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The Relationship Between Financial Technology Sector And Growth In Kenya: Evidence From Short-Run ARDL Dynamics.

Kenya'da Finansal Teknoloji Sektörü İle Büyüme Arasındaki İlişki:Kısa Dönem ARDL Dinamiklerinden Elde Edilen Kanıtlar.

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Abstract

The study aims to evaluate the relationship between fintech sector and growth in Kenya in the short run. The study employed secondary quarterly data from 2010Q1 to 2024Q4. Mobile money usage, payment card usage, fintech penetration, and M-Pesa revenue were used to proxy fintech sector. Investment rates, unemployment rates, inflation rates, and banks' interest on lending were employed as control variables. Growth was measured in terms of real GDP. The study adopted a quantitative explanatory research design and an Autoregressive Distributed lag (ARDL) model for data analysis. Fintech sector had a short-run relationship with growth in Kenya. The Error Correction Term of -0.59 indicated that any deviation from the long-run equilibrium was corrected at a speed of 59.1% towards the long-run equilibrium each quarter. ARDL bound testing indicated an F-statistic of 4.594, which was highly significant (1%), which confirmed the presence of a long-run relationship and validated the short-run positive interplay between fintech sector and growth in Kenya. Fintech sector is a crucial pillar of growth in Kenya. It is a positive contributor to aggregate productivity in the short-term. It has heightened money velocity, financial inclusion and lowered transaction time and costs, thus increasing economic participation. All the fintech proxies exhibited a positive short-run relationship with growth, except for mobile money usage. This underscores the disruptive nature of mobile money to existing financial institutions in the short run. The study advances a step higher compared to previous studies by employing diverse fintech indicators such as mobile money usage, payment card usage, and M-Pesa revenue, which is one of the fintech firms in Kenya, to assess the interplay between the fintech sector and growth in a multidimensional way. Furthermore, the ARDL model is being employed in the study, which captures the short-term relationship between fintech sector and growth.

Keywords: Financial technology (Fintech) sector, Growth, Autoregressive Distributed Lag (ARDL)

Özet

Bu çalışma, Kenya'da fintech sektörü ile büyüme arasındaki ilişkiyi kısa vadede değerlendirmeyi amaçlamaktadır. Çalışmada, 2010 yılının ilk çeyreğinden 2024 yılının dördüncü çeyreğine kadar olan ikincil üç aylık veriler kullanılmıştır. Fintech sektörü, mobil para kullanımı, ödeme kartı kullanımı, fintech yaygınlığı ve M-Pesa gelirleri ile temsil edilmiştir. Kontrol değişkenleri olarak yatırım oranları, işsizlik oranları, enflasyon oranları ve bankaların kredi faiz oranları kullanılmıştır. Büyüme, reel GSYİH cinsinden ölçülmüştür. Çalışmada, nicel açıklayıcı araştırma tasarımı ve veri analizi için Otoregresif Dağılımlı Gecikme (ARDL) modeli benimsenmiştir. Fintech sektörü, Kenya'daki büyüme ile kısa vadeli bir ilişkiye sahiptir. -0,59 değerindeki Hata Düzeltme Terimi, uzun vadeli dengeden meydana gelen herhangi bir sapmanın her çeyrekte %59,1 oranında uzun vadeli dengeye doğru düzeltildiğini göstermektedir. ARDL sınır testi, 4,594'lük bir F-istatistiği gösterdi; bu, son derece anlamlıydı (%1) ve uzun vadeli bir ilişkinin varlığını doğruladı; ayrıca Kenya'da fintech sektörü ile büyüme arasındaki kısa vadeli pozitif etkileşimi de teyit etti.Fintech sektörü, Kenya'da büyümenin temel dayanaklarından biridir. Kısa vadede toplam verimliliğe olumlu katkı sağlamaktadır. Para dolaşım hızını ve finansal kapsayıcılığı artırmış, işlem sürelerini ve maliyetlerini azaltarak ekonomik katılımı artırmıştır. Mobil para kullanımı hariç tüm fintech göstergeleri, büyüme ile kısa vadede pozitif bir ilişki sergilemiştir. Bu durum, kısa vadede mobil paranın mevcut finansal kurumlar üzerinde

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yarattığı yıkıcı etkiyi vurgulamaktadır. Bu çalışma, fintech sektörü ile büyüme arasındaki etkileşimi çok boyutlu bir şekilde değerlendirmek amacıyla mobil para kullanımı, ödeme kartı kullanımı ve Kenya'daki fintech şirketlerinden biri olan M-Pesa'nın gelirleri gibi çeşitli fintech sektörü göstergelerini kullanarak önceki çalışmalara kıyasla bir adım daha ileri gitmektedir. Ayrıca, çalışmada fintech sektörü ile büyüme arasındaki kısa vadeli ilişkiyi ortaya koyan ARDL modeli kullanılmaktadır.

Anahtar Kelimeler: Finansal teknoloji (Fintech) sektörü**, Büyüme, Otoregresif Dağıtılmış Gecikme (ARDL)**

Genişletilmiş Özet

Bu çalışmanın amacı,Kenya'da fintech sektörü ile büyüme arasındaki ilişkiyi kısa vadede değerlendirmektir. Kenya, Sahra Altı Afrika'nın en hızlı büyüyen ekonomileri arasında yer almaktadır. Aynı zamanda Afrika'nın önde gelen fintech merkezlerinden biridir; bu başarısının kökeni, M-Pesa'nın piyasaya sürüldüğü 2007 yılına kadar uzanmaktadır. Kenya, Vizyon 2030'a doğru ilerlemektedir ve 2030 yılına kadar %10'luk yıllık büyüme hedefine henüz ulaşmamıştır. Bunun gerçeğe dönüşmesi için, politika yapıcıların yatırım yapılması gereken kritik alanlara ilişkin içgörülere sahip olması gerekmektedir. Ayrıca, Kenya'nın büyüme oranı dalgalı ve değişken bir seyir izlemektedir. Fintech ile büyüme arasındaki ilişkiye dair sınırlı sayıda çalışma bulunmaktadır ve mevcut çalışmalar ya metodolojik, kavramsal ya da bağlamsal bir boşluğa işaret etmektedir.

