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RESEARCH ARTICLE

FinTech Investment and GDP Relationship: An Empirical Study for High Income Countries

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Abstract

Technology, the internet, and demographic change have started a rapid transformation in the financial services sector. The widespread use of innovation and technology in financial services in social and economic areas made these services more effective and companies called Fintech have emerged important economic actors. The Fintech sector has generated changes in the traditional financial service understanding and the delivery of these services. In this area, Fintech companies are developing new financial business models with the help of the latest technological developments and offering innovative financial products and services such as payment services, asset management, and insurance services.

This study investigates, the relationship between GDP and Fintech investment using panel causality methods from 2014Q1 to 2020Q4 for eight high-income countries: The United States, United Kingdom, Singapore, Australia, Canada, Germany, Israel, and France. The results indicate the existence of cross-sectional dependence among countries. According to Westerlund's panel cointegration test results, a cointegration relationship between two variables has been found in the long run. In the short run, panel Granger causality variables have been found only in Germany. We find a positive effect of Fintech investment on GDP in seven countries, and we see a negative relationship in Singapore.

Keywords: FinTech, Technology, Financial Investments, Economic Growth
Jel Codes: O16, O4, G23

FinTech Yatırımları ve GSYİH İlişkisi: Yüksek Gelirli Ülkeler İçin Ampirik Bir Çalışma

Özet

Teknoloji, internet, ve demografik değişim finansal hizmet sektöründe hızlı bir dönüşüm başlatmıştır. Finansal hizmetlerdeki inovasyon ve teknolojinin sosyal ve ekonomik alanda oldukça yaygın kullanımı, bu hizmetleri daha etkin hale getirmiş ve Fintech olarak adlandırılan şirketler önemli bir ekonomik aktör olarak ortaya çıkmıştır. Fintech sektörü, geleneksel finansal hizmet anlayışında ve finansal hizmetlerin sunumumda değişimler meydana getirmiştir. Bu sektörde, Fintech şirketleri, son teknolojik gelişmelerin yardımıyla yeni finansal iş modelleri geliştirmekte ve ödeme hizmetleri, varlık yönetimi, sigorta hizmetleri gibi yenilikçi finansal ürün ve hizmetler sunmaktadır.

Bu çalışmada, GSYİH ve Fintech yatırımları arasındaki ilişki, sekiz yüksek gelirli ülke (ABD, İngiltere, Singapur, Avustralya, Kanada, Almanya, İsrail ve Fransa) için 2014Q1 - 2020Q4 döneminde panel nedensellik yöntemleriyle araştırılmıştır. Elde edilen sonuçlar, ülkeler arasında yatay kesit bağımlılığının varlığını göstermektedir. Westerlund panel eşbütünleşme testi sonuçlarına göre, uzun dönemde iki değişken arasında eşbütünleşme ilişkisi bulunmuştur. Kısa vadede, panel Granger nedensellik yalnızca Almanya'da bulunmuştur. Ele aldığımız yedi ülke için Fintech yatırımının GSYİH üzerinde olumlu bir etkisi görülürken, ilgili dönemde Singapur için olumsuz bir ilişkisi olduğu gözlemlenmiştir.

Anahtar kelimeler: FinTech, Teknoloji, Finansal Yatırımlar, Ekonomik Büyüme
Jel Kodu: O16, O4, G23

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1. INTRODUCTION

The level of development in the financial sector is taking part as an important component in the economic development and GDP growth of the countries. However, particularly digitalization and rapid developments in technology induce significant transformations in the financial systems. For instance, many technological innovations, such as cryptocurrencies, artificial intelligence, mobile payment systems, and digital trading platforms generate abrupt changes in the financial system and significantly alter the functioning of the industry. Technological innovations, which are strongly associated with the performance, profitability, and development of the financial sector, also offer new opportunities for investors. Fintech, where technological innovations find application areas, also show their effect as an important transformer in the financial services sector.

The concept of Fintech is comprised of much more than financial or technology institutions and is changing the way financial services are presented. According to the definition of the Financial Stability Board, "Fintech" is defined as "technologically activated innovation in financial services that could lead to new business models, processes, applications or products that have a significant impact on financial institutions, markets, and the financial services provision" (The Financial Stability Board, 2021).

The main purpose of Fintech applications is to provide financial services to customers in the form of faster, better, more flexible, lower-cost, and personalized products through innovation (Yazici, 2019). These applications facilitate the lives of customers with the technological solutions they offer and are moving on the way to changing the business world from top to bottom.

Advanced technological innovations are significantly effective in promoting Fintech development. In addition, among the driving forces of Fintech, which can be described as technology-oriented innovation in financial services and have become more common in recent years, lower costs and economies of scale that can increase the efficiency and accessibility of financial services (Silva, 2018). In this sense, Fintech affects many areas in the economy such as the trade, banking sector, and energy, and reshapes the financial environment. Moreover, besides improving distribution services that strengthen the financial sector, Fintech can improve the competitiveness, profitability, and performance of banks.

In this respect, it can be said that Fintech has a fairly wide ecosystem. In this ecosystem, financial technology startups have significantly increased recently and have started to be the hot topic on the agenda (The Interbank Card Center, 2018). The introduction of new and extensive opportunities activation by the digital world, the gradually increasing mobile use through technological devices, and the ease of access to the internet from anywhere have been effective in this increase.

Although increasing investments in the Fintech sector and the returns generated by the sector accelerate the growth in the sector, the real potential of Fintech cannot be utilized in many countries. In order to reveal the real potential in this sector, it is necessary to create a favorable environment and ecosystem for the sector. The role of government policies is important in the creation of this ecosystem. However, the biggest challenge for many states and policymaker is, seems to be to determine the priorities to invest in services such as peer-to-peer lending, digital wallets, and insurance. In the creation of this ecosystem, the present technological, financial, and economic structure should be carefully evaluated, and the appropriate infrastructure should be established (Jiao, Shahid, Mirza, Tan, 2021). Many countries and markets are trying to make their infrastructures and regulations suitable for the Fintech ecosystem. A thought is that these regulations may lead to the development of a deeper and leaner credit market. For instance, the UK has announced in its 2020 budget there will be a strategic Fintech sector review about how the government can support Fintech growth and competitiveness. Australia has reopened applications to Select Committee on the Financial and Regulatory Technology to understand better how COVID-19 is impacting the industry

and specify supports that can be implemented quickly. Moreover, Hong Kong (SAR) and Singapore have launched licensing programs for Digital Asset Exchanges (KPMG, 2020).

