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THE RELATIONSHIP OF FINANCIAL INNOVATION AND ECONOMIC GROWTH: EXAMPLE OF TÜRKİYE

FİNANSAL İNOVASYON İLE EKONOMİK BÜYÜME ARASINDAKİ İLİŞKİ: TÜRKİYE ÖRNEĞİ

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Abstract

The aim of this study is to research the relationship between financial innovation and economic growth during the 1970–2019 period in Turkey's economy. Here, GDP per capita is used as an indicator of economic growth, GDP ratio of domestic credits to private sector and the ratio of broad/narrow money supply as indicators of financial innovation, and GDP ratio of gross fixed capital formation as an indicator of financial growth. The annual data set for the variables used obtained from the World Bank (WB) and Central Bank of the Republic of Turkey(CBRT) databes. Eviews 10 Package program was used in the analysis. The relationship between financial innovation and economic growth is analyzed by means of Dolado-Lüthkepol and ARDL methods. Findings reveal that financial innovation and development had an impact on growth in Turkey's economy during the 1970–2019 period. It has been established that the GDP ratio of private sector loans, used as an indicator of financial innovation, and GDP ratio of gross fixed capital formation, used as an indicator of financial development, have a positive effect on growth. On the other hand, it has been determined that the effect of the variable broad money supply/narrow money supply, which is used as an indicator of financial innovation, on growth is negative. Accordingly, it has been determined that financial innovation has positive and negative effects on Turkey's economy

Keywords: Financial Innovation, Economic Growth, ARDL, Financial Development

Öz

Bu çalışmanın amacı, Türkiye ekonomisinde 1970-2019 dönemi finansal inovasyon ile ekonomik büyüme ilişkisi araştırmaktır. Çalışmada, ekonomik büyüme göstergesi olarak kişi başına düşen GSYİH, finansal inovasyon göstergesi olarak Özel Sektöre verilen yurtiçi kredilerin GSYİH oranı ve Geniş/Dar Para arzının oranı, finansal büyüme göstergesi olarak Brüt Sabit Sermaye Oluşumunun GSYIH oranı kullanılmıştır. Kullanılan değişkenlere ait yıllık veri seti, Dünya Bankası (DB) ve Türkiye Cumhuriyeti Merkez Bankası (TCMB) veri tabanlarından elde edilmiştir. Analizde Eviews 10 Paket programı kullanılmıştır. Finansal inovasyon ile ekonomik büyüme arasındaki ilişki Dolado-Lüthkepol ve ARDL yöntemleri yardımıyla incelenmiştir. Analizden elde edilen bulgularda, 1970-2019 dönemi Türkiye ekonomisinde finansal inovasyon ve gelişmenin büyüme üzerinde etkili olduğu görülmektedir. Finansal inovasyon göstergesi olarak çalışmada kullanılan Özel sektör kredilerinin GSYH oranı ve finansal gelişme göstergesi olarak kullanılan Brüt Sabit Sermaye Oluşumunun GSYIH oranı değişkenlerinin büyüme üzerinde olumlu etkisi olduğu tespit edilmiştir. Diğer taraftan ise, finansal inovasyon göstergesi olarak kullanılan Geniş Para Arzı/Dar Para arzı değişkeninin büyüme üzerinde etkinin olumsuz olduğu sonucuna ulaşılmıştır. Dolayısıyla Türkiye ekonomisinde finansal inovasyonun olumlu ve olumsuz etkilerinin olduğu tespit edilmiştir.

Anahtar Kelimeler: Financial Innovation, Economic Growth, ARDL, Financial Development

EXTENDED SUMMARY

Çalışmanın Amacı

Bu çalışmanın amacı, Türkiye ekonomisinde finansal inovasyon ile ekonomik büyüme arasındaki ilişkiyi araştırmaktır.

Araştırma Soruları

Finansal inovasyon ekonomik büyümeyi etkiliyor mu? Etkiliyorsa nasıl ve hangi yönde etekilemektedir?

Literatür Araştırması

Literatürde, finansal inovasyon ile ekonomik büyüme arasında bir ilişki olduğunu ortaya koyan çalışmalar mevcuttur. Levine (1997), Chin ve Chou (2001), Valverde, Del Paso ve Rodriguez (2004), Llewellyn (2008), Mishra (2008), Michalopoulos, Laeven ve Levine (2009), Chou (2007), Hasan, Renzis ve Schmiedel (2013), Hsu, Tian ve Xu (2014), Idun ve Aboagye (2014), Sood ve Ranjan (2015), Bara, Mugano ve Roux (2016), Ajide (2016), Bara ve Mudzingiri (2016), Motsatsi (2016), Beck, Chen, Lin ve Song (2016), Qamruzzaman ve Jianguo (2017), Qamruzzaman ve Jianguo (2018), Bernier ve Plouffe (2019), Chukwunulu (2019), Cookey ve diğerleri (2020), Satia ve Okle (2020), Pholkerd ve Nittayakamolphun(2022), Nsor-Ambala ve Amevu (2023) finansal inovasyonun ekonomik büyümeyi etkilediğini ortaya koymuşlardır.