Çalışmada, Kenya Merkez Bankası (CBK), Kenya Ulusal İstatistik Bürosu (KNBS), Dünya Bankası ve Safaricom yıllık raporlarından elde edilen, 2010 yılının ilk çeyreğinden 2024 yılının dördüncü çeyreğine kadar uzanan ikincil üç aylık veriler (60 gözlem) kullanılmıştır. Büyüme (bağımlı değişken) reel GSYİH cinsinden ölçülmüştür. Fintech sektörü (bağımsız değişken) ise mobil para kullanımı, ödeme kartı kullanımı, M-Pesa gelirleri ve fintech penetrasyonu açısından ölçülmüştür. Yatırım oranları, işsizlik oranları, enflasyon ve kredi faizleri kontrol değişkenleri olarak kullanılmıştır. Çalışmada, E-views 12 istatistik yazılımı ile tahmin edilen Otoregresif Dağıtılmış Gecikmelermodeli (ARDL) kullanılmıştır Modelin tahmin edilmesinden önce, tahmin öncesi testler olarak durağanlık testi (ADF, PP ve KPSS testi), gecikme uzunluğu seçimi ve eşentegrasyon testi gerçekleştirilmiştir. Teşhis testleri olarak Breusch-Godfrey Seri Korelasyon LM Testi, heteroskedastisite için Breusch-Pagan-Godfrey Testi, spesifikasyon için Ramsey RESET Testi ve normallik için Jarque-Bera Testi kullanılmıştır.

Stasyonerlik testi bulguları, tüm değişkenlerin seviye veya birinci farkta stasyoner olduğunu ve hiçbir değişkenin I(2) derecede stasyoner olmadığını, dolayısıyla ARDL koşulunu karşıladığını göstermiştir. Gecikme uzunluğu seçimi, gecikme 4'ü optimal gecikme olarak belirlemiş ve bu nedenle modele dahil edilmiştir. Eşentegrasyon testi, 4,5938'lik bir F-sınır testi değeri gösterdi; bu değer hem üst hem de alt kritik değerleri aştı ve Kenya'da fintech sektörü ile büyüme arasında son derece anlamlı bir uzun vadeli ilişki (1%) olduğunu doğruladı. Bu bulgu, fintech ile büyüme arasındaki kısa vadeli ilişkiyi tahmin etmek için istatistiksel bir gerekçe sağladı. Tüm tanılama testlerinin olasılığı 0,05'ten yüksekti, bu da modelin iyi tanımlanmış ve sağlam olduğunu doğruladı. Böylece, bulgular politika önerileri ve çıkarımlar için istatistiksel olarak güvenilirdi. ARDL kısa vadeli tahmin bulguları, %1 düzeyinde oldukça anlamlı olan -0,59'luk bir Hata Düzeltme Terimi (ECT) gösterdi. Bu durum, uzun vadeli dengeden sapmaların her çeyrekte %59,1'lik bir hızla dengeye doğru düzeltildiğini göstermektedir. Ayrı ayrı ele alındığında, ödeme kartı kullanımı büyümeyle pozitif ve istatistiksel olarak anlamlı bir ilişki sergilemiştir (0,0602). Mobil para kullanımı ise büyüme ile negatif ve istatistiksel olarak anlamlı bir ilişki göstermiştir (-0,2399). Fintech penetrasyonu, pozitif ve istatistiksel olarak sağlam bir ilişki göstermiştir (0,6217). Ayrıca, M-Pesa gelirleri de büyüme ile pozitif bir ilişki göstermiştir (0,4788).

Sonuç olarak, çalışma Kenya'da fintech sektörü ile büyüme arasında önemli ve pozitif bir kısa vadeli ilişki olduğunu ortaya koymaktadır. Spesifik olarak, M-Pesa gelirleri, fintech penetrasyonu ve ödeme kartı kullanımı büyüme ile pozitif bir etkileşim sergilerken, mobil para ile negatif bir ilişki sergilenmiştir. Dolayısıyla, fintech sektörü Kenya'daki büyümenin önemli bir ayağıdır; para hızını artırır, işlem süresini ve maliyetlerini azaltır ve finansal kapsayıcılığı artırır; bu da nihayetinde ekonomik katılımı ve üretkenliği artırır. Bu bulgular, hükümetin yıllık %10 büyüme ulusal hedefine ulaşmak için strateji geliştirirken kullanılabilir. Fintech firmaları ve ticari bankalar, fintech penetrasyonunu artıracak daha tüketici odaklı çözümler geliştirmek için işbirliğine devam etmelidir. Hükümet, fintech sektörünün işleyişi için fiziksel bir altyapı görevi gören internet bağlantısı ve telekom kuleleri gibi Bilgi ve İletişim Teknolojileri (BİT) alanına yatırım yapmaya devam etmelidir. Çalışmada bazı sınırlamalar da göze çarpmıştır; işsizlik, yatırım ve M-Pesa gelirleri ile ilgili olarak yıllık verilerin üç aylık gözlemlere uyarlanması yoluyla elde edilen veriler kullanılmıştır ve bu durum bazı sapmalara yol açabilir. Gelecekteki araştırmalarda, daha sağlam sonuçlar elde etmek için daha fazla üç aylık veri kullanılmalı ve daha uzun zaman dilimleri dikkate alınmalıdır. Kenya'da fintech sektörü ile küçük ve orta ölçekli işletmeler (KOBİ'ler) arasındaki büyük ölçüde keşfedilmemiş ilişkiyi değerlendirmek için kritik bir ihtiyaç bulunmaktadır.