The rising relevance of technology in financial markets, especially accelerated by the effects of the 2008 financial crisis, has resulted in a dramatic growth in the number of Fintech ventures available around the world (Cumming and Schwienbacher, 2018). Many factors influenced the emergence of Fintech initiatives, including the drop in bank lending following the 2008 financial crisis, the development and expansion of the sharing economy and the internet, and the usage of smart devices in financial activities (Yazici, 2019).

Fintech offers opportunities such as expanding access to financial services, encouraging financial transactions, reducing the costs of sending money, and income stream and wealth accumulation. In addition, it is claimed that Fintech promotes e-commerce, improves information transfer, increases productivity, provides easier access to loans, and reduces household risks. Accordingly, it is argued that Fintech can affect economic growth by improving household consumption, savings, investments, job growth, employment, and incomes (Zhang, Zhang, Wan, Luo, 2019).

Today, most people use credit cards as a payment tool such as in commercial works, online shopping, and in restaurants. Even without a credit card, mobile phones can be used to pay for many transactions. Moreover, mobile loans can be used with Fintech applications. All these economic activities contribute to growth.

Financial technology is an abbreviation for technology and finance, and it has a solid theoretical basis for generating economic growth. The financial system plays a crucial role in directing funds from those who have surplus funds to those who need funds, so that economic activities can be carried out efficiently and effectively. In this fund flow process, financial intermediaries play a critical role in reducing the costs of transactions, the presence of a risk-sharing system, and preventing moral hazard and adverse selection by enabling symmetrical information. Thereby, fund holders and borrowers who have a small number of funds can engage in financial markets and increase economic efficiency as a whole (Mishkin and Serletis, 2011). Productivity gains can significantly increase economic growth by ensuring that limited resources are allocated to productive activities.

In endogenous economic growth theory, which concentrates on positive exteriorities and the spillover effect of a knowledge-based economy that originate innovation which can direct economic development, technology, and innovation are considered to be factors that can direct the economic growth in the long run. It is theoretically accepted that the integration of technological developments into the financial system has significant effects on the economy. Especially rapid developments in information technologies have carried financial services to an advanced level and boosted financial efficiency. These advancements in information technologies provide to access unrestricted data and lead to creating added value from previously unoptimized data. However, the abundance and availability of real-time and accurate data will significantly decrease the asymmetric information potential (Athoillah, 2019).

It has always been argued that financial participation has positive effects on economies. The Fintech sector, which has gained significant momentum recently and is related to financial inclusion, is also considered the engine of digital finance. The report published by the McKinsey Global Institute supports this view. According to the report, it is estimated that by 2025, digital finance has the potential to boost the GDP of developing economies by 6%, or up to $3.7 trillion (Mckinsey Company, 2016).

In the research conducted by the Economics and Finance Development Institute (Indef) on the role of Fintech loans in Indonesian economy, it has been revealed that the contribution of Fintech development to GDP is Rp 25.97 trillion. Fintech also sectorally can have the potential to foster

growth in the financial services sector, the information and communication sector, insurance, pension funds, and the corporate services sector. Another conclusion is that the growth of Fintech has absorbed the workforce of 215,433 workers, increasing 4.56 trillion in labor income in the form of pay and salaries. Fintech loans have also been proven to improve the economy by lending specifically to the MSME sector (Athoillah, 2019).

The Fintech sector experienced a significant boom with global funding of $91.5 million by October 2021. Compared to the year 2020, this amount is almost double the amount collected in the whole of 2020. In the last quarter, it is seen that the USA accounted for 38% of global Fintech deals and continues to be the region with the most Fintech deals. Asia follows the USA with a share of 26% (Forbes, 2021).

Global investments in Fintech reached record levels in 2021, reaching a total of $98 billion from nearly 2500 deals. In the recently published Pulse of Fintech H1 2020 report of KPMG, it is stated that investments have largely stopped due to the Covid-19 outbreak, but the recovery continues at full speed, and strategic agreement activities continue to be seen. In addition, it was emphasized that digitalization has become a critical necessity, especially during the Covid-19 pandemic process, therefore strategic mergers, acquisitions, and investments can play an important role. The report argued that Fintech is a hot investment area, and this is not expected to change anytime soon, given the number of Fintech hubs attracting investment and the growing number of deals. The report also stated that Fintech is trying to come to the fore as a dominant market player, either regionally or globally, and predicted that they anticipate more consolidation in mature Fintech areas (KPMG, 2020).

In the literature, studies examining the effects of Fintech, which have become quite common around the world and significantly changed the functioning of the financial sector, on economic growth and sustainable development are very rare. However, while there is consensus in academia that Fintech can significantly influence economic growth, it remains unclear whether Fintech will stimulate or restrain economic growth (Deng, Huang, Cheng, 2019).

In addition to studies that investigate the relationship between Fintech investments and GDP, our study approaches the literature in terms of cross-sectional dependency and heterogeneity. This study supports the studies in the literature in the context of long-term relationships and causality with the results obtained.

This study is structured as follows; section 2 concentrates on the literature review. Section 3 explains the data and methodology and section 4 outlines the empirical results. Section 5 discusses the results and gives policy recommendations.

2. LITERATURE REVIEW

During the digital transformation process Fintech activity helps to increase financial inclusion and it is expected to create a positive effect on GDP. Frost (2020) emphasized the importance of fintech ecosystem development for emerging and developing countries both demand and supply side factors. Due to the lack of financial services, fintech companies could find several opportunities to meet consumer demand. On the other hand, growing fintech investments can expand to access alternative financial instruments for small and medium-sized enterprises. Despite the decreasing trust for technology firms in recent years, for the future of Fintech will have been shaped by the market demand while overcoming specific market failures and reducing the risks. Cornellii et al. (2020) indicate reducing the possible risks of traditional finance and remaining financial stability will support fintech sector credits in the future. On the other hand, Fintech investment might be an opportunity to lower costs and a stable financial system for developing and emerging countries.

The drivers of financial technologies depend on country-level micro and macro characteristics. Also both of them can be attributed as a cause and result of Fintech investments. High-income countries can create a better environment and ecosystem for Fintech investments. These countries, which attach importance to technological innovations and develop technology, apply this innovation and technology to financial systems and create new financial innovations. In the emergence of financial innovations in these countries; The rapid expansion of information technologies, the internet, mobile phones, and digital technologies such as cryptocurrencies, blockchain, initial coin offerings, peer-to-peer lending, robo advice, and open banking are among the important factors. However, this does not mean that Fintech alone has an impact on GDP growth. Fintech is impacting GDP growth by reshaping and redesigning the financial environment, influencing many aspects of the economy such as trade, the banking system, and energy (Gozman et al, 2018). Fintech growth and the amount of investment made in this sector are high, but the returns are also higher.

