suryanto et al. (2022), can encourage investment in renewable energy, sustainable infrastructure, and other climate-mitigation initiatives. The platforms support the development of a low-carbon economy by enhancing investor trust in sustainable projects via their openness and effectiveness (Tamasiga et al., 2022). FinTech may help mitigate climate change by facilitating climate-smart investments and risk management measures, in addition to boosting financial access. Asante Boakye et al. (2023) analyzed how blockchain technology might enhance traceability, efficiency, and transparency in green funding for sustainable projects. Furthermore, FinTech companies are developing new financial tools tailored to reduce risks associated with climate change. Weather index insurance, accessible via mobile platforms, offers financial protection to farmers against crop failures due to droughts or floods, helping to reduce the economic consequences of climatic catastrophes.

While there are potential advantages to combining FinTech with efforts to address climate change, there are also many barriers that impede the successful implementation of these opportunities. Regulatory constraints and policy fragmentation hinder the scaling of climate-aligned FinTech solutions, necessitating coordinated national and international initiatives (Sarkis et al., 2021). Inequities in financial literacy and digital infrastructure impede people from accessing FinTech services equitably, exacerbating socioeconomic gaps in climate resilience (Kovacevic-Opacic & Marjanovic, 2020). The World Bank Group (2022) highlights the persistent presence of significant disparities in digital literacy and infrastructure, particularly in developing regions. The digital gap might hinder equitable access to financial technology solutions, exacerbating existing inequalities and limiting disadvantaged groups' access to climate-smart financial goods. To address this situation effectively, it is crucial to provide targeted initiatives that close the digital gap and ensure equal access to the benefits of FinTech. Also, financial technology advancement necessitates the creation of regulatory frameworks that encourage innovation and responsible behaviour. Prioritising the resolution of data privacy, security, and algorithmic biases is crucial to protect customers and prevent greenwashing schemes that misrepresent the environmental sustainability of financial goods (Rani et al., 2024).

The effectiveness of FinTech initiatives depends on equipping people with the necessary information and skills to understand and use these solutions effectively. By promoting financial literacy programmes and raising awareness about climate vulnerabilities and adaptation measures, people may make educated financial decisions and use FinTech solutions to reduce risks. Comprehensive policy frameworks are needed to address these difficulties by integrating FinTech innovation into climate change objectives. Policymakers should prioritise promoting investments in green technology and establishing regulatory sandboxes for climate-focused FinTech enterprises to encourage sustainable FinTech practices (Bhowmik, 2022). Creating partnerships between technology companies, financial organisations, and governments is essential for developing innovation ecosystems that support climate action (Busch et al., 2023).

2.2.2.5 Economic growth and financial stability

One of the earliest studies on the relationship between economic growth and financial stability was conducted by Demirgüç-Kunt and Detragiache (1998). They found that financial instability, measured by the frequency and magnitude of banking crises, was negatively related to economic growth. They argued that financial instability can undermine the allocation of resources, reduce investment, and decrease economic efficiency. Another study by Levine and Zervos (1998) found a positive relationship between financial development and economic growth. They argued that financial development, measured by the depth and efficiency of financial markets, can enhance resource allocation, mobilize savings, and promote investment. They also found that the positive relationship between financial development and economic growth was stronger in countries with better legal and regulatory frameworks.

A more recent study by Beck et al. (2010) confirmed the positive relationship between financial development and economic growth but also found that excessive financial development could lead to financial instability. They argued that financial development can create moral hazards, increase systemic risk, and lead to asset bubbles. They suggested that policymakers need to strike a balance between promoting financial development and maintaining financial stability. Another study by Dell'Ariccia et al. (2012) explored the relationship between bank regulation and financial stability. They found that stricter bank regulation, measured by higher capital requirements and lower leverage ratios, was associated with a lower probability of banking crises. However, they also found that excessively strict bank regulation could have negative effects on economic growth, as it could reduce credit availability and increase borrowing costs.

A study by Cerutti et al. (2017) examined the role of macroprudential policies in promoting financial stability. They found that macroprudential policies, such as countercyclical capital buffers and loan-to-value limits, can help reduce systemic risk and prevent financial crises. However, they also found that the effectiveness of macroprudential policies depends on the quality of institutions and the level of economic development. Laeven and Valencia (2012) examined the relationship between financial crises and economic growth in a sample of over 100 countries. They found that financial crises can have long-lasting negative effects on economic growth, with the average loss of GDP growth being around 1% per year for five years after the crisis. They also found that the impact of financial crises on economic growth is more severe in countries with weaker institutions and lower levels of economic development.

Claessens and Kodres (2014) analyzed the relationship between financial sector regulation and systemic risk. They found that while stricter regulation can reduce systemic risk and increase financial stability, the effectiveness of regulation depends on the specific regulatory measures used, as well as the quality of institutions and the level of economic development. They also emphasized the importance of taking a holistic approach to financial sector regulation, which considers the interactions between different types of regulation. Laeven et al. (2016) examined the relationship between bank capital and systemic risk in a sample of over 300 banks from 46 countries. They found that higher bank capital buffers can reduce the probability of systemic risk, but the effect depends on the level of capitalization and the business model of the bank. They also found that the optimal level of bank capital depends on the specific circumstances of the bank and the wider macroeconomic environment.

Beck and Cull (2014) analyzed the impact of bank competition on financial stability in a sample of over 70 countries. They found that higher levels of bank competition can lead to greater financial stability, but the effect depends on the specific institutional and economic context of the country. They also found that the relationship between bank competition and financial stability is non-linear, with too little or too much competition leading to greater financial instability. Dell'Ariccia et al. (2015) studied the impact of credit booms on financial stability in a sample of over 100 countries. They found that credit booms can increase the risk of financial instability, particularly in countries with weaker institutions and lower levels of economic development. They also found that the impact of credit booms on financial stability is greater when accompanied by asset price booms.

Asli Demirguc-Kunt et al. (2018) examined the relationship between financial inclusion and financial stability in a sample of over 100 countries. They found that greater financial inclusion, measured by higher levels of access to financial services, can lead to greater financial stability, but the effect depends on the specific institutional and economic context of the country. They also found that the relationship between financial inclusion and financial stability is non-linear, with too little or too much inclusion leading to greater financial instability. Fernandez and Shaw (2020) analyzed the impact of financial crises on income inequality in a sample of over 100 countries. They found that financial crises can increase income inequality, with the impact being greater in countries with weaker institutions and lower levels of economic development. They also found that the impact of financial crises on income inequality is greater when accompanied by a larger decline in economic growth.

These studies suggest that there is a complex relationship between economic growth and financial stability. Financial development can promote economic growth, but excessive financial development can lead to financial instability. Stricter bank regulation can promote financial stability, but excessively strict regulation can have negative effects on economic growth. Finally, macroprudential policies can promote financial stability, but their effectiveness depends on the quality of institutions and the level of economic development.

2.2.2.6 Moderating effects of FinTech adoption on the relationship between financial literacy and financial inclusion

FinTech has emerged as a disruptive force in the financial industry, with the potential to transform traditional financial services, particularly in regions where access to such services is limited. The concepts of financial inclusion and financial literacy are crucial components of individuals' financial well-being. While there is limited research on the relationship between these concepts and the impact of FinTech adoption, existing studies provide valuable insights into the potential benefits and challenges associated with the integration of FinTech in promoting financial inclusion and enhancing financial literacy.