Yöntem

Finansal inovasyon ile ekonomik büyüme arasındaki ilişki, Dolado-Lütkepohl (DL) nedensellik ve ARDL yöntemleri yardımıyla analiz edilmiştir. 1970-2019 dönemi analizde kullanılan değişkenlere ait yıllık veri seti, Dünya Bankası (DB) ve Türkiye Cumhuriyeti Merkez Bankası (TCMB) veri tabanlarından elde edilmiştir. Analizde Eviews 10 Paket programı kullanılmıştır. Dolado-Lütkepohl (DL) nedensellik yönteminde, VAR analizi yardımıyla optimal gecikme belirlenerek k+1 gecikme uzunluğuna sahip VAR (k+1) modeli tahmin edilmektedir. Tahmin edilen VAR modelinde yer alan değişkenlere ait k gecikmeli katsayı matrisine Wald testi uygulanarak değişkenler arasındaki nedensellik ilişkisi tespit edilir ARDL yaklaşımı, sınır testi ile eşbütünleşme ilişkisinin tespit edilmesi, uzun dönem ARDL modelinin kurularak uzun dönem katsayıları ile ARDL Hata Düzeltme modeli tahmin edilerek kısa dönem katsayılarının belirlenmesi aşamalarından oluşmaktadır.

Sonuç ve Değerlendirme

1970-2019 dönemi Türkiye ekonomisinde finansal inovasyon ve gelişmenin büyüme üzerinde etkili olduğu görülmektedir. Finansal inovasyon göstergesi olarak çalışmada kullanılan Özel sektör kredilerinin GSYİH oranı ve finansal gelişme göstergesi olarak kullanılan Brüt Sabit Sermaye Oluşumunun GSYİH oranı değişkenlerinin büyüme üzerinde olumlu etkisi olduğu tespit edilmiştir. Bu sonuç, Türkiye ekonomisinde finansal kurumların işletmelere ve hane halkına sağladığı kredi hacmindeki artışların büyüme üzerinde etkili olduğunu göstermektedir. Ayrıca artan kredi hacminin, sermaye birikimi ve teknolojik inovasyon aracılığıyla verimli alanlara ve yatırımlara yönlendirilerek büyümeye olumlu etki ettiği ifade edilebilir. Bununla birlikte bankacılık sektöründe yaşanan finansal gelişme, inovasyon faaliyetlerini hızlandırarak ekonomik büyümeye katkı sağlamaktadır. Diğer taraftan ise, finansal inovasyon göstergesi olarak kullanılan Geniş Para Arzı/Dar Para Arzı değişkeninin büyüme

üzerinde etkinin olumsuz olduğu sonucuna ulaşılmıştır. Bu bulguda, Türkiye ekonomisinde yüksek enflasyon, faiz ve döviz kuru kaynaklı olan para arzı artışlarının büyümeyi olumsuz etkilediği şeklinde yorumlanabilir.

1. INTRODUCTION

Innovation is typically defined as the introduction of a new product into a market or the production of an existing product in a new way. The financial innovation process occurs because market participants are constantly seeking new ways to increase profits, which includes financial instruments, institution practices, and changes in markets. In broad terms, financial innovation affects the nature and composition of monetary aggregates through new financial instruments or changes in the old instruments, along with the maturity and conditions of debt/credit arrangements (Koğar, 1995).

Financial innovation is the modification, differentiation of an existing product, rather than the creation of a completely new product that did not exist before (Aksoy, 1998; 54). Financial innovation is a continuing process in which companies try to produce their products and services more efficiently, differentiate these products from existing products, and respond to sudden and gradual changes in the economy. Companies operating in the financial system make this tool more efficient in the financial innovation process via differentiations in financial instruments in three different ways, i.e., inventing a whole new class of products, replacing existing products, or combining features of several different products. Financial innovation can be defined as the appearance of new financial instruments and services and new forms of organization in more sophisticated and complete financial markets (Mishra, 2008; 2). Financial innovation enables firms to increase capital in larger amounts at a lower cost than they normally would and, in some cases, to obtain financing that may appear unattainable, e.g., biotechnology startups (Lerner and Tufano, 2011).

Creating a usable classification scheme for financial innovation is generally based on the type of financial intermediation function performed. The reference system used in classification has three functions: 1) a financial sector that provides a mechanism for economic units to transfer risk between each other; 2) a financial sector that provides liquidity to the economy (liquidity, in general, is used in broad terms that includes not only near money deposit instruments but also the marketability and transferability of receivables); 3) a financial sector that provides demands on the revenues of economic units. These demands come in two different forms, i.e., debt obligations and stocks. These functional separations result in the following classification of financial innovation (Bank for International Settlement-BIS, 1986):

1) Innovations that transfer risk;
2) Innovations that enhance liquidity;
3) Innovations that generate credit (or generate debt);
4) Innovations that generate equity.

Innovations that transfer risk in the first group are new tools or techniques that allow economic units to transfer price or credit risks specific to financial positions between each other. Innovations that enhance liquidity typically increase the “money” or transferability of existing financial instruments or

represent new instruments with improved liquidity properties. Innovations that generate credit are innovations that expand economic units' access to credit resources. Innovations that generate equity expand economic units' access to equity financing (BIS, 1986).

In addition to the classification made by BIS, financial innovations can be classified in different ways. Financial system innovations, for example, are started with changes in business structures, the establishment of new types of financial intermediaries, or changes in the legal and supervisory framework. Process innovations involve increased productivity and the beginning of new business processes leading to market expansion. To increase the productivity of the financial system, product innovations include the implementation of new credit, deposit, insurance leasing, lease purchase, and other financial products (Mishra, 2008).