In addition, Fintech can also improve delivery services, which increases the competitiveness of banks and thus strengthens the financial sector (Berger and DeYoung, 2001). Fintech can impact financial development by increasing banks' profitability, competitiveness and performance (H˜obe and Alas, 2015). Therefore, as a source of competition, fintech can be the main driver of financial sector performance (Brem et al., 2016). The performance increases international adoptance of financial services which help to share market risk accross economies.

However, in the literature on the Fintech sector, it is stated that the rapidly increasing new start-ups in this sector have positive effects on the economic performance of countries. While fintech companies generally focus on specific economies at the beginning, the business model that they build can create cross-border competition. In this context, digital finance promises to increase the gross domestic product (GDP) of digitalized economies by providing easy access to a wide range of financial products and services (and credit facilities) for individuals as well as small, medium and large businesses. Digital finance can provide greater economic stability and increased financial intermediation for both customers and the economy. All of this could lead to improvements in GDP levels, boosting overall growth and spending.

Cumming and Schwienbacher (2018) answered questions in their study that "where in the world are Fintech venture capital investments accrue?" and "what role do institutional variables play in international Fintech venture capital allocation?". They indicated that following the global financial crisis, they observed a significant change in the Fintech venture capital (VC) investments pattern in comparison to other forms of investments around the world. They demonstrated that after the financial crisis, nations with weaker regulatory enforcement and no significant financial center are comparatively more likely to invest in Fintech venture capital.

Haddad and Hornuf (2018) examined several economic and technological factors that have promoted the establishment of Fintech startups in 55 countries. They used multivariate panel regression to forecast the annual number of Fintech startups in 55 countries between 2006 and 2014 to see which country-level factors promote the development of new Fintech formations. According to their results, when the economy of the country is well-developed and venture capital is readily suitable, more Fintech startups are formed. They indicated that the number of safe internet servers, mobile phone subscriptions, and labor force availability all contribute to the growth of this new market area. They also found that having access to venture capital is a critical element in promoting the formation of Fintech startups. In addition, they stated that when the companies have more difficulty accessing the loans, the number of Fintech startups formations is higher in the country.

Deng et al. (2019) analyzed the relationship between Fintech and sustainable development and proposed an indicator system. They used the data from peer-to-peer platforms (P2P) in 31 Chinese provinces. They created a China-specific sustainable development indicator system and utilized

principal component analysis (PCA) in order to measure sustainable development level. They also employed mediation effect analysis and the dynamic system generalized method of moments (DS-GMM). Their findings revealed that there is a U-shaped relationship between Fintech and sustainable development. They stated that this U-shaped relationship is the substantial reason mostly due to China's long-term extensive pattern of economic growth. Moreover, they employed heterogeneity analysis and revealed that Fintech has considerably distinct regional effects on sustainable development, it is most noticeable in China's eastern and central regions, and less so in the western region, with the greatest impact in the region of center.

Khiewngamdee and Yan (2019) purposed of their study is to examine if Fintech e-payment has an impact on economic development in APEC countries, specifically on productivity, income inequality, income growth, and price volatility. They employed RMIT University's and TRPC's e-payment index, as well as quantile regression with the GME technique. According to their empirical results, Fintech has a significant influence on APEC economic development. They also stated that Fintech not only supports low-level growth and productivity, but it also helps to reduce income inequality and low-level price volatility. Furthermore, they determined that Fintech's contributions to economic development are high during the low levels of economic factors and reduce at medium and high levels of economic variables.

Nasihin Aziz (2019) aimed to find out if Fintech development has an impact on the economic growth of Indonesia by making a descriptive analysis and literature study. Nasihin Aziz indicated in the study that the advancement of Fintech has contributed to GDP growth and boosted the financial industry and employment growth in Indonesia. He stated that the development of Fintech has increased Indonesia's GDP by Rp 25.97 trillion.

Zhang et al. (2019) used household survey data from China in order to analyze Fintech development effects on the growth and distribution and examined whether Fintech development in China helps to increase the income of households, decrease disparity of income, and contributes to financial inclusion. They found that there is a positive correlation between Fintech development and household income, and they stated that the positive effect is bigger for rural households than the urban counterpart, implying that the growth of Fintech has aided narrow the income gap of urban-rural.

Kammoun, Loukil, Loukil (2020) discussed the impacts of Fintech on economic performance in the setting of political instability in the countries in MENA zone. They used a multiple regression model for predict time series data for selected 10 countries in MENA zone for the years 2011, 2014, and 2017. They asserted in their study that the lending activities of Fintech boost inflation and that this impact could be significantly mitigated by effective regulations and policies. Furthermore, they found the empirical support that Fintech has a role as a driving force of economic growth and important lead up to creative ventures in an environment of freedom of media, expression, and association.

Nizam, Karim, Rahman, Sarmidi (2020) examined the impact of financial inclusiveness on economic growth for 63 developed and developing countries between the years 2014-2017. They used a cross-sectional threshold regression technique in order to predict the impact of financial inclusiveness on economic growth. Their results demonstrated that the financial inclusiveness-growth nexus has a threshold effect, revealing that financial inclusiveness has a non-monotonic positive relationship with economic growth.

Sadigov, Vasilyeva, Rubanov (2020) investigated the effect of the Fintech sector on economic development in several groups of countries by using regression and correlation analysis. According to their study, they verified that the most important transformative impact of the Fintech segment's on the financial services market is in banking services, specifically payments and transfers. The findings of the correlation analysis confirmed that there is an existing direct relationship between

GDP per capita and a number of digitization indicators in the banking sector. Moreover, they stated that development of Fintech sector makes a contribution to economic growth through increasing GDP created in the sector of finance, and implicitly by enhancing e-commerce turnover and real-sector finance, particularly by providing convenient lending opportunity for small and medium-sized firms.

Banna, Mia, Nourani, Yarovaya (2021) created an index in order to quantify financial inclusion and empirically examine its influence in reducing microfinance institutions' risk-taking behavior. They used Principal Component Analysis (PCA) technique to construct the index. Given the effect of financial inclusion on the risk-taking behavior of microfinance institutions (MFI), they considered the baseline regression. Based on their result, they stressed the significance of a Fintech solution's overall functionality and accessibility in reducing the risks of MFI. Additively, they stated that the solutions of Fintech are more related to small-scale MFIs.

Otoo and Song (2021) investigated the direct effects and indirect effects of Fintech, its third-party payment sub-measures, and credit on poverty measured by household per capita consumption by using the panel of 31 China' provinces between the years 2011-2017. They used the IV-GMM model for the analysis. Their findings showed that Fintech and related sub-measures appear to decrease poverty in China. The findings also revealed that Fintech helps China in order to reduce poverty by complementing economic growth and financial development.