Several studies have explored the role of FinTech in reducing the gap in financial inclusion. Asli Demirguc-Kunt et al. (2018) found that the implementation of mobile money, a popular form of FinTech, significantly enhances financial inclusion, especially in developing countries. Liu et al. (2021) also suggest that FinTech adoption can improve access to financial services, particularly for underserved groups such as women and rural residents. These findings highlight the potential of FinTech to expand financial inclusion by providing access to a wider range of financial services. The impact of FinTech on financial inclusion goes beyond accessibility to financial services. Financial literacy plays a significant role in individuals' ability to effectively utilize FinTech services and derive benefits from them. Hasan et al. (2023) and Morgan and Trinh (2020) suggest that financial literacy initiatives can enhance individuals' understanding of financial products and services, including those offered by FinTech companies. By improving financial literacy, individuals can better navigate FinTech platforms and make informed financial decisions, ultimately leading to increased financial inclusion.

Recent research has also examined the relationship between FinTech adoption, financial literacy, and financial inclusion. Danladi et al. (2023)found that in countries with higher FinTech adoption rates, financial literacy had a more significant positive impact on financial inclusion. This suggests that FinTech can act as a catalyst in strengthening the link between financial literacy and financial inclusion, thereby enhancing the overall financial well-being of individuals. Various mechanisms may explain how FinTech moderates the relationship between financial literacy and financial inclusion. FinTech platforms often incorporate gamification elements and user-friendly interfaces, making them more engaging and accessible to individuals with limited financial literacy compared to traditional financial institutions(Rahman et al., 2024). Additionally, FinTech companies leverage data analytics and machine learning to customize financial products and services to meet the specific needs of individuals with varying levels of financial expertise.

While FinTech has the potential to promote financial inclusion and enhance financial literacy, it is essential to address potential barriers and risks associated with its adoption. Sangwan et al. (2020) highlighted the importance of mobile money in improving financial inclusion in sub-Saharan African countries, emphasizing the need for user-friendly financial services to assist individuals with limited financial literacy. Regulatory frameworks must also evolve to address challenges such as algorithmic bias, digital literacy, and data privacy to ensure responsible innovation in the FinTech industry.

Studies by Ayaz et al. (2023) in Turkey and Prabhakaran and Mynavathi (2023) in Vietnam further underscore the impact of FinTech adoption on the relationship between financial literacy and financial inclusion. Ayaz et al. (2023) found that areas with higher FinTech adoption rates exhibited a stronger correlation between loan availability and financial literacy, suggesting that FinTech platforms can facilitate access to financing for well-informed individuals. Prabhakaran and Mynavathi (2023) highlighted the importance of FinTech literacy in enhancing overall financial literacy and promoting financial inclusion, emphasizing the need for tailored financial education programs that address the specific requirements of the FinTech industry.

However, it is crucial to recognize that increased access to FinTech does not always translate to improved financial well-being. (Arner et al., 2020) discovered in Tanzania that while FinTech adoption increased financial inclusion, it did not necessarily lead to better financial outcomes. They stress the importance of consumer protection measures and responsible FinTech development to ensure that increased access results in improved financial outcomes. Raj and Upadhyay (2020) analyzed the potential risks associated with the implementation of FinTech in India. Concerns expressed include data privacy, the exclusion of marginalised groups due to a lack of digital literacy, and the necessity for regulatory frameworks to evolve in response to the FinTech industry's transformation.

2.2.2.7 Moderating role of FinTech adoption on the nexus between financial inclusion and climate change

In recent years, the worldwide financial industry has undergone significant transformation due to the exponential growth of FinTech. The escalating international apprehension regarding climate change has compelled various stakeholders to investigate sustainable methodologies in every sector. The potential ramifications of FinTech adoption and the convergence of these two concerns are generating a growing amount of attention concerning endeavours to mitigate and adjust to climate change. Adoption of FinTech solutions may have numerous environmentally detrimental effects. The digitalization of financial services, which eliminates the need for physical infrastructure and paper transactions, is an essential component. Carbon emissions may decrease as a result of the transition to digital platforms in banking operations, including online transactions and paperless statements (Hughes et al., 2019). By facilitating electronic transactions, FinTech advancements such as mobile payment systems and digital wallets help reduce the environmental impact of financial operations (Hwang et al., 2021; Seo & Yoo, 2020).

Blockchain applications, mobile money, and other cutting-edge FinTech possess the capacity to empower communities and individuals who are susceptible to the impacts of climate change while also narrowing the disparity in financial inclusion (Landi, 2023). The utilisation of financial technology (FinTech) may strengthen the positive correlation between financial literacy and financial inclusion, according to Damayanti and Wicaksana (2021). This may make it simpler for individuals residing in remote regions impacted by climate change to obtain critical financial services such as credit, insurance, and savings accounts. The expansion of financial services and the facilitation of financial transactions via mobile money systems in rural areas have increased the resilience of these areas to the impacts of climate change.

Nonetheless, the environmental advantages of FinTech implementation are not indisputable. Carbon emissions and energy consumption have become subjects of concern due to the expanding data centres that support digital financial services and the escalating demand for computing power (Zhu et al., 2023). Furthermore, the generation and elimination of electronic waste are influenced by the production and disposal of electronic apparatus utilised in FinTech operations (Alarood et al., 2023). Therefore, while the incorporation of FinTech may present prospects for ecological sustainability, it is critical to thoroughly assess its wider environmental ramifications.

Despite its environmental repercussions, FinTech adoption has the potential to bolster resistance to climate change through the implementation of innovative financial solutions. An important area of emphasis is the utilisation of FinTech to assist in climate-related insurance and risk management. FinTech platforms can offer customised risk assessment and insurance alternatives to vulnerable populations and businesses confronted with climate-related hazards through the implementation of advanced data analytics and artificial intelligence (Bachmann et al., 2022). This phenomenon strengthens the capacity to acclimatise to climate-related concerns and advances financial inclusion.

In addition, financial technology facilitates the pooling of climate funds and encourages sustainable investment. Financial technology (FinTech) facilitates the reallocation of funds towards sustainable initiatives and projects by employing blockchain-based finance, green bonds, and crowdfunding platforms (Dai, 2020). FinTech platforms bolster investor confidence in sustainable enterprises through the facilitation of transparency and efficiency, thereby contributing to the advancement of a low-carbon economy(Bayram et al., 2022). By facilitating financial access and encouraging climate-smart investments and risk management, FinTech may contribute to the fight against climate change. Shin et al. (2020) analyzed to determine how blockchain technology could improve sustainable project funding traceability, efficiency, and transparency. Furthermore, FinTech firms are devising new financial instruments specifically designed to mitigate climate change-related hazards. For instance, by providing financial protection to farmers against crop failures caused by droughts or floods, mobile-accessible weather index insurance could mitigate the economic impact of climate catastrophes.

Although there exist prospective benefits in merging FinTech with initiatives to tackle climate change, there are also numerous obstacles that hinder the effective utilisation of these prospects. The expansion of climate-aligned FinTech solutions is impeded by regulatory limitations and policy fragmentation; therefore, coordinated national and international efforts are required (Pavlidis, 2022). The unequal availability of digital infrastructure and financial literacy hinders individuals' equitable access to FinTech services, thereby widening socioeconomic disparities in climate resilience (Mhlanga, 2023).

The World Bank Group (2022) emphasises the enduring existence of substantial inequalities in digital literacy and infrastructure, specifically in regions undergoing development. The digital divide may impede fair and equal access to FinTech solutions, further widening pre-existing disparities and restricting the ability of disadvantaged communities to obtain climate-smart financial products. To adequately tackle this predicament, it is imperative to implement focused endeavours that bridge the digital divide and guarantee equitable opportunities to benefit from FinTech. The swift progression of FinTech necessitates regulatory structures that foster both innovation and ethical conduct. It is imperative to give utmost importance to addressing data privacy, security, and algorithmic biases to safeguard consumers and avert greenwashing schemes that deceive regarding the ecological sustainability of financial products (Sadiq et al., 2024).

