Linear and non-linear ARDL estimation of financial innovation and economic growth in Ghana

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Abstract

Purpose – This study aimed to explore the effect of Financial Innovation (FI) on economic growth in Ghana, with a dataset spanning 1960–2019, adopting a broader conceptualization of FI as the ratio of broad money to narrow money.

Design/methodology/approach – The study employs a non-linear autoregressive distributed lag (ARDL) time series econometric model to estimate data from the World Bank (1960–2019).

Findings – There is no evidence that FI significantly impacts economic growth. This could be due to the early and strict regulation of the financial technology (FIN-TECH) sector and the general inconclusiveness of the impact of financial development on economic growth.

Practical implications – Policymakers must empirically explore the impact of early and strict regulation on the transformational impact of FI.

Originality/value – The paper is among the first to apply a broader conceptualization of FI in estimating the impact of FI on economic growth.

Keywords Economic growth, Financial innovation, FIN-TECH, Ghana, Non-linear autoregressive distributed lag, Regulation

Paper type Research paper

1. Introduction

This study is motivated by the lack of consensus about the impact of Financial Innovation (FI) on major welfare indices such as economic growth (GDP). The Schumpeterian innovation process remains a critical and persistent part of any profit-maximizing economy. However, despite the interest in FIs, there is no consensus on its macroeconomic effects. We explore the impact of FI on economic growth using a dataset from Ghana.

The findings of the study have implications for policymakers. FI can affect the transmission of monetary policy and the informational content of monetary indicators. Therefore, regulators may gain useful insights into the effects of FI (especially from non-bank finance and FINTECH) on monetary policy transmission and modify regulations in tandem. Additionally, the study has relevance to an international audience. There is active participation of foreign capital inflow in the FI sector in Ghana (especially in FINTECH). There is also a sizeable number of blue-chip multinational entities operating in Ghana. Therefore, international readers will improve their understanding of the levers and triggers of economic growth as well as the impact and evolution of regulation within the financial sector. This is even more vital considering that the traditional and nontraditional financial intermediary process is dominated by foreign-owned entities.

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There are two contrasting views about FI; *innovation-growth* and *innovation-fragility* views. FI can produce either a positive or a negative effect on an economy by either decreasing economic stability and impeding growth or be growth-enhancing (Barnett-Hart, 2009). Unfortunately, the literature on FI is inconclusive concerning its impact on economic growth requiring continuous and vernal studies. FI has, for instance, been blamed for the Great Financial Crisis (2007–2008). In response, policymakers use regulations to limit systemic risk induced by FI. Other scholars have attempted to resolve the contentions by isolating short-run impacts from the long-run effects of FI. Unfortunately, the dearth of literature on this approach is limited. Added to this, it is not necessarily the case that a surge in FI will have an opposite effect to FI's dip. Nevertheless, there is reason to believe that the manner of the evolution of FI, the extent of trade openness (i.e. globalization), the dominant regulatory disposition, as well as the inherent structural rigidities within an economy affect the direction and magnitude of FI's impact on economic growth and welfare (Barth *et al.*, 2004). Added to this, some scholars have suggested that innovation is affected by cultural, social and geopolitical considerations, as well as national characteristics and governance systems (Chortareas *et al.*, 2013). Hence exploration of the impact of FI on economic growth may be more valuable if it is country-specific.

Janicko (2015) has emphasized that the plurality of studies about the positive consequences of FI are at odds with the findings from the case and country-specific studies. Lee *et al.* (2020) and Khan *et al.* (2017), for instance, argue that FI is detrimental to the growth and stability of banks in emerging markets in apparent contradiction to Beck *et al.* (2016) findings for OECD (organisation for economic co-operation and development) countries. Lozano-Vivas and Pasiouras (2014) also argue that economic growth varies among countries with different development levels. Emanating from this, the excessive focus of empirical studies on this phenomenon with the advanced country dataset has limited usefulness for policy advocacy and decisions in developing countries.

Another problem is a challenge with the conceptualization of FI. Khraisha and Arthur (2018) have argued that FI does not necessarily come from financial institutions and can come from non-financial institutions. Unfortunately, most of the proxies within the literature restrict FI to traditional banks and obscure the current evolution of FI outside the mainstream financial boundaries. In Ghana mobile banking activities (that control a substantial portion of deposits are innovations initiated, owned and championed by telecommunication companies. To capture the essence of "*out of mainstream banking FI*," we adopt a broader definition of FI as the ratio of broad money to narrow money. Qamruzzaman and Jianguo (2018), Bara *et al.* (2016) and Ansong *et al.* (2011) applied a similar approach. This study, therefore, seeks to answer the question

What is the net effect of FI on economic growth?

