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Nonlinear Causality Analysis of Finance-Growth Relation: Evidence from Turkey

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The aim of this study is to examine the causal relation between financial deepening and economic growth by means of Smooth Transition Autoregressive (STAR) model-based Granger causality analysis applied to the monthly data of Turkey over the period 1998M1-2012M3. The results show that non-linear structure of the series should be considered as the evidence from linear and non-linear causality analysis differs. According to non-linear Granger causality analysis, the financial deepening is found to be causing variable for economic growth in Turkey.

Introduction

The financial deepening attributed to the development of financial markets has a crucial role in growth process since it provides the efficient allocation of accumulated savings to productive sectors. Though the contribution of finance on economic growth is theoretically postulated, the relation should be examined empirically due to the discrepancies in the regarding literature. According to the framework of Patrick (1966), two possible causal links between financial deepening and economic growth can be classified as demand- following view and supply-leading phenomena. The demand-following approach states that the demand of the investors and savers in the real economy for the services of financial sector would lead to the development of financial sector. Furthermore, the supply-leading view, emphasizing the importance of finance for economic growth, points out two functions of the financial sector that are the transfer of resources to modern sectors

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and stimulation of an entrepreneurial response in these productive sectors. Patrick (1966) seperates the growth process into two stages that begins by supply-leading and proceeds with demand-following approaches. More briefly, in the first stage of growth process, the creation of modern financial institutions contributes to the economic development. However, in the second stage, economic growth induces the demand for financial services and provides financial development. Beside the demand following and supply leading views, the variables in question may be biderectionally related or have no causal link at all.

Although the finance-economic growth relation has been widely studied in last decades, the theoretical background of the issue is based on the past literature going back to Schumpeter (1911) that argues the role of financial intermediaries in technological innovation and economic development. More recently, Gurley and Shaw (1955), Goldsmith (1969) and Hicks (1969) point out the importance of financial system for stimulating economic growth. Besides, McKinnon (1973) and Shaw (1973) specify economic growth arising from financial development as a result of financial liberalisation. Contrarily, Robinson (1952) contributes to the related literature from a different perspective arguing that economic growth leads to financial development via increasing demand for financial services.

According to Ang (2008) , though the theory can be traced back 1950s, empirical perspective of the finance-economic growth relation has developed since 1990s, following cross-country analysis of King and Levine (1993). As the related study, the evidence of positive effect of financial development on economic growth is supported by Levine and Zervos (1998), Calderon and Liu (2003), Christopoulos and Tsionas (2004), Ang (2009). On the other hand, various studies as Thornton (1996), Darrat (1999), Demetriades and Hussein (1999), Deidda and Fattouh (2002), Dritsakis and Adamopoulos (2004), Shan (2005), Ang and McKibbin (2007), Apergis, Filippidis and Economidou (2007) point to different type of interactions rather than the mechanism that output growth is significantly determined by financial development.

Although a wide literature on finance-growth relation has been carried out, this study considerably contributes since the relation is firstly analyzed by employing causality test to a non-linear model, STAR (Smooth Transition Autoregressive Model). Two main motives may be pointed for non-linear STAR modelling. First, since economic crises leading the change in policy implementations affect both the movement of the variables and the relation between them, a linear model cannot be adequate to capture these asymmetries. Second, STAR model is chosen for modelling non-linearities since it makes possible the transition between the regimes to be gradual.

Non-linear analysis of finance-growth causal relation is important for Turkey since the variables in question are expected to follow non-linear processes over the considered period due to 2001 and 2008 financial crises and the succeeding fiscal and monetary policy responses. Hence, STAR model is employed to Turkish monthly data over the period 1998M1-2012M3. The results of empirical analysis are crucial for determining the optimal policies regarding economic growth and financial markets.

The remainder of the paper is organized as follows. Section 2 discusses the methodology. Section 3 presents the data set and empirical results. Section 4 is concluded.

