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**Master Thesis U.S.E.**

# The Effects of FinTech and Financial Development on Economic Growth

**MSc Financial Management**
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## Abstract:

From mobile payment solutions in emerging economies to online banking services in developed countries, technology is revolutionizing the way people access and manage their finances globally. This research aims to investigate the impact of financial technology and financial development on economic growth in countries with different levels of economic and financial development. Specifically, it seeks to explore whether financial development influences the relationship between economic growth and FinTech in a positive way; and whether the separate effects of FinTech and financial development on future economic growth are positive. The research question is addressed through a cross-country analysis using a panel data regression model, which incorporates fixed-effects variables for both year and country, covering a span of nine years and including data from 102 countries. The results prove that financial development does have a positive impact on GDP per capita growth, but FinTech does not. However, it is inferred that FinTech has a greater positive impact on economic growth in countries with higher levels of financial development.

**Keywords:** Economic Growth, Financial Development, Financial Technology, World, Panel Data, Cross-country analysis, Development Indicators.

**JEL-codes:** F36; P52.

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# 1 Introduction

How FinTech and financial development affect economic growth has proven to be a notorious topic of discussion in recent years. Financial technology, or FinTech, has developed as a rapidly expanding industry, revolutionizing how consumers access and manage their finances. As a result of the new financial products and services that have been made possible by technology, individuals and companies have greater opportunities to access financial services easily and quickly. The most well-known FinTechs are peer-to-peer lending, cryptocurrencies, mobile payments, etc. Financial technology has emerged as a game-changer in the financial industry, particularly in the area of financial inclusion. FinTech has the ability to reach and include the financially excluded people, including low-income households, small businesses, and marginalized groups, by providing them with access to affordable financial services, such as mobile banking, digital payments, and microfinance. As a result, FinTech has the potential to reduce poverty and promote economic development in underserved communities.

Since this thesis includes a cross-country analysis for countries with different levels of development, financial and economic, it is important to consider financial inclusion as part of financial development. With the progression of the financial industry around the globe, in today's world every country has some form of financial sector. The size and complexity of the financial sector may differ considerably depending on the level of economic development and the regulatory and political environment. On one hand, developed countries have significantly more advanced financial systems than developing countries. On the other hand, even the smallest and least developed economies usually have some basic financial services available. The process of providing people and companies who are generally excluded from financial services such as banking, credit, insurance, and payment systems access is known as financial inclusion. With all that being said, for the purpose of the research, the term financial inclusion will be considered as part of financial development in underdeveloped countries. Financial development should prioritize financial inclusion since it can improve the financial system's accessibility and efficiency, which may result in greater economic growth and the reduction of poverty.

The individual impacts of financial development and financial technology on economic growth have been the subject of many papers, and have proven to be a significant topic of discussion. On the other hand, not a lot of study has been done on how financial

development influences the link between economic growth and FinTech, even though it is a very important field to study and it would implicate further research and improvement. The few studies that have been done on this subject have proven that there is a positive effect on economic growth in countries with more developed financial sectors (Feyen et al., 2022; Haftu, 2019). This suggests that financial technology can be a more effective driver of economic growth in countries that already have a more advanced financial sector, while in less developed countries, other factors such as improving financial infrastructure, improving financial literacy and greater regulations might be more important.

Firstly, financial technology development is the first measure to test its effects on economic growth, and following that the impact and direction of financial development on GDP per capita growth is checked, therefore, becoming main variables for the analysis. Additionally, the influence of controls like inflation, population growth, trade openness, and government expenditure on these variables are of significant interest. This is done by including these indicators as control variables, while using fixed-effects for year and country. The implementation of an interaction term for the main variables, FinTech and financial development is the key component of the analysis and the answer to the question. In addition, various tests are done, including asymmetry analysis, and assessment of multicollinearity. Adjustments are made based on the results of these tests, and heteroskedasticity is addressed using robust standard errors. The regression results are presented in a way that allows for sensitivity testing. Additionally, an alternative specification is utilized to address causality. Also, alternative proxies are used for economic growth and financial development, and a separate analysis is conducted to compare countries at different levels of economic development, considering the potential variations in the impact of FinTech and financial development on economic growth.

The results from the analysis indicate that financial technology development has a greater positive impact on economic growth measured by GDP per capita growth in countries that are more financially developed. The impact of financial development on economic growth is also proved to be positive and significant. However, contrary to evidence from previous research, FinTech development does not impact economic growth as expected, with the result showing insignificance. These findings could inspire more research into the policy implications of the findings, including the development of regulatory frameworks and financial education projects that might promote financial development and financial technology. Further, this information might be helpful for investors and regulators who wish

to invest funds and create policies that support financial and economic development. Additionally, researchers could examine the impact of financial technology development and financial development on income inequality and poverty, as greater economic growth may not necessarily mean reduced inequality and poverty.

The remainder of this paper is therefore structured as follows: a literature review of previous academic papers regarding the relations between financial development, financial technology and economic growth, as well as regulation, financial exclusion, inequality and poverty, is displayed in section 2; in section 3, the data sources and methodology are presented; section 4 shows the empirical analysis and the interpretations of the results; and lastly, section 5 concludes the research.

# 2 Literature review

## *2.1 Financial technology, financial development and regulation*

Most studies suggest that financial technology (FinTech) is positively impacting financial inclusion by improving access to financial services. Additionally, it is also proven that other determinants significantly influence this relationship, such as: education, income, and employment status (Nandru, Chendragiri and Velayutham, 2021). Moreover, a study from Olanrele and Awode (2022) concludes that FinTech is positively changing the pattern of financial inclusion in countries in Sub-Saharan Africa. However, they also prove that the adoption and usage of FinTech is low, particularly among disadvantaged societies. Furthermore, the results from Yermack's (2018) analysis reveal that the success of M-Pesa in Kenya is exceptional, as the research additionally highlights how the expansion of FinTech companies has been limited in other industries and countries, and how it has only just begun to pick up speed from a low starting point. In addition, Goyal and Chakrabarti (2020) provide evidence from India which proves that the adoption of FinTech has enabled the goal of financial inclusion to create enhanced social and financial empowerment and drive economic participation in rural areas. Similarly, in Malaysia, the adoption of FinTech is shown to benefit the financial development of the country (Othman, Zaghlol and Ramdhan, 2021). Moreover, between 2014 and 2017, the share of account owners using their accounts for digital payments in high-income countries grew by only 5 percent, however in developing economies, it increased by 10 percent (Demirgüç-Kunt, Hu and Klapper, 2019). Mobile banking services are particularly attractive to the financially excluded, however basic

financial education is needed to ensure people understand how to use digital financial products effectively (Gutierrez and Singh, 2013; Ansar, Klapper and Singer, 2023).

It has been proven many times that FinTech has a significant positive effect on financial development (Lavrinenko, 2023; Olanrele and Awode, 2022; Gutierrez and Singh, 2013; Othman, Zaghlol and Ramdhan, 2021; Michael, 2021; Kanga, Oughton, Harris and Murinde, 2021; Rose Innes and Andrieu, 2022; Demirgüç-Kunt, Klapper and Singer, 2017; Ernst & Young, 2019). Lavrinenko's (2023) research shows a favorable relationship between financial development and the depth and efficiency of financial markets and financial institutions' depth. This is due to the ability of financial institutions, both traditional banks and FinTech services, to attract more deposits and savings from consumers. However, the study also shows that there is a negative correlation between FinTech and financial institutions access, particularly in areas with a low number of commercial bank branches and ATMs per 100,000 people. On the other hand, in developing economies, the use of digital payments has grown rapidly, outpacing growth in account ownership (Demirgüç-Kunt, Klapper, Singer and Ansar, 2022). According to Musabegovic, Özer, Djukovic and Jovanovic's (2019) study, FinTech companies increase competition in the financial markets by offering services that traditional banks either don't offer or do, but less efficiently. Moreover, Stolbov and Shchepeleva's (2023) studies on cryptocurrencies and P2P lending companies have shown that the determinants of the cryptocurrency segment differ from those found in the overall FinTech market development and peer-to-peer lending segment, requiring specific measures to foster their development.

Demirgüç-Kunt et al. (2017) show that financial inclusion is proved to provide safer and more efficient everyday transactions, expand investment and risk management options. Furthermore, technological advances will continue to change how financial services are delivered, consequently impacting economic growth. There is evidence from Kanga et al. (2021) that FinTech (mobile phones and ATMs) has a positive impact on per capita income in the long run, but the depth dimension has no significant effect on GDP per capita. FinTech has transformed the way banking services are provided globally, and its diffusion increases with financial inclusion, human capital, and GDP per capita. However, even though there are many cases where it is proven that financial development and FinTech have a positive effect on growth, and at the same time, inflation has a negative effect on GDP growth, studies have shown that there is a positive relationship between financial development, digital or traditional, and inflation (Magaldi de Sousa, 2015). In contrast, a study by Arshad, Ahmed,

Ramzan, Shabbir, Bashir and Khan (2021) proves that financial development reduces inflation. It is important to keep in mind that, inflation is additionally influenced by other elements including governmental regulations, supply chain issues, and general economic conditions. In order to combat inflationary pressures, policymakers should use an extensive framework that may include monetary, fiscal, and regulatory actions.

Gutierrez and Singh (2013) found that a stronger regulatory framework is linked to greater use of mobile banking services. Many papers recommend proactive policies to regulate FinTech to stimulate financial development through a dynamic regulatory framework (Alonso Gispert, Chatain, Driessen, Queiroz Palermo, Plaitakis, Carjaval and Dohotaru, 2022; Beck, 2020; Evbuomwan, 2022; Lavrinenko, 2023; Kanga et al., 2021; Feyen,Frost, Gambacorta, Natarajan and Saal, 2022; Chinoda and Kapingura, 2023; Demirgüç-Kunt, Klapper, Singer, Ansar and Hess, 2018; Banna, Mia, Nourani and Yarovaya, 2021; World Bank and BIS, 2022). These policies should include improving prudential guidelines and increasing accessibility to digital financial services to reduce corruption and economic risks (Alonso Gispert et al. 2022; Nandru et al., 2021; Evbuomwan et al., 2022; Kanga et al., 2021). However, studies from Lavrinenko (2023) and Alonso Gispert et al. (2022) suggest that financial authorities need to manage risks associated with FinTech while avoiding unnecessary barriers to development and competition. Moreover, Michael's (2021) study highlights the EU's passing of 10 laws to develop protocols for sustainable FinTech operations as step towards success.

## *2.2 Financial technology and economic growth*

According to multiple academic studies, the development of financial technology has been shown to boost economic growth by increasing the GDP growth (Feyen et al., 2022; Haftu, 2019; Aker and Mbiti, 2010; Sahay, Ogawa, Khera and Ng, 2021). Moreover, other research has revealed a positive correlation between a country's income measured by GNI per capita and the use of digital payment services, as determined by the percentage of individuals making and receiving digital payments (Antonijević, Ljumović and Lukić, 2021). Furthermore, empirical evidence has suggested that mobile phones have the potential to benefit individuals at almost every income level, contributing to broader economic development (Aker et al., 2010). Conversely, several researchers question these conclusions. Research has demonstrated that high FinTech adoption is linked to economic development in a reversed matter with economic growth playing a significant role in driving the diffusion of technology and innovation, including digital payment adoption. Furthermore, a study from

Chinoda et al. (2023) has found a bi-directional causal relationship between economic growth and digital financial inclusion. Additionally, only a limited amount of research has shown that FinTech positively affects economic growth in countries with more developed financial sectors. (Feyen et al., 2022; Haftu, 2019). Therefore, this research is concentrating on the effects financial technology has on economic growth measured by GDP per capita growth while taking the level of financial development into account.

The widespread adoption of FinTech in various markets around the world is evident. The Netherlands, the UK, and Ireland have shown the highest adoption rates among developed countries, largely due to the development of open banking in Europe (Ernst & Young, 2019). However, some academics proved that digital banking has no direct impact on economic growth, as a result of high levels of financial development (Sadigov, Vasilyeva and Rubanov, 2020). Nonetheless, emerging markets are driving FinTech's growth. Evidence from China suggests policymakers should encourage FinTech's expansion as a 10% increase in FinTech raises China's economic growth by 8% at an adoption rate of 87% (Song and Appiah-Otoo, 2022; Arner, Buckley and Zetzsche 2018; Ernst & Young, 2019; Prasad, 2019). Additionally, other studies show the same evidence of rapid progress in India (Arner et al., 2018; Ernst & Young, 2019).