This paper makes contributions to the literature by testing the symmetric and asymmetric impact of FI on economic growth using autoregressive distributed lag (ARDL) bounds testing and non-linear ARDL. Poutanen *et al.* (2016 p. 207) support a non-linear exploration of the impact of FI on economic growth with the assertion that; "*the innovation process has been historically understood as a linear sequence of events, but in reality, it is much more intricate and complex, including unpredictable interactions between different phases . . . . .. that blurs the boundaries between different entities and participants' roles*."

The study covers a wide range of time-series data, 1960–2019, and broadly conceptualizes FI. To our knowledge, this is among a few to test the impact of FI on economic growth based on the broader conceptualized FI as the ratio of broad to narrow money with dataset in Ghana. The broader range of time series data may offer a newer perspective to Ansong *et al.* (2011). FI has an inter-temporal value through time, and hence the impacts of FI can occur in

the future, further from the initiation and deployment. Therefore, the extended period of the study is helpful.

2. Literature review

Schumpeter's (1950) endogenous growth theory and depiction of creative destruction provide the earliest empirical evidence of the impact of FI on economic growth. He argues that financial intermediation enables technological innovation and economic development (King and Levine, 1993). This framework continues to guide researchers in studying the impact on innovation. Laeven *et al.* (2015) apply the framework to confirm that FI improves economic growth through its direct positive impact on technical innovation and its ability to mitigate the moral hazard associated with capital allocation. Morales (2003) also applies the framework to confirm that improving financial intermediation through FI has a positive impact on the economy because it increases the productivity of entrepreneurial activity. Chou (2007) builds on Morales' (2003) work and affirms that FI improves the financial intermediation process, effectively allocating savings capital to investment capital. Invariably, converting illiquid assets to tradeable securities (i.e. securitization) enables risk diversification and enhances economic growth.

However, Keys *et al.* (2010) cautions that such radical securitization can contribute immensely to financial distress, such as the Great Financial Crisis (2007–2008), when it effectively magnifies problems with loan origination. Barnett-Hart (2009) suggests an appropriate ecosystem of regulations and policy to avoid incentive misalignment. Janicko (2015) emphasizes that the plurality of studies about the positive consequences of FI are at odds with the findings from the case and country-specific studies.

Miller (1986) proposes regulatory reform as the key driver of FI. This is because FI arises from the need to exploit regulatory gaps. Invariably it is a vicious cycle where new regulations trigger FI, which triggers further regulatory reform, prompting further innovation (Ross, 2016). For example, Yorulmazer (2013) demonstrates how FI helps to circumvent capital and reserve requirements through credit default swaps (CDSs) to transfer risk-weighted assets from the balance sheet without necessarily reducing risk. Robitaille (2011) finds similar evidence about the circumventing of reserve requirements with FI in Brazil. However, if regulations are designed to mitigate systematic risk, their clever avoidance via FI could be problematic and with adverse long-term consequences on economic growth (IMF, 2011), even though a short-term outlook may be impressive and/or stable.

Other studies have confirmed that any consequences of FI, may not be wholesome but industry-specific. Banks, for instance, may enjoy higher than expected non-core revenue (non-interest revenue) from FI including benefiting from FI in terms of risk-sharing, increased liquidity and an intensified competition effect (Calmès and Théoret, 2015). Instefjord (2005) shows that applying FI to the credit derivative markets improves risk allocation. Grydaki and Bezemer (2013) discovered that liquidity and credit flow improved during the Great Moderation due to FI. Duygun *et al.* (2013) confirm that as competition through FI intensifies, banks' overall cost and profit efficiency improve.

Lerner and Tufano (2011) define FI as "*the act of crafting and then popularising new financial instruments, technologies, institutions, markets, processes and business models including the new application of existing ideas in a different market context*." Mention and Torkkeli (2014) contest this definition as narrow, preferring a more holistic conceptualization of FI that quantifies FI's economic and/or intangible impact on society. Mention and Torkkeli (2014) define FI as a process that is "*carried out by any institution, that involves the creation, promotion and adoption of new (including both incremental and radical) products, platforms, processes or enabling technologies that introduce new ways or changes to the way a financial activity is carried out.*" Khraisha and Arthur (2018) have also argued that FI transcends innovations in the financial instruments category and can come from non-financial institutions.