Financial innovation, on functional basis, is also categorized as aggressive or defensive. Aggressive innovation is the introduction of a new product or process in response to the perceived demand. Defensive innovation is the introduction of a new product or process in response to a changing environment or transaction costs (Koğar, 1995).

The traditional innovation-growth theory, which adopts the positive impact of financial innovation on economic growth, presumes that financial innovations help improve the quality and diversity of banking services (Beck, Chen, Lin and Song, 2016; 28). Hence, it is believed that innovation supports activities that enable growth of real economy and finances these activities [Chin and Chou (2001); Chou (2007); Michalopoulos, Laeven and Levine (2009); Bernier and Plouffe (2019)].

The financial system is a tool that contributes to social and economic well-being. However, the dramatic development and expansion in financial markets and institutions is outpacing the real economic development. It is emphasized that by realizing the disproportionate financialization of the global economy within the framework of legal regulations and ethical rules, it is possible to prevent the collapses that will occur in the financial markets (Hacıoğlu ve Aksoy, 2021). The financial crisis, which began in 2007, increased excessive risk-taking situations in privatized innovative products, weakened the financial system, and brought about the deepest and longest-lasting economic crisis since the Great Depression. These developments in the financial system demonstrated the negative impact of financial innovation on economic growth (Arnaboldi and Rossignoli, 2015).

The innovation-fragility hypothesis, unlike traditional innovation-growth theory, does not foresee such an effect, or at least a long-term sustainable growth effect, as financial innovations mainly serve regulatory arbitrage purposes and undermine stable financial intermediaries with negative impacts on the real economy. The 2007 global financial crisis presented updated extensive views of the "dark" as well as the "bright" sides of financial innovation (Beck, Chen, Lin and Song, 2016; 28). It is emphasized that excessive and uncontrolled or poor innovation will cause serious negative

consequences on the real economic growth, according to this theory [Levine (1997); Llewellyn (2008); Idun and Aboagye (2014); Satia and Okle (2020)].

The general aim of this research is to investigate the relationship between financial innovation and economic growth in Turkey during the 1970–2019 period. In line with this purpose, the second part of the study includes examination of empirical literature. The study data, methodology, and findings obtained from analysis are presented in the third section. In the fourth section and conclusion, the study findings are evaluated, and policy recommendations are made.

2. LITERATURE REVIEW

The effect of financial innovation on Turkey's economic growth is generally analyzed in this study. The literature examined for this purpose reveals a positive and negative relationship between financial innovation and economic growth. Accordingly, it can be concluded that financial innovation has a good as well as bad side that affects economic growth (Bara and Mudzingiri, 2016).

Levine (1997), who proved that the dark side of financial innovation affects economic growth, found that successful innovation accelerates technological change; in addition, innovation is risky. However, the ability to have a diversified portfolio of innovative projects reduces risk and encourages investment in innovative activities with risk-averse agents that increase growth. Hereby, the author expressed that financial systems that ease risk diversification can accelerate technological change and economic growth. Chin and Chou (2001) determined that financial innovations can cause long-term growth only via risk capital. The authors remarked that the transformative role of the financial sector will only cause temporary growth effects en route to a steady state. Valverde, Del Paso, and Rodriguez (2004) established that financial innovation has a positive effect on economic growth. The authors also determined that the role of financial sector innovation or development on economic growth depends on the level of development of the financial sector; further, its effect on economic growth is more in the developed financial sector and less in the undeveloped financial sector. Llewellyn (2008) proved two opposing opinions on the stability characteristics of financial innovation and, notably, the instruments that alter credit risk. His first view stands up in that they increase the steadiness of the financial system because they have the best potential to change risks. On the other hand, the other stands up in that they have the potential to weaken financial steadiness. The author stated that financial innovation developed until 2007 largely in a stable economic environment with strong and reasonable growth in the world economy, strong profitability of banks, and low and reasonably steady inflation rates, especially in respect to credit risk. The author found that the increased use of derivatives in this economic environment (especially in terms of credit risk) can render them more defenseless against major systemic shocks, such as reduced liquidity in international markets against major systemic shocks such as reduced liquidity in international markets; the author also claimed that financial innovation caused the 2008 Global Financial Crisis. Mishra (2008) found that financial innovations in the form of new financial

instruments, services, institutions, technologies, and markets affect the rate of capital accumulation; thus, economic growth benefits in a positive way by instigating financial surpluses from final savers and transferring them into the most productive investment routes.

Michalopoulos, Laeven, and Levine (2009) claimed that regulations that hinder financial innovation could have a lasting and negative impact on economic growth and also showed that economic growth would slow down without financial innovations. Chou (2007) expressed that financial innovation has a positive effect on the efficiency of financial intermediation by increasing the variety of financial products and services that, in turn, leads to economic growth through accumulation of capital via better matching the needs of personal savers with the needs of firms raising funds to expand future production. Hasan, Renzis, and Schmiedel (2013) underlined that technological innovations offer profitable payment systems in providing services to customers in the financial sector; thus, innovations are important in promoting the performance and efficiency of financial institutions, i.e., the availability of resources that promote investment, consumption, trade, and eventually economic growth. Hsu, Tian, and Xu (2014) emphasized that the development of the financial sector by means of innovation is necessary to promote competition between financial institutions, and that this will increase economic growth with more competition.