### *2.3 Financial development and economic growth*

It has been proven by many previous researchers that there is a statistically significant and positive correlation between economic growth and financial development (Valickova, Havranek and Horvath, 2013; Murinde, 2012; Caporale, Rault, Sova and Sova, 2015; Mhadhbi, 2014; De Gregorio and Guidotti, 1995, Nizam, Karim, Rahman and Sarmidi, 2020). Particularly, it is found that financial inclusion has a lower effect on long-term economic growth than a robust financial system (Govil, López and Martín, 2014; Demirgüç-Kunt and Klapper, 2012). Furthermore, a research done by Chen (2023) indicates that the quality of financial development is crucial in boosting economic growth. However, this study also shows that the quantity of financial development decreases growth. Moreover, the same is concluded by Mhadhbi (2014) in the case of emerging countries, but not when it comes to developed countries. In contrast to their studies, Hassan, Sanchez and Yu (2011b) show a positive relationship between finance and growth only with regard to middle-income and low-income countries, and not more developed countries.

Contradictory to the aforementioned studies, many academics have gotten opposite results in their analyses. A study by Swamy and Dharani (2019b) shows that financial development and economic growth have a negative linear relationship in the long run. Moreover, some studies even prove that there is no relation among these variables (Dawson, 2003b). In addition, there is also evidence of bi-directional causality between financial development and economic growth (Hassan, Sanchez and Yu, 2011b; Swamy et al., 2019b)

### *2.4 Linkage to financial exclusion, inequality and poverty – The bigger picture*

Digital finance has the potential to exclude technology-averse individuals and aggravate existing inequalities, particularly in rural areas. Unfortunately, financial exclusion causes bigger problems i.e. it contributes to poverty. However, studies have shown that FinTech has the ability to include the financially excluded people (Baber, 2019; Heng and Tok, 2022). Furthermore, FinTech shows potential to reduce poverty by providing automated money guidance and identifying benefits eligibility (Honecker and Chalmers, 2022; Banna et al., 2021). In addition, studies show that FinTech and financial inclusion have a negative effect on income inequality (Demir, Pesqué-Cela, Altunbas and Murinde, 2022). And, another study by Altunbaş and Thornton (2019) proves that financial development promotes equality in upper-middle income countries, but promotes inequality in low-income and high-income countries.

## 3 Data and methodology

### *3.1 Data*

The data sample includes 102 countries. I choose those specific countries because of the data availability limitations. A list of the countries that are taken into account for this analysis is provided in Appendix 1, and alongside that, the income levels of the specific countries are presented. Moreover, some observations are dropped from the analysis, also due to data limitations for some variables, specifically the domestic credit to private sector, and liquid liabilities measures.

The World Bank has its own database where different indicators can be found, such as the Global Findex and World Development Indicators which are two comprehensive data sources that provide valuable insights for research on various socio-economic topics. The Global Findex indicators offer a wide range of data on financial inclusion, as well as financial technology development. On the other hand, the World Development Indicators provide a

large selection of data on economic and social development, including indicators like GDP growth, inflation, population, government spending, and more. The International Monetary Fund (IMF) uses a strict data collection process and methodology to guarantee the accuracy and reliability of the data, as it offers thorough and updated data on global economic indicators.

For this research the dependent variable which is economic growth is based on the measure for GDP per capita growth used by Ashenafi and Dong (2022).

However, although Ashenafi and Dong (2022) and Sadigov et al. (2020) used digital payments made in the past year as a percentage of the population older than 15 and the value of mobile and internet banking, respectively, as indicators of financial technology, I applied the percentage of digital payments made or received by people over the age of 15. I took this approach because of data availability limitations regarding the value of mobile and internet banking for the aforementioned countries; as well as the imprecision i.e. not accounting for the received digital payments alongside the made digital payments. The indicator for the main independent variable FinTech is retrieved from the Global Financial Inclusion Indicators (Global Findex) through the World Bank Open Data site.

The other main independent variable of interest is financial development. Following the example of multiple researchers, the metrics from this variable is calculated through various dimensions of financial development (Ashenafi and Dong, 2022; Allen et al., 2014; Caporale et al., 2015; Hassan et al., 2011b). The financial development measure encompasses four dimensions. The first dimension, financial inclusion, is determined by three variables: account ownership, borrowings from financial institutions, and savings at financial institutions. These variables measure the extent to which individuals have access to and engage in formal financial services and the data is gathered from the Global Financial Inclusion Indicators i.e. Global Findex (World Bank Open Data). The second dimension, financial depth, is represented by the variable domestic credit to private sector, which indicates the availability of domestic credit for the private sector as a percentage of GDP. The third dimension, the size of the financial sector, is captured by the variable liquid liabilities, which represents the broad money supply as a percentage of GDP. Finally, the fourth dimension, the efficiency of the financial sector, is measured by the Financial Markets Depth Index, which considers various factors such as stock market capitalization, traded stocks, and debt securities as a percentage of GDP. This data is extracted from the World Development

Indicators through the World Bank Open Data, while the data for the Financial Market Depth Index is sourced from the Financial Development Index Database which belongs to the International Monetary Fund.

The data sample spans through 9 years, incorporating country-level data from 2012 to 2020. All data is available from the year 2012 to 2021 with the exception of the measure for financial development which is missing all data for the year 2021, and as a result that year is excluded from the analysis. It is important to note that the data for the FinTech indicator (Made or received digital payments (% age 15+)) which is taken from the World Bank's Global Findex database provides triennial data i.e. data for every three years because of the slow-progress of financial inclusion and financial technology development. Additionally, there is an exception where they skipped over the year 2020 as a result of the COVID-19 pandemic. Consequently, they provided data for the year 2021 instead. The available data for FinTech covers the years 2014, 2017 and 2021, therefore I used the data of each year as data for the previous 2 years as well e.g. the data for 2014 will be considered as the data for 2012-2014; the data for 2017 as data for the period 2015-2017; and the data for 2021 as data for 2018-2021 (2018-2020).

For the purpose of this analysis, five different metrics serve as control variables. These measures, population growth (annual percentage), trade openness (trade as percentage of GDP), government expenditure (general government final consumption expenditure, percentage of GDP) and inflation rate (GDP deflator, annual percentage). The data for each of these indicators is collected from the World Development Indicators through the World Bank Open Data.

Additionally, an alternative methodology is utilized to approximate the variables of economic growth and financial development in the analysis. The financial development variable is substituted with GDP per capita measured in the local currency as an alternative measure. Likewise, GDP growth, which signifies the percentage change in Gross Domestic Product over a specified timeframe, is employed as an alternative indicator for measuring economic growth. The data for both variables are sourced from the World Development Indicators through the World Bank Open Data.

Furthermore, an interaction term is used to test Hypothesis 1. This variable is the product of the percentage of made or received digital payments and the financial development indicator and is presented in percentages starting from 0.37% to 94.37%, as

shown in Table 1. The interaction term is created by multiplying the values of FinTech and financial development. It captures the joint effect between these two variables on economic growth.

Therefore, the effective panel dataset consists of 102 countries with 918 observations for both the dependent and some independent variables, with the exception of one the main variables, financial development with 697 observations. This is due to the inclusion of the domestic credit to private sector, and liquid liabilities measures within the financial development variable, thus cutting observations in FINTERACT as well. This is shown in Table 1.

**Table 1**: Descriptive statistics

| VARIABLES | (1) Obs. | (2) Mean | (3) Std. Dev. | (4) Min | (5) Med | (6) Max |
|---|---|---|---|---|---|---|
| Economic Growth | 918 | 1.41 | 3.83 | -22.49 | 1.88 | 23.20 |
| FinTech | 918 | 60.45 | 29.19 | 4.32 | 62.59 | 100.00 |
| Account Ownership | 918 | 65.17 | 29.22 | 6.17 | 70.26 | 100.00 |
| Savings | 918 | 27.65 | 20.93 | 0.96 | 19.82 | 80.93 |
| Borrowings | 918 | 27.19 | 18.80 | 1.57 | 21.65 | 82.83 |
| Financial Market | 918 | 0.31 | 0.32 | 0.00 | 0.17 | 1.00 |
| Domestic credit to private sector | 875 | 68.00 | 48.78 | 0.00 | 54.57 | 258.90 |
| Liquid Liabilities | 713 | 72.08 | 56.61 | 0.02 | 58.94 | 454.70 |
| Financial Development | 697 | 8.63 | 5.63 | 0.19 | 7.22 | 22.00 |
| Inflation | 918 | 3.97 | 6.76 | -17.59 | 2.36 | 84.30 |
| Population | 918 | 1.06 | 1.28 | -2.88 | 1.02 | 11.79 |
| Government Expenditure | 918 | 16.02 | 4.76 | 4.40 | 16.18 | 30.00 |
| Trade | 918 | 89.40 | 59.28 | 11.86 | 75.70 | 442.6 |
| FINTERACT | 697 | 7.63 | 3.83 | -3.01 | 7.45 | 14.11 |

According to Table 1, the high standard deviations for FinTech, Account Ownership, Savings, and Borrowings, as well as, Domestic Credit to Private Sector, Liquid Liabilities, and Trade indicate significant variation in these variables across the observed countries or time periods. For FinTech, the high standard deviation of 29.19% suggests that the adoption and usage of financial technology solutions vary widely across countries or over time. Different factors such as technological infrastructure and regulatory environment may contribute to this variability. Account Ownership, Savings, and Borrowings also exhibit high standard deviations, 29.22%, 20.93%, and 18.80%, respectively, indicating substantial

disparities in financial inclusion and engagement with formal financial services. These variations could be attributed to differences in economic development, access to banking services, cultural norms, and financial literacy levels among the populations of different countries. Domestic Credit to Private Sector and Liquid Liabilities also display high standard deviations, suggesting significant differences in the availability and utilization of domestic credit, 48.78%, and broad money supply, 56.61%, respectively. These variations might reflect disparities in financial market development, banking sector efficiency, and monetary policy frameworks across countries. Similarly, Trade exhibits a high standard deviation with 59.28%, indicating substantial diversity in the volume and nature of international trade across countries. Factors such as geographic location, economic specialization, trade policies, and global market conditions contribute to the observed variations in trade. The high standard deviations for these variables highlight the heterogeneity and diversity in the financial and economic characteristics among the observed countries or time periods, emphasizing the need for tailored approaches and considerations when analyzing and interpreting their relationships with other variables of interest. Thus, these variables will be adjusted accordingly, as presented in the following sections.

### *3.2 Classification of data for level of economic development analysis*

In accordance with this research, a separate analysis is conducted to test and compare between groups of countries in different stages of development. This allows for a better understanding of how the relationship between financial technology, financial development, and economic growth differs across the groups of countries. Moreover, this helps to account for the specific conditions and challenges faced by countries at different stages of economic development.

For the purpose of the classification of the groups according to their stage of development, I incorporated the income level specification as described by The World Bank. By using The World Bank's classification as reference for this research, I specify the countries' development stage according to their income level according to the Gross National Income per capita measure. The World Bank has differentiated four income level groups, high income, over €13,205 GNI per capita; upper-middle income, between €4,256 and €13,205 GNI per capita; lower-middle income, between €1,086 and €4,255 GNI per capita; low income, less than €1,085 GNI per capita (Table 2).

**Table 2**: The World Bank's classifications of the world's economies into four income groups: low, lower-middle, upper-middle, and high income

| Group | July 1, 2022 for FY23 (new) |
|---|---|
| Low income | < 1,085 |
| Lower-middle income | 1,086 – 4,255 |
| Upper-middle income | 4,256 -13,205 |
| High income | > 13,205 |

**Source**: https://datahelpdesk.worldbank.org/

The group-specific analysis of this thesis, however, is consistent of only two development groups. As shown in Table 3, the groups are distinguished as developed countries and underdeveloped countries. The group of developed countries includes all economies with high income level and upper-middle income level nations. In contrast, the underdeveloped group of countries covers both lower-middle income level and low income level economies. This is done with the purpose of minimizing the potential difficulties arising from data gaps or inconsistencies across countries. While these countries may differ in some aspects, they share certain similarities in terms of economic indicators and development challenges compared to high income or upper-middle income countries.