FinTech initiatives are only as effective as those that provide individuals with the knowledge and abilities required to comprehend and implement these solutions proficiently (Allahham et al., 2024). The dissemination of information regarding climate-related vulnerabilities and adaptation strategies, along with the promotion of financial literacy initiatives, can enable individuals to make informed financial choices and employ FinTech solutions to mitigate these risks. To tackle these challenges, it is imperative to establish all-encompassing policy frameworks that coordinate FinTech innovation with climate change objectives. To incentivize sustainable FinTech practices, policymakers ought to give precedence to the promotion of investments in green technology and the establishment of regulatory sandboxes for climate-focused FinTech enterprises (Wang et al., 2021). Governments, financial institutions, and technology corporations must form alliances to foster innovation ecosystems that promote climate action.

2.2.2.8 Moderating role of financial stability on the nexus between financial inclusion and climate change

The effects of financial stability on the correlation between climate change consequences and financial inclusion are crucial. The effectiveness of financial inclusion efforts in enhancing resilience to climate-related hazards depends on the stability of the financial system since these efforts aim to provide formal financial services to excluded groups. Several empirical researches have explored the complex interactions among climate change, financial stability, and financial inclusion. A study conducted by the International Monetary Fund (2018) highlighted the risk of climate-related events, like natural disasters and extreme weather, causing disruptions in financial markets, reducing asset values, and exacerbating financial vulnerabilities, particularly for individuals and communities facing financial exclusion.

A resilient financial system can act as a buffer, absorbing the financial shocks caused by climate events like floods or droughts. This helps to protect vulnerable populations, who often lack savings and access to credit, from falling deeper into poverty due to climate-related setbacks (George & Merrill, 2021). Financial stability has a role in modulating the availability and accessibility of financial services for climate adaptation and mitigation. Financial inclusion programmes are more effective in countries with stable banking sectors and robust financial systems when providing resources to disadvantaged communities to address climate-related concerns (Issa & Issa, 2020). In financially unstable and risky contexts, concerns about unclear regulations, credit risk, liquidity constraints, and credit risk might hinder the provision of complete financial services (Demirgüç-Kunt et al., 2020).

Financial stability is crucial for carrying out effective financial inclusion projects that improve climate resilience. The accessibility and cost of climate-resilient financial goods and services are influenced by the stability of the financial system (Baptista et al., 2022a). Studies have shown that well-established banking systems and effective financial markets play a crucial role in promoting and disseminating investment opportunities, savings methods, and insurance products tailored to tackle the issues related to climate adaptation and mitigation (Kusuma Ratnawati, 2020). Financial stability fosters an environment conducive to investment. When the financial system is stable, banks and other financial institutions are more likely to offer climate-smart financial products like green bonds and weather index insurance. These products can help individuals and communities invest in renewable energy, climate-resilient infrastructure, and other solutions to mitigate climate change and adapt to its effects (Kusuma Ratnawati, 2020). Market volatility and financial instability may inhibit the adoption of climate-smart financial products and limit households' ability to build adaptive skills in response to climate change (Udeagha & Breitenbach, 2023).

An adaptable financial system with robust risk management frameworks can predict and mitigate climate-related financial hazards proactively. This involves performing stress tests on financial institutions to evaluate their ability to endure climate-related disruptions, promoting responsible lending practices that consider climate risks, and developing innovative financial tools like weather index insurance to reduce particular climate vulnerabilities (Bhattacharyay, 2021). The Hannig and Jansen (2010) research highlights the need to integrate climate risks into financial oversight and rules to protect a secure financial system that can support financial inclusion in the face of climate-related difficulties. Financial inclusion allows communities and people to create financial reserves and handle financial disruptions caused by climate change by offering savings accounts, credit lines, and insurance. Financial inclusion allows individuals and communities to build financial resilience by saving money, accessing credit to rebuild after disasters, and purchasing insurance to protect against climate risks. This financial safety net empowers them to adapt to changing environmental circumstances and recover from climate-induced setbacks (Tsuchiya, 2023).

The Tsuchiya (2023) study shows that people may use financial services to bounce back from setbacks, invest in sustainable livelihoods, and adjust to changing environmental circumstances. Incorporating financial inclusion within a secure financial system improves communities' overall ability to withstand climate-related difficulties. An environment marked by macroeconomic stability, little inflation, and sustained economic development is conducive to advancing financial inclusion and investments that are resilient to climate change. The Nkwi et al. (2023)studies highlight the importance of harmonising financial regulations and policies with climate goals to promote investments in sustainable infrastructure and green technologies, thus enhancing endeavours to combat and adjust to climate change.

Financial inclusion's impact on climate change outcomes is influenced by financial stability via transmission channels. Consumers are more inclined to engage actively in financial markets and employ inclusive financial services to improve climate resilience in the presence of a stable financial system(Talpur et al., 2020). Conversely, occurrences of financial instability and banking crises may erode public trust in financial institutions. This may lead to disintermediation and reduced use of financial goods and services, particularly those intended to address and adjust to climate change (Kanapiyanova et al., 2023). The effectiveness of financial inclusion in managing climate risks depends on the stability of the financial system.

Empirical data suggests that the regulatory and policy environment plays a vital role in connecting climate change resilience, financial inclusion, and financial stability. Regulatory frameworks that enhance prudential monitoring, risk mitigation, and consumer protection support the stability of the financial system and validate the credibility of inclusive financial services as tools for climate adaptation (Luu et al., 2023). Inadequate regulatory oversight and regulatory arbitrage might jeopardise financial stability and impede efforts to expand the supply of climate-resilient financial goods and services (Velasco et al., 2021). Effective governance and regulation are essential to harness the promise of financial inclusion in addressing climate vulnerability. The empirical review suggests that financial stability could have a moderating effect, however there is little empirical data with inconclusive outcomes. Current research primarily focuses on specific aspects of the relationship between financial inclusion, climate change, and financial stability. There is a lack of research exploring the combined effects of these factors or how financial stability could influence them.

2.2.2.9 The moderating effect of economic growth on the association between climate change and financial stability

The relationship between climate change and financial stability is complex and multifaceted, wherein economic expansion significantly impacts this correlation. The intricate interplay between economic development and the repercussions of climate change on financial stability has been the subject of empirical research. Economic development influences the frequency and severity of climate-related disruptions, which is a critical factor in mitigating their effect on financial stability. According to Batrancea et al. (2022), empirical evidence suggests that rapid economic growth could exacerbate the vulnerability of financial systems to climate-related hazards by increasing their exposure to physical and transition risks associated with climate change. Developed infrastructure, urbanisation, and industrialization make burgeoning economies more susceptible to natural disasters, supply chain disruptions, and calamitous weather events. These risks have the potential to place a strain on financial institutions and markets (Diallo et al., 2023).

While economic expansion contributes to prosperity and development, it also heightens the systemic risks that climate change poses to financial stability. The resilience of financial stability is influenced by the capacity of financial systems to withstand and recover from climate-related disruptions, a factor that is in turn impacted by economic development. Research has indicated that due to their enhanced fiscal reserves, robust institutions, and capacity to adapt to disruptions, robust and diverse economies that are undergoing substantial economic growth are more resilient to climate-related risks (Panth, 2021). Economies that are undergoing periods of stagnant or declining development may exhibit heightened vulnerability to disruptions caused by climate change as a result of their constrained capabilities and resources to manage adverse impacts on public finances, employment, and income (Copley, 2023). The ability of financial stability to endure the repercussions of climate change is influenced by economic expansion in both favourable and unfavourable ways.