3. DATA AND METHODOLOGY

The literature reviews above, emphasize the Fintech's multi-dimentional structure and its relation to economic growth. Although, Fintech investment comperatively more common in countries that have lack of regulatary and financial centers, high income countries play crucial role to create spillover effects of Fintech investment. As the drives of Fintech is explained technology, funding, regulations, financial service integration, and talent. All these factors expected to come together in high income countries. Data for Fintech investment is not available for many countries but current data can give some valuable insights. Thus, we put forward hypothesise that Fintech investments is in positive relation to GDP in selected high income countries in the long run. On the other hand, because of the high income countries can easily integrate to the international financial system, Fintech investment among countries create cross sectional relationship. Therefore, our second hypothesise is to test existance of cross sectional dependence during the period. While we are expecting the cross sectional dependence among countries, Fintech's dynamic environment also depends on a country level characteristic. Hence, the panel expected to be heteregeneous.

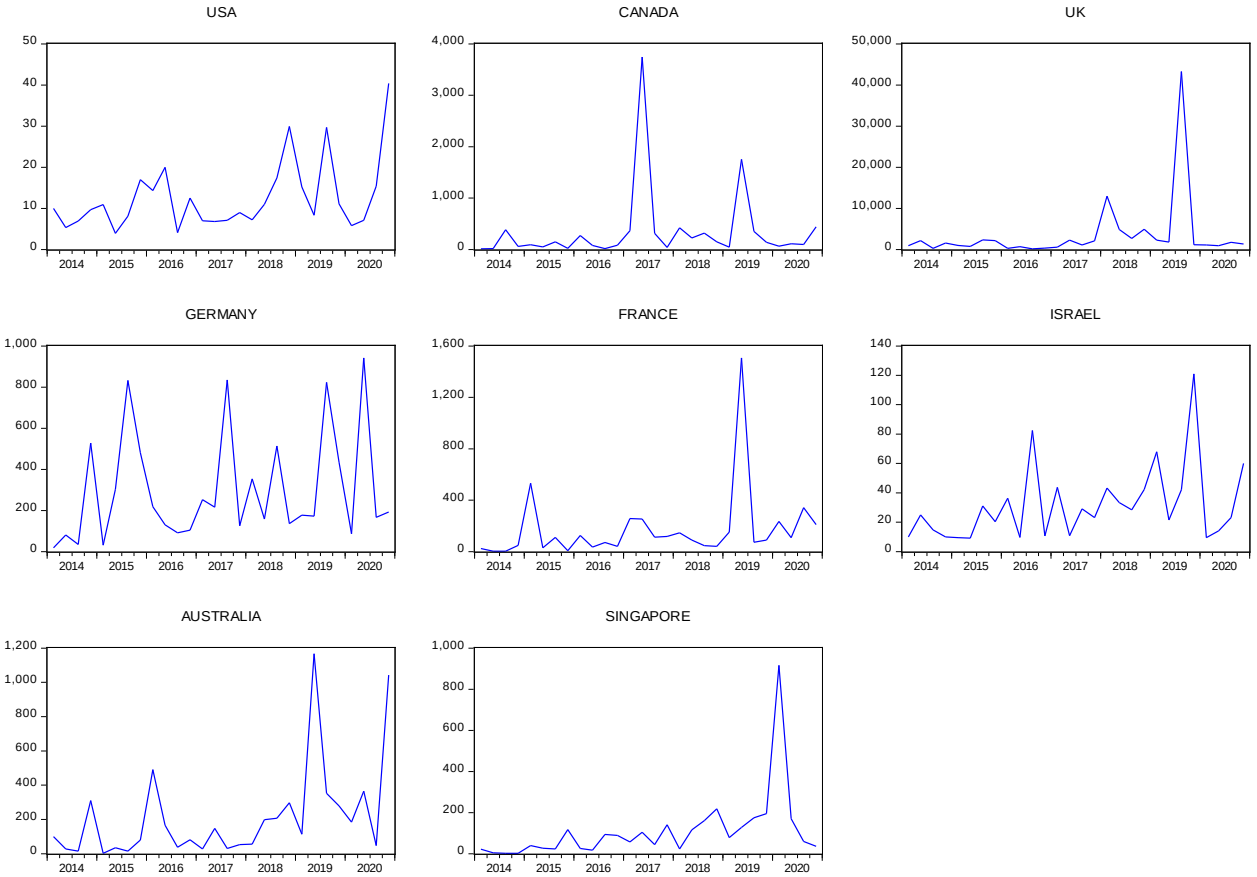
The GDP and Fintech investment dataset consists of eight high-income countries from the period 2014Q1 to 2020Q4: The United States, United Kingdom, Singapore, Australia, Canada, Germany, Israel, and France. With the aim of forming a balance in the panel, the selected eight countries and the time period are based on the data availability for high income countries. The quarterly data for Fintech investments were collected from KPMG, and GDP data obtained from World Bank Open Data as billion dollars. The countries in the panel are taking part in the top 20 in KPMG Fintech country rankings which are depicted in Table 1.

Table 1: Fintech Country Rankings

Countries	Rank	Total Score
United States	1	31.789
United Kingdom	2	23.262
Singapore	3	19.176
Australia	8	13.555
Canada	9	13.322
Germany	11	12.787
Israel	12	12.771
France	16	11.803

In this study, in order to investigate the relationship between Fintech investments and GDP with the panel data analysis, we used the cross-sectional dependency test first, thereafter homogeneity, and second-generation panel unit root tests. Then, cointegration tests with breaks have done and long-run coefficients were obtained. Lastly, the causality relationship was tested. The variables were used in logarithm form. Figure 1 below, shows the country-based Fintech investment trends which fluctuated over the term.

Figure 1: Fintech Investments Trends



3.1. Cross Sectional Dependence and Homogeneity

Beginning of the empirical part of this study, it is necessary to investigate the existence of cross-sectional dependence and homogeneity. Especially in recent years, countries have become sensitive to financial and economic shocks coming from each other. Fintech, on the other hand, triggers the volatile situation with the ecosystem it has created. As Pesaran (2006) discussed without considering

these two important characteristics of the panel can cause the error term would not be independent and identically distributed (iid) anymore. So, testing cross-sectional dependence and homogeneity allow us whether to continue with new generation panel data analysis methods.