2. The Methodology

This section examines three issues that are the non-linearity of the series, modelling non-linearities by using appropriate STAR models and the non-linear causal relations. In this context, a univariate STAR model is given by

$$y_t = \pi_{10} + \pi_1^{'} w_t + (\pi_{20} + \pi_2^{'} w_t) F(y_{t-d}) + u_t \qquad (2.1)$$

where $\pi_j = (\pi_{j1}, ..., \pi_{jp})'$, j=1,2, $w_t = (y_{t-1}, ..., y_{t-p})'$, $u_t \sim nid(0, \sigma_u^2)$ and $F(y_{t-d})$ denotes transition function. There are two choices for the transition function that are logistic function in (2.2) and exponential function expressed in (2.3).

$$F(y_{t-d}) = (1 + \exp\{-\gamma_L (y_{t-d} - c_L)\})^{-1} \qquad \gamma_L > 0 \qquad (2.2)$$

$$F(y_{t-d}) = (1 - \exp\{-\gamma_E (y_{t-d} - c_E)^2\} \qquad \gamma_E > 0 \qquad (2.3)$$

The transition functions in (2.2) and (2.3) yield logistic STAR (LSTAR) and exponential STAR (ESTAR) models, respectively. In LSTAR model, two regimes are presented depending on the small and large values of the transition variable relative to the threshold parameter, c_L. This type of models can be appropriate to model business cycle asymmetries where expansion and contraction periods have different dynamics. On the other hand, the regimes in ESTAR model are subject to small and large absolute values of the transition function relative to c_E. The ESTAR transition function is symmetric around the threshold parameter, while the values close to c_E differ.

Prior to the non-linear causality analysis, STAR modelling procedure can be reviewed in three steps with reference to Teräsvirta (1994). First, a linear autoregressive AR(p) model is specified where appropriate lag length, p, is determined by applying autocorrelation tests and selection criteria such as Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC). Second, linearity is tested against STAR type non-linearity for different values of delay parameter. The delay parameter, d, with the smallest p-value is selected. The rejection of the null hypothesis $H_0 : \gamma_2 = \gamma_3 = \gamma_4 = 0$ in (2.4) for the delay parameter chosen specifes the non-linear structure. Once the non-linear structure is detected, the next step is to determine the transition variable by the testing procedure detailed in Teräsvirta (1994). The testing procedure is based on the third-order Taylor approximation of the transition function

$$y_t = \gamma_0 + \gamma_1^{'} w_t + \gamma_2^{'}(w_t y_{t-d}) + \gamma_3^{'}(w_t y_{t-d}^2) + \gamma_4^{'}(w_t y_{t-d}^3) + v_t^{''} \qquad (2.4)$$

where $v_t^{''} \sim nid(0, \sigma_{v''}^2)$, $w_t = (y_{t-1}, ..., y_{t-p})'$ and $\gamma_j = (\gamma_{1j}, ..., \gamma_{1p})'$.

The following null hypotheses in Table 1 are tested by using LM type tests to select between LSTAR and ESTAR models. Following Van Dijk et al. (2000), the decision rule is simply that ESTAR model is chosen in case the p-value corresponding to F_3 test is the smallest while in other cases LSTAR model should be selected.

Table 1. Selection between logistic and exponential transition functions

F-test	Null hypothesis	Alternative hypothesis
F_4-test	$H_{01}: \gamma_4 = 0$	$H_{11}: \gamma_4 \neq 0$
F_3-test	$H_{02}: \gamma_3 = 0 \vert \gamma_4 = 0$	$H_{12}: \gamma_3 \neq 0 \vert \gamma_4 = 0$
F_2-test	$H_{03}: \gamma_2 = 0 \vert \gamma_3 = \gamma_4 = 0$	$H_{13}: \gamma_2 \neq 0 \vert \gamma_3 = \gamma_4 = 0$

Source: Table is generated by the author in accordance withTeräsvirta (1994).