INTRODUCTION

Fintech is the convergence of finance and technology and encompasses innovations designed to enhance the efficiency and expand the accessibility of financial services (Miah, 2023: 206). The origins of fintech date back to the 19th century, when the first telegraph and transatlantic cable systems were

established (Arner, Barberis, and Buckley, 2015: 4). These cable systems facilitated the cross-border transmission of financial information, enabling faster and more efficient communication between financial institutions (Arner et al., 2015: 4). Later, in the 1950s, the first universal credit card was introduced in 1958, paving the way for American Express cards to reduce the burden of cash transportation. This was followed by the launch of the first ATM in London by Barclays Bank in 1967, which was a significant step towards the branchless banking model (Khiewngamdee and Yan, 2019: 1).

Fintech sector is part of the fourth industrial revolution and is attracting global attention for its role in revolutionizing financial services and addressing persistent challenges in the financial sector (Mhlanga, 2024: 1). The global fintech revolution is a result of advances in communication technologies such as the internet and mobile phones, data analysis, cloud computing, and changing consumer habits and needs (Miah, 2023: 207). Fintech has the capacity to make financial systems more efficient and increase financial inclusion (Cevik, 2024: 1103). Global financial institutions such as banks have realized that by leveraging financial technologies such as mobile banking, they can reach the majority of the unbanked population, reduce their operating costs, and increase their profitability (Bochaberi and Job, 2021: 92). Fintech has increased transaction speed, reduced transaction costs, increased access to financial services for the public and businesses, and promoted efficiency, which in turn affects growth (Rizky et al., 2025: 47).

Kenya ranks among the rapidly growing economies in sub-Saharan Africa with an average annual growth rate of 5.4%. Kenya's nominal GDP rose from 15 billion Kenyan shillings in 2023 to 16.2 billion KES in 2024 (KNBS Economic Survey, 2025: 2). Kenya is one of Africa's leading fintech hubs. Kenya's fintech success dates back to 2007, when M-Pesa, a mobile money fintech service offered by Safaricom Kenya Limited, was incepted. Following the launch of M-Pesa in 2007, in 2010, commercial banks in Kenya launched agent banking as a competitive tool to expand their customer base and bring financial services closer to the public. Equity Bank Kenya pioneered agent banking fintech in 2010 with Equity Agent, followed by KCB Bank in 2011 with KCB Mtaani agents. In 2013, Cooperative Bank established Co-op Kwa Jirani agents, while Family Bank established Pesa Pap agent services (Waiyaki, 2016: 7). Due to the growth of the fintech sector, Kenya ranks fifth in the African region with a financial inclusion rate of 85% (FinAccess household survey, 2024: 24).

Banks in Kenya are also collaborating with fintech companies and telecommunications companies. This has led to the emergence of new fintech solutions such as KCB-M-Pesa, a partnership between KCB bank and M-Pesa that allows consumers to manage their savings and fixed deposit accounts via their phones. Fuliza-overdraft facility which is a partnership between M-Pesa, KCB Bank, and NCBA Bank, providing consumers with access to credit facilities via their phones. Additionally, M-Shwari which is an alliance between M-Pesa and NCBA Bank, enabling consumers to borrow and save via their phones. All these fintech solutions do not require a formal bank account to operate. This has significantly reduced financial exclusion in Kenya; as of 2024, the financial exclusion rate was 9.9% (Fin Access Household Survey, 2024: 11).

Fintech sector is a fundamental requirement for financial inclusion in Sub-Saharan Africa. Access to finance in developing countries in Sub-Saharan Africa, South Asia, and Latin America is more of a luxury than the norm, making financial exclusion a serious concern in these regions (Ayeni 2025: 2266). Kenya is progressing towards the realization of Vision 2030. However, Kenya has not yet achieved Vision 2030's annual growth target of 10% (Kenya Vision 2030). This elusive growth rate target requires an understanding of the critical investment areas to focus on to make it a reality. Moreover, Kenya’s growth has been volatile, characterized by periods of GDP growth increase followed by subsequent decline. CBK statistics show that the highest growth rate achieved in the previous 15 years was 8.4% in 2010, growth rates after 2010 have been fluctuating between 4% and 6.5% (Wachira, 2023). Kenya's formal financial access surged from 40.4% in 2009 to 84.8% in 2024 (FinAccess household survey, 2024: 11). Furthermore, although Kenya's mobile money penetration reached 82% in 2024, GDP growth continues to fluctuate between 4% and 6.5%, remaining below the Vision 2030 target of 10%.

Currently, there is also a dearth of studies that have investigated the relationship between fintech and growth. This is because fintech sector is still young and developing. Scholars agree that fintech can affect growth, but it is still unclear whether it will accelerate or hinder growth (Deng, Huang, and Cheng, 2019: 2). Existing research on fintech and its impact on growth has yielded mixed results, Utami (2022), Ngong et al. (2024), and Chepngeno (2022) found a positive relationship between fintech and economic growth, while Nabi et al. (2023) found a negative relationship. Furthermore, most previous studies indicate either a methodological, conceptual or contextual gap. They have either defined fintech in a restrictive manner,

used annual data for a short period of time, failed to include essential control variables in the model or used simple models. The current study goes a step further by synthesizing these conflicting results using various fintech variables such as mobile money, payment cards, fintech penetration, and M-Pesa revenue, which depicts the broad scope of the fintech sector. Moreover, the current study employs a more robust model (ARDL), quarterly data that covered 15 years and includes more control variables in the model for more robust findings. The findings of this analysis will be helpful to policymakers as they set strategies on which investments to focus on for the realisation of Kenya's vision 2030 annual growth rate of 10%. The policymakers will also be in a position to make evidence-based regulatory measures of whether to inhibit or promote fintech sector growth. Moreover, the study will contribute to the existing empirical literature on the relationship between fintech sector and growth.