Economic growth affects the effectiveness of risk management strategies and policy responses intended to safeguard financial stability in a volatile environment, according to empirical research. To bolster the resilience of financial systems in the face of climate-related risks, scholarly investigations have underscored the criticality of proactive adaptation strategies and sustainable investment policies (Borio & Disyatat, 2021). However, rapidly developing economies may present obstacles for policymakers attempting to implement these reforms, including competing objectives and limited resources(Carney, 2021). The magnitude and pace of economic growth could exacerbate social inequalities and the distributional impacts of climate change, posing challenges for inclusive and equitable financial stability policies (Fowowe & Folarin, 2019). The policies and governance structures that supervise financial stability in the context of climate change are impacted by economic development.

Climate change poses significant threats to financial stability through various channels. Prolonged periods of severe weather, rising sea levels, and resource scarcity possess the capacity to disrupt economic activities, cause damage to infrastructure, and lead to financial setbacks. Climate change could exacerbate financial hazards for banks, insurers, and other financial institutions, posing a threat to economic growth and stability, according to research from Zhou et al. (2023). The potential benefits of economic development include enhanced resilience, promotion of financial innovation, and facilitation of resource mobilisation.

By enabling countries to invest in climate-resilient infrastructure, adopt green technology, and implement adaptation strategies, economic development enhances resilience. Investment in climate-resilient infrastructure, such as early warning systems or flood protection systems, may reduce the economic costs of climate catastrophes and preserve financial stability (Warren-Myers & Cradduck, 2023). Countries can bolster their resilience to future disruptions and mitigate the financial risks associated with climate change through the allocation of resources towards climate adaptation.

Economic expansion fosters a conducive environment for financial innovation, which in turn facilitates the development of novel financial products and services that mitigate risks associated with climate change. The research conducted by Agur et al. (2020) places significant emphasis on the potential of innovative financial instruments, such as catastrophe bonds and climate-focused insurance products, to efficiently distribute and mitigate climate-related risks, thereby diminishing their impact on macroeconomic stability (Ilic & Jankovic, 2023). Financial innovation plays a critical role in bolstering climate change resilience by providing governments, businesses, and individuals with strategies to manage unpredictable conditions and mitigate climate-related risks.

Robust economic progress could potentially endow governments with increased financial means to undertake climate mitigation and adaptation initiatives, thereby alleviating enduring fiscal apprehensions. Settle (2022) obtaining financial resources from both the public and private sectors is crucial to facilitate the transition to a low-carbon economy and bolster the capacity to withstand climate-related difficulties. Aiding the transition to more resilient and environmentally benign economic systems, economic development facilitates sustainable resource mobilisation and investment (Tall et al., 2021).

According to the theoretical framework, economic development might exert a moderating influence; however, the empirical evidence is inconclusive and contingent upon the specific conditions. The existing body of research primarily focuses on the detrimental impacts of climate change on financial stability, while relatively few studies have explored the potential mitigating effects of economic development. Further empirical research is necessary to gain a more comprehensive comprehension of how economic development influences the relationship between climate change and financial stability across different countries, regions, and economic conditions. Policymakers and practitioners may be able to devise more effective strategies for mitigating climate risks and bolstering financial stability in an environment changing by addressing these knowledge gaps.

2.2.10 The moderating influence of financial stability on the link between FinTech adoption and climate change

Financial stability plays a crucial role in the adoption of FinTech solutions for climate resilience. Study indicates that the stability of financial institutions and markets can significantly influence the success of FinTech businesses in developing innovative solutions for climate-related challenges. This stability is essential for the successful scaling and implementation of FinTech solutions, as it helps to mitigate the impact of climate change on the environment (Ashraf, 2022). Robust banking systems help financial institutions integrate climate risk assessment tools into their decision-making processes, allowing banks to better manage climate-related risks in their investment and lending activities (Battiston et al., 2021). Promoting financial stability encourages the development of climate-friendly technology and business models by boosting investor confidence and attracting funding to FinTech enterprises (Landi, 2023).

Financial stability enables the adoption and general approval of financial technology innovations that help in addressing and adjusting to climate change. For FinTech to have a meaningful impact on climate change adaptation and mitigation, it is critical to prioritise financial stability. Financial stability refers to a robust financial system that can withstand shocks and maintain vital financial services. Ahenkan (2020) research highlights how climate-related events, such as natural catastrophes and extreme weather, may harm financial markets by reducing asset prices and worsening financial weaknesses. A stable financial system may act as a protective barrier, ensuring continuous access to FinTech solutions for communities and people, particularly those most vulnerable to the impacts of climate change, by averting major financial disruptions.

Conversely, the stability of financial institutions may influence the direction and focus of FinTech innovations in response to climate change. Werth et al. (2023) discovered that investors and risk-averse financial institutions may choose FinTech solutions that provide instant financial benefits above long-term sustainability goals. The absence of supportive legal frameworks and incentives for climate-aligned investments may hinder the implementation of financial technology in areas such as sustainable agriculture, renewable energy, and green finance (Claessens & Rojas-Suárez, 2020). Investors may hesitate to support FinTech enterprises and initiatives focused on addressing or adapting to climate change owing to worries about financial stability, such as credit risk and market volatility (Suryono et al., 2020). The progress and speed of FinTech developments in addressing climate-related challenges depend on the stability of financial systems.

Financial stability helps reduce the negative effects and interconnected risks related to using FinTech to address climate change. FinTech technologies provide opportunities to enhance transparency, efficiency, and inclusion in financial markets. Nevertheless, they also introduce new vulnerabilities and hazards, such as cyber-attacks, breaches of data privacy, and issues of regulatory compliance (Buckmann et al., 2021; Djenna et al., 2021). The ability of institutions and markets to endure and mitigate the possible negative impacts of disruptions from FinTech depends on the stability of financial systems (Demirgüç-Kunt et al., 2021). Strong regulatory frameworks and risk management procedures help protect financial institutions from climate-related concerns by reducing the systemic risks linked to the implementation of FinTech, as discussed by Singh (2022).

The influence of financial stability on how FinTech adoption affects climate change resistance is crucial. Implementing robust risk management frameworks in a secure financial system may help drive the adoption and advancement of innovative FinTech solutions designed to address climate-related risks. This includes promoting responsible financing practices that include climate vulnerabilities, urging FinTech platforms to provide weather index insurance products, and fostering responsible investing methods that prioritise sustainability. According to research by the Financial Stability Board (2020), creating a favourable environment for incorporating climate risks into financial regulation and monitoring is essential for the development and implementation of climate-resilient FinTech solutions.

Financial stability fosters an environment conducive to financial inclusion, enabling broader access to financial services including credit, insurance, and savings. This enables communities and people to invest in sustainable livelihoods that can withstand the effects of climate change, adopt eco-friendly habits, and use climate-focused financial tools offered by FinTech platforms. Research released by the Hussain and Rasheed (2023) suggests that financial inclusion may help mobilise financial resources at the individual and community levels to support investments in climate mitigation and adaptation activities. Financial stability promotes the flow of cash into sustainable ventures and boosts investor confidence. This might encourage the acceptance and advancement of financial technology solutions that support the establishment of climate-resilient infrastructure, renewable energy projects, and environmentally friendly technologies.

Ratnawati and Yuana (2022) highlight the need to align financial policies and regulations with climate goals. Aligning with this is essential to promote sustainable financial technology progress and attract investments aimed at tackling climate concerns. The theoretical framework suggests that financial stability could have a moderating effect, but there is not enough empirical data to support this claim, thus more inquiry is needed. The existing study mostly focuses on certain aspects of the relationship between financial stability, climate change, FinTech adoption, and climate change. Few studies investigate the relationship between these factors and how financial stability might moderate their influence.