Following the modelling process, the STAR-based test of Granger causality is performed by additive smooth transition regression model presented below with reference to Skalin and Teräsvirta (1996)

$$y_t = \pi_{10} + \pi_1^{'} w_t + (\pi_{20} + \pi_2^{'} w_t) F(y_{t-d}) + \delta_1^{'} v_t + (\delta_{20} + \delta_2^{'} v_t) G(x_{t-e}) + u_t \qquad (2.5)$$

In the regression, $\delta_j = (\delta_{j1}, ..., \delta_{jq})', j = 1, 2, v_t = (x_{t-1}, ..., x_{t-q})', G(.)$ shows the transition function, and *e* is an unknown delay parameter. The non-causality hypothesis is $H_0 : G \equiv 0$ and $\delta_{1i} = 0,\ i = 1, ..., q$. In case there is an identification problem of (2.5) under null hypothesis, it is necessary to approximate second transition function G by its third degree Taylor approximation. Therefore, following Luukkonen et al. (1988), for unknown *e* lag, Taylor approximation of (2.5) has the form

$$y_t = \pi_{10} + \pi_1^{'} w_t + (\pi_{20} + \pi_2^{'} w_t) F(y_{t-d}) + \kappa' v_t + \sum_{i=1}^{q} \sum_{j=1}^{q} \phi_{ij} x_{t-i} x_{t-j} + \sum_{i=1}^{q} \varphi_i x_{t-i}^3 + r_t \qquad (2.6)$$

where $\kappa = (\kappa_1, ..., \kappa_q)'$. The null hypothesis of non-causality analysis is $H_0 : \kappa_i = 0$, $\phi_{ij} = 0$, $\varphi_i = 0$, i=1,…,q, j=i,…,q and the resulted test statistic has $q(q+1)/2 + 2q$ degrees of freedom with χ^2-distribution.

3. Data set and empirical results

To investigate the finance-growth causal relation in Turkey over the period 1998M1-2012M3, two models are generated. Accordance with the related literature (King and Levine 1993; Rousseau and Wachtel

1998; Ang and McKibbin 2007), the first model uses the ratio of M3 obtained from CBRT Electronic Data Distribution System, to expenditure-based GDP at 1998 prices acquired from Turkish Statistical Institute as a proxy for financial deepening. However, following De Gregorie and Guidotti (1995), Levine (1999), Beck and Levine (2001), Calderon and Liu (2003), the second model employs credits/GDP (credit) rather than M3/GDP (m3) for financal deepening since it directly presents the volume of funds canalized to the private sector. In both models, as a proxy for economic growth, the real GDP per capita (gdpc) is generated by dividing GDP to midyear population estimations of Turkish Statistical Institute.

Prior to the empirical analysis, the unit root test results are reported to examine the stationarity of the seasonally adjusted series. Table 2 includes the results of the ADF (Augmented Dickey Fuller) and PP (Philips- Perron) unit root tests.

Table 2. Stationarity results

Variables	ADF		PP	
	Level	First difference	Level	First difference
credit	1.66 (0)	-4.27*(3)	1.29	-13.42*
m3	-2.12 (3)	-5.59* (2)	-1.92	-11.69*
gdpc	-2.40 (0)	-14.43* (0)	-2.53	-14.38*

Source: Author’s estimation.

Notes: (1) The parentheses indicate the appropriate lag length for the ADF regressions. The lags are determined by SIC. **(2)** * ,** and *** denote that the test statistics are significant at 1%, 5% and %10 level, respectively.

According to both ADF and PP unit root tests, all series are found to be integrated of order one at %1 significance level. As the first step of the analysis, the length of the autoregression, p, is specified by implementing selection criteria and autocorrelation test to the linear autoregressive model. After selecting the order of autoregression as p=1 for gdpc, p=3 for m3 and p=4 for credit, the delay parameters are determined by choosing the value that minimize the p-values of the linearity tests. According to the results in Table 3, the delay parameter, d=1, is selected for both m3 and credit. On the other hand, the smallest value of p_{F_L} indicates d=3 for variable gdpc. The linearity tests for gdpc and the variables representing financial deepening verify the non-linear structure of the considered variables.