The other sections of the paper are outlined as follows: the second section literature review, the third section details the research methodology, the fourth section reports the study findings, and the fifth section outlines the conclusion of the study.

Theoretical Review

The study drew support from Schumpeter's theory of economic development and Romer's endogenous technological change theory.

The theory of economic development(Joseph A. Schumpeter in 1934)

Schumpeter (1934:45) asserts that economic development results from endogenous innovations that disrupt the circular flow of economic life.Innovations, or new combinations, take various forms. Schumpeter (1934:47) defined development "as the carrying out of new combinations" which involves either "the introduction of a novel product, the introduction of a novel method of production, the launching of a new market, conquest of a new source of supply of raw materials or the carrying out of the new organisation of any industry".In the modern context, fintech represents new combinations that are disrupting the traditional circular flow of the economy. Fintech solutions are disrupting and replacing traditional financial systems that are opposed to innovation leading to a more competitive financial sector, which in the long run may enhance economic growth.The theory further postulates that Innovation is the main propeller of economic growth, and the entrepreneur acts as the central innovator. In the Kenyan context, fintech firms such as M-Pesa represent the innovative entrepreneurs who are revolutionizing financial delivery. Entrepreneurial profits lure new businesses to innovate, which heightens production and competition (Schumpeter,1934:96). Similarly, in the Kenyan context, the advent of M-Pesa, a fintech firm in Kenya, and its success in financial services delivery have paved the way for the emergence of other fintech solutions. Fintech in the Kenyan context represents the new combination that is transforming the financial sector. Fintech solutions are able to bypass the constraints linked to financial access, which ultimately may have an effect on economic growth.

The endogenous technological change theory(Romer, P.M, 1989)

The theory is built on 3 fundamental pillars: technological change as the engine of growth, intentionality and market incentives, and the non-rivalry of ideas (Romer,1989:1) .It places technology change, such as fintech at the heart of economic growth and posits that technology is an essential endogenous factor of production. The theory defines technological change as the improvement in the instructions for mixing raw materials (Romer 1989:1).Similarly, fintech in Kenya indicates the integration of technology in the delivery of financial services, which is revolutionising the Kenyan financial sector. It is an improvement in the delivery of financial services in Kenya, which may affect economic growth

The second pillar is that technological change arises in large part because of intentional actions taken by people who respond to market incentives, it is endogenous rather than exogenous (Romer 1989:1). This indicates that fintech innovation is as a result of deliberate actions by entrepreneurs in response to market incentives and gaps. Technology is a purely non-rival input to growth (Romer,1939:4).Once the initial cost of developing a technology is incurred, İt can be used repeatedly with no additional costs (Romer,1939:2). This undescores the crucial role played by technology in production.This theory is relevant in the current study since fintech resonates with a technological change in the delivery of financial services which is transforming the financial sector and ultimately may affect economic growth.

2. LITERATURE REVIEW

Globally, Rizky et al. (2025) determined the impact of fintech payments and loans on economic growth in developing countries from 2017 to 2022. The findings indicated that fintech payments and loans had a positive effect on economic growth. However, this study revealed gaps that the current study attempts to address. The study denotes a contextual gap; it only covers 6 years, which is insufficient to capture robust effects of fintech on growth. Furthermore, the study includes a panel of developing countries with different economic landscapes compared to Kenya. The current study fills this gap by focusing on Kenya, a developing lower-middle-income country and using quarterly data covering a 15-year period.

Utami (2022) assessed the impact of fintech on the Indonesian economy during the COVID-19 pandemic from 2020 to 2022. The study findings found that fintech had a positive impact on economic growth. However, the study denotes a conceptual gap in that it did not include control variables in the model, which may have led to biased results. The study also presents a methodological gap; it employed simple linear regression on time -series data, which is not preferred for small data. Furthermore, the study only covers 3 years and was conducted in Indonesia, a country with a distinct fintech and growth landscape compared to Kenya. The current study employs ARDL and includes control variables in the model. Furthermore, the study covers a longer period and focuses specifically on Kenya.

Mugableh and Hammouri (2022) investigated the impact of fintech on economic growth in Jordan from 1990 to 2021. The findings indicated that fintech positively affected economic growth in Jordan. The study presents a conceptual gap as it relied heavily on ICT-based access proxies as fintech variables, ignoring the financial aspect of fintech. Moreover, the study fails to control in the model for other factors that may affect growth. The study also contains a contextual gap as it was conducted in Jordan. The current study employed broad fintech variables that encompass both the financial and technological aspects of fintech. Furthermore, the current study includes other determinants of growth in the model and focuses specifically on Kenya.

Ngeze and Seif (2024) analysed the impact of fintech on economic growth in Tanzania from 2008 to 2022. The findings found a positive fintech effect on GDP growth. However, the study operationalized fintech variables as just ICT connectivity measures. This presents a conceptual gap as the financial aspect of fintech was ignored. Additionally, the study failed to include in the model other factors that affect economic growth as control variables. The current study employs fintech proxies that incorporate both the financial and technological aspects of fintech, includes in the model other factors affecting growth as control variables and specifically focuses on Kenya.

Locally, Ongaga (2022) explored the impact of fintech on financial deepening in Kenya between 2012 and 2021. The study found a positive fintech effect on financial deepening. The study depicted a conceptual gap by focusing on the impact of fintech on financial deepening. The current study advances to evaluate how fintech affects growth. Moreover, the study adopts ordinary least squares model, which is not preferred for small data and fails to capture the short-term relationship between variables. The current study employs ARDL model, which captures the short-term relationship between fintech and growth.