This study tests, the cross-sectional dependence hypothesis using the Breusch and Pagan (1980) LM test, Pesaran (2004) LM test and Pesaran, Ulah, and Yamagata (2008) tests. For all tests, the null hypothesis is no cross-sectional dependence among the countries and the alternative hypothesis is assuming the existence of cross-sectional dependence. These tests start from Equation 1 and differ from each other regarding the panel data's cross-section and time. Breusch and Pagan's (1980) Lagrange Multiplier LM Test provides the relative ease of estimation under the null and alternative hypothesis (Equation 2). But LM test is useful while the cross-section is greater than the time period. Pesaran (2004) solved this problem by developed models named CD_{LM} and CD to test cross-sectional dependence (Equation 3 and Equation 4). CD_{LM} is consistent when the cross-section N is large and time T is small and the CD test is useful when N and T tend to infinity. Pesaran, Ulah, and Yamagata (2008) suggested Bias-adjusted LM test which provides strong test statistics under fixed T and large N by keeping the panel power at a sufficient level with exogenous regressors and normal errors (Equation 5).

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it} \qquad i=1, 2, ..., N; \quad \text{and} \quad t= 1, 2, ...,T \tag{1}$$

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \, , \chi^2_{N(N-1)/2} \tag{2}$$

$$CD_{LM} = \left(\frac{1}{N(N-1)}\right)^{0.5} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(T\hat{\rho}_{ij}^2 - 1\right), N(0,1) \tag{3}$$

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right), N(0,1) \tag{4}$$

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \frac{(T-k)\hat{\rho}_{ij}^2 - \mu\tau_{it}}{v_{Tij}^2} \, , N(0,1) \tag{5}$$

Analyzing the homogeneity of slope coefficients, we used Pesaran and Yamagata's (2008) Delta (Δ) (Equation 7) and Deltaadj (Δ_{adj}) (Equation 8) tests which depend on Swamy's asymptotically efficient $\tilde{S}$ statistics (Equation 6). For both tests, the null hypothesis assumes homogeneity of slope coefficients and the alternative assumes heterogeneous slope coefficients.

$$\tilde{S} = \sum_{i=1}^{N} \left(\hat{\beta}_i - \tilde{\beta}_{WFE}\right)' \frac{x'_i M_\tau x_i}{\tilde{\sigma}_i^2} \left(\hat{\beta}_i - \tilde{\beta}_{WFE}\right) \tag{6}$$

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - k}{\sqrt{2k}}\right) \tag{7}$$

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - E(\tilde{z}_{IT})}{\sqrt{var(\tilde{z}_{IT})}}\right) \tag{8}$$

3.2. Second Generation Unit Root Test

We performed one of the most preferred second-generation unit root tests named cross-sectionally augmented Dickey–Fuller (CADF hereafter) which is developed by Pesaran (2007). In this method, the stationarity of variables is determined by taking into consideration cross-sectional dependence.

To eliminate cross-sectional dependence, for each series the cross-section averages of lagged levels and first differences are augmented with ADF regressions in this method. CADF test based on Equation 9 which include $v_{it} = g_i\theta_t + \mu_{it}\theta_t$ is a common factor and μ_{it} is white noise. The CADF model is given Equation 10 without the autocorrelation of μ_{it}.

$$\Delta x_{it} = \alpha_i + \varrho x_{it-1} + v_{it} \quad (9)$$

$$\Delta x_{it} = \alpha_i + \varrho x_{it} + c_i\bar{x}_{t-1} + d_i\Delta\bar{x}_{t-1} + \varepsilon_{it} \quad (10)$$

Equation 11 shows the Pesaran statistics with the cross-sectionally augmented IPS (CIPS hereafter) statistics to decide whether the panel include unit root or not. Assuming the null hypotheis means series have a unit root and the alternative one means stationary of series.

$$CIPS(N,T) = \frac{1}{N}\sum_{i=1}^{q} t_i(N,T) \quad (11)$$

3.3. Panel Cointegration Test and Long-Run Estimators

Westerlund (2006) developed a second-generation panel cointegration test that allows to get long-run relationship among variables with multiple structural breaks in both intercept and trend forms. Equation 12 shows the panel cointegration test where j is the structural breaks ($j=1,\ldots,M_{i+1}$) for the period between $T_{1i},\ldots,T_{iMi}$, (T_{1i}=0 and T_{iMi}=1), $u_{it} = r_{it} + \mu_{it}$, and $r_{it} = r_{it} + \alpha_i\mu_{it}$.

$$I_{it} = \delta_{ij} + \beta_i S_{it} + u_{it} \quad (12)$$

In this test, through the cross-sectional dependence bootstrap critical values are used. The null hypothesis presumes the existence of cointegration which means panel have a long-term relationship while the alternative presumes no cointegration. Equation 13 shows the panel LM test's statistic calculation, where S_{it} states error correction term as $\sum_{T_{ij-1}+1}^{t} W_{st}$ and $\widehat{\omega}'_{i1.2} = \widehat{\omega}'_{i1.1} - \widehat{\omega}'_{i2.1}\widehat{\Omega}'_{i2.2}\widehat{\omega}'_{i2.1}$.

$$Z(M) \equiv \sum_{i=1}^{N}\sum_{j=!}^{M_i}\sum_{t=T_{ij-1}+1}^{T_{ij}}(T_{ij} - T_{ij-1})^{-2}\widehat{\omega}'_{i1.2}S_{it}^2 \quad (13)$$

The cointegration between relevant variables requires checking the long-run relationship of the panel. Because of the existence of cross-sectional dependence, the methods should consider the panel correlation such as CCEMG estimator developed by Pesaran (2006) and AMG estimator developed by Eberhardt and Teal (2010) and Bond and Eberhardt (2013). These are the most applied estimation techniques which provide a robust estimation of individual's results for units. The difference between them depends on the unobservable common factors structure that the AMG method runs as a common dynamic process in contrast CCEMG method runs in the error term (Mrabet, Alsamara, Saleh, Anwar, 2019). AMG estimation procedure has two steps. Equation 14 shows the first step of estimation depends on the pooled ordinary least square method and include c_t as standard dynamic process and time dummies' coefficient. Equation 15 shows the second step where $\hat{\beta}_{AMG}$ specifies the mean group estimator of AMG. CCEMG estimator can be calculated using Equation 16, where β'_i shows time-variant unobservable heterogeneous effects.

$$\Delta I_{it} = \beta'\Delta S_{it} + \sum_{t=2}^{T} c_t\Delta D_t + u_{it} \text{ and } \hat{c}_t \equiv \hat{\mu}_t \quad (14)$$

$$I_{it} = \delta_i + \beta'_i S_{it} + c_i t + d_i\hat{\mu}_t + u_{it} \quad (15)$$

$$\beta'_{i_{CCEMG}} = N^{-1}\sum_{i=!}^{N}\beta'_i \quad (16)$$

3.4. Panel Causality Test

The bootstrap panel causality test is developed by Konya (2006) that based on seemingly unrelated regression (SUR) estimation. In this test, bootstrap critical values are creating to comprise with Wald statistics. If the Wald test statistic for each unit higher than the bootstrap critical values which means confirming the existence of causality. The method uses the SUR Equation System 17 and 18 to estimate bootstrap panel causality where $y = [y_{1t}, y_{2t} \dots, y_{Nt}]'$ and $x = [x_{1t}, x_{2t} \dots, yx_{Nt}]'$ denote dependent and independent variables.

