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DYNAMIC PANEL DATA EVIDENCE ON THE FINANCE-INVESTMENT LINK

YONGFU HUANG

Department of Land Economy
University of Cambridge
19 Silver Street
Cambridge CB3 9EP
U. K.
e-mail: yh279@cam.ac.uk

Abstract

This paper investigates the causality between aggregate private investment and financial development for 43 developing countries. GMM estimation on averaged data suggests the positive causal effects going in both directions, controlling for the possibility of endogeneity bias and omitted variable bias. The findings have rich implications for the conduct of macroeconomic policies in developing countries.

1. Introduction

This paper aims to explore the existence and directions of causality between aggregate private investment and financial development. The dynamic panel data evidence suggests the positive causal effects going in both directions between them.

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As two important aspects of economic activities, aggregate private investment and financial development interact in a significant way. On the one hand, when financial markets perform well, they can channel capital through the investment chain to its highest valued use. They are crucial to the success of all businesses and the productivity and growth in the economy. However, financial markets instability to some extent disrupts its ability to promote private investment and support the economy. After the housing bubbles burst in mid-2007, the credit crunch become a major economic phenomenon, where banks were reluctant to provide sufficient credit to creditworthy investors so as to hold more capital to protect themselves against worst-case scenarios. The failure of Lehman Brothers in the US intensified the credit market stress, triggering the worst global financial crisis for generations.

On the other hand, the active entrepreneur's investment behaviours increase the demand for external finance, leading to the deepening of financial intermediation. To satisfy the rising demand of external finance, financial intermediaries tend to induce savers to establish a portfolio allocation in favour of productive investment by transfering their holdings of unproductive tangible assets to bank deposits. Financial intermediaries usually achieve this by providing liquidity to the depositors, reducing transaction costs, and helping corporate control. However, during the period of 2007-2009, when global financial markets suffered a sustained period of stress and instability, the entrepreneurs tended to cut investment or spending in order to reduce risk. Investors were also reluctant to provide funds to the banks, further eroding the bank's lending capacity with adverse consequences for the economy as a whole.

In general, research on the existence and directions of causality between these two important economic activities has been sparse.[1] Under

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[1]Benhabib and Spiegel [6] show that financial development positively influences the investment rate. Schich and Pelgrin [27] indicate a positive effect going from financial development to private investment in 19 OECD countries over 1970 to 1997. Ndikumana [23, 24] finds that the development of banks and stock markets tends to stimulate domestic investment.

this back-ground, this research examines the interactions between private investment and financial development, trying to answer the following questions. Do more advanced or efficient financial markets induce a surge of private investment, or do the poorly functioning financial markets discourage entrepreneur's investment behaviour? Does entrepreneur's investment behaviour drive the expansion of financial system or the reduction of agency costs, or does the decrease of private investment as a whole impede financial development?

This analysis applies the system GMM estimation method on data for 5-year averages, based on a dataset for 43 developing countries over the period 1970-98. It produces significant findings of the positive causal effects going in both directions, and indicates a high degree of persistence exists in the averaged data of financial development and private investment. The findings of this paper support the view that private investment is both the origin and consequence of financial development, and vice versa. It has significant policy implications for the conduct of macroeconomic policies in developing countries. Since the 1970s, many developing countries have sought to stimulate private sector-led growth by choosing to encourage private investment, which have significant repercussions for the development of financial markets. On the other hand, the developed financial markets improve the access to finance for the small and medium enterprises, which are regarded important for economic growth.

The remainder of the paper proceeds in Section 2 to describe the data. Section 3 sets out the system GMM estimation methods. Section 4 reports the empirical results. Section 5 concludes.

2. The Data

This section outlines the measures and data for private investment, financial development as well as trade openness, and GDP growth rate.

The measure of private investment, denoted by *PI*, is the ratio of nominal private investment to nominal GDP. The data are taken from the World Bank Global Development Network Database [29].[2]

The measure of financial development, denoted by *FD*. Since, commercial banks dominate the financial sector and stock markets play very minor roles in most developing countries, this research focuses on the level of financial intermediary development, for which a new index is constructed by using principal component analysis[3] based on three banking development indicators widely used in the literature.

The principal component analysis is based on the following three popular banking development indicators.[4]

The first measure, Liquid Liabilities (LLY), is one of the major indicators used to measure the size, relative to the economy, of financial intermediaries including three types of financial institutions: the central bank, deposit money banks, and other financial institutions. It is calculated by the ratio of liquid liabilities of banks and non-bank financial intermediaries (currency plus demand and interest-bearing liabilities) over GDP.