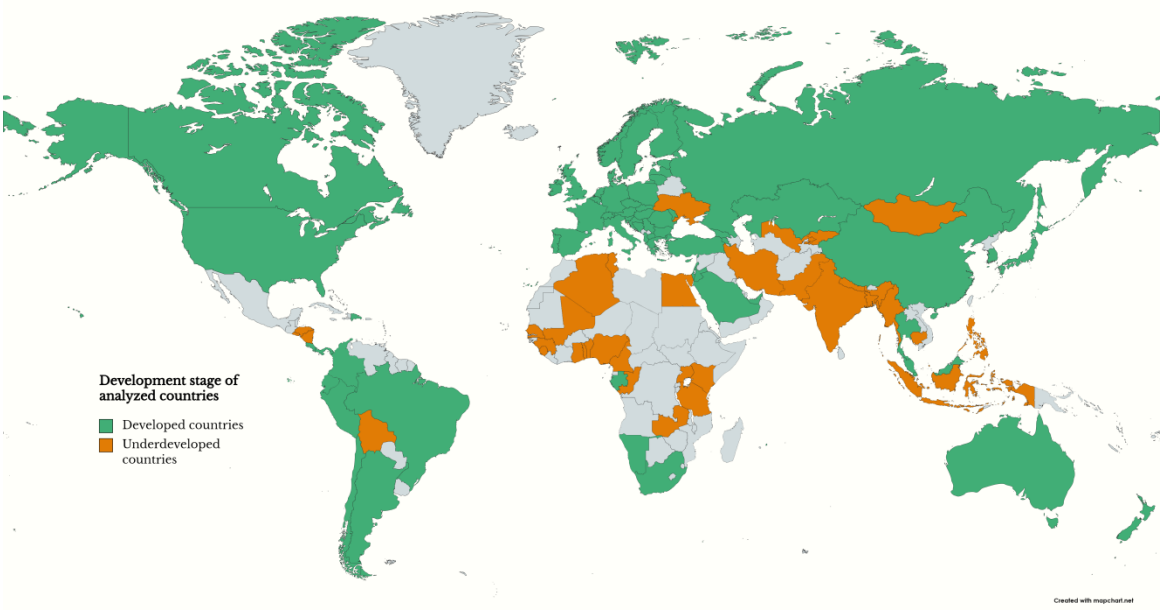
The World Bank updates their classification threshold annually, however, for this analysis I chose to follow the most recent classification made in July 2022.

**Table 3**: Adjusted frequency table of available countries from a specific development level

| Development stage | Income level | Freq. | Percent | Cum. |
|---|---|---|---|---|
| Developed countries | High income | 400 | 57.39 | 57.39 |
| Underdeveloped countries | Low income | 297 | 42.61 | 100.00 |
| | Total | 697 | 100.00 | |

Furthermore, Table 3 pictures the frequency table of available countries from a specific development level. It is clear that the frequency is reasonably similar between groups with 57.39% and 42.61%, therefore indicating a somewhat balanced data set for the analysis. This is also visually presented in Picture 1 where a map of the world, along with my classification, is shown. Moreover, the grey areas represent countries that are not included.

**Picture 1**: World map: Development stages of the analyzed countries




Moreover, it is clear that the highest frequency belongs to developed countries. This is due to the fact that data collection and reporting mechanisms in underdeveloped countries may be less robust or comprehensive compared to developed countries. As a result, the availability and quality of data on financial development and FinTech development may be limited or incomplete for many countries in these levels of development.

### *3.3 Methodology*

For the purpose of the empirical analysis, I combine the models developed by Chinoda and Kapingura (2023) and Haftu (2019), with minor modifications, to examine the impact of financial development and the development of financial technology on the growth of GDP per capita. In order to test the impact of mobile phones and the Internet on GDP per capita, Haftu (2019) used a dynamic panel data model with telecommunications infrastructure as one of its explanatory variables. Chinoda et al.'s (2023) model used a robust panel data technique to examine the role of institutions and governance on the digital financial inclusion-economic growth nexus in Sub-Saharian Africa.

The model is specified as follows:

$$GROWTH_{i,t+1} = \beta 0 + \beta 1\, FINTECH_{i,t} + \beta 2\, FINTECH_{i,t} * FD_{i,t} + \beta 3\, FD_{i,t} + \beta 4\, INF_{i,t} + \beta 5\, POPG_{i,t} + \beta 6\, TRADE_{i,t} + \beta 7\, GOV_{i,t} + yr_t + v_i + \varepsilon_{i,t} \quad (1)$$

where, the dependent variable $GROWTH_{i,t+1}$ refers to economic growth for which the percentage change in Gross Domestic Product (GDP) per capita for country i at time t+1 is used (Caporale et al., 2015; Hassan et al., 2011b; Chinoda et al., 2023; Ashenafi and Dong, 2022); the independent variable $FINTECH_{i,t}$ represents financial technology (FinTech) development measured as digital payments made or received as a percentage of the population that is over the age of 15 (Demir et al., 2022); the other main variable, $FD_{i,t}$ is a measure for financial development for country i at time t (Demir et al., 2022; Hassan et al., 2011b; Caporale et al., 2015 Allen et al., 2014); the term $FINTECH_{i,t} * FD_{i,t}$ is the interaction term between financial development and FinTech development for country i at time t, which captures the idea that financial technology can have a more significant impact on economic growth in countries with higher levels of financial development. This is due to the fact that financial technology is more effective in developed countries where there are more advanced financial systems, a greater access to financial services and a more efficient allocation of resources; the other variables are control variables for country i at time t, where $INF_{i,t}$ is the annual inflation rate i.e. percentage of GDP deflator (Haftu, 2019; Kanga et al., 2021; Hassan et al., 2011b; Chinoda et al., 2023; Allen, Carletti, Cull, Qian, Senbet and Valenzuela, 2014; Demir et al., 2022; Ashenafi and Dong, 2022); $POPG_{i,t}$ is a control variable representing the population growth rate (Demir et al., 2022; Haftu, 2019; Nizam et al., 2020; Chinoda et al., 2023; Sahay et al., 2021; Allen et al., 2014; Ashenafi and Dong, 2022); $TRADE_{i,t}$ controls for trade openness as a percentage of GDP (Demir et al., 2022; Altunbaş et al., 2019; Hassan et al., 2011b; Chinoda et al., 2023; Ashenafi and Dong, 2022); $GOV_{i,t}$ is a variable for government expenditure for which general government final consumption expenditure as a percentage of GDP will be used (Demir et al., 2022; Ashenafi and Dong, 2022; Haftu, 2019; Hassan et al., 2011b); $\varepsilon_{i,t}$ is the error term, which captures any random or unobserved factors that may affect the dependent variable; the other two variables are fixed-effects variables, where $yr_t$ is fixed-effects for year; and $v_i$ refers to country fixed-effects (Haftu, 2019; Kanga et al., 2021).

Financial development is a complex measure that assesses the overall level of development and sophistication of a country's financial system. It takes into account multiple dimensions and indicators related to the functioning and effectiveness of the financial sector. Therefore, to define the financial development variable, I utilize multiple indicators and categorize them into four distinct dimensions. By standardizing the values of each specific variable, I ensure comparability and consistency across the different indicators. This allows

me to combine these variables into a single measure that represents the overall level of financial development. The first dimension is financial inclusion ($FI_{i,t}$). Equation 2 outlines the methodology for calculating this dimension, which involves taking the average of three different measures: account ownership ($ACC_{i,t}$), borrowings from financial institutions ($BOR_{i,t}$), and savings at financial institutions ($SAV_{i,t}$). By considering these three variables collectively, a broader perspective of financial inclusion is captured (Ashenafi and Dong, 2022; Allen et al., 2014). Moreover, the second dimension, financial depth, is measured using the variable domestic credit to private sector ($DCPS_{i,t}$). This particular measure is chosen because it effectively captures the extent to which the private sector has access to domestic credit (Allen et al., 2014; Caporale et al., 2015; Hassan et al., 2011b). The next dimension of financial development reflects the size of the financial sector in a country and is represented by the variable liquid liabilities ($M3_{i,t}$). Liquid liabilities, also known as Monetary Aggregate 3 (M3) or broad money, refer to the total amount of money circulating within an economy. It includes physical currency, demand deposits, time deposits, and other liquid assets. By considering the $M3_{i,t}$variable, we can assess the magnitude of the financial sector and its role in the overall economy (Allen et al., 2014; Caporale et al., 2015; Hassan et al., 2011b). Finally, financial market depth ($FMD_{i,t}$) is incorporated as a measure of the dimension efficiency of the financial sector (Caporale et al., 2015). This variable relies on an index that takes into account several factors, including stock market capitalization, stocks traded, international government debt securities, total debt securities of financial corporations, and total debt securities of nonfinancial corporations. By considering these indicators, we gain insights into the depth and efficiency of the financial markets within the overall evaluation of financial development.

$$FI_{i,t} = \frac{ACC_{i,t} + BOR_{i,t} + SAV_{i,t}}{3} \tag{2}$$

$$FD_{i,t} = \frac{FI_{i,t} + DCPS_{i,t} + M3_{i,t} + FMD_{i,t}}{4} \tag{3}$$

Furthermore, including fixed-effects for both countries and years allows me to control for unobserved heterogeneity across both dimensions i.e. any unobserved time-varying or time-invariant factors that may be affecting the dependent variable. This can help to improve the accuracy of the estimates and avoid potential biases that may arise from omitting relevant factors that vary across countries or over time.

The transformation of the model is pictured in Equation 4 and 5.

$$GROWTH_{i,t+1} = \beta 0 + \beta 1\, FINTECH_{i,t} + \beta 2\, FINTECH_{i,t} * FD_{i,t} + \beta 3\, FD_{i,t} + \beta 4\, INF_{i,t} + \beta 5\, POPG_{i,t} + \beta 6\, TRADE_{i,t} + \beta 7\, GOV_{i,t} + \varepsilon_{i,t} \quad (4)$$

$$GROWTH_{i,t+1} = \beta 0 + \beta 1\, FINTECH_{i,t} + \beta 2\, FINTECH_{i,t} * FD_{i,t} + \beta 3\, FD_{i,t} + \beta 4\, INF_{i,t} + \beta 5\, POPG_{i,t} + \beta 6\, TRADE_{i,t} + \beta 7\, GOV_{i,t} + yr_t + v_i + \varepsilon_{i,t} \quad (5)$$

By including year fixed-effects, the model controls for time-varying factors that may influence the dependent variable, such as changes in macroeconomic conditions, policy changes, or global events i.e. time-specific shocks that equally affect all countries. On the other hand, country fixed-effects are the unobserved country-specific effects associated with an individual country which captures the impact of time-invariant individual characteristics of each country that may affect the explanatory variable (Haftu, 2019; Kanga et al., 2021).

The main goal of this panel data regression model is to test the effects that financial development and the advancing of financial technology have on economic growth, specifically the growth of Gross Domestic Product per capita.

Once choosing the appropriate regression model, usually there are a number of tests conducted prior to conducting the regressions. However, I use a command (regxfe) for estimating fixed-effects regression models with panel data that has the most important tests built-in. I check for asymmetry in the data through a histogram analysis. Moreover, I check for multicollinearity by analyzing the correlation matrix. After all of the assessments, an adjustment to the variables, and therefore the regression model, is done. Heteroskedasticity is addressed through the inclusion of robust standard errors, and is presented in the final regression. Lastly, the goodness of fit is analyzed since it is affected by the inclusion of fixed-effects for year and country. The regression results are presented in such a way that allows for a sensitivity test to be conducted.

Moreover, it is important to note that it is not sufficient to solely rely on the results of the main specification because the main regression analysis alone cannot establish causality. Thus, to strengthen my analysis and provide more robust evidence I analyze an additional specification where I use dummies for FinTech and financial development with the purpose to analyze the interaction term between these variables. The additional specification is shown in Equation 6.

The dummies are defined as above-median and below-median values of the aforementioned variables. By creating dummy variables, I divide the dataset into two groups: one representing observations above the median value and the other representing observations below the median. The purpose of including these dummies and the interaction terms is to examine whether the relationship between FinTech, financial development, and economic growth differs based on whether their values are above or below the median. This approach allows for a detailed understanding of how the interaction between FinTech and financial development influences economic growth in different contexts i.e. levels of financial development.

$$GROWTH_{i,t+1} = \beta 0 + \beta 1\, FINTECH\_am_{i,t} + \beta 2\, FINTECH\_bm_{i,t} + \beta 3\, FINTECH\_am_{i,t} * FD\_am_{i,t} + \beta 4\, FINTECH\_bm_{i,t} * FD\_bm_{\_i,t} + \beta 5\, FD\_am_{i,t} + \beta 6\, FD\_bm_{i,t} + \beta 7\, INF_{i,t} + \beta 8\, POPG_{i,t} + \beta 9\, TRADE_{i,t} + \beta 10\, GOV_{i,t} + yr_t + v_i + \varepsilon_{i,t} \quad (6)$$

Additionally, a separate analysis is conducted to test and compare between groups of countries from different levels of economic development. Since the main model includes fixed-effects for both year and country that capture time-specific and country-specific effects. And, the impact of FinTech and financial development on economic growth may vary depending on factors such as institutional frameworks, regulatory environments, and economic structures; analyzing different groups helps validate the consistency of the observed relationships across different sets of countries.