$$y_{1t} = \alpha_1 + \sum_{j=1}^{l_{y1}} \beta_{1j} y_{1t-j} + \sum_{j=1}^{l_{x1}} \delta_1 x_{1t-j} + \varepsilon_{1t}$$

$$y_{2t} = \alpha_2 + \sum_{j=1}^{l_{y1}} \beta_{2j} y_{2t-j} + \sum_{j=1}^{l_{x1}} \delta_2 x_{2t-j} + \varepsilon_{2t}$$

$$\vdots \qquad (17)$$

$$y_{Nt} = \alpha_N + \sum_{j=1}^{l_{y1}} \beta_{Nj} y_{Nt-j} + \sum_{j=1}^{l_{x1}} \delta_N x_{Nt-j} + \varepsilon_{Nt}$$

and

$$x_{1t} = \alpha'_1 + \sum_{j=1}^{l_{y2}} \beta_{1j} y_{1t-j} + \sum_{j=1}^{l_{x2}} \delta'_1 x_{1t-j} + \varepsilon'_{1t}$$

$$x_{2t} = \alpha'_2 + \sum_{j=1}^{l_{y2}} \beta_{2j} y_{2t-j} + \sum_{j=1}^{l_{x2}} \delta'_2 x_{2t-j} + \varepsilon'_{2t}$$

$$\vdots \qquad (18)$$

$$x_{Nt} = \alpha'_N + \sum_{j=1}^{l_{y2}} \beta_{Nj} y_{Nt-j} + \sum_{j=1}^{l_{x2}} \delta'_N x_{Nt-j} + \varepsilon'_{Nt}$$

4. EMPIRICAL RESULTS

The empirical part of this study consists of six steps as based on aforementioned methodology. At the first step, we determined the cross-sectional dependence among the units, which means any shock to GDP or Fintech investment in one of the countries, might affect each other. Table 2 shows the cross-sectional dependence and homogeneity tests results. To test the existence of cross-sectional dependence, we used LM, CD_{LM}, CD, and LM_{ajd} tests. As expected, the results confirmed cross-sectional dependence among countries. Furthermore, as the second step, to test for homogeneity, $\hat{\Delta}$ and $\hat{\Delta}_{adj}$ tests were used, which the results showed panel is heterogeneous.

Table 2: Cross Sectional Dependence and Homogeneity Tests

Test	Fintech → GDP
$\hat{\Delta}$	3.713***
$\hat{\Delta}_{adj}$	3.921***
LM	300.978***
CD_{LM}	36.478***
CD	14.939***
LM_{adj}	2.22***

Notes: *** and * show the rejection of the null hypothesis which assumes the existence of homogeneity and no cross-sectional dependence at 1% and 10% significance levels, respectively.

Thirdly, we aimed to determine whether the series are stationary or not. The results of the panel unit root tests are shown in Table 3. We applied Peseran CADF panel unit root test and obtained the series are stationary at the first difference I(1).

Table 3: Pesaran (2007) CADF Panel Unit Root Tests

	I(0)		I(1)	
	C	C+T	C	C+T
Fintech	-3.413	-3.174	-4.509***	-4.528***
GDP	-2.123	-1.945	-4.952***	-5.097***

Note: *** shows the rejection of the null hypothesis, which assumes the existence of a unit root at 1% significance levels.

After confirming the existence of cross-sectional dependence and heterogeneity in the panel, as the fourth step we conducted Panel LM cointegration tests with breaks. In this test, the null hypothesis is the existence of cointegration, and the alternative is rejected. Because our panel data include cross-sectional dependence and heterogeneity, we used bootstrap probability values for decision. According to the results obtained in Table 4, bootstrap probability values (0.633 and 0.467) are higher than 0.05, which means there is a long-term cointegration relationship between GDP and Fintech investments. It is also seen that there are structural breaks that changed in different periods, mainly in 2015 and 2017 for this panel. In the case of the panel, the country with the earliest fixed structural break was the United States, while a single break was observed in Canada, France, and Australia. A structural break in constant and trend, was observed only in UK, Germany, and Australia.

Table 4: Panel LM Cointegration Tests with Breaks

	Break in constant		Break in constant and trend	
Countries	Number of breaks	Break Dates	Number of breaks	Break Dates
United States	3	2015q1, 2017q1, 2019q1	0	-
Canada	1	2017q2	0	-
UK	2	2015q4, 2018q2	1	2019q2
Germany	2	2015q2, 2017q2	1	2018q3
France	1	2017q3	0	-
Israel	3	2015q2, 2017q1, 2018q3	0	-
Australia	1	2019q3	1	2019q3
Singapore	2	2016q3, 2018q2	0	-
	LM statistics:8.797	p-value:0.00[a], 0.633[b]	LM statistics:32.151	p-value:0.00[a], 0.467[b]
	Constant		Constant+trend	
	LM statistics:13.641	p-value:0.00[a], 0.00[b]	LM statistics:5.054	p-value:0.00[a], 0.03[b]

Notes: a represents the asymptotic probability value and b represents the bootstrap probability value. A maximum of four structural breaks were allowed. The number of bootstrap samples was 10,000

Table 5: Westerlund and Edgerton (2008) Panel Regime Cointegration

Models	Test Statistics	Coefficients
No Break	$Z_\phi(t)$	-1.2899 (0.00147)
	$Z_\tau(t)$	-1.5656 (0.071417)
Mean shift	$Z_\phi(t)$	-1.99801(0.084086)
	$Z_\tau(t)$	-2.08121(0.053236)
Regime shift	$Z_\phi(t)$	-3.39936 (0.099966)
	$Z_\tau(t)$	-2.72712 (0.095793)

Note: *p* values in parentheses

In Table 5, the results of Westerlund and Edgerton (2008) regime cointegration test confirmed the long-term cointegration between GDP and Fintech investment. Empirical analysis continued to the fifth step with the estimation of long run cointegration coefficients with AMG and CCEMG estimators as shown in Table 6. For the whole panel, the AMG estimator is obtained statistically significant and negative, which means Fintech investments have a little amount (0.007) negative effect on GDP for the period while the CCEMG estimator is statistically not significant. In accordance with the country based long-term coefficients, the AMG estimator is significant and positive for seven countries: United States, Canada, UK, Germany, France, Israel, and Australia. For Singapore its significant and negative. On the other hand, the CCEMG estimator is significant and positive for Israel. According to country-based results, the positive affect of Fintech investments on GDP found promising as a new indicator and a developing area. To enhance Fintech investments, requires financial resilience, diversity, potential, human capital and infrastructure investments and it can be affected by many different factors. So, our results show the improvement of Fintech investments and its effect to the GDP.