Idun and Aboagye (2014) revealed a negative relationship between financial innovation and economic growth in the long term and a positive relationship in the short term. Further, the results reveal a two-way causality between financial innovation and economic growth. The authors suggest, with this result, implementing further regulations for a more competitive banking system with more innovative products. Sood and Ranjan (2015) found that growth and inflation rates have a positive effect on contributing to financial innovation. Bara, Mugano, and Roux (2016) underlined that financial innovation has a positive relationship with economic growth in the long term, and that these countries should upgrade their financial sectors to increase financial innovations that support economic growth. Ajide (2016) emphasized that the increase in banking efficiency stemming from competition and financial innovation will improve economic growth and development. In addition to this, according to the author, the reduction in money demand caused by financial innovations can hinder economic growth and development; this is because individuals move from more liquid assets to fewer liquid assets. On the other hand, Ajide revealed that financial innovations could potentially lead to an increase in the demand for money, as payment systems improve and individuals direct demand to productive sectors for more liquid assets.

Bara and Mudzingiri (2016) found that financial innovation has a positive effect on economic growth in the long term; they also emphasized that innovation can be a source of growth. Nevertheless, they determined that financial innovation is not a sustainable source of economic growth in the short term. Motsatsi (2016) also determined that technological and commercial innovation has a positive

effect on economic growth. He proved that more disposability of ATMs will reduce labor costs in the financial sector, greater consumption of goods and services, greater spending on investment goods, and economic growth by easier payment of tradable goods and services. Beck, Chen, Lin, and Song (2016) stated that financial innovation has a net positive effect on economic growth and is higher correlated with growth in countries and industries with better growth opportunities. The authors further established that financial innovation is in association with more aggressive risk-taking by banks and higher bank growth, thus helping to provide firms and households with valuable credit and risk diversification services, which consequently increases capital distribution efficiency and economic growth. In addition to this, the authors expressed that different measures of financial innovation are in association with faster bank growth but also with higher bank fragility and worse bank performance. They underlined that financial innovation is in association with higher growth in countries and industries with better growth opportunities; however, too much or inefficient innovation may have serious consequences for macroeconomics.

Qamruzzaman and Jianguo (2017) revealed a long-term relationship between economic growth and financial innovation. The authors also showed that any shock in the economic development process or financial development by encouraging financial innovation can provide positive development in the economy; they further stated that financial innovation in the financial system can accelerate economic growth with positive financial development and the use of economic resources. Qamruzzaman and Jianguo (2018) stated that positive changes in financial innovation are positively associated with economic growth in the long run, and financial innovation boosts economic growth in the long term; the authors also revealed that financial innovation will affect economic growth in the long term by promoting financial service expansion, financial efficiency, capital accumulation, and efficient financial intermediation, which are necessary for sustainable economic growth. Bernier and Plouffe (2019) indicated a positive net relationship between financial innovation and gross capital formation, and the positive effect of financial innovation on economic growth by means of capital formation.

Karaçoban, Saltık, and Değirmen (2019) revealed technological developments in the banking sector, globalization, and innovation-based products and services, which were led by knowledge and provided affirmative and positive contributions to the economy in some regions and provinces of Turkey. Chukwunulu (2019) concluded that financial innovation has high forecast power on economic growth and positive effects in determining this growth. Nazir, Tan, and Nazir (2020) established that financial innovation has, in general, a positive effect on economic growth in the short and long terms. Cookey et al. (2020) revealed that financial innovation has a positive and significant effect on economic growth and that financial innovation supports economic growth in the long term. The authors also determined that there is a one-way causality relationship from financial innovation factors to economic growth. Satia and Okle (2020) found that financial innovation contributes to economic growth in the long term. In addition, the authors expressed that the ratio of domestic credits, which are used to

represent financial innovation to the private sector, and M_2 (money supply) have a negative effect on growth in the short term.

Pholkerd and Nittayakamolphun (2022), determined that the reason for the change in economic growth was financial innovation and they explained that financial innovation is the driving force of long-term economic growth by increasing the efficiency of financial intermediaries. Nsor-Ambala ve Amewu (2023), they found no evidence that financial innovation significantly advances, retards or negatively affects GDP. They stated that this was because the impact of fiscal development on GDP, which was further complicated by the premature and strict regulation of the FINANCIAL-TECH sector and the imperfections in the financial sector, was generally inconsistent.

3. DATA SET, METHODS, AND RESULTS

The relationship between financial innovation and economic growth in Turkey is analyzed by using annual time series variables for the 1970–2019 period. Definitions of the variables used in the study are given in Table 1.

Table 1. Definition of Variables

Variables	Definition	Source
KGDP	GDP per capita (2010 Constant US Dollar)	WDI
DCB	Domestic Credits to Private Sector (% of GDP)	WDI
M2M1	Broad/Narrow Money Supply	WDI and TCMB
GCF	Gross Fixed Capital Formation (% of GDP)	WDI
GEXP	Government Expenditures (% of GDP)	WDI
INF	Inflation Rate (% change in TÜFE)	WDI
TO	Openness to Trade (% of GDP)	WDI

Note: Variables are obtained from the World Bank (WDI) and the Central Bank of the Republic of Turkey (TCMB). Logs of the variables are taken. Eviews 10 Package program is used in the analysis. The table was created by the researchers.