There is no consensually agreed-upon proxy in the literature. Hay (2016) and Beck *et al.* (2016) used R&D expenditure as a proxy for two constructs of FI. The first is value-added intensity, measured as the ratio of R&D spend to the value-added in the financial intermediation sector. The second is cost intensity which is the ratio of R&D to operating costs. Beccalli (2007) highlights the paucity of data on R&D expenditure and the fecundity of approaches used in measuring such activities. Pérignon and Vallée (2017) considered structured products and new services, such as Internet banking, and ATMs, as FI. Other studies have proxied financial patents as FI (Li, 2018). Michalopoulos *et al.* (2009) proxied FI with the ratio of bank credit to the private sector to the GDP to indicate the effect of FI on financial development. Other studies have used bank credit to the private sector as a proxy indicator for FI (e.g. Idun and Aboagye, 2014).

Other studies use a functional approach in the measurement of FI. It involves analyzing the desired effects of the innovation. For instance, Farmer and Lafond (2016) proxy FI in the energy sector with energy production costs. Studies within the banking sector have proxied FI with liquidity (Hendershott *et al.*, 2021), volatility reduction (Dynan *et al.*, 2006), reduction in selected costs (Freixas and Rochet, 2008), access to credit (Ilyina and Samaniego, 2011) and risk-sharing and/or diversification (Allen and Gale, 1994). However, determining the outcome of FI is complex and can be constrained by information asymmetry (Arora *et al.*, 2010). Most of these proxies restrict FI to traditional banks and obscure the current evolution of FI outside the mainstream financial boundaries.

Distinct hypotheses explain the impact of FI on economic growth. The supply-side view argues that the effect of FI on economic growth depends on how it improves capital accumulation and the general efficiency of the financial intermediation process (Beck and Frame, 2018; Safari *et al.*, 2021; Derbali, 2021). Shittu (2012) confirms that efficiency in the financial intermediation process significantly influences economic growth (using a Nigerian dataset), and hence FI can improve economic growth. The demand-side hypothesis suggests that economic growth and its attendant expansionary effects increase pressure on financial systems necessitating FI. Finally, the feedback hypothesis suggests bidirectional causality between FI and economic growth, as confirmed by Bara *et al.* (2016).

Studies that have used a Ghana dataset have confirmed a negative impact of FI on economic growth. Idun and Aboagye (2014), used ARDL to explore the negative association between FI and GDP, arguing that FI adversely impacts saving propensity and hence reduces bank liquidity. An earlier study by Ansong *et al.* (2011) suggested that FI adversely affects growth in banks with diversified financial products. They studied the effects of FI on financial savings in Ghana for the period 1963 to 2006 using both perceptual index and M2/M1 as proxies for FI. FI exhibited a positive long-run relationship but a negative short-run relationship implying that FI reduces financial savings in the short run. This is because, at the time of their study, most FI products encouraged withdrawals rather than savings.

3. Research method

3.1 Data source and description

The dataset spans 60 years, from 1960 to 2019, and is drawn from sources such as the World Bank and Bank of Ghana. Table 1 summarizes the descriptive statistics. FI is expressed as the ratio of broad and narrow money, following Qamruzzaman and Jianguo (2018).

3.2 Model specification

We apply the ARDL model on a dataset spanning 1960–2019.

3.2.1 ARDLs model. This study uses the ARDL bound test because of its ability to deal with small data samples (Muhammad and Abdullahi, 2020). Besides, the bound test does not need our variables to be of the same order but rather a combination of integration at levels – I

	DCP	FI	GCF	GDP	INFL	TOPN
Description	Domestic credit to public	FI	Gross capital formation	GDP	Inflation	Trade openness
Source	World bank data	Central bank of Ghana[a]	World bank data	World bank data	World bank data	World bank data
Mean	13.8730	1.6095	22.5199	6.0001	14.8971	0.8172
Std. Dev.	1.5758	0.1042	5.5340	2.6984	6.6704	0.1607
Skewness	−0.2026	0.0815	−0.3531	0.2271	1.1866	0.6657
Kurtosis	1.5852	2.3687	1.8548	4.8125	3.9336	2.2066
Jarque-Bera test	1.8951	0.3720	1.5840	8.1447	5.6911	2.1017
Probability	0.3877	0.8303	0.4529	0.1010	0.1181	0.3496

Table 1. Descriptive statistics

Note(s): [a]The Bank of Ghana (Central Bank) website has data from 1990 for broad money. The additional data were provided by a senior staff member of the Bank of Ghana

(0) and order one – I (1). Finally, according to Rahman and Kashem (2017), the bound test eliminates issues of serial correlation and endogeneity of variables.