2.2.2.11 The joint moderating influence of financial development and regulatory quality on the relationship between economic growth and financial stability

A complex interplay exists among institutional components, economic mechanisms, and the robustness of the financial system regarding the joint influence of financial development and regulatory quality on the correlation between financial stability and economic growth. The objective of empirical research is to examine how the interplay between financial development, regulatory quality, and economic growth affects the stability of financial systems, thereby influencing sustainable development and economic stability as a whole.

Financial development, encompassing the efficiency, scope, and comprehensiveness of financial intermediation, plays a pivotal role in alleviating the adverse impacts of economic growth on financial stability. Scholarly investigations suggest that resilient financial institutions possess the capacity to efficiently assimilate and allocate capital, thereby reducing the likelihood of financial imbalances and systemic risks associated with rapid economic expansion (Lee et al., 2021). Financial systems are more resistant to external disruptions and cyclical fluctuation when robust banking sectors and diverse capital markets facilitate the sharing of risks and supply liquidity (Ellis et al., 2022). Also, Beck (2023) states that financial innovation and profundity enable governments, corporations, and families to efficiently manage financial risks and establish reserves to combat economic fluctuations by facilitating the provision of a wide range of financial products and services. Financial stability is moderated by the impact of economic expansion via financial development.

In several ways, economic development may impact financial stability. It has the potential to furnish financial institutions with the means to expand their operations and improve their approaches to risk management. Potentially leading to the development of novel financial products and services that mitigate risks and enhance financial stability, economic expansion could inspire financial innovation. An unsustainable or expeditious expansion of the economy has the potential to compromise financial stability. Potential consequences of asset inflation, excessive credit expansion, and systemic vulnerabilities include financial crises and economic disruptions.

The extent to which financial development mitigates hazards to economic growth is contingent upon the efficacy of regulatory frameworks and oversight agencies. Regulatory quality pertains to the transparency, consistency, and effectiveness of enforcement mechanisms and regulations that supervise financial institutions and markets (Cigu et al., 2020; Nwosu et al., 2021). According to Sodokin et al. (2023), empirical evidence suggests that strong regulatory bodies can enhance the stability of financial systems through the mitigation of moral hazard, reduction of information asymmetries, and enforcement of compliance with prudential regulations. Strict banking regulations and processes safeguard the stability of financial institutions and prevent engagement in excessively risky activities that occur during periods of economic expansion (Anginer et al., 2021). Butt and Ain (2023) state that transparent and effectively enforced securities regulations bolster investor confidence and market integrity, thereby enhancing financial stability as a whole.

To control the impact of economic expansion on financial stability, financial development which comprises the efficacy, profundity, and scope of financial markets and institutions is crucial. Levine (2021) conducted research which indicates that sophisticated financial systems are more adept at managing disruptions, mitigating financial risks, and facilitating optimal resource allocation. Consequently, these systems foster financial stability, even during periods of rapid economic expansion. As financial vulnerabilities intensify and the likelihood of financial crises increases, underdeveloped financial systems may exacerbate the adverse effects of economic expansion.

The quality of financial regulation, encompassing the transparency and effectiveness of regulatory frameworks and supervisory approaches, is crucial in establishing a link between financial stability and economic development. Robust regulatory frameworks may reduce hazardous behaviour in financial institutions, increase financial inclusion, and maintain the stability of financial institutions, thereby contributing to a more secure financial system, according to Anarfo and Abor (2020). Inadequate regulatory frameworks have the potential to exacerbate financial vulnerabilities, moral hazards, and the adverse impacts of economic development on financial stability.

In conjunction with policy responses and country-specific institutional frameworks, financial development and regulatory integrity moderate the effect of economic expansion on financial stability. When analysing the influence of financial factors on economic stability, it is imperative to consider historical events and institutional diversity, according to research (Sun et al., 2022). Nations that possess resilient financial systems and regulatory frameworks are more capable of withstanding economic crises and abrupt economic growth (Cihak & Sahay, 2020; Hoekstra, 2021). Nations characterised by underdeveloped financial sectors and inadequate regulatory frameworks may encounter heightened financial instability and vulnerability to economic downturns, notwithstanding the presence of moderate rates of economic growth (Tyson, 2021). Financial stability is moderated to some extent by the interaction between regulatory quality and financial development. Robust regulatory frameworks and a sophisticated financial system enable the efficient allocation of resources, mitigation of risks, and preservation of financial stability, even during periods of rapid economic expansion. Economic expansion may engender more severe repercussions due to underdeveloped financial systems and inadequate regulatory frameworks, thereby heightening the threshold for financial instability.

In their comprehensive cross-country study, Beck (2020) examined the interconnections between financial stability, regulatory quality, economic growth, and financial development. The research findings indicate that nations equipped with sophisticated financial systems and strong regulatory institutions were more successful in mitigating the adverse effects of economic volatility on financial stability. Even during periods of rapid economic expansion, enhanced banking regulations and effective oversight systems were associated with a decreased likelihood of banking crises and extensive financial disruptions.

The relationship between regulatory quality and financial development as it relates to the resilience of financial systems against external disruptions was the subject of a study by (Allioui & Mourdi, 2023). Using panel data methods, the researchers discovered that countries characterised by robust financial development and transparent regulatory practices exhibited greater resilience to economic disruptions, including currency crises and sudden capital outflows. The study placed considerable emphasis on the criticality of regulatory consistency and enforcement in maintaining investor confidence and market trust in the face of economic instability.

Phan et al. (2021) conducted an empirical study to examine the impact of regulatory quality on the relationship between financial stability and economic development. Through the examination of data spanning multiple decades and numerous countries, the study identified a correlation between improvements in regulatory quality and a reduction in the likelihood of financial crises as well as an increase in the capacity to endure economic downturns. Regulatory actions, such as capital adequacy requirements and risk-based supervision, are critical for preserving the stability of the financial system in a variety of economic conditions. The empirical research offers compelling evidence regarding the interplay between financial development, regulatory quality, and the correlation between financial stability and economic growth.

Robust regulatory frameworks and robust financial institutions contribute to sustainable development and economic resilience by enhancing the capacity of financial systems to endure disruptions, efficiently allocate capital, and enforce prudential obligations (Campiglio, 2019). Further research is necessary to examine how the interplay of economic dynamics, regulatory frameworks, and financial elements impacts financial stability outcomes across different institutional contexts. The theoretical approach posits that financial development and regulatory quality may moderate the relationship in tandem; however, the empirical data is inconclusive and requires additional research. Few studies have investigated the collective effects of economic growth, financial development, financial stability, and regulatory quality, let alone their shared moderating effect. Presently, the majority of research focuses on examining individual components of the correlation among these variables.

2.3 Research Framework and Hypotheses Development

The research framework and hypotheses development are essential components of any study as they provide a systematic and structured approach to conducting research. The research framework serves as a blueprint for the study, outlining the main variables, concepts, and relationships that will be investigated. On the other hand, hypothesis development involves formulating testable statements that are based on the research questions and objectives. In the context of the study on financial literacy, financial inclusion, climate change, economic growth, and financial stability in SSA countries, the research framework and hypotheses development will provide a structured approach to investigating the complex relationships between these variables (Grant & Osanloo, 2014). The framework guides the identification and measurement of key variables, while hypotheses development helps to test the proposed relationships between these variables. Ultimately, the research framework and hypotheses development helps to ensure that the study is conducted rigorously and systematically, with clearly defined objectives, research questions, and testable hypotheses.