GDP per capita is used as an indicator of economic growth, the GDP ratio of domestic credits to the private sector and the ratio of broad/narrow money supply as an indicator of financial innovation [Tyavambiza and Nyangara (2015); Qamruzzaman and Jianguo (2017, 2018); Satia and Okle (2020)], and GDP ratio of gross fixed capital formation as financial growth indicator. Inflation rate, openness to trade rate and GDP ratio of the government's expenditures are included in the analysis as other macro variables.

ADF- Augmented Dickey Fuller (Dickey and Fuller (1981)) and PP- Philips&Perron (Phillips and Perron (1988)) unit root tests are used in order to determine the stationary levels of the variables. Unit root test results are shown in Table 2.

Table 2. ADF and PP Unit Root Test

		ADF Test		PP Test	
		Constant	Constant+Trend	Constant	Constant+Trend
Variables					
KGDP		0.33	-1.98	0.33	-2.07
DCB		0.20	-1.23	-0.04	-1.37
M2M1		-1.33	-1.20	-1.33	-1.38
GCF		-1.97	-2.74	-1.99	-2.90
GEXP		-1.13	-3.11	-1.41	-2.29
INF		-1.66	-2.47	-1.67	-2.47
TO		-1.82	-2.45	-1.82	-2.45
ΔKGDP		**-6.67***	**-6.68***	**-6.67***	**-6.68***
ΔDCB		**-5.29***	**-5.34***	**-5.25***	**-5.19***
ΔM2M1		**-2.91****	**-3.88****	**-6.12***	**-6.13***
ΔGCF		**-6.33***	**-6.34***	**-6.29***	**-6.31***
ΔGEXP		**-6.46***	**-6.47***	**-6.53***	**-6.54***
ΔINF		**-6.92***	**-6.88***	**-6.92***	**-6.89***
ΔTO		**-6.03***	**-5.97***	**-6.12***	**-6.06***
Significance Level	1%	-3.57	-4.15	-3.57	-4.15
	5%	-2.92	-3.50	-2.92	-3.50
	10%	-2.59	-3.18	-2.59	-3.18

Note: Values in [ ] brackets represent the *p*-value of the *t*-statistics. Δ represents difference operator. *, **, and *** refer to 1%, 5%, and 10% significance levels, respectively. The table was created by the researchers.

It is seen that all variables are stationary at first difference I(1), according to the ADF and PP unit root tests in Table 2.

The relationship between financial innovation and economic growth is analyzed with the help of Dolado-Lütkepohl (DL) causality and ARDL methods.

3.1. Dolado-Lütkepohl (DL) Causality Analysis

In the DL causality method, the optimal lag is determined with the help of VAR analysis, and the VAR(*k*+1) model with *k*+1 lag length is estimated. The causality relationship between the variables is determined by using the Wald test to the *k*-lagged coefficient matrix of the variables in the estimated VAR model. In addition, diagnostic tests are made on the VAR model.

With the help of the DL causality test, Eq. (1) is formed in the analysis of the causality relationship between variables such as *X* and *Y*.

$$\begin{bmatrix} In\ X_t \\ In\ Y_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \end{bmatrix} + \begin{bmatrix} \beta_{11,1} & \beta_{12,1} \\ \beta_{21,1} & \beta_{22,1} \end{bmatrix} \begin{bmatrix} In\ X_{t-1} \\ In\ Y_{t-1} \end{bmatrix} + \cdots \begin{bmatrix} \beta_{11,k} & \beta_{12,k} \\ \beta_{21,k} & \beta_{22,k} \end{bmatrix} \begin{bmatrix} In\ X_{t-k} \\ In\ Y_{t-k} \end{bmatrix} + \begin{bmatrix} \beta_{11,n} & \beta_{12,n} \\ \beta_{21,n} & \beta_{22,n} \end{bmatrix} \begin{bmatrix} In\ X_{t-n} \\ In\ Y_{t-n} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad (1)$$

In Eq. (1), *k* represents optimal lag, *n* (*k*+1) lag, β coefficients, and ε error term. As a result of the Wald test applied to the *k*-lag coefficient matrix in the VAR (*k*+1) model, it is accepted that there is a causal relationship from *Y* to *X*, if $\beta_{12,1...k} \neq 0$; and from *X* to *Y*, if $\beta_{21,1...k} \neq 0$.

DL causality analysis results are given in Table 3.

Table 3. DL Causality Test Results

VAR (k+1) Model	Wald İst,	Causality	LM	White	AR Roots	Finding
KGDP→DCB DCB→KGDP	0.53 5.99*	No causality. DCB→KGDP (0.13)	2.81 (0.58)	21.35 (0.61)	<0.99	One way positive causality
KGDP→M2M1 M2M1→KGDP	0.70 49,58*	No causality. M2M1→ KGDP (-1.08)	1.72 (0.58)	30.77 (0.17)	<0.99	One way negative causality
KGDP→GCF GCF→KGDP	1.87 11.20*	No causality. GCF→ KGDP (0.69)	2.17 (0.60)	20.53 (0.66)	<0.93	One way positive causality
KGDP→GEXP GEXP→KGDP	1.37 12.55*	No causality. GEXP→ KGDP (0.43)	2.41 (0.66)	50.66 (0.17)	<0,85	One way positive causality
KGDP→INF INF→KGDP	0.68 3.52**	No causality. INF→ KGDP (-0.03)	2.32 (0.67)	22.01 (0,57)	<0.86	One way negative causality
KGDP→TO TO→KGDP	0.05 39.72*	No causality. TO→ KGDP (0.95)	1.89 (0.75)	78.89 (0.27)	<0,78	One way positive causality

Note: *, **, and *** refer to 1%, 5%, and 10% significance levels, respectively. LM is for Breusch–Godfrey LM autocorrelation, BPG is for Breusch-Pagan-Godfrey heteroscedasticity, JB is for Jarque-Bera normality test. Values in brackets in the diagnostic test results represent the probability value of the relevant statistics. The table was created by the researchers.