The generalized form of the study model is represented as follows:

$$\overbrace{\text{GDP}}^{\text{Economic growth}} = f\left(\overbrace{\text{FI}}^{\text{Financial innovation}}, \overbrace{\text{DCP, DCF, INFL, TOPN}}^{\text{Control macroeconomic variables}}\right) \tag{1}$$

To correctly specify the linear ARDL model, the lags of both the dependent variable and control variables must be included. For p lags of our dependent variable and k lags of independent variables, we construct the following ARDL:

$$\text{GDP}_t = \beta_0 + \sum_{i=1}^{p} \beta_i \text{GDP}_{t-i} + \sum_{i=0}^{k_1} \gamma_0 \text{FI}_{t-i} + \sum_{i=0}^{k_2} \delta_i \text{DCP}_{t-i} + \sum_{i=0}^{k_3} \rho_i \text{GCF}_{t-i} + \sum_{i=0}^{k_4} \tau_i \text{INFL}_{t-i} + \sum_{i=0}^{k_5} \sigma_i \text{TOPN}_{t-i} + \varepsilon_t \tag{2}$$

Here, k_q for $q = 1,2,3 \ldots, 5$ denote the maximum number of lags for FI, DCP, GCF, INFL and TOPN, respectively. This study uses the EViews software and the optimal lag for each variable is automatically selected by the software.

The ARDL bound test is formulated as follows in equation (3):

$$\Delta ln\text{GDP}_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta ln\text{GDP}_{t-i} + \sum_{i=0}^{k} \gamma_i \Delta ln\text{FI}_{t-i} + \sum_{i=0}^{k} \delta_i \Delta ln\text{DCP}_{t-i} + \sum_{i=0}^{k} \rho_i \Delta ln\text{DCF}_{t-i} + \sum_{i=0}^{k} \tau_i \Delta ln\text{INFL}_{t-i} + \sum_{i=0}^{k} \sigma_i \Delta ln\text{TOPN}_{t-i} + \lambda_1 ln\text{GDP}_{t-1} + \lambda_2 ln\text{FI}_{t-1} + \lambda_3 ln\text{DCP}_{t-1} + \lambda_4 ln\text{DCF}_{t-1} + \lambda_5 ln\text{INFL}_{t-1} + \varepsilon_t \tag{3}$$

Δ is the difference operator, and ln is the natural log of the variables. From equation (3), the short-run dynamics are captured by λ_i, for $i = 1, 2,3 \ldots, 5$ and the long-run dynamics are captured by $\beta_i,\ \gamma_i,\ \delta_i, \rho_i,\ \tau_i,\ and\ \sigma_i$ for $i = 1, 2, 3, \ldots, p$.

Using a shorter and an error correction model, equation (3) could be written as follows:

$$\Delta lnGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta lnGDP_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta lnFI_{t-i} + \sum_{i=0}^{p} \delta_i \Delta lnDCP_{t-i} + \sum_{i=0}^{p} \rho_i \Delta lnDCF_{t-i} + \sum_{i=0}^{p} \tau_i \Delta lnINFL_{t-i} + \sum_{i=0}^{p} \sigma_i \Delta lnTOPN_{t-i} + \lambda ECT_{t-1} + \varepsilon_t \quad (4)$$

ECT is the error correction term that captures the long-run relationship between the variables and its coefficient, λ, measures the speed of adjustment to long-run equilibrium given any shock to the system.

3.2.2 Non-linear autoregressive distributed lags (NARDL) model. We decompose our independent variable of interest. FI, into two sets of negative and positive signals denoted by FI^- and FI^+ respectively. Thus, the decomposition series can be expressed as follows:

$$NEG(FI)_t = \sum_{s=1}^{t} lnFI_s^- = \sum_{s=1}^{T} Max(\Delta lnFI_s, 0) \quad (5)$$

$$POS(FI)_t = \sum_{s=1}^{t} lnFI_s^+ = \sum_{s=1}^{T} Max(\Delta lnFI_s, 0) \quad (6)$$