Aicha (2023) evaluated the impact of fintech on financial inclusion in Kenya from 2007 to 2021. The correlation and regression findings denoted a positive relationship between fintech and financial inclusion. The study denoted a conceptual gap; It focused on the impact of fintech on financial inclusion. The current study advances a step higher and evaluates whether the heightened financial inclusion resulting from fintech affects growth. Moreover, the study denotes a methodological gap; it employs a linear regression model on fintech transaction values that trend over time, which may lead to erroneous findings. The current study uses the ARDL model to evaluate the short- term interplay between fintech and growth and suits the study since its more preferred for small data samples.

Chepngeno (2022) delved into the impact of fintech on economic growth in Kenya and found that fintech had positive effect on economic growth. However, the study denoted a methodological gap, as it employed a basic regression model for time series data for 10 years. The study also indicated a conceptual gap by employing only two control variables; in contrast, growth is influenced by many other factors that the researcher ignored. The current study employed the ARDL model that captures the short -term relationships between variables and included in the model other determinants of growth as control variables.

3. RESEARCH METHOD

The research method describes the data sources and variable descriptions, the research design used, and the analysis of the collected data.

3.1. Data Sources and Variable Description

The study employed quantitative secondary data collected quarterly over a 15-year period from 2010Q1 to 2024Q4. This period was selected as it witnessed both the advent of most fintech solutions in Kenya and the increased adoption of fintech. The study data was obtained from the Central Bank of Kenya (CBK) website, the Kenya National Bureau of Statistics (KNBS) website, Safaricom Annual Reports and the World Bank. The dependent variable, growth (lngdp) was measured in terms of real GDP in Kenya Shillings (KES) in Millions, and the data was collected quarterly from the Kenya National Bureau of Statistics (KNBS) website. Unemployment, investment, interest on lending, and inflation rates were used as control variables. Unemployment (une) was measured in terms of unemployment, total (% of total labor force) and data collected annually from the World Bank. Investment (inv)was measured in terms of Gross fixed capital formation(annual% growth) and data was collected from the World Bank. Inflation (infla) was proxied by inflation rates and data was collected from the Central Bank of Kenya (CBK) website. Interest on lending (il) was proxied by commercial banks weighted average rates on lending, and data was collected from the CBK website. The independent variable (fintech sector) was proxied by mobile money usage, payment cards usage, fintech penetration, and M-Pesa revenue. Mobile money usage (lnmmu) was proxied by mobile money transaction values in KES millions. Payment card usage (lnpcu) was proxied by total cards transactions at Point of Sale (POS) machines in KES millions. M-Pesa revenue data was collected from Safaricom Annual reports in KES million. Fintech penetration was proxied by the combination of the number of active agents, registered mobile money accounts and Automated teller machines in millions which were summed in absolute terms. ATMs was included as part of fintech penetration because in Kenya it's still treated as a new solution to financial access as the population is continuously adopting it. Mobile money usage, payment cards usage and fintech penetration data was collected from the CBK website and was only available on a monthly basis, a summation of 3 months' data was taken as one quarter observation. Inflation and interest rate was also available monthly, and an average of the summation of 3 months' data was taken as an observation for each of the quarter. M-Pesa revenue, investment, and unemployment data was only available annually and was interpolated into quarterly basis by using linear interpolation to align with the study's quarterly analysis framework. Value-based variables were converted to natural logs (ln) to account for scale differences and to stabilize variance in the model.

3.2. Research Design

The study employs a quantitative explanatory research design. This design is deemed appropriate for this study as it evaluates the causal interplay between fintech and growth in Kenya using secondary time series data. It is based on evidence that one variable causes a change in another.

3.3. Data Analysis

The study adopted the Autoregressive Distributed Lags (ARDL) model, which was developed by Pesaran et al. (2001). E-views version 12 statistical software was used to run the

study model. The model was deemed suitable for analysis as it estimates the short -term relationship between variables and is preferred for small data sample. The model is considered suitable for studies with limited and finite sample sizes and is inapplicable when variables are stationary at the second difference (Seth and Manocha, 2023: 168). Before estimating the model, unit root test, lag length selection, and cointegration test were done as pre-estimation steps. Later, to check for model stability, Breusch-Godfrey (BG) Serial Correlation LM Test, Breusch-Pagan-Godfrey, Ramsey RESET Test, and Jarque-Bera test were employed.

Before the model was estimated, the time series properties of the variables were evaluated to determine their integration orders. The Augmented Dickey-Fuller (ADF) test developed by Dickey and Fuller (1979), the Phillips-Perron (PP) test developed by Phillip and Perron (1988), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test developed by Kwiatkowski et al. (1992) were employed together. After the stationarity condition was ascertained, the lag length selection and the cointegration test were conducted. While the study focused on the short-run interplay between fintech and growth, the ARDL cointegration test is mandatory to ensure the statistical validity of short-run results. F-bound testing was employed to test for cointegration. It has two bounds: the lower bound and the upper bound. If the calculated F-statistic is greater than the upper bound critical value, cointegration exists (long-term relationship); if the F-statistic is less than the lower bound critical value, it indicates that there is no cointegration; if it falls between the two, the findings are inconclusive (Nkoro and Uko, 2016: 82). Finally, several diagnostic tests were performed to test the robustness of the model and the reliability of the results. The study employed the Breusch-Godfrey LM Test to test for correlation, the Breusch-Pagan-Godfrey Test for heteroscedasticity, the Jarque-Bera Test for normality, and the Ramsey reset test for linearity.