The analysis results in Table 3 establish a one-way positive and statistically significant relationship from DCB, GCF, GEXP, and TO variables to the KGDP variable. It is concluded that the variables of GDP ratio of domestic credit to private sector, GDP ratio of gross fixed capital formation, openness to trade ratio, and GDP ratio of final government expenditures affect economic growth positively.

It is seen that there is a one-way negative and statistically significant relationship from M2M1 and INF variables to the KGDP variable. It is determined that the ratio of broad/narrow money supply and inflation rate variables affect economic growth negatively.

It is also seen that there is no diagnostic problem in the predicted models, as shown in Table 3. It is seen that the AR roots value is less than 1 in the estimated models; the probability values of Breusch–Godfrey LM autocorrelation, Breusch-Pagan-Godfrey heteroscedasticity, and Jarque-Bera normality tests are greater than 0.10 (they do not have autocorrelation and heteroscedasticity problems and have a normal distribution).

3. 2. ARDL Approach

The ARDL approach consists of the stages of determining the cointegration relationship with the bound test, the long-term ARDL coefficients by establishing the long-term ARDL model, and the short-term coefficients by estimating the ARDL error correction model.

The relationship between the variables in the ARDL method is investigated by establishing three different models. ARDL equations are established with reference to Tyavambiza and Nyangara (2015), Qamruzzaman and Jianguo (2017, 2018), and Satia and Okle (2020). The variable *X*, one of the independent variables in the equations, represents DCB for Model 1, M2M1 for Model 2, and GCF for Model 3. GEXP, INF, and TO variables are included in the models as other macro variables.

In order to determine the cointegration relationship with the *F*-statistic used in the bounds test, Eq. (2) is estimated. *m*, *n*, *p*, *q*, and *r* represent optimal lag lengths; "Δ" represents first-order differences in the equation.

$$\Delta KGDP_t = \beta_0+\beta_1 KGDP_{t-1}+\beta_2 X_{t-1}+\beta_3 GEXP_{t-1}+\beta_4 INF_{t-1}+\beta_5 TO_{t-1}+\sum_{i=1}^{m}\delta\,\Delta KGDP_{t-i}+\sum_{i=1}^{n}\alpha\,\Delta X_{t-i}+\sum_{i=1}^{p}\lambda\,\Delta GEXP_{t-i}+\sum_{i=1}^{q}\phi\,\Delta INF_{t-i}+\sum_{i=1}^{r}\mu\,\Delta TO_{t-i}+\boldsymbol{\varepsilon}_t \quad (2)$$

After determining the optimal lag lengths in Eq. (2), the *F*-test is performed. H_0: There is no cointegration relationship ($\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$); H_1: There is cointegration relationship ($\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$). Hypotheses are tested with the *F*-test to determine if there is a cointegration relationship between the variables.

After determining the cointegration relationship in the estimated ARDL model, the model giving the long-term coefficients is as in Eq. (3).

$$KGDP_t = \beta_0+\sum_{i=1}^{m}\delta KGDP_{t-i}+\sum_{i=1}^{n}\alpha X_{t-i}+\sum_{i=1}^{p}\lambda GEXP_{t-i}+\sum_{i=1}^{q}\phi INF_{t-i}+\sum_{i=1}^{r}\mu TO_{-i}+\boldsymbol{\varepsilon}_t \quad (3)$$

The error correction model giving the short-term coefficients is shown in Eq. (4).

$$\Delta KGDP_t = \beta_0+\beta_1 EC_{t-1}+\sum_{i=1}^{m}\delta\,\Delta KGDP_{t-i}+\sum_{i=1}^{n}\alpha\,\Delta X_{t-i}+\sum_{i=1}^{p}\lambda\,\Delta GEXP_{t-i}+\sum_{i=1}^{q}\phi\,\Delta INF_{t-i}+\sum_{i=1}^{r}\mu\,\Delta TO_{t-i}+u_t \quad (4)$$

In Eq. (4) ECT_{t-1} is the error correction term. The coefficient β_1 for this term is expected to be negative and significant.

The results of the *F*-statistics used in the bounds test in order to determine the cointegration relationship are shown in Table 4.

Table 4. Bounds Test Results

Model	F statistics		
Model 1: KGDP=f(DCB, GEXP, INF, TO)	7.05*		
Model 2: KGDP=f(M2M1, GEXP, INF, TO)	8.18*		
Model 3: KBGDP=f(GCF, GEXP, INF, TO)	8.32*		
Table critical values		**Lower Bound I(0)**	**Upper Bound I(1)**
Peseran et. al (2001)			
Significance Levels	%10	2.37	3.32
	%5	2.82	3.87
	%1	3.84	5.15
Narayan (2005)			

Significance Levels	%10	2.61	3.74
	%5	3.13	4.41
	%1	4.30	5.87

Note: *, **, and *** refer to 1%, 5%, and 10% significance levels, respectively. The critical values are the values for *k*=4 and *n*=49 cases in Case (III) for the fixed model in Narayan (2005:1988). The table was created by the researchers.