Equations (5) and (6) are included in equation (3) to form our NARDL model, which is expressed as follows:

$$\Delta lnGDP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \Delta lnGDP_{t-i} + \sum_{i=0}^{p} \alpha_i^- \Delta lnNEG(FI)_{t-i} + \sum_{i=0}^{p} \alpha_i^+ \Delta lnPOS(FI)_{t-i} + \sum_{i=0}^{p} \delta_i \Delta lnDCP_{t-i} + \sum_{i=0}^{p} \rho_i \Delta lnDCF_{t-i} + \sum_{i=0}^{p} \tau_i \Delta lnINFL_{t-i} + \sum_{i=0}^{p} \varphi_i \Delta lnOIL_{t-i} + \sum_{i=0}^{p} \sigma_i \Delta lnTOPN_{t-i} + \lambda_1 lnGDP_{t-1} + \lambda_2^- lnNEG(FI)_{t-1} + \lambda_2^+ lnPOS(FI)_{t-1} + \lambda_3 lnDCP_{t-1} + \lambda_4 lnDCF_{t-1} + \lambda_5 lnINFL_{t-1} + \lambda_6 lnOIL_{t-1} + \omega_t \quad (7)$$

4. Results and discussion

Table 1 provides the descriptive statistics of all the variables. All the variables are normally skewed except DCP and GCF. The Jarque-Bera test statistics confirm normality across all the series.

Table 2 presents the unit root tests using the DF-GLS (Panel A) and Ng-Perron test (Panel B). The Ng-Perron test are similar to DF-GLS implying acceptance of the null hypothesis of unit roots in the series, except GDP, GCF and INFL. However, the first differencing of all the series attain stationarity at all conversational levels for DF-GLS and Ng-Perron tests which

Variable	At Level Constant	At Level Constant and trend	First difference Constant	First difference Constant and trend	I
Panel A: DF-GLS					
GDP	−0.6058	−0.7120	−2.8811[a]	−2.9221[a]	I (1)
FI	−0.2088	−0.4784	−1.0925[a]	−1.1417[a]	I (1)
GCF	−0.1017[c]	−0.1571[b]	−0.6816[a]	−1.1121[a]	I (1)
DCP	−0.0477	−0.1076	−0.9940[a]	−1.0914[b]	I (1)
INFL	−0.3076[b]	−0.3375[b]	−1.5239[a]	−1.5274[a]	I (1)
TOPN	−0.0627	−0.0958	−0.9595[a]	−1.2222[a]	I (1)
Panel B: Ng-Perron test (MSB)					
GDP	0.1410[b]	0.1361[a]	0.3681[a]	0.3833[a]	I (1)
FI	0.3356	0.2694	0.2334[b]	0.2339[b]	I (1)
GCF	0.2455[c]	0.2455[b]	0.1378[a]	0.0967[a]	I (1)
DCP	0.3889	0.2883	0.1318[a]	0.1318[a]	I (1)
INFL	0.2219[b]	0.2134[b]	0.1542[a]	0.1546[b]	I (1)
TOPN	0.3695	0.3141	0.1314[a]	0.1005[a]	I (1)

Note(s): The values are the test statistic which are compared with test critical values/asymptotic critical values for the 1%, 5% and 10% significant levels. I is the order of integration while [a], [b] and [c] are statistical significance at 1% a 5% and 10%, respectively

Table 2.
Unit root tests

confirms that none of the variables is I (2). Therefore, the series exhibit a mixed order of integration, which is the requirement for using the ARDL technique.

Tables 3 and 4 confirm cointegration between FI and GDP suggesting a long-term nexus between GDP and FI.

FI and Inflation do not significantly impact GDP. The diagnoses of the linear ARDL model is presented in Table 5. The adjusted R-squared shows that the model explains 86.25% of the variance and a 1% significance of F-statistics suggests the prediction value of the model. The model is stable because the *p*-values of the autocorrelation test, heteroskedasticity test, Jarque-Bera normality test and Ramsey regression equation specification error test (RESET) are insignificant. Therefore, the model does not have serial correlation issues, has no heteroscedasticity problems and has normally distributed residuals. The RESET confirms no issue of omitted variable and incorrect functional form or model misspecification. From Figure 1 the CUSUM and CUSUM of squares fall between the critical bounds at a 5% significance level confirming the accuracy of the short and long-run coefficients.