2.3.1 Grand research framework

The grand research model employs a holistic methodology to examine the complex interconnections among financial inclusion, FinTech adoption, financial stability, economic development, climate change, and regulatory quality in SSA countries. Each individual sub-model contributes to the development of a holistic comprehension by demonstrating the interdependencies among different facets. The sub-model of financial inclusion and FinTech adoption (H1a, H1b) serves as the stimulus for the model. Within this particular framework, a correlation emerges between FinTech and financial literacy, which serves to augment the accessibility of financial services. Through facilitating active participation in the broader economic and environmental aspects explored in the model, financial inclusion empowers individuals and communities.

Expanding on the existing foundation, the financial inclusion, climate change, and financial stability sub-model emphasises the capacity of financial inclusion to resolve climate change (H2a). An increased supply of financial resources facilitates the participation of individuals and businesses in sustainable endeavours, including investments in climate-resilient agriculture and renewable energy. Adoption of FinTech facilitates concentrated investments in sectors that exhibit resilience to climate change, thereby augmenting this advantageous outcome (H2b).

Stability of finances is an essential component of the model. A resilient financial system may facilitate these climate-resilient investments (H2c) more efficiently, while also mitigating the negative impacts of climate change on economic activity (H3a). In addition, the existence of financial stability fosters a conducive environment that facilitates the growth of the economy (H5a). The sub-model pertaining to economic growth and climate change acknowledges the complex interrelation that exists between these two factors. Economic growth might provide the resources required for adapting to and mitigating climate change (H3b), despite the fact that climate change could impede economic development (H3a).

The sub-model of FinTech adoption and climate change emphasises the direct contribution of FinTech adoption to mitigating the consequences of climate change, in addition to its promotion of financial inclusion (H4a). These technologies may facilitate and support infrastructure and activity investments that are favourable to the environment. The presence of financial stability fosters an environment that is more favourable for the development of innovative FinTech solutions (H4b). The sub-model concerning economic development and regulatory quality recognises the importance of strong regulations in encouraging prudent financial behaviour and reducing systemic risks (H5c). As a result of bolstering the stability of the financial system, the enforcement of these regulations fosters economic growth (H5a).

The sub-model of financial development places significant emphasis on the role of financial development in regulating the relationship between financial stability and economic growth (H5b). A sophisticated financial system offers superior risk mitigation instruments in relation to economic expansion.

Through the integration of multiple sub-models into a cohesive research framework, this study achieves a comprehensive understanding of the interconnectedness of these elements within the context of SSA countries.

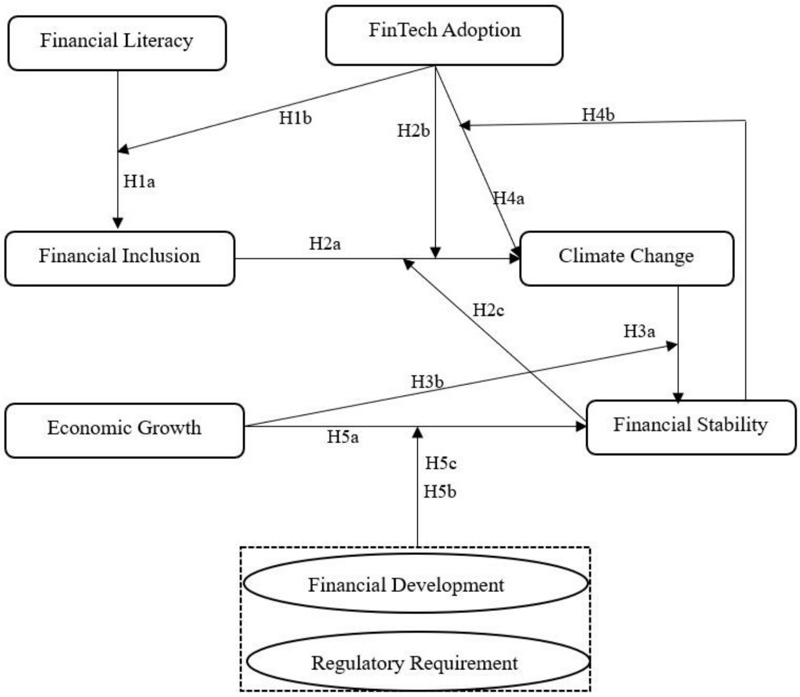

Figure 2.1 Grand Research Framework

Source: Author’s Construct (2024)

By combining these sub-models into a grand research model, the research gains a comprehensive understanding of the interconnectedness of these factors in the context of SSA countries. It explores how financial inclusion, FinTech adoption, and financial stability can work together to promote economic growth and mitigate the negative impacts of climate change. Regulatory quality is also highlighted as a crucial factor in creating an environment that supports these positive developments. The model underscores the importance of financial inclusion, FinTech adoption, and financial stability in fostering a more sustainable future for SSA countries.

2.3.2 Hypotheses

2.3.2.1 Relationship between FinTech adoption, financial literacy and financial inclusion

Several studies have shown a strong connection between financial inclusion and financial literacy. Individuals with high financial literacy can effectively use financial products, manage their funds, and make informed financial decisions, potentially leading to increased access to financial services like savings accounts and credit. Studies by Hasan et al. (2024) highlighted a positive correlation between financial literacy and financial inclusion, indicating that those with higher financial literacy are more likely to access formal financial services. Initiatives to improve financial literacy, as suggested by Huang et al. (2024), have the potential to enhance financial inclusion by empowering individuals to make better financial choices and manage their money wisely. Based on the discussions, the following hypothesis is formulated:

H1a: Financial literacy has a significant positive relationship with financial inclusion in SSA countries.

The adoption of FinTech can influence the relationship between financial inclusion and financial literacy in various ways. FinTech solutions can enhance financial literacy by providing user-friendly platforms and tools that improve access to financial services and simplify financial management, especially for individuals with limited financial knowledge (Canguende-Valentim et al., 2024). This can potentially strengthen the positive effects of financial literacy on financial inclusion. FinTech adoption may also reduce the need for extensive financial knowledge, as intuitive mobile money services can enable individuals to perform basic financial transactions without deep financial understanding (Mutamimah & Indriastuti, 2023). However, there is a lack of empirical research on this relationship in SSA, where the effects of FinTech implementation may vary based on factors like cultural perspectives on technology, smartphone accessibility, and digital infrastructure (Singh et al., 2020). The literature suggests that FinTech can influence the relationship between financial inclusion and financial literacy in SSA countries, with a moderating effect that enhances financial literacy (Aloulou et al., 2023). Thus, the hypothesis is proposed as follows:

H1b: FinTech adoption moderates the relationship between financial literacy and financial inclusion in SSA countries.

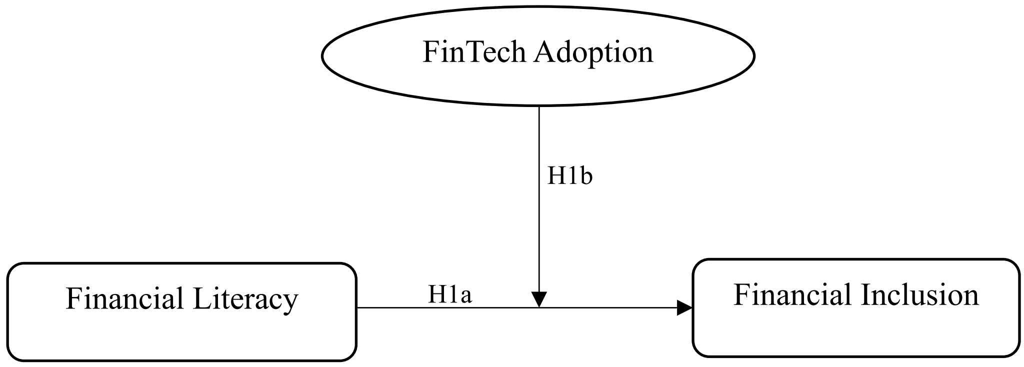

Figure 2.2 Hypothesis 1 Research Framework

Source: Author' Construct (2024)

2.3.2.2 Relationship between FinTech adoption, financial stability, financial inclusion and climate change

The relationship between climate change and financial inclusion is a growing area of interest, lacking empirical evidence but supported by theoretical reasoning. Financial inclusion can empower individuals and communities to adopt sustainable practices and mitigate climate change impacts by providing access to resources like savings and insurance (Chinoda & Kapingura, 2024). However, there is a lack of comprehensive empirical studies focusing on SSA nations, where the relationship between climate change and financial inclusion may vary based on factors like regional climate conditions, available financial services, and financial literacy levels (He et al., 2022). Extent research suggests a positive relationship between financial inclusion levels and awareness and action on climate change in these countries (Baptista et al., 2022b; Chitimira & Warikandwa, 2023). The hypothesis is therefore developed as follows:

H2a: Financial inclusion has a significant and positive nexus with climate change in SSA countries.