A cointegration relationship is determined between the variables, as a result of the bounds test. The long-term coefficients of the estimated ARDL models and the findings of the diagnostic tests are listed in Table 5.

Table 5. Long Term Coefficients of ARDL Models

Independent Variables	**Model 1** ARDL(1,1,2,1,2)	**Model 2** ARDL(3,2,3,1,4)	**Model 3** ARDL(1,1,1,1,1)
C	2.88*	1.47*	2.45*
DCB	***0.34****		
M2M1		***-1.21 ****	
GCF			***0.08****
GEXP	0.33*	0.69*	0.52**
INF	-0.13 **	-0.18*	-0.15*
TO	0.49*	1.67*	0.48*
Diagnostic Tests			
Breusch –Godfrey LM Autocorrelation Test	0.32 (0.72)	1.49 (0.24)	0.57(0.56)
Breusch Pagan Godfrey Heteroscedasticity Test	0.74(0.68)	0.28(0.99)	0.93(0.50)

Note: *, **, and *** refer to 1%, 5%, and 10% significance levels, respectively. The values in brackets represent the probability value of the relevant statistics. The table was created by the researchers.

In Model 1, DCB, GEXP, and TO variables are found to affect CGDP positively in the long term, while they affect the INF variable negatively.

Model 2 shows that GEXP and TO variables affect economic growth positively in the long term, while they affect M2/M1 and INF variables negatively.

Model 3 shows that the GCF, GEXP, and TO variables affect economic growth positively in the long term, while they affect INF variable negatively.

In ARDL models estimated as Model 1, Model 2, and Model 3, as seen in Table 5, the long-term coefficients of DCB, GCF, GEXP, and TO variables are positive, while the coefficients of M2/M1 and INF variables are negative; further, the coefficients are statistically significant. In other words, it is detected that the variables of the GDP ratio of domestic credits to private sector, the GDP ratio of gross fixed capital formation, the openness to trade ratio, and the GDP ratio of government expenditures affect economic growth positively in the long term, while the variables of broad/narrow money supply ratio and inflation rate affect economic growth negatively.

The findings of ARDL error correction models are given in Table 6.

Table 6. Short Term Coefficients

Independent Variables	**Model 1** ARDL(1,1,2,1,2)	**Model 2** ARDL(3,2,3,1,4)	**Model 3** ARDL(1,1,1,1,1)
ECT(-1)	-0.13*	-0.20*	-0.08*
DCB	0.18*		
M2M1		-0.09***	
GCF			0.25*
GEXP	0.21*	0.23*	0.04
INF	-0.005	-0.03*	-0.007
TO	0.07**	0.06**	0.02

Note: *, **, and *** refer to 1%, 5%, and 10% significance levels, respectively. The values in brackets represent the probability value of the relevant statistics. The table was created by the researchers.

In Model 1, DCB, GEXP, and TO variables are found to affect economic growth positively in the short term. The coefficient of the INF variable is not construed because it is negative but statistically insignificant.

Model 2 shows that GEXP and TO variables affected economic growth positively in the short term, while M2/M1 and INF variables affected negatively. The coefficients are statistically significant.

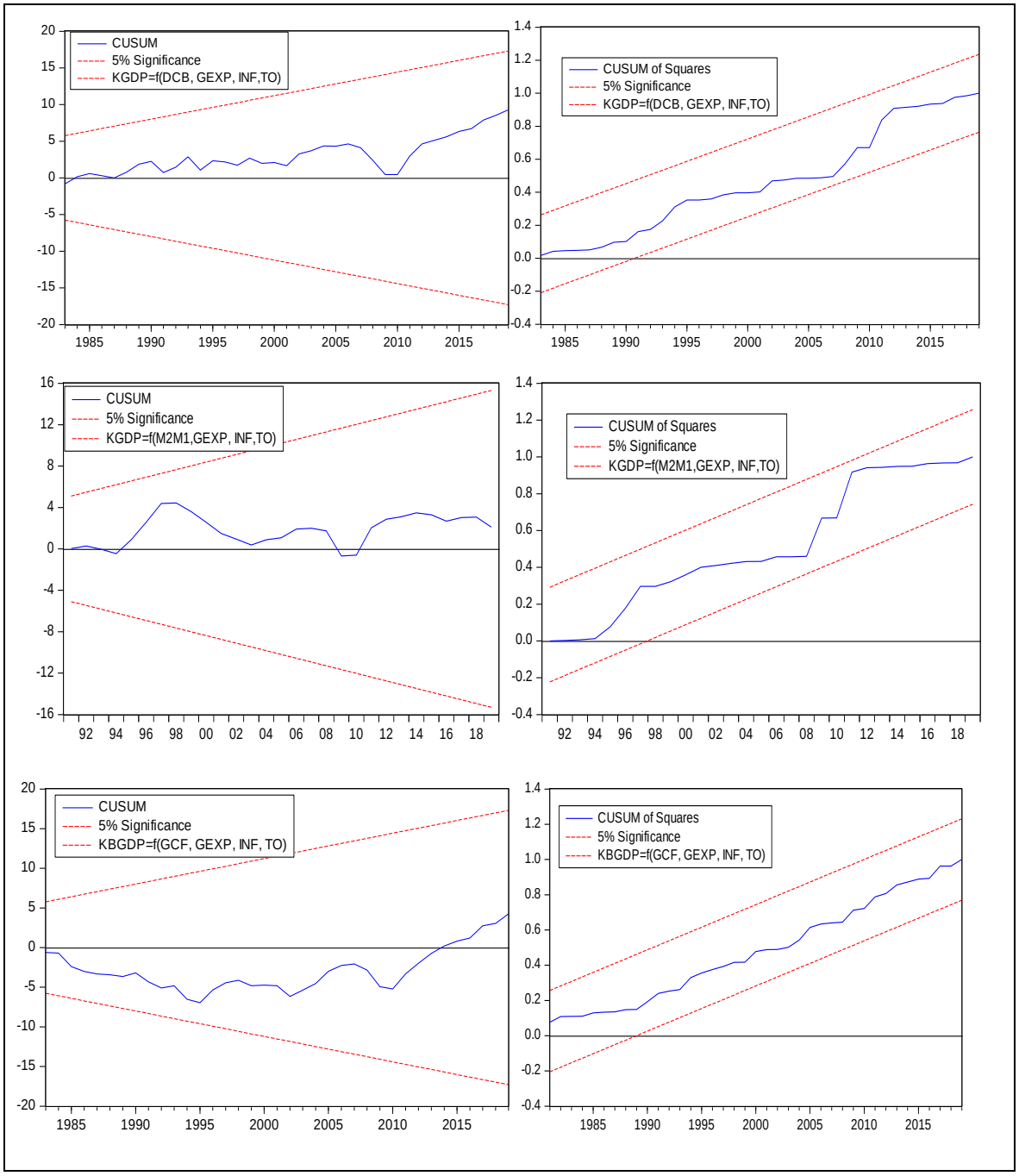
Model 3 shows that the GCF variable has a positive effect on economic growth in the short term. The coefficients of the GEXP, TO, and INF variables are not construed because they are statistically insignificant.