Table 5 summarizes the NARDL estimation between GDP and FI. The first lag of GDP, DCP, GCF and INFL significantly influence GDP. Similarly, coefficients of the current value of DCP, GCF and INFL are significant, implying that a 1 unit change in DCP, GCF and INFL will reduce GDP by 0.3912, 0.1558 and 0.2524, respectively. Although the bound test suggests a relationship between GDP and FI, in the asymmetric form, FI shows no significant effect on GDP. A further short and long-run nexus between GDP and FI suggests no significant short or long-run impact.

The post-estimation diagnosis of the NARDL model residuals for the short and long-run asymmetric relation show no serial correlation and heteroskedasticity effect. The RESET confirms that the model's functional form is correctly specified, and the CUSUM and CUSUM of squares (Figure 2) indicate that the model is stable.

There is no evidence of a significant impact of FI on growth in the short or long run. Internationally, it contradicts Qamruzzaman and Jiangua's (2018) findings with data from Bangladesh and Bara and Mudzingiri (2016) with data from Zimbabwe. It also contradicts the results of studies, such as Idun and Aboagye (2014) and Ansong *et al.* (2011) that use a Ghana

Critical values bound of the F-statistics intercept and no trend						
k	99%		95%		90%	
5	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
	3.5	4.63	2.81	3.76	2.49	3.38

Model	Estimated F-Stas	Inference
F (GDP) = (GDP/FI,GCF,DCP,INFL,TOPN)	7.6056[a]	Cointegration
F (FI) = (FI/GDP,GCF,DCP,INFL,TOPN)	2.8617	No cointegration
F (GCF) = (GCF/FI,GDP,DCP,INFL,TOPN)	4.1161[b]	Cointegration
F (DCP) = (DCP/FI,GCF,GDP,INFL,TOPN)	5.9826[a]	Cointegration
F (INFL) = (INFL/FI,GCF,DCP,GDP,TOPN)	6.1822[a]	Cointegration
F (POPN) = (TOPN/FI,GCF,DCP,INFL,GDP)	1.6199	No cointegration

Note(s): Models estimated using Unrestricted Constant and Restricted Trend. K is the number of regressors. Critical values are extracted from Narayan (2004) while [a], [b] and [c] are statistically significant at 1% a 5% and 10%, respectively

Table 3. Bound test for cointegration of variables

Panel A: Long-run			Panel B: Short-run			Model diagnosis		
Variable	Coef	*t*-Stat	Variable	Coef	*t*-Stat	*R*-squared	0.8625	
FI	−2.2702	−0.9186	D (FI)	−2.8895	−0.5897	*F*-statistic	17.5571	(0.0000)
GCF	−0.2480[a]	−4.3761	D (GCF)	−0.1317	−1.7039	X^2 autocorrelation	10.7325	(0.4007)
DCP	0.2831[c]	1.9041	D (DCP)	0.4190[b]	2.5561	X^2 Heteroskedasticity	14.0687	(0.9538)
INFL	−0.2959[a]	−4.6521	D (INFL)	−0.3339[a]	−5.0362	X^2 Normality	0.1033	(0.9496)
TOPN	4.9427	1.6542	ECF_{t-1}	−1.5244[a]	−8.2515	X^2 RESET	1.2052	(0.3438)
Constant	16.6031[b]	2.218	Constant	22.8599[a]	8.3105	ARCH effect	0.0061	(0.9379)

Note(s): The dependent variable is GDP, [a], [b] and [c] are statistically significant at 1%, 5% and 10%, respectively, values in the bracket under the diagnosis column are the probabilities. The ARDL model selected based on the Schwarz Bayesian Criteria is ARDL(1, 0, 1, 1, 1, 0) for long-run and ARDL(1, 1, 1, 1, 1, 0) for short-run

Table 4. Long-run and short-run under ARDL

dataset. As explained earlier, existing studies with the Ghana dataset have generally suggested a negative and significant impact of FI on GDP. Our study confirms the negative relationship, albeit insignificant. Impliedly, there is no significant impact of FI on GDP.

Beck *et al.* (2016); Bara *et al.* (2016) also confirm no significant impact of FI on economic growth [1] and no causality, in any direction, between FI and growth, both in the short and long run. The hypothesis supporting the "widely held view" of a positive impact of FI on GDP is premised on the assumption that FI improves the efficiency of financial intermediation by "*increasing the variety of financial products and services, resulting in the improved matching of the needs of individual savers with those of firms raising funds for expanding future production*"(Chou, 2007). However, Bara *et al.* (2016) suggest that FI can negatively impact GDP through excessive increases in liquidity outside of the banking system, triggering inflationary pressures due to low productivity and relatively higher imports. In addition, Idun and Aboagye (2014) argue that FI adversely impacts saving propensity in Ghana and reduces bank liquidity.