The re-estimation of Equation 1 for the separate groups of countries is shown in Equations 7 and 8.

$$H\_GROWTH_{i,t+1} = \beta 0 + \beta 1\, H\_FINTECH_{i,t} + \beta 2\, H\_FINTECH_{i,t} * H\_FD_{i,t} + \beta 3\, H\_FD_{i,t} + \beta 4\, H\_INF_{i,t} + \beta 5\, H\_POPG_{i,t} + \beta 6\, H\_TRADE_{i,t} + \beta 7\, H\_GOV_{i,t} + yr_t + v_i + \varepsilon_{i,t} \quad (7)$$

$$L\_GROWTH_{i,t+1} = \beta 0 + \beta 1\, L\_FINTECH_{i,t} + \beta 2\, L\_FINTECH_{i,t} * L\_FD_{i,t} + \beta 3\, L\_FD_{i,t} + \beta 4\, L\_INF_{i,t} + \beta 5\, L\_POPG_{i,t} + \beta 6\, L\_TRADE_{i,t} + \beta 7\, L\_GOV_{i,t} + yr_t + v_i + \varepsilon_{i,t} \quad (8)$$

The variables used in these models are the same as the main model specification, with the exception of the groupings where the prefixes “H” and “L” indicate high income (developed countries), and low income (underdeveloped countries), respectively.

Furthermore, another analysis for the main specification is done by using alternative proxies for the variables economic growth and financial development. GDP per capita (local currency) is used as an alternative indicator for financial development. Whereas, the reason for changing the proxy for economic growth from GDP per capita growth to GDP growth is to ensure consistency and avoid potential endogeneity issues when using GDP per capita as a proxy for financial development.

### *3.4 Hypotheses*

Many researchers have investigated the separate effects of financial development and financial technology on economic growth. However, relatively little research has been conducted on how financial development affects the relationship between economic growth and FinTech. The few studies that have been done on this subject have proven that there is a positive effect on economic growth in countries with more developed financial sectors. (Feyen et al., 2022; Haftu, 2019). In accordance with these studies, I anticipate that the results will show that FinTech does have a greater impact on economic growth in more financially developed countries, and that this influence is positive, when controlled for inflation, population growth, trade openness and government spending.

*Hypothesis 1: Financial technology development has a stronger positive effect on GDP per capita growth in countries with a higher level of financial development than in economies with lower levels of financial development.*

Nonetheless, the majority of research indicates that financial development also affects growth in a positive direction (Allen et al., 2014; Caporale et al., 2015; Hassan et al., 2011b; Song et al., 2022; Nizam et al., 2020; Ashenafi and Dong, 2022). In addition, most academics that studied the relationship between FinTech and economic growth suggest that there is a favorable correlation between financial technology and economic growth (Haftu, 2019; Kanga et al., 2021). In line with the findings of previous academic research, I expect that both FinTech and financial development will have a positive effect on GDP per capita growth.

*Hypothesis 2: Financial development has a positive and significant effect on economic growth, controlling for other variables.*

*Hypothesis 3: Financial technology development has a positive and significant effect on economic growth, controlling for other variables.*

# 4 Empirical analysis

## *4.1 Empirical approach*

In this section, I present the adjustments of the variables, as well as certain specifications. First, I define the variable financial development. It is a complex measure that takes into account various dimensions and indicators related to the sophistication and functioning of a country's financial system. To achieve this, I utilize multiple indicators and categorize them into four distinct dimensions and use normalization. By standardizing the values of each indicator, I ensure comparability and consistency, allowing me to combine them into a single measure that represents the overall level of financial development.

**Table 4: Correlation Matrix**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| (1 ) Economic Growth | 1 | | | | | | |
| (2) FinTech | -0.142 | 1 | | | | | |
| (3) Financial Development | -0.082 | 0.892 | 1 | | | | |
| (4) Inflation | -0.002 | -0.168 | -0.225 | 1 | | | |
| (5) Population | -0.172 | -0.325 | -0.349 | 0.077 | 1 | | |
| (6) Government Expenditure | -0.095 | 0.131 | 0.177 | -0.048 | -0.105 | 1 | |
| (7) Trade | 0.014 | 0.257 | 0.299 | -0.158 | -0.165 | -0.045 | 1 |

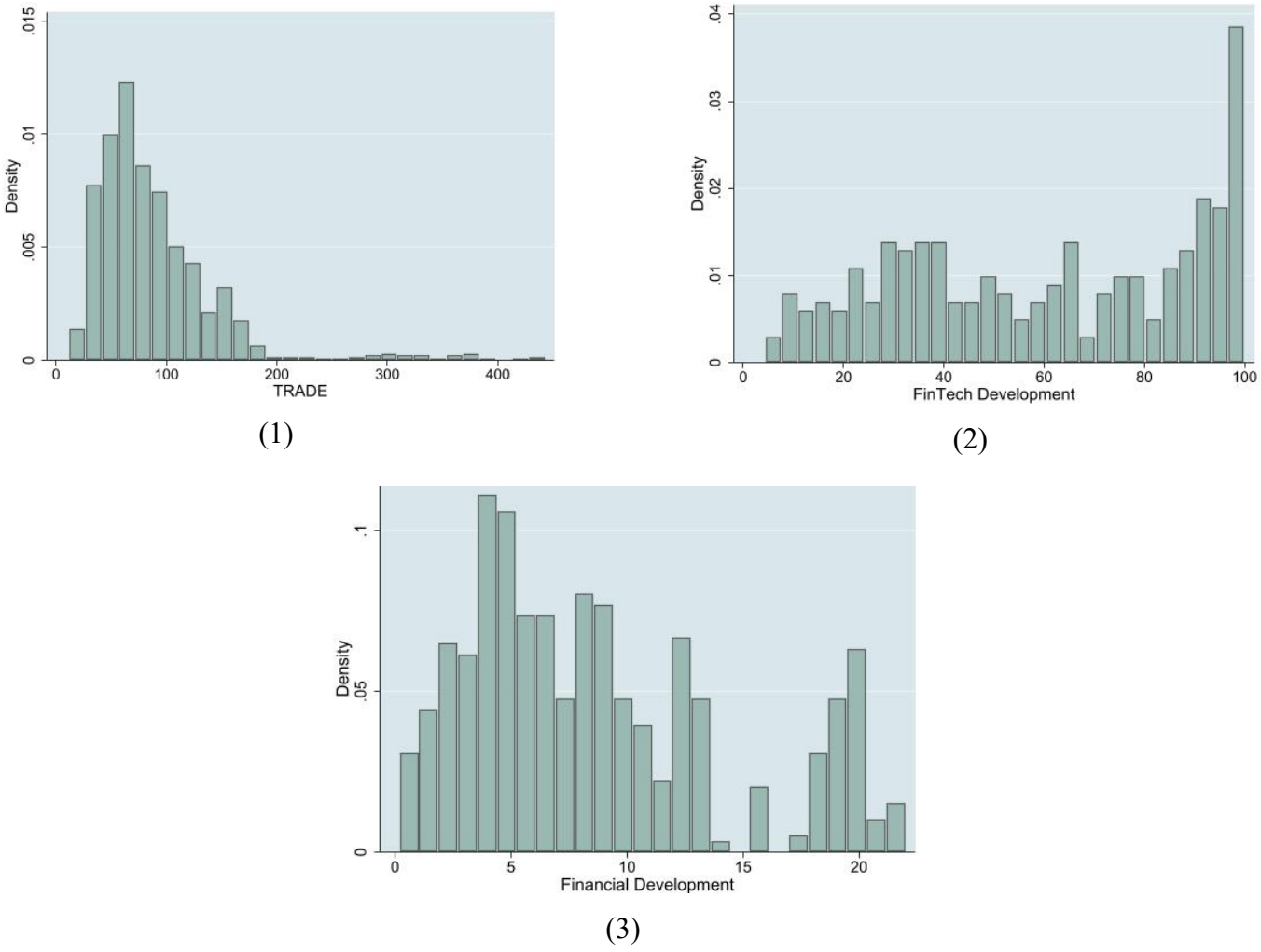
Moreover, I examine the relationship among the variables included in the model by analyzing Pearson's correlation matrix. The correlation matrix provides valuable insights into the strength and direction of associations between pairs of variables. I am using a threshold of 0.7 as recommended by Kanga et al. (2021). This threshold indicates a strong positive or negative linear relationship between variables. Evaluating the correlation matrix helps me identify variables that are highly correlated, which can potentially indicate multicollinearity. Multicollinearity can pose challenges in regression analysis, such as unstable coefficient

estimates and difficulties in interpreting individual variable effects. Hence, in order to address this concern, highly correlated variables are not simultaneously included in the regressions.

Table 4 indicates that the majority of variable pairs do not demonstrate a substantial level of correlation. Specifically, only 1 pair of variables exhibits a correlation exceeding the threshold of 0.7. This observation is important because high correlations between variables can impact the reliability of the regression coefficients and their associated standard errors.

The pair of variables that show high correlation are FinTech and financial development. Their correlation coefficient is above the 0.7 threshold and stands at 0.892. The explanation behind this is pretty straightforward. The advancements in FinTech contribute to the modernization and efficiency of financial systems, leading to enhanced financial development. Thus, to mitigate potential issues of multicollinearity, these highly correlated variables are not simultaneously included in the regressions.

**Figure 1: Histograms of (1) trade; (2) FinTech; and (3) financial development**




(1) (2)

(3)

Following the logarithmic transformation of these variables, as well as the creation of the interaction term between financial technology development and financial development, FINTERACT, the regression analysis is conducted and heteroskedasticity is addressed. The table is designed to facilitate a comparison of the results before and after the inclusion of the interaction term in both regressions.

The initial regression results, including fixed-effects for both year and country, are presented in Appendix C. The reason for this is because I conduct a robustness check by including robust standard errors that aim to address heteroskedasticity. Including the robust command has the potential to alter the significance levels of the results, leading to more reliable inferences. By comparing the results of the final regression, which incorporates robust standard errors, with the initial regression, I can assess the presence of heteroskedasticity. In this case, heteroskedasticity is not present, considering the results are particularly similar.

### *4.2 Regression results*

The results using robust standard errors are presented in Table 5. These findings demonstrate the influence of the independent variables on economic growth across different countries in the dataset, while considering the effects of country-specific fixed factors and time-specific fixed factors. Thus, by addressing issues such as heteroskedasticity, multicollinearity, and asymmetry, I can confidently interpret the regression coefficients and ensure the reliability of the regression results.

The results presented in Table 5 show that the coefficient for FinTech development is 0.083. This coefficient is statistically insignificant at conventional levels, as indicated by the t-statistic of 0.23. Therefore, there is no strong evidence to support a significant relationship between financial technology development and future economic growth. This could be due to the limitation of only using digital payments made and received as a proxy for FinTech development, as well as excluding financial development from the regression as to avoid multicollinearity. Connecting this to my hypothesis, the finding does not fully support the notion that financial technology development has a positive and significant effect on economic growth, whilst controlling for other variables. These findings are in accordance with the results reported by Sadigov et al. (2020).

**Table 5: Main regression results**

| | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ |
|---|---|---|---|
| ln_FinTech $_{i,t}$ | 0.3014 | | -0.5190 |
| | (0.79) | | (-0.70) |
| ln_Financial Development $_{i,t}$ | | 1.5326*** | 2.0550** |
| | | (2.64) | (2.19) |
| Inflation $_{i,t}$ | -0.1209*** | -0.1216*** | -0.1219*** |
| | (-2.60) | (-2.66) | (-2.67) |
| Population $_{i,t}$ | -0.8936*** | -0.9084*** | -0.9066*** |
| | (-13.26) | (-13.54) | (-13.34) |
| Government Expenditure $_{i,t}$ | -0.1753* | -0.1817* | -0.1767* |
| | (-1.89) | (-1.95) | (-1.87) |
| ln_Trade $_{i,t}$ | 3.0819*** | 2.8797*** | 2.8420*** |
| | (3.15) | (3.15) | (3.19) |
| FINTERACT $_{i,t}$ | | | -0.0415 |
| | | | (-0.12) |
| Constant | -8.2132* | -9.0092** | -7.6432* |
| | (-1.81) | (-2.23) | (-1.81) |
| *N* | 697 | 697 | 697 |
| $R^2$ - Overall | 0.61 | 0.62 | 0.62 |
| $R^2$ - Within | 0.11 | 0.12 | 0.12 |
| adj. $R^2$ | 0.10 | 0.11 | 0.11 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

It is crucial to acknowledge that, in the regression analysis solely focusing on FinTech, all available data is included. However, in order to ensure a fair and valid comparison across regressions, observations that are missing due to data limitations for the variable of financial development are excluded. The complete results, including all observations, can be found in Appendix C for reference and transparency.

Moreover, the coefficient for financial development in the model is positive and statistically significant at the 1% level. The positive value indicates that a 1% increase in financial development is associated with a 0.015 percentage points increase in growth. This is in line with the results shown by multiple researchers (Allen et al., 2014; Caporale et al., 2015; Hassan et al., 2011b; Song et al., 2022; Nizam et al., 2020; Ashenafi and Dong, 2022). Having stated that, I can conclude that the results support my hypothesis, and therefore, financial development does have a positive and significant impact on future economic growth when controlling for inflation, population growth, government expenditure and trade. This suggests that well-developed financial systems, characterized by robust infrastructure,

efficient financial intermediation, and access to financial services, are associated with higher GDP per capita growth.