It is seen that the short-term coefficients of the DCB, GCF, GEXP, and TO variables in the estimated ARDL models are positive, while the coefficients of the M2/M1 and TO variables are negative, as shown in Table 6.

It is found that the ECT(-1) coefficient in the estimated ARDL error correction models as Model 1, Model 2, and Model 3 are negative and statistically significant; in all three models, it is -0.13, -0.20, and -0.08, respectively. This result can be expressed that 13%, 20%, and 8% of the deviation that will occur in the short term in all three models, respectively, will be corrected in the next period.

Cusum and Cusum-sq charts of ARDL models are shown in Figure 1.

Figure 1. Cusum and Cusum-sq Charts of ARDL Models



It is concluded that there is no structural break problem in Cusum and Cusum-sq charts of ARDL models.

4. CONCLUSIONS AND RECOMMENDATIONS

The relationship between financial innovation and economic growth for the 1970–2019 period in Turkey is investigated in this study with the help of Dolado-Lütkepohl (DL) causality and ARDL methods.

According to the results of the Dolado-Lütkepohl analysis, it is concluded that the GDP ratio of domestic credits to the private sector, the GDP ratio of gross fixed capital formation, the openness to trade ratio, and the GDP ratio of the government's expenditures affect economic growth positively. It is determined that the ratio of broad/narrow money supply and inflation rate variables affect economic growth negatively.

According to the ARDL analysis results, the variables of the GDP ratio of domestic credits to the private sector, the GDP ratio of gross fixed capital formation, openness to trade ratio, and the GDP ratio of government's expenditures affect economic growth positively in the long and short term, while the variables of broad/narrow money supply ratio and inflation rate affect negatively.

The findings reveal that financial innovation and development have an effect on growth between the 1970–2019 period in Turkey's economy. This study establishes that the GDP ratio of private sector credits used as an indicator of financial innovation and the GDP ratio of gross fixed capital formation used as an indicator of financial development have a positive effect on growth. This result shows that the increase in volume of credits provided by financial institutions to businesses and households in Turkey's economy has an impact on growth. Besides, it can be said that the increasing credit volume has a positive effect on growth by directing it to productive areas and investments through capital accumulation and technological innovation. In addition, the financial development in the banking sector contributes to economic growth by accelerating innovation activities. On the other hand, it is concluded that the broad/narrow money supply variable, which is used as an indicator of financial innovation, has a negative effect on growth.

This finding can be interpreted as money supply increases in Turkey's economy due to high inflation and interest and exchange rates that affect growth negatively. Kemal et al. (2007) and Tyavambiza and Nyangara (2015) note that financial innovation can affect growth negatively in countries with high inflation problems. In addition, political, social, and political money supply increases slow growth due to structural problems in Turkey's economy. Therefore, it can be said that financial innovation has positive and negative effects in Turkey's economy. Accordingly, financial innovation should encourage economic growth by maintaining policies that can limit structural problems and have a more dominant positive effect. When estimated in general, the findings support Tyavambiza and Nyangara (2015), Qamruzzaman and Jianguo (2017, 2018), and Satia and Okle (2020).

Consequently, financial innovations affect Turkey's economic growth. Policies that prevent the negative effects of structural problems in Turkey's economy, e.g., high inflation and interest and exchange rates on the money supply, expand the credits given to the private sector, direct them to productive investment areas, reveal the positive effects of financial innovation, and support growth by increasing production of goods and services. Since studies investigating the relationship between financial innovation and economic growth for Turkey's economy are limited, it is thought that this study

can be contribute to the literature. For policy makers and researchers, the scope of study can be examined for different countries or groups of countries.

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