4. RESULTS AND DISCUSSION

The findings of the study are as follows

Table 1. Descriptive statistics of the variables used in model Estimation

Variable	observations	Mean	Median	Maximum	Minimum	Std. Dev.
Lngdp	60	14.459	14.544	15.272	13.561	0.508
Lnmmu	60	13.629	13.717	14.658	11.948	0.729
Lnpcu	60	10.311	10.259	11.275	9.184	0.589
Lnmpsr	60	10.681	10.917	11.850	8.931	0.863
Lnfp	60	3.689	3.635	4.442	2.446	0.543
Il	60	14.842	13.930	24.093	9.110	2.749
Infla	60	6.952	6.420	16.290	4.033	2.503
Inv	60	5.709	2.410	19.843	-3.767	6.649
Une	60	4.006	3.541	5.707	2.682	1.308

Source: KNBS, CBK, Safaricom plc annual reports, World Bank

Table 1 indicates the descriptive statistics of the study variables for the period 2010q1-2024q4. The study variables' mean and median values were close to each other, depicting a symmetrical distribution. The (LNGDP) had a mean of 14.459 and a relatively low standard deviation value of 0.508, indicating a moderate variation of growth during this period. Among the fintech sector variables, M-Pesa revenue (LNMPSR) had the highest standard deviation value (0.863), indicating that it was the most volatile. Fintech penetration (LNFP) had the lowest average (3.689), representing the infrastructure aspect of fintech. Furthermore, the narrow range between min (2.446) and max (4.442) indicates that fintech penetration is steadily increasing in the country. For the control variables, both inflation and investment exhibit a wider range, indicating

fluctuations in investment and inflation rates in Kenya. The average inflation rate is 6.952, and the highest inflation spike was at 16.290%, indicating some price shocks during the research period. Investment, despite showing a large range, exhibited a high volatility (Std. Dev 6.6), indicating significant sensitivity to political or economic change. The high mean of interest on lending rate (il) (14.84%) indicated that the interest on lending in Kenya has historically been high. Unemployment (UNE) remains relatively stable. However, in summary, the stability of the key fintech sector variables and growth provides a solid foundation for the model estimation.

Table 2. Stationarity tests

Variable	ADF,I(0) test statistic value	ADF,I(1) test statistic value	PP, I(0) test statistic value	PP,I(1) test statistic value	KPSS,I(0) Tes statistic value	KPSS, I(1) Test statistic value
Lngdp	-3.1292**	-16.6709**	-0.5992	-18.5598***	0.9631***	0.1347
Lnmmu	-3.3870**	-5.8043***	-3.8945***	-5.6832***	0.9451***	0.5571**
Lnpcu	-1.1823	-6.9960***	-1.1838	-7.0020***	0.8660***	0.0612
Lnfp	-2.3075	-4.7965***	-2.8631*	-4.7965***	0.9677***	0.3731*
Lnmpsr	-1.5750	-2.3914	-3.5273**	-9.6045***	0.9475***	0.3880*
Il	-2.0906	13.0955***	-3.7248***	-14.0459***	0.4118*	0.1309
İnfla	-5.8334***	-3.2963**	-2.8896*	-3.2963**	0.1981	0.0311
Une	-1.6706	-1.4537	-0.4152	-7.9579***	0.8473***	0.2138
İnv	-2.5679	-7.6576***	-3.5355**	-7.4923***	0.3223	0.0466
Note,*,**,*** asterisks represent statistical significance at 10%,5%, and 1% levels, respectively.						

Source: E-views statistical software stationarity test results

To ensure the robustness of the time series properties, a series of complementary unit root tests was employed: the Augmented Dickey-Fuller (ADF) test, the Phillips-Peron (PP) test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. The null hypothesis of the ADF and PP tests indicates that the variable has a unit root. Therefore, if the test statistic was found significant, the null hypothesis was rejected and concluded that the variable is stationary. In KPSS, the null hypothesis states that the variable is stationary. Therefore, if the test statistic was significant (has an asterisk), the null hypothesis was rejected, and the variable was concluded to be non-stationary. All the study variables in Table 2 were stationary at levels or in the first difference in all the three tests; ADF, PP, and KPSS, except lnmmu,lnfp, and lnmpsr variables which indicated some significance at KPSS I(1).Since,the other units test confirmed that lnfp,lnmmu and lnmpsr were either stationary at level or first difference,the variables were assumed to meet the ARDL condition.In addition Zivot-Andrews test confirmed that after structural breaks were excluded they were stationary at first difference as indicated in table 3.This certified the ARDL model condition. The ARDL model is applicable when the study variables represent a mixture of integration orders under the assumption that no variable is stationary at the second difference (Pesaran et al., 2001: 289).

Moreover, the study period contained some structural breaks in Kenya’s financial sector such

as the as the rapid scalling of M-Pesa and the COVID-19 shocks. Standard ADF and PP tests are size distorted in the presence of structural breaks (Perron, 1989). Therefore Zivot-Andrews test (Zivot and Andrews,1992) was applied to all variable seres a s a robustness check.

Table 3: Zivot-Andrews Stationarity Test

Variable	Test-statistic value	Breaking period
lngdp	-5.157**	2015q1
dlngdp	-19.288***	2020q4
lnmmu	-3.593	2022q3
dlnmmu	-8.383***	2020q3
lnpcu	-4.227	2013q3
dlnpcu	-7.796***	2015q2
lnfp	-6.858***	2018q2
dlnfp	-5.572***	2017q4
lnmpsr	-3.226	2020q4
dlnmpsr	-16.785***	2022q1
il	-3.431	2016q4
dil	-13.518***	2012q3
infla	7.368***	2014q1
dinfla	-6.328	2019q4
une	-4.339	2018q1
dune	-9.554***	2017q1
inv	-5.939***	2015q1
dinv	-7.610***	2015q1
Note,*,**,*** asterisks represent statistical significance at 10%,5% and 1% levels, respectively		

Source: E-views statistical software

Table 3 above indicates that all the variables had a significant test statistic value (with asterisk) either at level or first difference; therefore, the null hypothesis of unit root was rejected. Thus, confirming that all the variables were either stationary at level or first difference even after accounting for structural breaks during the study period. This supports the validity of using ARDL model for this study.