However, the non-significant coefficient for FINTERACT suggests that the interaction between FinTech and financial development does not have a significant additional effect on economic growth beyond the individual effects of these variables. This finding does not support my hypothesis that financial technology development has a stronger positive effect on GDP per capita growth in countries with a higher level of financial development, compared to less financially developed countries. Therefore, it is in line with the findings of Sadigov et al. (2020).

Firstly, even though financial development alone shows a positive and significant impact on economic growth, the inclusion of FinTech in the analysis may not contribute significantly to the explanatory power of the model. This suggests that there is insufficient evidence to neither support nor refute hypothesis 1. The impact of FinTech on economic growth may be mediated or influenced by other factors that are not captured in the current model. Moreover, causality is not yet addressed. Thus, to gain further insights, additional analyses are conducted, including an alternative specification and a comparative analysis of countries at different levels of economic development.

As for the control variables, the results indicate that there are statistically significant relationships between the variables and economic growth. The negative coefficients suggest that a higher inflation rate, population growth, and government expenditure are associated with lower GDP per capita growth rates. Higher inflation erodes purchasing power and reduces investment incentives, leading to lower economic growth. Moreover, higher population growth can strain resources and lead to less per capita output, negatively affecting growth. Lastly, increased government expenditure may crowd out private investment and result in inefficiency, which can hamper economic growth. On the other hand, the positive coefficients for trade indicate that higher trade openness has a positive impact on economic growth. Trade openness promotes access to larger markets, encourages competition, facilitates technology transfer, and enhances productivity through specialization and economies of scale.

Furthermore, the goodness of fit measures how well the regression model fits the observed data. Overall, the R-squared values suggest that the model explains a substantial portion of the total variation in the dependent variable with around 62%, but it has limited

ability to explain the within-group variation i.e. 12%. The adjusted R-squared values reinforce this observation, indicating that the model's explanatory power is not significantly improved when accounting for the number of variables and sample size. It is important to note that in the presence of fixed-effects, these measures may be lower compared to a model without fixed-effects. This is due to the fact that some of the variation in economic growth is attributed to the fixed effects rather than the independent variables. Therefore, the explanatory power of the model may appear weaker.

### *4.3 Regression results of alternative model specification*

In this section of my thesis, I aim to strengthen the analysis and provide more robust evidence through the alternative specification to further examine the relationship between financial technology, financial development, and economic growth. The purpose is to investigate whether the impact of FinTech on economic growth differs depending on the level of financial development. As mentioned before, to achieve this, dummy variables are created to distinguish observations above and below the median values of FinTech and financial development.

The findings in Table 6, from the above-median analysis suggest that, even though positive, the above-median levels of financial development do not have a statistically significant impact on economic growth. This may indicate that the relationship between financial development and economic growth is not as straightforward, and, the presence of a well-developed financial sector alone may not guarantee significant economic growth. Additionally, the non-significant positive coefficient for the interaction term implies that the joint effect of FinTech and financial development in the above-median group does not significantly influence GDP per capita growth, thus may not provide any additional boost to economic growth. Therefore, these results partially support my hypothesis that financial technology development has a stronger positive effect on GDP per capita growth in countries with a higher level of financial development. The positive coefficients indicate a potential positive relationship, aligning with my hypothesis. However, the lack of statistical significance suggests that the observed effects may be weak or non-existent. In contrast, FinTech exhibits a positive and significant result, which means that with every increase of FinTech development by 1%, future economic growth rises by 0.013 percentage points. The reason for this result might be that in countries with developed financial sectors there is already a strong foundation of financial institutions, infrastructure, and regulatory frameworks. This provides a favorable environment for the effective adoption and integration

of FinTech solutions, allowing for greater efficiency, accessibility, and innovation in financial services. Furthermore, in countries with developed financial sectors, there is typically a higher level of financial literacy and digital readiness among the population. This facilitates the adoption and usage of FinTech services, leading to increased utilization and positive economic outcomes.

**Table 6: Regression results for above-median and below-median analysis**

| | Growth $_{i,t+1}$ | | | | | |
|---|---|---|---|---|---|---|
| Specification for independent variables: | *above-median* | | | *below-median* | | |
| FinTech $_{i,t}$ | 0.0131** | | 0.0049 | -0.0109* | | -0.0071 |
| | (2.41) | | (0.34) | (-1.72) | | (-0.91) |
| Financial Dev. $_{i,t}$ | | 0.0985 | 0.0542 | | -0.0084 | 0.1629 |
| | | (1.44) | (0.73) | | (-0.10) | (0.97) |
| Inflation $_{i,t}$ | -0.1198** | -0.1236*** | -0.1224*** | -0.1203*** | -0.1210*** | -0.1206** |
| | (-2.58) | (-2.64) | (-4.98) | (-2.60) | (-2.60) | (-2.58) |
| Population $_{i,t}$ | -0.8940*** | -0.9035*** | -0.9034*** | -0.8882*** | -0.8910*** | -0.8827*** |
| | (-13.15) | (-13.40) | (-6.06) | (-13.00) | (-13.33) | (-12.74) |
| Government Exp. $_{i,t}$ | -0.1781* | -0.1927** | -0.1876** | -0.1697* | -0.1731* | -0.1625* |
| | (-1.93) | (-2.04) | (-2.05) | (-1.84) | (-1.85) | (-1.75) |
| ln_Trade $_{i,t}$ | 3.0540*** | 3.1280*** | 3.0737*** | 3.0469*** | 3.0968*** | 3.0354*** |
| | (3.18) | (3.21) | (3.96) | (3.17) | (3.18) | (3.17) |
| FINTERACT $_{i,t}$ | | | 0.0006 | | | -0.0036 |
| | | | (0.50) | | | (-0.90) |
| Constant | -7.3278* | -7.6112* | -7.6250** | -6.7893* | -7.1564* | -7.0396* |
| | (-1.84) | (-1.87) | (-2.20) | (-1.69) | (-1.77) | (-1.75) |
| *N* | 697 | 697 | 697 | 697 | 697 | 697 |
| $R^2$ - Overall | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 |
| $R^2$ - Within | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| adj. $R^2$ | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

Moreover, the lack of a significant impact on economic growth despite having a well-developed financial sector can be attributed to several factors, such as governance issues. Governance plays a crucial role in determining the effectiveness and efficiency of financial systems. In some cases, even with well-developed financial institutions, weak governance structures and inadequate regulatory frameworks can hinder the transmission of financial development into tangible economic growth. Governance failures, such as corruption, lack of transparency, and weak rule of law, can undermine the trust and confidence necessary for financial systems to effectively support economic activity. Additionally, corruption can

undermine the positive effects of financial development on economic growth. Corruption can distort the functioning of financial systems, impede investment and innovation, and deter foreign direct investment, ultimately hindering economic growth.

The findings from the below-median analysis suggest that lower levels of financial development do not have a significant impact on economic growth. However, FinTech exhibits a significant negative result. This can be interpreted as a negative impact of 0.0109 percentage points on GDP per capita growth resulting from increasing levels of FinTech development. In countries with underdeveloped financial systems, there may be limited access to financial services, inadequate infrastructure, and weak regulatory frameworks, as well as, a lack of financial literacy and digital readiness among the population, which is contrasting to more developed financial sectors. Moreover, the results pertaining to the interaction term, FINTERACT, in the below-median analysis exhibits outcomes similar to the main specification, further strengthening the notion that my hypothesis is rejected. One possible explanation for these results could be that in countries with lower levels of FinTech and financial development, other factors such as institutional factors, macroeconomic conditions, or specific characteristics of the economy might play a more significant role in driving economic growth.

Additionally, I can conclude that the result in the main model specification is most likely insignificant due to the contrasting results across the countries, more specifically countries with more developed, and less developed financial sectors and FinTech solutions.

### *4.4 Comparative analysis between levels of economic development*

In this section, I present a comparative analysis aimed at examining the relationship between FinTech, financial development, and economic growth across different groups of countries with varying levels of economic development. It allows for the assessment of how the impact of FinTech and financial development on economic growth may vary in the presence of different institutional and economic contexts. The comparative analysis helps validate the consistency of the observed relationships across diverse sets of countries, shedding light on the intricate dynamics between these factors and their implications for economic growth. The results of this regression with robust standard errors are shown in Table 7. Similarly, for this regression analysis, I am once again excluding certain observations due to the same data limitations pertaining to the variable of financial

development, ensuring consistency with the previous approach, thus, results with all available data for FinTech is presented in Appendix C.

**Table 7: Regression results by level of economic development**

| | **Developed** | | | **Underdeveloped** | | |
|---|---|---|---|---|---|---|
| | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ |
| ln_FinTech $_{i,t}$ | -0.9328 | | -3.4454** | 1.4067*** | | 0.5898 |
| | (-1.35) | | (-2.43) | (2.84) | | (0.60) |
| ln_Financial Development $_{i,t}$ | | -0.6475 | -5.2141 | | 2.5215*** | 2.5755** |
| | | (-0.58) | (-1.29) | | (3.38) | (2.11) |
| Inflation $_{i,t}$ | -0.1807*** | -0.1809*** | -0.1831*** | -0.1087** | -0.1095** | -0.1105** |
| | (-4.39) | (-4.37) | (-4.47) | (-2.05) | (-2.14) | (-2.13) |
| Population $_{i,t}$ | -1.0043*** | -1.0003*** | -1.0433*** | 1.4044 | 1.1405 | 1.1874 |
| | (-12.80) | (-13.49) | (-12.23) | (1.03) | (0.90) | (0.93) |
| Government Expenditure $_{i,t}$ | -0.0905 | -0.0980 | -0.1113 | -0.1425 | -0.1250 | -0.1158 |
| | (-0.96) | (-1.02) | (-1.17) | (-0.75) | (-0.66) | (-0.60) |
| ln_Trade $_{i,t}$ | 8.1965*** | 8.4078*** | 8.1252*** | 1.2464 | 1.0479 | 1.0123 |
| | (5.20) | (5.33) | (5.07) | (1.26) | (1.12) | (1.08) |
| FINTERACT $_{i,t}$ | | | 1.5749* | | | -0.1375 |
| | | | (1.76) | | | (-0.23) |
| Constant | -27.6589*** | -30.7774*** | -19.9006** | -7.8160* | -5.3608 | -6.8326 |
| | (-3.65) | (-4.26) | (-2.26) | (-1.73) | (-1.33) | (-1.54) |
| *N* | 400 | 400 | 400 | 297 | 297 | 297 |
| $R^2$ - Overall | 0.76 | 0.76 | 0.77 | 0.51 | 0.53 | 0.53 |
| $R^2$ - Within | 0.28 | 0.28 | 0.29 | 0.07 | 0.09 | 0.09 |
| adj. $R^2$ | 0.27 | 0.27 | 0.28 | 0.05 | 0.08 | 0.07 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

Table 7 indicates that higher levels of financial development have a significant positive effect on economic growth in underdeveloped economies. Specifically, a 1% increase in financial development in underdeveloped countries increases their GDP per capita growth by 0.025 percentage points. In underdeveloped economies, there is often a lack of well-functioning financial systems, limited access to credit, and inadequate financial intermediation. Therefore, when financial development is enhanced in these economies, it has significant positive effects on economic growth. Furthermore, it promotes financial inclusion, enabling a broader segment of the population to access financial services and participate in economic activities. Moreover, regarding FinTech in underdeveloped countries, the significant result suggests that financial technology development plays a crucial role in promoting economic growth in underdeveloped economies. The coefficient estimate indicates

that GDP per capita increases by 0.014 percentage points when FinTech development increases by 1%. Therefore, in these countries, where traditional financial systems may be limited, FinTech solutions can act as catalysts for change by improving financial inclusion, expanding access to capital, and enhancing efficiency in financial transactions. The introduction and adoption of FinTech can address existing gaps and outdated infrastructure, driving significant economic growth.

In contrast, developed countries already possess well-established financial systems and advanced banking infrastructure, making the incremental impact of financial development less pronounced. These countries typically have efficient financial institutions, deep and liquid capital markets, and advanced financial infrastructure. As a result, the scope for further improvement in financial development may be limited, leading to smaller incremental effects on economic growth. Similarly, the coefficient for FinTech does not reach statistical significance. Therefore, based on these results, I cannot conclude that financial technology development alone has a significant influence on economic growth in more economically developed countries. This might be due to their advanced financial systems and high adoption of FinTech, leading to synergistic benefits.