FinTech adoption can play a crucial role in addressing the correlation between climate change and financial inclusion. By enabling investments in climate-resilient sectors like agriculture and renewable energy, FinTech solutions can enhance the positive impact of financial inclusion on climate change (Allahham et al., 2024). These technologies can increase access to financial services, particularly in unbanked communities, thereby aiding in the fight against climate change (Allahham et al., 2024). However, there is a lack of research on how FinTech adoption influences the relationship between financial inclusion and climate change in SSA (Vijaya et al., 2023). The moderating effect of FinTech may vary across different African nations and the types of solutions available. Robust financial institutions and systems can encourage investments in sustainable technologies, further boosting the benefits of financial inclusion in climate change mitigation. Funding preventative measures adaptation strategies, and financial stability can help communities cope with climate-related financial risks (Mhlanga, 2022a). based on the discussions in literature, the following hypotheses are proposed:

H2b: FinTech adoption moderates the positive nexus between financial inclusion and climate change in SSA countries.

H2c: Financial stability positively moderates the nexus between financial inclusion and climate change in SSA countries.

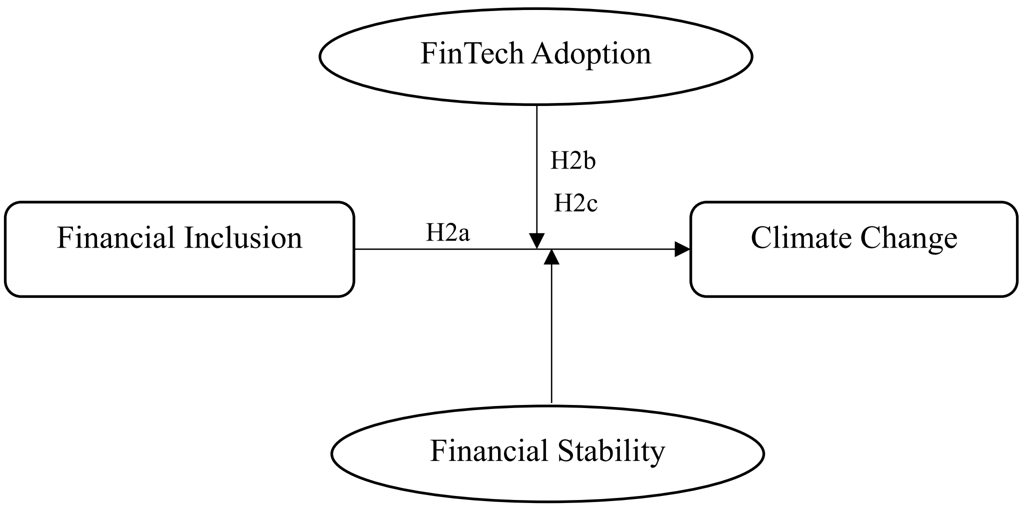

Figure 2.3 Hypothesis 2 Research Framework

Source: Author' Construct (2024)

2.3.2.3 Association between economic growth, climate change and financial stability

Ozili and Iorember (2023) suggest an inverse relationship between financial stability in Sub-Saharan African nations and climate change. It highlights those severe consequences of climate change, like droughts and extreme weather events, can challenge financial stability by disrupting critical sectors such as agriculture and tourism. This disruption can lead to economic setbacks, decreased productivity, increased insurance payments, loan defaults, and asset losses (Brunetti et al., 2021). The unpredictability of climate risks may deter investments in long-term projects and critical infrastructure, hindering economic growth and financial stability. The hypothesis implies that countries facing severe climate change impacts may struggle to maintain financial stability due to the strain on financial institutions and the broader financial system. The following hypothesis is stated based on the literature discussed as follows:

H3a: There exists a significant negative effect association between climate change and financial stability in SSA countries.

Economic development can moderate the relationship between climate change and financial stability, particularly in SSA countries. The hypothesis argues that strong economies have more resources to allocate towards climate adaptation and mitigation efforts, such as developing drought-resistant crops and improving early warning systems (Farooq et al., 2023). Investments in climate resilience can enhance financial stability by reducing economic disruptions and losses caused by climate change. Diversified economies are less vulnerable to climate change impacts, as certain industries may be less affected than others (Rjoub et al., 2021). Economic growth can lead to improved financial institutions and increased government revenues, which can enhance financial stability and resilience to climate-induced economic disruptions (Quispe-Adauto et al., 2023). Thus, the hypothesis posits that rapid economic development can make countries more resilient to the negative effects of climate change on financial stability.

H3b: Economic growth moderates the negative association between climate change and financial stability in SSA counties.

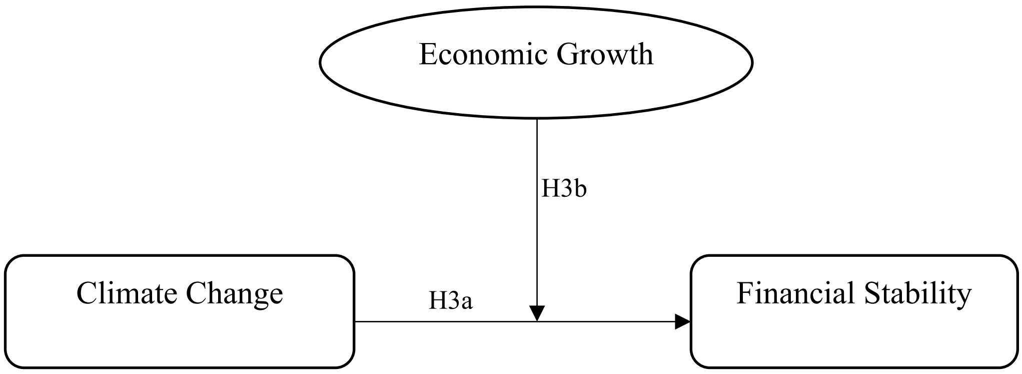

Figure 2.4 Hypothesis 3 Research Framework

Source: Author' Construct (2024)

2.3.2.4 Relationship between financial stability, FinTech and climate change

The adoption of FinTech in SSA countries holds promise in mitigating climate change through various means. FinTech solutions can facilitate investments in sustainable agriculture, green infrastructure, and renewable energy, thereby accelerating the shift towards a low-carbon economy and reducing the impacts of climate change (Sadiq et al., 2024). Providing access to financial services for unbanked populations and promoting financial inclusion, FinTech can empower individuals and organizations to engage in climate-friendly initiatives like adopting energy-efficient technologies and sustainable practices (Udeagha & Ngepah, 2023). Additionally, platforms like micro-savings and weather index insurance can help communities and individuals manage climate-related financial risks, enhancing their resilience to environmental challenges (Allahham et al., 2024).