Table 3. Linearity test results

	p_{F_L}		
	gdpc (p=1)	m3 (p=3)	credit (p=4)
d=1	0.3957	**0.0000***	**0.0000***
d=2	0.2370	0.0464**	0.0002*
d=3	**0.0007***	0.0020*	0.4036
d=4	0.9350	0.0744***	0.0006*
d=5	0.8358	0.0045*	0.0025*
d=6	0.0082*	0.0000*	0.0027*
d=7	0.4051	0.0001*	0.0090*
d=8	0.2085	0.0003*	0.0012*
d=9	0.0960	0.0001*	0.0711***
d=10	0.7565	0.2228	0.0036*
d=11	0.8327	0.0401**	0.0426**
d=12	0.5865	0.0821***	0.2034

Source: Author’s estimation.

Notes: 1) p signifies the length of the autoregression, d indicates delay parameter, p_{F_L} shows p-values for F_L linearity tests. **2)** The values in bold show the delay parameters corresponding min (p_{F_L}) over delays d=1,…,12.

Since linearity is rejected against STAR, the following step of the analysis should be the model determination between ESTAR and LSTAR. According to Table 4 summarizing the results of model selection process, ESTAR models for gdpc and m3 are chosen for estimation since the values of F_3 are the smallest among the test statistics F_4, F_3 and F_2. On the other hand, as a result of the large value of F3, LSTAR is selected to model non-linear credit variable.

Table 4. Model selection results

	F_4	F_3	F_2	STAR
gdpc	5.307428** (0.0225)	9.591974* (0.0023)	2.483232 (0.1170)	ESTAR
m3	4.999461* (0.0025)	9.195534* (0.0000)	3.622462* (0.0144)	ESTAR
credit	5.230635* (0.0006)	2.148257*** (0.0775)	4.533683* (0.0017)	LSTAR

Source: Author's estimation.

Note: The values in brackets show the p-values for F-statistics.

Table 5 presents the results of non-linear Granger causality tests based on the estimated STAR models. The tests are performed for q=1 in (2.6) to avoid size distortion due to the number of degrees of freedom. The results show that both m3 and credit are causing variables rather than caused variables. To sum up, the analysis reveals evidence of causality running from financial deepening to economic growth.

Table 5. Non-linear Granger causality test results

Caused variable	Causing variable		
	gdpc	m3	credit
gdpc	-	12.07*	9.53*
m3	1.48	-	-
credit	0.23	-	-

Source: Author's estimation.

Notes: 1) The values in brackets show the appropriate lag lengths selected by selection criterion (AIC, SIC) and autocorrelation tests. **2)** The table merely indicates the results associated with the causality analysis in the study.

The Granger causality analysis is also performed linearly and the results are reported in Table 6. The linear causality tests suggest that gdpc is a causing variable contrary to the results of non-linear model. Comparing those results from linear and non-linear analysis shows the importance of considering non-linearity.

Table 6. Linear Granger causality test results

Caused variable	Causing variable		
	gdpc	m3	credit
gdpc	-	0.66(1)	0.42(1)
m3	2.53**(3)	-	-
credit	6.95*(4)	-	-

Source: Author's estimation.

4. Concluding remarks

In this study, financial deepening and economic growth relation has been examined for Turkey. The non-linear causality analysis based on STAR, that is one of the regime shifting models is employed. The empirical analysis draws three important conclusions. First, the study lays emphasis on the importance of considering non-linear structures of the series due to the contradiction between the results of linear and non-linear causality analysis. Second, the results are found to be robust to diferent definitions of the proxies for financial deepening, that are m3 and credit. Third, the empirical analysis shows evidence of causality from financial deepening to economic growth, in other words the validity of supply-leading view of Patrick (1966). This conclusion suggests that the reform process of financial sector has contributed not only to financial deepening indicators but also economic growth in Turkey. Particularly, the fiscal and monetary policies implemented after 2001 crisis have improved fiscal balance leading to a decrease in the pressure of public sector on financial sector. Hence, the transfer of the resources to productive sectors has accelerated economic growth process. As a result, the effect of financial sector on growth should be taken into account by policy makers to foresee the potential effects of economic policies.

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