Furthermore, the FINTERACT variable shows significant results for developed economies. Thus, indicating that when both financial development and FinTech development rise by 1% at the same time, GDP per capita growth in developed countries increases by 0.016 percentage points. The results indicate that in more developed countries, not only is FinTech positively influenced by financial development, but it is also reliant on it. This relationship is evident from the insignificant negative result when analyzing FinTech alone. It suggests that the presence and advancement of financial development are crucial for the effective functioning and growth of the FinTech sector in these countries. Also, the analysis comparing countries based on their level of financial development and FinTech adoption did not provide a clear conclusion on whether financial development enhances the positive impact of FinTech on economic growth. This uncertainty was mainly due to the non-significant result of the interaction term, FINTERACT, despite having a positive coefficient. However, when examining the results based on the levels of economic development, FINTERACT showed both significance and a positive coefficient, allowing me to infer that higher levels of financial development indeed amplify the effect of FinTech on GDP per capita growth.

Moreover, I can draw further conclusions. Considering this analysis reveals statistically significant and positive results for developed economies. This might suggest that the insignificant, yet positive, results observed in the above-median analysis are likely to be significant as well. The findings indicate that economies with more developed financial sectors have a stronger positive impact on GDP per capita growth as financial technology develops. Additionally, these findings are consistent with previous research in the field (Feyen et al., 2022; Haftu, 2019). However, it is important to note that the regressions in this thesis were conducted without simultaneously including financial development and FinTech development as independent variables. Also, the proxy used for measuring FinTech development is the percentage of digital payments made or received in specific countries across different levels of economic development. Relying solely on that proxy may oversimplify the complex nature of FinTech evolution and its impact on economic growth.

On the other hand, the negative and insignificant result for the joint effect of FinTech and financial development in underdeveloped countries indicates no direct impact on GDP per capita's growth. In underdeveloped countries where financial development is limited and FinTech adoption is low, the combined influence of these factors may result in a negative impact. This can be attributed to various challenges, including corruption, inequality, and poverty, which hinder the efficient utilization and equitable distribution of financial resources. These socio-economic factors act as obstacles, preventing the full realization of the potential benefits associated with FinTech and financial development, thereby hindering economic growth.

The overall R-squared values indicate that the independent variables in the model explain approximately 76% and 53% of the variation in the dependent variable for the developed countries and underdeveloped countries groups, respectively. The R-squared within values would suggest that the fixed effects account for a relatively small portion of the variation in the dependent variable within each group. The results suggest that the independent variables in the model have a relatively higher explanatory power for the group of developed countries compared to the underdeveloped country group. However, it's important to consider other factors that may influence the results, such as the specific variables included in the model and the nature of the fixed effects.

### *4.5 Regression results with alternative proxies*

As mentioned before, I run an alternative regression to test the model by using GDP per capita in local currency as a proxy for financial development, and GDP growth (%) as a proxy for economic growth. GDP per capita is often used as a proxy for financial development due to its correlation with the level of economic development and financial sector development in a country. While it may not capture all aspects of financial development, it can provide a rough estimate or serve as an indicator in many cases. On the other hand, GDP growth is used as a proxy for economic growth because it provides a standardized and widely accepted measure of the overall increase in the value of goods and services produced within a country, reflecting the expansion of economic activity. This change aligns with my shift to using GDP per capita as a proxy for financial development.

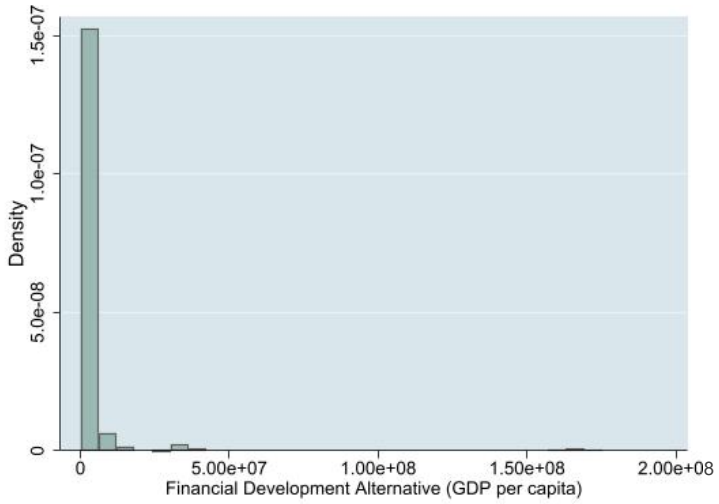
**Table 8: Correlation matrix with alternative proxies for economic growth and financial development**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| (1) Economic Growth *(alt.)* | 1 | | | | | | |
| (2) FinTech Development | -0.227 | 1 | | | | | |
| (3) Financial Development *(alt.)* | -0.025 | 0.070 | 1 | | | | |
| (4) Inflation Rate | -0.067 | -0.201 | 0.246 | 1 | | | |
| (5) Population Growth | 0.231 | -0.358 | 0.037 | 0.068 | 1 | | |
| (6) Government Expenditure | -0.132 | 0.115 | -0.164 | -0.043 | -0.092 | 1 | |
| (7) Trade Openness | 0.036 | 0.314 | -0.105 | -0.181 | -0.151 | -0.083 | 1 |

Moreover, the intention behind presenting Table 8 is to demonstrate that when using the alternative proxy of GDP per capita, there is no strong correlation between financial development and FinTech development, keeping in mind the specified threshold of 0.7. Consequently, there is no indication of multicollinearity, and both variables will be included in the regression analysis at the same time.

Figure 2 displays a histogram of GDP per capita used as an alternative proxy for financial development, revealing an evident asymmetrical distribution of the data. To address this, a logarithmic transformation of the variable is implemented.

**Figure 2: Histogram of GDP per capita as an alternative proxy to financial development**




After making all necessary adjustments, the regression depicted in Table 9 is performed using robust standard errors. It is important to note that for this regression all data is available, however, for the purpose of a fair and valid comparison between regressions, I exclude the observations that are missing in the other analyses. The results with all observations are notably similar to the results in Table 9 and are depicted in Appendix C. Moreover, it is confirmed that heteroskedasticity is not present considering that the results in Table 9 do not change when compared to the results with normal standard errors, in Appendix C.

The coefficient estimate for financial technology development is -0.0116, suggesting a negative relationship with economic growth. The negative coefficient for financial technology development would suggest that, on average, an increase in financial technology development may have a negative impact on economic growth. However, the lack of statistical significance implies that this relationship may not be reliable. Therefore, the results do not support the hypothesis that financial technology development has a positive and significant effect on economic growth, as the coefficient is not statistically significant and negative.

Furthermore, the results indicate that financial development, represented by GDP per capita in logarithmic form, has a positive and statistically significant effect on economic growth, as captured by GDP growth (%). The positive coefficient estimates suggest that a 1% increase in financial development, as reflected by higher GDP per capita, is associated with a 0.1209 percentage point increase in future economic growth. These findings align with the

results of my main regression with the initial proxies. Thus, it strengthens my conclusion that hypothesis 2 is supported.

**Table 9: Alternative proxies' regression**

| | Growth $_{i,t+1}$ *(alternative)* | Growth $_{i,t+1}$ *(alternative)* |
|---|---|---|
| ln_FinTech $_{i,t}$ | -0.0116 | 0.1181 |
| | (-0.03) | (0.06) |
| ln_Financial Development $_{i,t}$ *(alternative)* | 12.0911*** | 12.1281*** |
| | (4.42) | (4.17) |
| Inflation $_{i,t}$ | -0.1083** | -0.1082** |
| | (-2.49) | (-2.48) |
| Population $_{i,t}$ | 0.0296 | 0.0302 |
| | (0.31) | (0.32) |
| Government Expeniture $_{i,t}$ | -0.1691* | -0.1699* |
| | (-1.88) | (-1.86) |
| Trade $_{i,t}$ | 2.3927** | 2.4018** |
| | (2.39) | (2.40) |
| FINTERACT $_{i,t}$ | | -0.0102 |
| | | (-0.07) |
| Constant | -152.2918*** | -152.7907*** |
| | (-4.64) | (-4.34) |
| *N* | 697 | 697 |
| $R^2$ - Overall | 0.64 | 0.64 |
| $R^2$ - Within | 0.13 | 0.13 |
| adj. $R^2$ | 0.13 | 0.12 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

The coefficient estimate for FINTERACT is -0.0102, but it is not statistically significant. The insignificant coefficient implies that the joint effect of FinTech and financial development on GDP growth may not be statistically distinguishable from zero. These results are in line with the findings in the main regression.

The overall R-squared values for the regression model are 0.64, indicating that the model explains 64% of the total variation in the dependent variable. The within-group R-squared values are 0.13, suggests that the model would explain 13% of the variation within each group. Whereas, the adjusted R-squared values are 0.12 and 0.13, accounting for the number of variables and sample size.

Additionally, the comparative analysis regressions, as well as the alternative specification regression with above and below median values, are also conducted with the alternative proxies for economic growth and financial development. The results are included in Appendix C.

# 5 Conclusion and discussion

This study focuses on investigating the relationship between financial development, financial technology, and economic growth. The research aims to determine whether FinTech has a stronger positive effect on GDP per capita growth in countries with higher levels of financial development and to assess the individual impacts of FinTech and financial development on economic growth while controlling for other variables. The methodology involves combining existing models with minor modifications, utilizing panel data regression analysis with fixed-effects for both countries and years. The inclusion of sensitivity tests and analysis of different country groups adds robustness to the findings. By employing various proxies for economic growth and financial development, the study ensures consistency and addresses potential endogeneity issues. The regression results from both specifications, as well as the comparative analysis across country groups provide insights into the relationship between FinTech, financial development, and economic growth in different contexts.

Moreover, the data analysis in this research is based on a sample of 102 countries over a span of 9 years from 2012 to 2020, consisting of 918 observations. However, some observations are dropped because of data limitations, making the final number of observations 697. Additionally, the comparative analysis considers the economic development stages of the countries, with 400 classified as developed, and 297 as underdeveloped countries, providing insights into the variations across different levels of economic development. The panel dataset is unbalanced as a result of the countries in the data sample not having complete and sufficient data for all years in the period of interest.

The main regression results of the analysis, as supported by the results of the alternative-proxies analysis, indicate there is no significant relationship between financial technology development and future economic growth, when using digital payments as a proxy for FinTech. On the other hand, the coefficient for financial development is positive and statistically significant, suggesting that a highly developed financial sector may have a positive impact on economic growth. Lastly, after analyzing additional regression results, it

can be concluded that a well-developed financial system combined with advancements in financial technology creates a more favorable environment for economic growth.

Furthermore, with respect to the alternative specification regression and the regression analyzing different levels of development, several conclusions can be drawn. Firstly, the findings for financially developed countries i.e. those with above-median values of financial development, as well as the results for highly developed economies, demonstrate insignificance. Thus, this further strengthens the validity of the results for financial development. Nevertheless, it is evident that FinTech development has a positive impact on GDP per capita growth in countries with more advanced financial sectors. It is important to note that this inference does not imply that all highly developed economies analyzed in this study are significantly affected by FinTech. Rather, it suggests that the positive influence of FinTech on economic growth is more pronounced in highly developed economies that at the same time demonstrate higher levels of financial development.

Following the empirical work done by other scholars in this field, the three hypotheses that arise from this study state that financial technology development has a stronger positive effect on GDP per capita growth in countries with a higher level of financial development than in economies with lower levels of financial development (Feyen et al., 2022; Haftu, 2019); and that financial development has a positive and significant effect on economic growth, controlling for other variables (Allen et al., 2014; Caporale et al., 2015; Hassan et al., 2011b; Song et al., 2022; Nizam et al., 2020; Ashenafi and Dong, 2022), as well as that financial technology development also has a positive and significant effect on economic growth (Haftu, 2019; Kanga et al., 2021). Ultimately, the analysis shows that two of these hypotheses are supported by the results, while one can be rejected. Hypothesis 3 can be rejected considering it is not supported by the findings. The coefficient for FinTech development is statistically insignificant, indicating that there is insufficient evidence to conclude a significant relationship between FinTech development and future economic growth, which disproves hypothesis 3. Thus, this further supports the research done by Sadigov et al. (2020). On the other hand, hypothesis 2 is fully supported by the results for financial development which is positive and statistically significant, indicating that higher levels of financial development have a significant positive effect on economic growth.

Finally, when analyzing the joint impact of FinTech and financial development on economic growth, there are multiple aspects that support or indicate the validity of hypothesis

1. Firstly, the insignificant results that show a negative coefficient in both the main specification, and the alternative proxy analysis, can be further examined through the additional regressions. These results, may potentially be connected to less developed economies, considering the positive and significant results in highly developed economies, and the evident negative and insignificant results in the less developed countries depicted in the below-median analysis and comparative analysis between levels of economic development. Therefore, given that the main hypothesis suggests a stronger positive influence of FinTech on GDP per capita growth in countries experiencing higher financial development, the results may indicate a higher probability that hypothesis 1 is substantiated. However, these results do not provide sufficient evidence. Additionally, the insignificant, yet positive, result in the alternative specification regression, specifically the above-median analysis for countries with more developed financial systems, is highly likely to be significant when taking into account the results for countries with high level of economic development which exhibit a positive and significant coefficient. Thus, this also supports that my main hypothesis is correct. Lastly, and most importantly, the joint effect of FinTech and financial development in developed countries confirms my hypothesis by having a positive and significant coefficient. Therefore, I can conclude that these various aspects, including significant results, consistent patterns, and logical reasoning, contribute to building a stronger case for the main hypothesis, lending credibility to its potential validity.