An explanation could be the lack of significant shifts in FI to propel a significant impact on GDP. The standard deviation measures of FI suggest that year-on-year movements of FI have not been significantly apart. It is possible that FI outside the financial system has not witnessed significant diversity in innovative actions or products to affect growth substantially. Currently, a considerable portion of FI is underpinned by a SIM-Based

Variable	Coefficient	*t*-Statistic	*p*-value
Panel A: NARDL estimation output			
GDP (−1)	−0.4134[b]	−2.8973	0.0177
FI_POS	−3.8029	−1.6121	0.1414
FI_NEG	−5.6639	−1.3315	0.2158
DCP	−0.3912[b]	−2.4879	0.0345
DCP(−1)	0.7297[a]	5.7412	0.0003
GCF	−0.1558[b]	−2.3296	0.0448
GCF(−1)	−0.2145[b]	−2.8993	0.0176
INFL	−0.2524[a]	−4.7742	0.001
INFL (−1)	−0.1430[b]	−2.4322	0.0378
TOPN	7.135	2.2336	0.0524
Constant	11.9438[b]	2.9225	0.017
Adjusted *R*-squared			0.8204
F-statistic			4.112
Prob (*F*-statistic)			0.0022
Panel B: Long-run and short-run of NARDL			
Long-run			
FI_POS	−2.6905	−1.5488	0.1558
FI_NEG	−4.0072	−1.3005	0.2257
DCP	0.2395	1.7491	0.1142
GCF	−0.2620[a]	−5.066	0.0007
INFL	−0.2797[a]	−5.0083	0.0007
TOPN	5.0479[b]	2.3496	0.0433
Constant	8.4501[b]	3.0846	0.013
Short-run			
D (DCP)	−0.3911[b]	−2.4438	0.0371
D (GCF)	−0.1558[c]	−2.1253	0.0625
D (INFL)	−0.2523[a]	−4.9396	0.0008
ECM(−1)	−1.4134[a]	−8.7592	0.0000
Model test diagnosis			
Breusch-Godfrey serial correlation LM test		*F*-stas = 4.5696	0.65
Heteroskedasticity test: Breusch-Pagan-Godfrey		*F*-stas = 2.4038	0.1103
Ramsey RESET test		*F*-stas = 1.7649	0.2207