Table 4. Lag length and Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-123.4832		1.51e-08	4.695829	4.985165	4.808004
1	296.2579	704.5654	4.69e-14	-8.009210	-5.405186*	-6.999635
2	381.3809	118.5642	2.53e-14	-8.763604	-3.844892	-6.856630
3	451.6247	77.76993	2.97e-14	-8.986597	-1.753198	-6.182223
4	601.2763	122.9281*	3.28e-15*	-12.04558*	-2.497495	-8.343809*
* Indicates lag order selected by the criterion.						

Source: E-views statistical software lag length and order selection results

To determine the lag period and lag selection criterion, the Lag Order criteria of Log Likelihood Ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn (HQ) were applied. All the criteria identified lag 4 as the optimal lag except for SC, which suggested lag 1as indicated in Table 4. Lag 4 was therefore adopted in the model, and it was theoretically appropriate for this study's dataset as it captured the annual cycle and the lagged transmission interplay between the fintech sector and growth.

Table 5. F-Bound Testing

Test-statistic value (F-statistic)	Significance level	Critical value, I(0)	Critical value, I(1)
4.5938 K=8	10%	1.95	3.06
	5%	2.22	3.39
	2.5%	2.48	3.7
	1%	2.79	4.1***
Note, asterisks *, **,*** ,denote 10%,5% and 1% significant level respectively			
Null hypothesis: No level relationship			

Source: E-views statistical software, ARDL F-Bound testing results

The ARDL bounds test for cointegration relies on standard F and t statistics to test the significance of the lagged level of variables in an univariate equilibrium correction mechanism (Pesaran et al., 2001: 289). The results revealed an F-statistic of 4.5938, which exceeded both the upper critical limit (4.1) and the lower critical limit (2.79) as indicated in Table 5. This confirmed a highly significant, long-term relationship between fintech and growth in Kenya. Consequently, the null hypothesis of no cointegration was rejected, which provided the statistical justification to estimate the short-run relationship between fintech and growth.

Table 6. Short-run ARDL results

Variable	Coefficient	Standard error	T-statistic
Δlngdp (-1)	-0.3749	0.0917	-4.0901***
Δlngdp (-2)	-0.6465	0.0811	-7.9721***
Δlngdp (-3)	-0.7128	0.0696	-10.2404***
Δlnmmu	-0.2399	0.0595	-4.0326***

Δlnmmu (-1)	-0.1160	0.0657	-1.7660*
Δlnmmu (-2)	-0.4684	0.0606	-7.7285***
Δlnmmu (-3)	0.2307	0.0502	4.5995***
Δlnpcu	0.0602	0.0223	2.7074**
Δlnpcu (-1)	0.2159	0.0307	7.0395***
Δlnpcu(-2)	0.0406	0.0260	1.5617
Δlnpcu (-3)	-0.0655	0.0234	-2.8012**
Δlnmpsr	0.4788	0.0500	9.5848***
Δlnmpsr (-1)	0.6306	0.0760	8.2967***
Δlnmpsr (-2)	0.5319	0.0757	7.0245***
Δlnmpsr (-3)	0.4310	0.0622	6.9304***
Δlnfp	0.6217	0.1926	3.2283***
Δlnfp (-1)	0.3818	0.1361	2.8040**
Δil	0.0091	0.0016	5.7863***
Δil (-1)	0.0120	0.0024	5.1194***
Δil (-2)	0.0048	0.0062	2.8785***
Δinfla	0.0172	0.0044	3.8981***
Δinfla (-1)	-0.0323	0.0062	-5.2165***
Δinfla (-2)	-0.0368	0.0057	-6.4467***
Δinfla (-3)	-0.0220	0.0053	-4.1681***
Δune	0.0444	0.02235	1.9877*
ECT (-1) *	-0.5913	0.0783	-7.5561***
Cons	6.7604	0.8878	7.6144***
R^2	0.9738		
Adjusted R^2	0.9503		
Durbin-Watson	2.3626		
Note, asterisks *, **,***, denote 10%,5% and 1% significant level, respectively.			

Source: E-views statistical software, ARDL short-run estimation results

The error correction term (ECT-1) in Table 6 indicates how quickly variables converge to equilibrium in Kenya. The coefficient value of ECT (-0.59) is negative and statistically significant at 1% level, as indicated in Table 5. This implies a stable long-term relationship between fintech and growth in Kenya and any deviations from the long run are corrected at a rate of 59% per quarter towards the long-term equilibrium.

The short-run mobile money usage (LNMMU) findings exhibited negative statistically significant coefficients (-0.2399) as indicated in Table 6. Furthermore, lag 1and 2 denoted negative coefficients, whereas lag 3 denoted a positive coefficient. This indicates a negative interplay between mobile money usage and growth. Mobile money usage can initially act as a disruptor to

traditional financial systems as funds start to flow from the formal financial institutions to mobile wallets. This can result in a short-term reduction in banks' liquidity and capital adequacy, which reduces the amount available for lending thus potentially limiting lending for production activities. This heightens the cost of doing business, which reduces aggregate output. The reduction in banks' liquidity and capital may thus result to a temporary negative effect on growth, which translate to a negative relationship between mobile money usage and growth in the short-term.

Payment card usage (LNPCU) denoted a positive statistically significant coefficient (0.0602) as exhibited in Table 6, depicting a positive relationship with growth in the short-term. Furthermore, lag 1had a positive coefficient, whereas lag 3 had a negative coefficient. In Kenya, payment card transactions transpire at point of sales (POS) machines, which are mostly located in high-end retail outlets. These POS machines are connected to formal merchant banks' accounts; Therefore, every card swipe maintains liquidity within the banks. Increased bank liquidity can translate to the availability of funds for private sector lending ultimately affecting growth. Moreover, LNPCU translates to heightened consumption of products and demand. This increases the production level and thus the output, which can result into the positive interplay between payment card usage and growth in the short run. The findings are consistent with Schumpeter's theory of economic development (1934) and Romer's endogenous technological change theory (1989) as they indicate the positive impact of innovation on economic growth.