While the potential benefits of FinTech in addressing climate change are significant, there is a lack of empirical research specifically exploring the link between FinTech adoption and climate change outcomes in SSA (Abor et al., 2022). The impact of FinTech on climate change mitigation may vary across countries in the region due to factors such as the diversity of available FinTech solutions, levels of financial literacy and digital engagement, and unique country circumstances (Hassan et al., 2020). Thus, the adoption of FinTech in SSA has the potential to positively impact climate change mitigation and adaptation efforts. Through increased access to financial services, support for sustainable investments, and risk management tools, FinTech can play a crucial role in building resilience and promoting environmentally conscious practices (Senyo et al., 2022). Based on the supposition, the following hypothesis is formulated as follows:

H4a: FinTech adoption has a significant positive relationship with climate change in SSA countries.

Financial stability has a moderating influence on the relationship between FinTech adoption and climate change mitigation (Sadiq et al., 2024). It suggests that a stable financial sector could create a conducive environment for innovative FinTech solutions targeting climate-related challenges. The stability in the financial sector may facilitate the development and deployment of FinTech solutions designed to mitigate climate-related financial risks, such as microloans for post-disaster recovery or weather insurance products (Song & Hao, 2024). This could potentially enhance the effectiveness of FinTech in addressing the adverse impacts of climate change. Studies also highlight the importance of sustainable infrastructure and environmentally friendly technology initiatives receiving support from well-established financial systems, which could boost the efficacy of FinTech solutions facilitating such investments (Boot et al., 2021; Hanafizadeh & Amin, 2023). Moreover, there is a lack of empirical data on the moderating effect of financial stability on the relationship between FinTech adoption and climate change in SSA (Oanh, 2023). It suggests that factors like regulatory frameworks, financial stability indicators, and economic development levels in different SSA countries could influence this relationship (Banna & Alam, 2021a). The influence of financial stability on the connection between climate change and FinTech adoption in SSA is deemed significant. Based on the discussions, the following hypothesis is formulated as:

H4b: Financial stability moderates the positive relationship between FinTech adoption and climate change in SSA countries

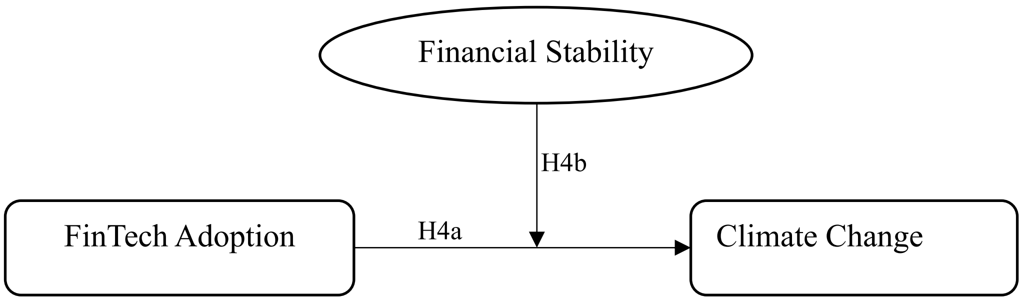

Figure 2.5 Hypothesis 4 Research Framework

Source: Author' Construct (2024)

2.3.2.5 Relationship between financial development, regulatory quality, economic growth and financial stability

Financial sector stability plays a crucial role in mitigating the effect of FinTech adoption on climate change. A secure financial infrastructure can facilitate the development and implementation of innovative FinTech solutions aimed at addressing climate-related challenges (Borio et al., 2023). These solutions, such as microloans for post-disaster recovery and weather insurance products, can help reduce climate-related financial risks (Borio et al., 2023). Additionally, established financial systems can support sustainable infrastructure and environmentally friendly technology projects, enhancing the effectiveness of FinTech solutions in enabling these investments. However, there is a lack of empirical evidence specifically exploring how financial stability influences the relationship between FinTech adoption and climate change in SSA (Kaur, 2023a). Factors such as legal frameworks for FinTech innovation, unique financial stability indices of different SSA nations, and levels of economic growth can influence the extent and nature of this moderating influence (Ngalawa & Derera, 2023). The study therefore theorised that:

H5a: Economic growth has a significant and positive relationship with financial stability in SSA countries.

Furthermore, financial development plays a crucial role in shaping the relationship between financial stability and economic growth (Rjoub et al., 2021). A sophisticated financial system can enhance resource allocation towards productive investments, thereby boosting economic progress and financial stability (Asante et al., 2023). Risk management instruments like insurance products and derivatives offered by advanced financial markets help individuals and organizations mitigate financial risks associated with economic fluctuations, promoting stability (P. K. Ozili, 2023). Robust financial institutions formed through financial development adhere to enhanced risk management protocols and regulations, strengthening the overall resilience of the financial system. In SSA countries, the influence of financial development on the correlation between economic growth and financial stability may vary due to factors like economic advancement, available financial institutions, and specific conditions (Abeka et al., 2021). Countries with more sophisticated financial systems in the region might experience a stronger link between economic growth and financial stability (Huang et al., 2021). The following hypothesis is formulated as follows:

H5b: Financial development positively moderates the relationship between economic growth and financial stability in SSA countries.

Regulatory quality plays a crucial role in shaping the relationship between financial stability and economic development. Strict regulations ensure that financial institutions operate prudently, manage risks effectively, and comply with laws, reducing reckless behaviour and promoting stability even during rapid economic growth (Ali et al., 2023). Well-implemented regulations can enhance transparency, competition, and fair market practices, encouraging responsible financial behaviour and reducing systemic risks. This, in turn, boosts investor confidence, attracting both domestic and international investments, and thereby fostering financial stability and economic growth (Ofoeda et al., 2024). However, there is a lack of research on the specific impact of regulatory quality on the financial stability and economic development relationship in SSA. Factors like political stability, regulatory frameworks, and enforcement systems can influence this relationship in different countries in the region (Degbedji et al., 2024). Financial stability is closely linked to economic development in SSA, especially in countries with strong regulatory quality. Based on the discussion in the literature, the following hypothesis is proposed:

H5c: Regulatory quality moderates the positive relationship between economic growth and financial stability in SSA countries.

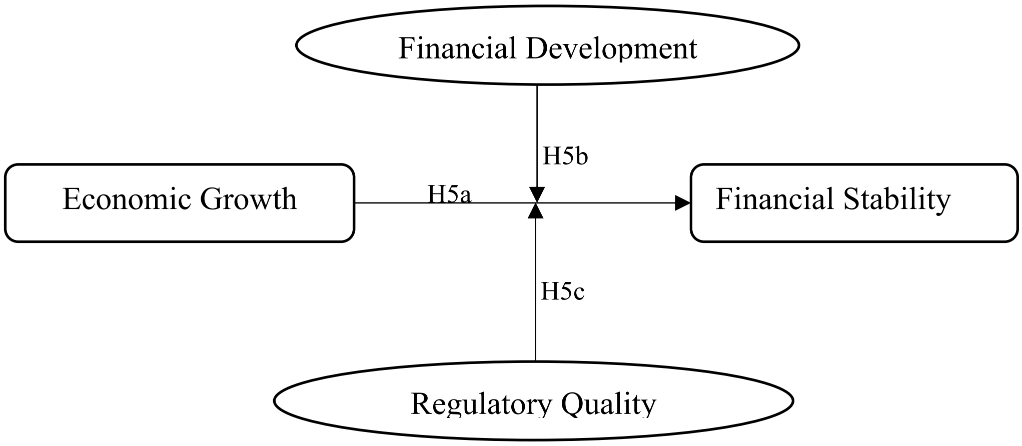

Figure 2.6 Hypothesis 4 Research Framework

Source: Author' Construct (2024)