Nonetheless, the validity of the findings and arguments presented in the main analysis should be carefully assessed. The use of robust standard errors and controlling for other variables, as well as addressing asymmetry and multicollinearity enhances the validity of the findings. However, it is important to consider the limitations of this study. The proxy used for measuring FinTech development, specifically the percentage of digital payments, may not fully capture the breadth and depth of FinTech advancements in different countries. Additionally, the financial development variables includes most aspects of financial institutions, however, it only includes the depth of financial markets. Thus, making this research limited, since it does not include the financial markets' efficiency and access, as a result of missing data. Furthermore, the regression analysis does not include simultaneous inclusion of both FinTech development and financial development as independent variables, which may limit the understanding of their joint effects on economic growth. Lastly, it is important to note that there is data limitation within some of the variables, specifically the domestic credit to private sector, and the liquid liabilities variables, therefore causing the

regressions to be conducted in a way where observations are cut from the analyses. Thus, future research should consider including a larger data sample to address this limitation of my thesis.

While the findings do not support the significant impact of FinTech development on economic growth in general, it indicates that FinTech's growth and effectiveness are closely linked to the presence and advancement of financial development. The analysis highlights the significance of the interaction between FinTech and financial development, particularly in countries with higher levels of financial development. Therefore, it may be more appropriate to focus on the relationship between FinTech and financial development, rather than viewing them as separate entities. Furthermore, it is crucial to conduct further research and refine measurement approaches to better capture the multidimensional nature of FinTech and its impact on GDP per capita growth.

Despite these limitations, the research contributes to the literature by highlighting the importance of the interaction between FinTech development and financial development in driving economic growth. It emphasizes that the joint effect of these factors is more significant in countries with higher levels of financial development, underscoring the complementarities between FinTech and a well-developed financial system. The findings call for policymakers to focus on creating an enabling environment that fosters both FinTech innovation and financial development, particularly in countries with limited financial infrastructure or underdeveloped financial sectors. Therefore, I recommend conducting further research that specifically focuses on underdeveloped countries through a separate and in-depth analysis. This analysis should not only examine the relationship between financial development, FinTech, and economic growth but also delve into the underlying factors of inequality, poverty, and corruption. By integrating these socio-economic factors into the analysis, a more comprehensive understanding of the complex dynamics at play can be achieved, leading to better insights for improving society and governance in underdeveloped countries.

In conclusion, while this thesis expands our understanding of the relationship between FinTech development, financial development, and economic growth, further investigation is needed to address the limitations and refine the analysis. By considering these insights and conducting more comprehensive studies, policymakers and practitioners can better leverage FinTech's potential to drive economic growth and foster sustainable development.

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# 7 Appendix

## *Appendix A – List of countries included in the data sample*

**Table 10: List of countries included in the data sample**

| No. | Country | Income level |
|---|---|---|
| 1 | Albania | High income |
| 2 | Algeria | Low income |
| 3 | Argentina | High income |
| 4 | Armenia | High income |
| 5 | Australia | High income |
| 6 | Austria | High income |
| 7 | Bangladesh | Low income |
| 8 | Belgium | High income |
| 9 | Benin | Low income |
| 10 | Bolivia | Low income |
| 11 | Bosnia and Herzegovina | High income |
| 12 | Brazil | High income |
| 13 | Bulgaria | High income |
| 14 | Cambodia | Low income |
| 15 | Cameroon | Low income |
| 16 | Canada | High income |
| 17 | Chile | High income |
| 18 | China | High income |
| 19 | Colombia | High income |
| 20 | Congo, Rep. | Low income |
| 21 | Costa Rica | High income |
| 22 | Croatia | High income |
| 23 | Cyprus | High income |
| 24 | Czechia | High income |
| 25 | Denmark | High income |

| | | |
|---|---|---|
| 26 | Dominican Republic | High income |
| 27 | Ecuador | High income |
| 28 | Egypt, Arab Rep. | Low income |
| 29 | El Salvador | Low income |
| 30 | Estonia | High income |
| 31 | Finland | High income |
| 32 | France | High income |
| 33 | Gabon | High income |
| 34 | Georgia | High income |
| 35 | Germany | High income |
| 36 | Ghana | Low income |
| 37 | Greece | High income |
| 38 | Guinea | Low income |
| 39 | Honduras | Low income |
| 40 | Hong Kong SAR, China | High income |
| 41 | Hungary | High income |
| 42 | India | Low income |
| 43 | Indonesia | Low income |
| 44 | Iran, Islamic Rep. | Low income |
| 45 | Ireland | High income |
| 46 | Israel | High income |
| 47 | Italy | High income |
| 48 | Japan | High income |
| 49 | Jordan | High income |
| 50 | Kazakhstan | High income |
| 51 | Kenya | Low income |
| 52 | Korea, Rep. | High income |
| 53 | Kyrgyz Republic | Low income |
| 54 | Latvia | High income |
| 55 | Lebanon | High income |
| 56 | Lithuania | High income |

| | | |
|---|---|---|
| 57 | Malaysia | High income |
| 58 | Mali | Low income |
| 59 | Malta | High income |
| 60 | Mauritius | High income |
| 61 | Moldova | High income |
| 62 | Mongolia | Low income |
| 63 | Myanmar | Low income |
| 64 | Namibia | High income |
| 65 | Nepal | Low income |
| 66 | Netherlands | High income |
| 67 | New Zealand | High income |
| 68 | Nicaragua | Low income |
| 69 | Nigeria | Low income |
| 70 | North Macedonia | High income |
| 71 | Norway | High income |
| 72 | Pakistan | Low income |
| 73 | Panama | High income |
| 74 | Peru | High income |
| 75 | Philippines | Low income |
| 76 | Poland | High income |
| 77 | Portugal | High income |
| 78 | Romania | High income |
| 79 | Russian Federation | High income |
| 80 | Saudi Arabia | High income |
| 81 | Senegal | Low income |
| 82 | Serbia | High income |
| 83 | Sierra Leone | Low income |
| 84 | Singapore | High income |
| 85 | Slovak Republic | High income |
| 86 | Slovenia | High income |
| 87 | South Africa | High income |

| | | |
|---|---|---|
| 88 | Spain | High income |
| 89 | Sweden | High income |
| 90 | Switzerland | High income |
| 91 | Tanzania | Low income |
| 92 | Thailand | High income |
| 93 | Togo | Low income |
| 94 | Tunisia | Low income |
| 95 | Turkiye | High income |
| 96 | Uganda | Low income |
| 97 | Ukraine | Low income |
| 98 | United Arab Emirates | High income |
| 99 | United Kingdom | High income |
| 100 | United States | High income |
| 101 | Uzbekistan | Low income |
| 102 | Zambia | Low income |

## *Appendix B – Description of variables*

**Table 11: Description of variables**

| Name of variable | Definition and measurement | Source | Description |
|---|---|---|---|
| ***- Dependent Variable:*** | | | |
| Economic Growth (Growth) | GDP per capita growth (%) | World Development Indicators (World Bank Open Data); Ashenafi and Dong (2022) | This variable measures the rate of growth in GDP (Gross Domestic Product) per capita over time. It serves as an indicator of the economic performance and development of a country. |
| Economic Growth *(Alternative)* | GDP growth (%) | World Development Indicators (World Bank Open Data) | This variable represents the alternative proxy for measuring economic growth, specifically the percentage change in GDP (Gross Domestic Product) over a specific period. It is used as an alternative to measuring economic growth instead of using the traditional measure of GDP per capita growth. |
| ***- Independent Variables:*** | | | |
| *a) Main variables:* | | | |
| FinTech Development | Percentage of digital payments made or received by people over the age of 15 (%) | Global Financial Inclusion Indicators i.e. Global Findex (World Bank Open Data) | This variable represents the extent of financial technology usage in a country. It measures the percentage of digital payments made or received by individuals aged 15 and above. It serves as an indicator of the level of adoption and utilization of digital payment systems within the population. |
| Account Ownership | Account (% age 15+) | Global Financial Inclusion Indicators i.e. Global Findex (World Bank Open Data); Ashenafi and Dong (2022); Allen et al. (2014) | This variable refers to the percentage of individuals aged 15 and above who have access to and own a financial account, such as a bank account. It is used as a measure of financial inclusion, which is one of the dimensions of financial development. |

| | | | |
|---|---|---|---|
| Savings at Financial Institutions | Saved at a financial institution (% age 15+) | Global Financial Inclusion Indicators i.e. Global Findex (World Bank Open Data); Ashenafi and Dong (2022); Allen et al. (2014) | This variable refers to the percentage of individuals aged 15 and above who deposit their savings in formal financial institutions, such as banks, credit unions, or other regulated financial institutions. It serves as a measure of financial inclusion, which is one of the dimensions of financial development. |
| Borrowings from Financial Institutions | Borrowed from a formal financial institution (% age 15+) | Global Financial Inclusion Indicators i.e. Global Findex (World Bank Open Data); Ashenafi and Dong (2022); Allen et al. (2014) | This variable refers to the percentage of individuals aged 15 and above who obtain loans or credit from formal financial institutions, such as banks, microfinance institutions, or other regulated financial entities. It is used as a measure of financial inclusion, which is one of the dimensions of financial development. |
| Financial Inclusion | Financial Inclusion is derived by averaging the values of Account Ownership, Savings at Financial Institutions, and Borrowings from Financial Institutions. (% age 15+) | Author's calculations | This variable represents the average of three indicators: Account Ownership, Savings at Financial Institutions, and Borrowings from Financial Institutions. It is a measure of the overall level of financial inclusion, which reflects the extent to which individuals aged 15 and above have access to and engage in formal financial services. Financial inclusion is an important aspect of financial development and indicates the degree of participation and integration of individuals into the formal financial system. |
| Domestic credit to private sector | Domestic credit to private sector (% of GDP) | World Development Indicators (World Bank Open Data); Allen et al. (2014); Caporale et al. (2015); Hassan et al. (2011b) | This variable measures the extent to which the private sector in a country has access to domestic credit, expressed as a percentage of the country's GDP. It is used to define one of the dimensions of financial development, specifically, financial depth. |

| | | | |
|---|---|---|---|
| Liquid Liabilities | Broad money (% of GDP) | World Development Indicators (World Bank Open Data); Allen et al. (2014); Caporale et al. (2015); Hassan et al. (2011b) | This variable refers to the total amount of money in circulation within an economy. This variable represents the broad money supply as a percentage of the country's GDP. It is used to define one of the dimensions of financial development, specifically, the size of the financial sector. |
| Financial Markets Depth | Financial Markets Depth Index | Financial Development Index Database (International Monetary Fund i.e. IMF) | This variable is measured using an index that considers various factors such as stock market capitalization, stocks traded, international debt securities of government, total debt securities of financial corporations, and total debt securities of nonfinancial corporations, all as a percentage of GDP. It is used to define one of the dimensions of financial development, specifically, the efficiency of the financial sector. |
| Financial Development | Financial Development is calculated as the average of the normalized values of four variables: Financial Inclusion, Domestic credit to private sector, Liquid Liabilities, and Financial Markets Depth. | Author's calculations | This variable provides an overall measure of the level of financial development in a country, taking into account various dimensions such as financial inclusion, financial depth, the size, and the efficiency of the financial sectors. |
| FINTERACT | Product of the author's calculations of the measure for financial development and percentage of digital payments made or received by people over the age of 15 (%) | Author's calculations | This variable represents an interaction term between FinTech and financial development. The interaction term is created by multiplying the values of these two variables together. It captures the joint effect or interaction between FinTech and financial development on economic growth. |

| | | | |
|---|---|---|---|
| Financial Development *(Alternative)* | GDP per capita (current LCU) | World Development Indicators (World Bank Open Data) | This variable refers to an alternative measure or proxy for financial development. Instead of using the traditional Financial Development Index, GDP per capita is used as an alternative measure for financial development. It provides information on the level of financial development in a country based on its GDP per capita. |
| FINTERACT *(Alternative)* | Product of GDP per capita (current LCU) and percentage of digital payments made or received by people over the age of 15 | Author's calculations | This variable is another interaction term; however, it is created using the alternative measure of financial development i.e. GDP per capita and FinTech. The interaction term is created by multiplying the values of these two variables together. It captures the joint effect or interaction between the alternative measure of financial development and fintech on economic growth. |
| *b) Control variables:* | | | |
| Population Growth | Population growth (annual %) | World Development Indicators (World Bank Open Data) | This variable measures the annual percentage change in a country's population. It serves as a control for demographic changes that may influence economic growth. |
| Government Expenditure | General government final consumption expenditure (% of GDP) | World Development Indicators (World Bank Open Data) | This variable indicates the proportion of a country's GDP that is spent by the government on final consumption. It serves as a control for the role of government expenditure in influencing economic growth. |
| Inflation Rate | GDP deflator, annual percentage (%) | World Development Indicators (World Bank Open Data) | This variable measures the annual percentage change in the general price level of goods and services within a country. It serves as a control for inflationary pressures that may affect economic growth. |
| Trade Openness | Trade (% of GDP) | World Development Indicators (World Bank Open Data) | This variable represents the extent of a country's international trade in relation to its GDP. It measures the value of imports and exports as a percentage of the country's GDP. Thus, serves as a control for the impact of trade on economic growth. |