Table 6: Long Run Coefficients

Model: GDP = f (Fintech)	AMG	CCEMG
United States	0.0596477* (0.012)	0.0102754
Canada	0.0210856* (0.045)	-0.0038695
UK	0.0242703* (0.018)	-0.0024237
Germany	0.0210446* (0.070)	-0.0118925
France	0.0164182* (0.008)	-0.0018063
Israel	0.0687773* (0.001)	0.0292518* (0.023)
Australia	0.0405114* (0.000)	0.0080644
Singapore	- 0.03124741 * (0)	-0.0703433
Panel	- .0075899* (0.000)	- .005343 (0.603)

Note: * shows that the long-run coefficients obtained are significant at 10%.

In the last and the sixth step, the bootstrap panel causality test was performed to show the short-term correlation between GDP and Fintech. According to the results in Table 7, only in Germany we obtained a causality effect from Fintech investment to GDP while others were statistically not significant.

Table 7: The Bootstrap Panel Causality Test

Countries	Fintech → GDP
United States	0.156
Canada	1.046
UK	0.659
Germany	21.289* (0.00)
France	0.113
Israel	0.21
Australia	1.39
Singapore	0.892

5. CONCLUSION

In recent years, significant changes have occurred in both customer demands and needs, as well as the investment areas and working style of the business world, and new business areas have emerged. The demand and use of digital platforms, digital banking, touchless payments, and other Fintech related services has increased rapidly around the world. In addition to technological developments, the COVID-19 pandemic, which affects every part of the world and can be described as a black swan, has led to a significant increase in digital trends, especially in the Fintech industry. The industry, in which we have witnessed a very rapid technological transformation, particularly in the past 10 years, has accelerated with the effect of the pandemic and become attracted the attention of investors even more. This situation has pushed many institutions to double up their Fintech investments. As known, Fintech investments require more than capital, and investors both public and private, would like to obtain the return of investments as soon as possible with added value. It is thought that this rapid increase in Fintech investments and digital trends will make significant contributions to economic growth in terms of directing investment in other technology areas such as cyber security, fraud prevention and digital identity management (KPMG 2020).

In this study, we aimed to investigate the long-run relationship between Fintech investment and GDP for eight high income countries using by new generation panel data approach. The selected countries are from different regions and have specific characteristics. We used the KPMG data set for Fintech investment and the World Bank database for GDP from 2014 to 2020and transferred the data to logarithmic form. To examine the long-run relationship between Fintech investment and GDP, firstly we analyzed cross-sectional dependence and homogeneity. Thereafter we performed a second-generation unit root test, and we conducted Panel LM cointegration test with breaks. Lastly, we estimated long run cointegration coefficients with AMG and CCEMG estimators, and a bootstrap panel causality test was performed. For the whole panel we obtained cross-sectional dependence, heterogeneity, and cointegration relationship as in line with our hypothesis.

The economic interpretation of the existence of cross-sectional dependence is that a given shock to the Fintech investments and GDP in countries observed will effect the same variable in other countries forming the panel. This result is in line with our expectations and hypothesis, as these countries are economically dependent on each other. On the other hand, while the are countries cross-sectionally dependent, their heterogeneous characteristics can not be deniable. This suggests the dynamic effect between fintech investment and GDP across the countries. According to the results of Panel LM Cointegration Tests with Breaks, we obtained maximum 3 breakpoints. Due to developed countries have relatively agile financial systems, we expect a more stable environment for Fintech investment and GDP. The breakpoints could be obtained more, if the panel consists of developing or emerging countries which less strong financial systems or technology adaptation rate. The existence of cointegration which can be attributed to investments in the Fintech ecosystem affected the GDP during the period. Long-run coefficients indicate the United States, United Kingdom, Australia,

Canada, Germany, Israel, and France have a positive effect from Fintech investments to GDP, while Singapore has a negative. Even though we are expecting a positive relationship for all countries, in Singapore, Fintech investments have been accelerated since 2021 (Li, 2021). So, the positive contribution to investments might be reflected in GDP in the following years in that country.

The cost and benefits to invest Fintech ecosystem are open to discussion. The performance of the Fintech industry depends on how the players within the ecosystem interacted and adapted. Fintech could be disruptive to traditional financial systems. For example, parallel with the Fintech applications widespread some infrastructure could become useless. But Fintech offers new opportunities for doing business with the economy, society, and the especially energy sector. While technology is not a direct aim of sustainable development goals, Fintech can lead decision makers to behave and support green platforms. So, in recent years Fintech has been seen as a substantial driving force of sustainable development. Considering the positive impact of Fintech on sustainable development, it is important for countries to reform comprehensively the models of economic growth, strengthen industrial structure transformation and improvement, and encourage low consumption sustainable development. Therefore, many countries around the world are working on a favorable ecosystem for Fintech, and creating policies and making strategic decisions that support the ecosystem. To promote Fintech and implement the financial regulations, regional disparities effect should be taken into account and varied policies and precautions should be established. Also, associated with the pandemic, a shift has occurred in the industry, providing financial institutions that have been reluctant to Fintech to date to accept that this industry shift will have long-term effects.

For this panel data analysis, the positive results are encouraging to enhance Fintech investment. Moreover, if the Fintech environment continues to grow as expected, in near future we will need more detailed information to digest the developments. It would become important to understand the relationship between Fintech investments and GDP at the macroeconomic level. The limited country data on Fintech investments is among the limitations of the study. The study can be expanded as data access increases.

REFERENCES

Athoillah, N.A. (2019). Fintech contribution to Indonesia's economic growth. MPRA Paper No. 97884, 1-8.

Banna, H., Mia, Md.A., Nourani, M., Yarovaya, L. (2021), Fintech-based Financial Inclusion and Risk-taking of Microfinance Institutions (MFIs): Evidence from Sub-Saharan Africa. Finance Research Letters, doi.org/10.1016/j.frl.2021.102149

The Interbank Card Center, Türkiye FinTech Ekosisteminin Sürdürülebilir Gelişimi için 23 Öneri, 2018,https://bkm.com.tr/wp-content/uploads/2018/02/EY_T%C3%BCrkiye-Fintech-Ekosisteminin-S%C3%BCrd%C3%BCr%C3%BClebilir-Geli%C5%9Fimi-i%C3%A7in-23-%C3%96neri.pdf, Online Accessed: 2021/10/18

Berger, A.N., Deyoung, R. (2001). The Effects of Geographic Expansion on Bank Efficiency. Journal of Financial Services Research. Kluwer Academic Publishers. Manufactured in The Netherlands. 19: 2/3 163-184.