M-Pesa revenue (LNMPSR) indicated a statistically significant positive coefficient (0.4788) as indicated in Table 6. Additionally, all the lags indicated positive coefficients. This indicates that LNMPSR in Kenya has a positive relationship with growth in the short-term. M-Pesa revenue is a combination of charges from mobile transactions and businesses using the M-Pesa electronic payment system; thus it signifies a shift to a cashless economy. Part of the revenue is paid as tax to the government, which impacts growth. Additionally, Part of the revenue is distributed back to M-Pesa agents as commission. The distributed revenue increases both the amount available for re-investment and household disposable revenue, which can increase production and aggregate demand in the country. Thus, the positive relationship between M-Pesa revenue and growth in Kenya. The findings are consistent with Schumpeter's theory of economic development (1934) and Romer's endogenous technological change theory (1989) as they indicate the positive impact of innovation on economic growth.

Fintech penetration (LNFP) indicated a statistically positive coefficient (0.6217) in the short run as indicated in Table 6. Furthermore, the lag coefficient of LNFP was positive. Fintech penetration reduces the physical distance to financial touchpoints as individuals can access finances via their phones, agents or ATMs. This increases financial inclusion, which ultimately can heighten economic participation. Moreover, the time and costs incurred by individuals and small-scale traders to make payments or access cash are reduced. This reallocates unproductive travel time into productive labour, which can increase productivity. Additionally, agency banking and ATM banking foster liquidity of the economy. They motivate individuals to bank in the digital ecosystem as they can easily convert their digital money to cash or non-cash. This heightens the velocity of money in the economy, which is an immediate propeller of growth, this can result to the positive interplay between LNFP in Kenya and growth in the short-term. The findings are consistent with Schumpeter's theory of economic development (1934) and Romer's endogenous technological change theory (1989) as they indicate the positive impact of innovation on economic growth.

Interest on lending (IL) depicted a statistically positive coefficient (0.0091) in the short-term, as indicated in Table 6. Additionally, lag 1 and 2 had positive coefficients. This indicate a positive interplay between interest on lending and growth. In the Kenyan banking sector,an increase in interest rates on lending acts as an incentive that stimulates banks to heighten their lending as opposed to rationing it.The higher availability of credit motivates individuals and small enterprises to acquire credit and are less sensitive to the interest costs attached. Thus, they are able to obtain funds to expand their enterprise operations, which can heighten aggregate output. Thus the positive

interplay between interest on lending in Kenya and growth in the short-term.

Inflation (infla) indicated a statistically positive coefficient (0.0172) as depicted in Table 6. However, lag 1, 2 and 3 indicate negative coefficients. This indicates that inflation has a positive relationship with growth in the short-term. General price increases in Kenya are typically associated with demand-pull inflation, which requires businesses to increase production to meet rising demand levels. Increased production can boosts the country's overall output, leading to the short-term positive interplay between inflation and growth.

Unemployment (une) exhibited a slightly significant (at 10%) positive coefficient (0.0444) as depicted in Table 6. This depicts that unemployment exerts some positive effects on growth in the short-run. This indicates that in the short run, the productivity gains of capital-intensive sectors such as fintech outweigh the loss of traditional manual labor and thus the weak positive interplay between unemployment and growth.

Table 6. Model diagnostic Tests

Test	F-statistic	Probability
Breusch-Godfrey	1.815106	0.1724
Breusch-Pagan-Godfrey	0.678298	0.8468
Ramsey RESET	0.085180	0.7734
Jarque-Bera	1.918095	0.3833

Source: E-views statistical software ARDL diagnostic test results

The diagnostic tests confirmed the model was well specified and robust and therefore the findings were reliable for policy recommendations and inferences. As indicated in Table 6, the Breusch-Godfrey serial correlation LM test indicated a probability of 0.1724>0.05, therefore it was concluded that the model residuals were free of serial correlation. In the Breusch-Pagan-Godfrey test, the probability was 0.8468 > 0.05, so it was concluded that the model error variance was constant. The Ramsey RESET Test denoted a probability of 0.7734 > 0.05, therefore it was concluded that the model was correctly specified. Finally, the Jarque-Bera test indicated a probability of 0.38 > 0.05, therefore it was concluded that the residuals in the model followed a normal distribution.

CONCLUSION

The study found that the fintech sector in Kenya has a significant positive relationship with growth in the short-term. It has heightened money velocity, financial inclusion and lowered transaction time and costs thus increasing economic participation and productivity. All the fintech sector variables had a positive interplay with growth, except mobile money usage, which had a negative relationship. This exhibits the disruptive effects of mobile money to the existing financial institutions, such as banks in the short run. Mobile money reduces liquidity from the banks as funds flow from formal bank accounts to mobile wallets. This reduces the amount available for lending, thus limiting firms' access to funds for expansion of their production activities, which can exert an adverse effect on growth. The study’s findings can be used by policy makers as they strategize to achieve Kenya Vision 2030 target of a 10% annual growth by prioritising fintech sector investment. According to the study's findings, the fintech sector and banks should continue to collaborate to develop more consumer-centric fintech solutions that will increase fintech penetration. The government should continue to invest in ICT infrastructure, such as internet connectivity and telecom towers, as they serve as the physical rails upon which fintech operates. The study encountered some data limitations that future studies can build on. Data for unemployment, M-Pesa revenue, and investment, which were only available on an annual basis, was interpolated into quarterly data through linear interpolation, which may reflect a biased

observation. Future studies should employ quarterly data on these variables for more robust findings. They should also consider longer periods. Furthermore, they should attempt to evaluate the interplay between fintech sector SMEs in Kenya, which remains largely unexplored.

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