## *Appendix C – Additional outputs*

**Table 12: Correlation matrix in depth**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Economic Growth | 1 | | | | | | | | | | | |
| (2) FinTech | -0.142 | 1 | | | | | | | | | | |
| (3) Account Ownership | -0.086 | 0.914 | 1 | | | | | | | | | |
| (4) Borrowings | -0.058 | 0.775 | 0.776 | 1 | | | | | | | | |
| (5) Savings | -0.065 | 0.797 | 0.792 | 0.821 | 1 | | | | | | | |
| (6) D. credit to private sector | -0.095 | 0.652 | 0.717 | 0.754 | 0.792 | 1 | | | | | | |
| (7) Liquid Liabilities | -0.092 | 0.398 | 0.493 | 0.535 | 0.514 | 0.771 | 1 | | | | | |
| (8) Financial Markets | -0.087 | 0.673 | 0.712 | 0.719 | 0.813 | 0.852 | 0.600 | 1 | | | | |
| (9) Inflation | -0.002 | -0.168 | -0.177 | -0.182 | -0.246 | -0.273 | -0.225 | -0.219 | 1 | | | |
| (10) Population | -0.172 | -0.325 | -0.444 | -0.290 | -0.209 | -0.277 | -0.193 | -0.149 | 0.077 | 1 | | |
| (11) Government expenditure | -0.095 | 0.131 | 0.202 | 0.120 | 0.150 | 0.185 | 0.083 | 0.144 | -0.048 | -0.105 | 1 | |
| (12) Trade | 0.014 | 0.257 | 0.283 | 0.233 | 0.248 | 0.357 | 0.478 | 0.244 | -0.158 | -0.165 | -0.045 | 1 |

**Table 13: Initial frequency table of available countries from a specific development level**

| Development stage | Income level | Freq. | Percent | Cum. |
|---|---|---|---|---|
| Developed countries | High income | 612 | 66.67 | 66.67 |
| Underdeveloped countries | Low income | 306 | 33.33 | 100.00 |
| | Total | 918 | 100.00 | |

**Table 14: Initial regression results**

| | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ |
|---|---|---|---|
| ln_FinTech $_{i,t}$ | 0.3014 | | -0.5190 |
| | (0.79) | | (-0.86) |
| ln_Financial Development $_{i,t}$ | -0.1209*** | 1.5326*** | 2.0550* |
| | (-2.60) | (3.01) | (1.92) |
| Inflation $_{i,t}$ | -0.8936*** | -0.1216*** | -0.1219*** |
| | (-13.26) | (-5.01) | (-5.01) |
| Population $_{i,t}$ | -0.1753* | -0.9084*** | -0.9066*** |
| | (-1.89) | (-6.13) | (-6.11) |
| Government Expenditure $_{i,t}$ | 3.0819*** | -0.1817** | -0.1767* |
| | (3.15) | (-2.02) | (-1.94) |
| ln_Trade $_{i,t}$ | 0.3014 | 2.8797*** | 2.8420*** |
| | (0.79) | (3.72) | (3.66) |
| FINTERACT $_{i,t}$ | | | -0.0415 |
| | | | (-0.12) |
| Constant | -8.2132* | -9.0092*** | -7.6432** |
| | (-1.81) | (-2.59) | (-2.03) |
| *N* | 697 | 697 | 697 |
| $R^2$ - Overall | 0.61 | 0.62 | 0.62 |
| $R^2$ - Within | 0.11 | 0.12 | 0.12 |
| adj. $R^2$ | 0.10 | 0.11 | 0.11 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

**Table 15: Regression results by level of economic development (without excluding missing observations)**

| | **Developed** | | | **Underdeveloped** | | |
|---|---|---|---|---|---|---|
| | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ | Growth $_{i,t+1}$ |
| ln_FinTech $_{i,t}$ | -0.6079 | | -3.4454** | 1.2325** | | 0.5898 |
| | (-0.92) | | (-2.43) | (2.46) | | (0.60) |
| ln_Financial Development $_{i,t}$ | | -0.6475 | -5.2141 | | 2.5215*** | 2.5755** |
| | | (-0.58) | (-1.29) | | (3.38) | (2.11) |
| Inflation $_{i,t}$ | -0.1324*** | -0.1809*** | -0.1831*** | -0.0777 | -0.1095** | -0.1105** |
| | (-5.49) | (-4.37) | (-4.47) | (-1.40) | (-2.14) | (-2.13) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Population $_{i,t}$ | -0.8638*** | -1.0003*** | -1.0433*** | 0.4192 | 1.1405 | 1.1874 |
| | (-7.75) | (-13.49) | (-12.23) | (0.29) | (0.90) | (0.93) |
| Government Expenditure $_{i,t}$ | -0.2148** | -0.0980 | -0.1113 | -0.2228 | -0.1250 | -0.1158 |
| | (-2.00) | (-1.02) | (-1.17) | (-1.13) | (-0.66) | (-0.60) |
| ln_Trade $_{i,t}$ | 10.8251*** | 8.4078*** | 8.1252*** | 1.5109 | 1.0479 | 1.0123 |
| | (6.92) | (5.33) | (5.07) | (1.46) | (1.12) | (1.08) |
| FINTERACT $_{i,t}$ | | | 1.5749* | | | -0.1375 |
| | | | (1.76) | | | (-0.23) |
| Constant | -39.8738*** | -30.7774*** | -19.9006** | -5.5583 | -5.3608 | -6.8326 |
| | (-5.31) | (-4.26) | (-2.26) | (-1.18) | (-1.33) | (-1.54) |
| *N* | 612 | 400 | 400 | 306 | 297 | 297 |
| $R^2$ - Overall | 0.73 | 0.76 | 0.77 | 0.50 | 0.53 | 0.53 |
| $R^2$ - Within | 0.24 | 0.28 | 0.29 | 0.05 | 0.09 | 0.09 |
| adj. $R^2$ | 0.23 | 0.27 | 0.28 | 0.03 | 0.08 | 0.07 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

**Table 16: Descriptive statistics for alternative proxies for economic growth and financial development**

| VARIABLE | Obs. | Mean | Std. Dev. | Min | Med | Max |
|---|---|---|---|---|---|---|
| Economic growth *(alt.)* | 918 | 2.49 | 3.97 | -21.40 | 2.88 | 24.37 |
| Financial development *(alt.)* | 918 | 3.25e+06 | 1.72e+07 | 2,716 | 77,775.39 | 1.752e+08 |

**Table 17: Alternative proxies' regression before corrections (all observations)**

| | Growth $_{i,t+1}$ *(alternative)* | Growth $_{i,t+1}$ *(alternative)* |
|---|---|---|
| ln_FinTech $_{i,t}$ | -0.2323 | -0.1638 |
| | (-0.64) | (-0.09) |
| ln_Financial Development $_{i,t}$ | 12.9939*** | 13.0155*** |
| *(alternative)* | (8.30) | (7.78) |
| Inflation $_{i,t}$ | -0.0832*** | -0.0833*** |
| | (-4.41) | (-4.41) |
| Population $_{i,t}$ | 0.1266 | 0.1273 |
| | (0.95) | (0.94) |
| Government Expeniture $_{i,t}$ | -0.2980*** | -0.2983*** |
| | (-3.71) | (-3.69) |
| Trade $_{i,t}$ | 3.7937*** | 3.7977*** |
| | (5.14) | (5.08) |
| FINTERACT $_{i,t}$ | | -0.0053 |
| | | (-0.04) |
| Constant | -161.8574*** | -162.1472*** |

| | | |
|---|---|---|
| | (-8.82) | (-8.11) |
| *N* | 918 | 918 |
| $R^2$ - Overall | 0.65 | 0.65 |
| $R^2$ - Within | 0.17 | 0.17 |
| adj. $R^2$ | 0.16 | 0.16 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

**Table 18: Alternative proxies' regression (all observations)**

| | Growth $_{i,t+1}$ *(alternative)* | Growth $_{i,t+1}$ *(alternative)* |
|---|---|---|
| ln_FinTech $_{i,t}$ | -0.2323 | -0.1638 |
| | (-0.63) | (-0.08) |
| ln_Financial Development $_{i,t}$ | 12.9939*** | 13.0155*** |
| *(alternative)* | (5.46) | (5.03) |
| Inflation $_{i,t}$ | -0.0832** | -0.0833** |
| | (-2.57) | (-2.57) |
| Population $_{i,t}$ | 0.1266 | 0.1273 |
| | (1.10) | (1.11) |
| Government Expeniture $_{i,t}$ | -0.2980*** | -0.2983*** |
| | (-3.09) | (-3.04) |
| Trade $_{i,t}$ | 3.7937*** | 3.7977*** |
| | (3.38) | (3.36) |
| FINTERACT $_{i,t}$ | | -0.0053 |
| | | (-0.04) |
| Constant | -161.8574*** | -162.1472*** |
| | (-5.77) | (-5.25) |
| *N* | 918 | 918 |
| $R^2$ - Overall | 0.65 | 0.65 |
| $R^2$ - Within | 0.17 | 0.17 |
| adj. $R^2$ | 0.16 | 0.16 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

**Table 19: Alternative proxies' regression results for above-median and below-median analysis (all observations)**

| | Growth $_{i,t+1}$ (alt.) | |
|---|---|---|
| Specification for independent variables: | *above-median* | *below-median* |
| FinTech $_{i,t}$ | 0.0106* | -0.0020 |
| | (1.91) | (-0.29) |
| Financial Development $_{i,t}$ | 0.0000** | 0.0000* |
| (alternative) | (2.30) | (1.70) |
| Inflation $_{i,t}$ | -0.1046*** | -0.1099*** |
| | (-3.18) | (-3.18) |

| | | |
|---|---|---|
| Population $_{i,t}$ | 0.2556** | 0.2535** |
| | (2.53) | (2.43) |
| Government Expenditure $_{i,t}$ | -0.3024*** | -0.3037*** |
| | (-2.95) | (-2.93) |
| ln_Trade $_{i,t}$ | 4.5055*** | 4.5966*** |
| | (4.11) | (4.12) |
| FINTERACT $_{i,t}$ | -0.0000 | -0.0000 |
| | (-0.85) | (-0.96) |
| Constant | -13.6239*** | -12.4933*** |
| | (-2.94) | (-2.66) |
| *N* | 918 | 918 |
| $R^2$ - Overall | 0.63 | 0.63 |
| $R^2$ - Within | 0.10 | 0.10 |
| adj. $R^2$ | 0.10 | 0.09 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01

**Table 20: Alternative regression results by level of development (all observations)**

| | **Developed** | **Underdeveloped** |
|---|---|---|
| | Growth $_{i,t+1}$ *(alt.)* | Growth $_{i,t+1}$ *(alt.)* |
| ln_FinTech $_{i,t}$ | -0.4946 | 1.9597 |
| | (-0.18) | (0.69) |
| ln_Financial Development $_{i,t}$ | 11.7984*** | 13.2422*** |
| *(alt.)* | (5.32) | (3.01) |
| Inflation $_{i,t}$ | -0.1074*** | -0.0545 |
| | (-4.14) | (-1.03) |
| Population $_{i,t}$ | 0.0183 | 0.9602 |
| | (0.14) | (0.69) |
| Government Expenditure $_{i,t}$ | -0.2599** | -0.1267 |
| | (-2.52) | (-0.64) |
| ln_Trade $_{i,t}$ | 9.6321*** | 1.0165 |
| | (6.53) | (0.95) |
| FINTERACT $_{i,t}$ | -0.0302 | -0.0820 |
| | (-0.14) | (-0.38) |
| Constant | -168.4086*** | -168.9826*** |
| | (-6.17) | (-3.09) |
| *N* | 612 | 306 |
| $R^2$ - Overall | 0.74 | 0.54 |
| $R^2$ - Within | 0.29 | 0.12 |
| adj. $R^2$ | 0.28 | 0.10 |

*T* statistics in parentheses; * p<.10, ** p<.05, *** p<.01