Brem, A., Maier, M., Wimschneider, C., 2016. Competitive Advantage Through Innovation: The Case Of Nespresso. European Journal of Innovation Management 19 (1), 133–148.

Breusch, T. S., and A. R. Pagan. 1980. The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. The Review of Economic Studies 47 (1): 239–253.

Bond, S. R., and M. Eberhardt. 2013. Accounting for Unobserved Heterogeneity in Panel Time Series Models Working Paper. Oxford: Nuffield College, University of Oxford.

Cornelli, G., Frost, J., Gambacorta, R., Wardrop, R., and Ziegler, T. (2020). Fintech and Big Tech Credit: A New Database, Bank For International Settlements Working Paper, No. 88

Cumming, D.J., Schwienbacher, A. (2018). Fintech venture capital. Wiley, Corp Govern Int Rev. 2018;26:374–389.

Deng, X., Huang, Z., Cheng, X. (2019). FinTech and Sustainable Development: Evidence from China Based on P2P Data. Sustainability, MDPI, 2-19.

Gozman, D., Liebenau, J., Mangan, J. (2018). The Innovation Mechanisms of Fintech Start-Ups: Insights from SWIFT's Innotribe Competition. Journal of Management Information Systems. 145-179.

Eberhardt, M., and Teal, F. 2010. Productivity Analysis in Global Manufacturing Production. Economics Series Working Papers, 515. University of Oxford, Department of Economics.

Forbes, 2021, https://www.forbes.com/sites/isabelcontreras/2021/10/18/fintech-investments-have-hit-915-billion-in-2021-nearly-doubling-last-years-total/?sh=166ba8994a2e, Online Accessed: 2021/10/18

Frost, J. (2020). The Economic Forces Driving Fintech Adoption Across Countries. Bank For International Settlements Working Paper, No. 838

Haddad, C., Hornuf, L., (2018). The Emergence Of The Global Fintech Market: Economic And Technological Determinants. Springer, Small Bus Econ, 53(3), 81-105.

H˜obe, L., Alas, R., 2015. A Financial Services Innovation Management Model For Banks. Journal of Management and Change 34/35 (1/2), 138–154.

Jiao, Z., Shahid, M.S, Mirza, N., Tan, Z. (2021). Should the fourth industrial revolution be widespread or confined geographically? A country-level analysis of Fintech economies. Technological Forecasting & Social Change, 163, 1-7

Kammoun, S., Loukil, S., Loukil, Y.B. (2020). The Impact of FinTech on Economic Performance and Financial Stability in MENA Zone. Impact of Financial Technology (FinTech) on Islamic Finance and Financial Stability (pp. 253-277)., IGI Global.

Khiewngamdee, C., Yan, H. (2019). The role of Fintech e-payment on APEC economic development. Journal of Physics: Conf. Series 1324, 012099, 1-8.

Kónya, L. 2006. Exports and Growth: Granger Causality Analysis on OECD Countries with a Panel Data Approach. Economic Modelling 23 (6): 978–992.

KPMG. (2020). Pulse of Fintech H1 2020, 1-76.

Li, L. (2021), With $3B expected in 2021, Singapore is becoming a fintech capital, With $3B expected in 2021, Singapore is becoming a fintech capital | TechCrunch, Online Access: 14.08.2022

McKinsey&Company, (2016). Digital Finance For All: Powering Inclusive Growth In Emerging Economies. McKinsey Global Institute, , 1-24.

Mrabet Z, Alsamara M, Saleh, A. S., Anwar, S., (2019). Urbanization and non-renewable energy demand: A comparison of developed and emerging countries. Energy, 170 (2019) 832-839.

Mishkin, F.S., Serletis, A., (2011). The Economics of Money, Banking, and Financial Markets, Pearson.

Nasihin Aziz, A. (2019). Fintech Contribution to Indonesia's Economic Growth. Munich Personal RePEc Archive (MPRA), Paper No. 97884, 1-8.

Nizam, R., Karim, Z.A., Rahman, A.A., Sarmidi, T. (2020). Financial inclusiveness and economic growth: new evidence using a threshold regression analysis. Economic Research-Ekonomska Istraživanja, 33:1, 1465-1484

Otoo, I.A, Song, N. (2021). The Impact of Fintech on Poverty Reduction: Evidence from China. Sustainability, 13, 5225, 1-13.

Pesaran, M. H. 2004. General Diagnostic Tests for Cross Section Dependence in Panels. CESifo Working Paper Series No. 1229; IZA Discussion Paper No. 1240.

Pesaran, M. H. 2006. Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure. Econometrica 74 (4): 967–1012.

Pesaran, M. H. 2007. A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence. Journal of Applied Econometrics 22 (2): 265–312.

Pesaran, M. H., A. Ullah, and T. Yamagata. 2008. A Bias-Adjusted LM Test of Error Cross-Section Independence. The Econometrics Journal 11 (1): 105–127.

Pesaran, M. H., and T. Yamagata. 2008. Testing Slope Homogeneity in Large Panels. Journal of Econometrics 142 (1): 50–93.

Sadigov, S., Vasilyeva, T., Rubanov, P. (2020). FinTech in Economic Growth: Cross-Country Analysis. 55th International Scientific Conference on Economic and Social Development, Baku, 729-739.

Silva, L.A.P. (2018). Fintech in EMEs: blessing or curse?. Bank for International Settlements, p.1-11.

The Financial Stability Board, https://www.fsb.org/work-of-the-fsb/financial-innovation-and-structural-change/fintech/, 2021, Online Accessed: 2021/10/18

Westerlund, J. 2006. Testing for Panel Cointegration with Multiple Structural Breaks. Oxford Bulletin of Economics and Statistics 68 (1): 101–132.

Westerlund, J., and D. L. Edgerton. 2008. A Simple Test for Cointegration in Dependent Panels with Structural Breaks. Oxford Bulletin of Economics and Statistics 70 (5): 665–704

Yazici, S. (2019). The Analysis of Fintech Ecosystem In Turkey. Journal of Business, Economics and Finance (JBEF), V.8, ISS.4. p.188-197.

Zhang, X., Zhang, J., Wan, G., Luo, Z. (2019). Fintech, Growth, and Inequality: Evidence from China's Household Survey Data, The Singapore Economic Review, 1-26