Table 5.
NARDL estimation output, Long-run and short-run results

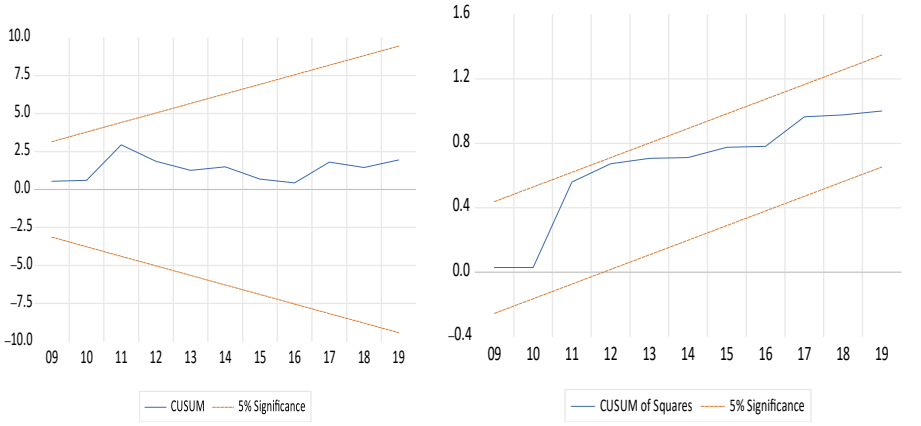

Figure 1.
ARDL plot of CUSUM And CUSUM of squares

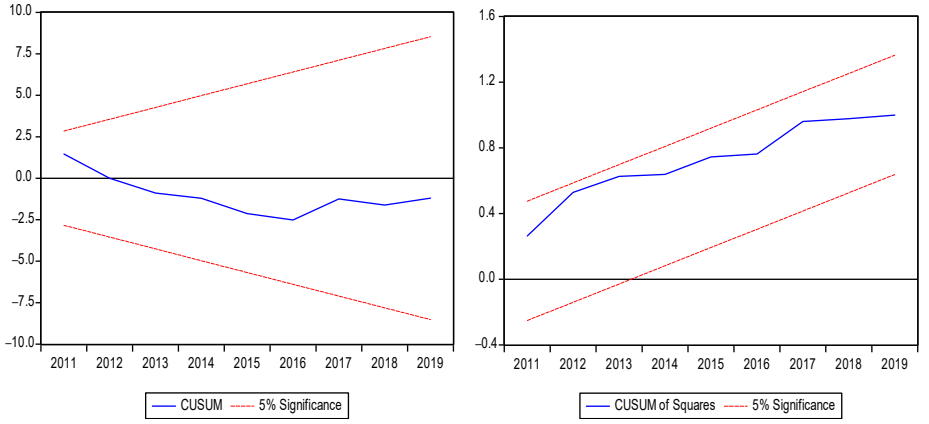

Figure 2.
NARDL plot of CUSUM and CUSUM of squares

mobile payment system, dubbed MOMO, and there is minimal distinction between various platforms, solutions and products that are licensed and registered as financial technology (FIN-TECH). Therefore, this evolution, whereas innovative is not "disruptive" enough, especially as existing regulations from the Central Bank, enforced the continuous inclusion of mainstream financial institutions as partners for FIN-TECH product and/or ensured strict adherence to rules for approving new products to market.

In most cases, these approval processes for new solutions mitigate the introduction of disruptive innovations as the regulators are unapologetically conservative. Substantively, then FIN-TECHs are merely becoming an extension of existing mainstream financial institutions. Admittedly, this assertion requires further empirical exploration, but it is logical to assume that the early regulation of FIN-TECH within Ghana has neutralized its impact on GDP.

Also, Bara *et al.* (2016) provide evidence that the level of financial development can affect FI's impact on economic metrics. Until recently, FI was utterly dependent on the financial sector's maturity and agility. The measure of broad money to narrow money that is beginning to gain traction as a measure for FI are also proxies for financial development. Therefore, it is probable that the lack of a tangible impact of FI on growth, in this study, reflects the impact of financial development on growth in Ghana. The inconsistent relationship between financial development and GDP has been empirically confirmed (Moyo and Le Roux, 2020). Besides, the financial institutions in Ghana have not been very competitive, with a few dominant players. Considering the conscious regulatory strategy to mainstream FIN-TECH actors and metamorphose them into traditional financial institutions, the lack of competition among financial institutions mitigates FI's impact on GDP. Competition among financial institutions will have leapfrogged FI and leveraged the existence of FI to propel business growth and with attendant effects on GDP.

5. Conclusion

This study explored the effect of FI on economic development in Ghana, with a comparatively broader conceptualization of FI, to reflect the country reality that a significant proportion of FI occurs outside the financial industry. There is no evidence that FI advances, retards, or negatively impacts GDP significantly using the Ghanaian dataset. This could be due to the early and strict regulation of the FIN-TECH sector and the general inconclusiveness of the

impact of financial development on GDP further complicated by the imperfections in the financial sector.

It is not exactly clear if the deliberate and conscious conservatism in the regulation of the FIN-TECH sector is a lousy policy. Early studies have confirmed that FI can reduce the propensity to save or introduce excessive liquidity not backed by productivity on one side of the continuum or improve the intermediation process on the other side of the continuum. In the case of Ghana, earlier studies have confirmed that FI hurts growth, and financial development does not positively impact growth. The challenges of intermediation in Ghana are mainly due to institutional rigidities, excessive government borrowing on the open market that crowds out the private sector, lack of sustainable investments outlets seeking private capital, corruption, wrong regulatory action, political interference and high levels of nonperforming loans. It is conceivable that FIN-TECHs that have drastically impacted the FI space will have minimal ability to address these challenges, at least in the medium term. Therefore, policymakers must empirically explore the impact of early and strict regulation on the transformational effect of FI.

The findings of this study must be considered with an informed view of its limitations. Firstly, even though the data emanate from reputable sources, these sources have occasionally suffered data credibility and accuracy issues. For instance, the same data from the World Bank and IMF sources are not exact, albeit only marginally different. To that extent, the findings from this study are constrained by the credibility of the data sources. Other studies can also explore a broader set of control variables or apply statistical methods other than ARDL.

Note

1. Their study confirms that mobile banking is positively associated with economic growth in the long run.

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