The second indicator, Private Credit (PRIVO), is defined as credit issued to the private sector by banks and other financial intermediaries divided by GDP. This excludes the credit issued to government,

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[2]This source could be the best one for private investment ratio. Although, data for private investment are only up to 1998, they are sufficient (or long enough) to conduct this analysis. While the private investment ratio can be calculated by deducting the net inflows of FDI and public investment from the gross fixed capital formation, the measurement errors could be large.

[3]Essentially, the principal component analysis takes *N* specific indicators and produces new indices (the principal components) $X_1, X_2, \ldots, X_N$ that are mutually uncorrelated. Each principal component, a linear combination of the *N* indicators, captures a different dimension of the data. Typically, the variances of several of the principal components are low enough to be negligible, and hence the majority of the variation in the data will then be captured by a small number of indices.

[4]The summary below is heavily drawn from Demirgüç-Kunt and Levine [14, 15].

government agencies, and public enterprises, as well as the credit issued by the monetary authority and development banks. It is a general indicator of financial intermediary activities provided to the private sector.

The third one, Commercial-Central Bank (BTOT), is the ratio of commercial bank assets to the sum of commercial bank and central bank assets. It reflects the advantage of financial intermediaries in dealing with lending, monitoring, and mobilizing saving and facilitating risk management relative to the central bank.

Data on these financial development indicators are obtained from the World Bank's Financial Structure and Economic Development Database [30]. *FD* is the first principal component of these three indicators above and accounts for 74% of their variation. The weights resulting from principal component analysis over the period 1990-98 are 0.60 for Liquid Liabilities, 0.63 for Private Credit, and 0.49 for Commercial-Central Bank. Since, these indicators are used to measure the size of financial intermediary development[5], the composite index, *FD*, mainly captures the depth of bank-based intermediation.

To test for the robustness, we make use of GDP per capita and trade openness. The real GDP per capita (chain) taken in log is denoted by *LGDP*. The trade openness is the sum of exports and imports over GDP (in current price), denoted by *OPENC*. In the regression, it is replaced by the logarithm of one plus trade openness divided by 100. Data for GDP per capita and trade openness are taken from the Penn World Table 6.2 due to Heston et al. [17].

The panel dataset contains 43 developing countries with a maximum of 6 observations per country over the period 1970-98. The transition economies are omitted. We also exclude countries with less than 20 observations over 1970-98.

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[5]Two measures for the efficiency of financial intermediation widely used are overhead costs, the ratio of overhead costs to total bank assets, and net interest margin, the difference between bank interest income and interest expenses, divided by total assets. Due to the incompleteness of the available data, they are not included in this analysis.

3. Methodology: System GMM

To examine the relationship between private investment and financial development, this paper conducts panel data estimation for 43 developing countries over 1970-98, based on averaged data over non-overlapping, five-year periods. Panel data estimation tends to produce more convincing findings than cross section analysis, and classical time series analysis since it exploits both the cross section and time dimensions of the data.[6] It allows us to control for unobserved country-specific effects and omitted variables bias, and look at both long-run effects and short-run effects.

This section briefly describes the system GMM method proposed by Arellano and Bover [5] and Blundell and Bond [7], using 5-year averaged data. As widely used in the growth literature (Islam [19], Caselli et al. [12], Levine et al. [21]), averaging data over fixed intervals has the potential for eliminating business cycle fluctuations, and makes it easier to capture the relationships of interest.

The following AR(1) model has been found appropriate for this application[7]:

$$\mathbf{FD}_{it} = \alpha_{11}\mathbf{FD}_{i,t-1} + \mathbf{PI}_{i,t-1}\beta_{11} + \eta_{i1} + \phi_{1t} + v_{it1}, \tag{1}$$

$$\mathbf{PI}_{it} = \alpha_{12}\mathbf{PI}_{i,t-1} + \mathbf{FD}_{i,t-1}\beta_{12} + \eta_{i2} + \phi_{2t} + v_{it2}, \tag{2}$$

$$i = 1, 2, \ldots, 43 \text{ and } t = 2, \ldots, 6.$$

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[6]In the growth and convergence context, both the panel data analysis of Caselli et al. [12], and the cross section analysis of Mankiw et al. [22] find a negative effect of initial income on growth, but the former identifies a much larger effect than the latter, implying a 10 per cent covergence rate relative to 2-3 per cent suggested by Mankiw et al. [22].

[7]Starting from a general model with three lags of the dependent and independent variables and testing the null hypothesis of the coefficients being zero for the longest lag, we end up with one lagged independent variable and one lagged dependent variable appearing in the model for this context, given that the relevant specification tests are satisfied.

For the sake of convenience, denote by y, the dependent variable (either FD or PI) and by x, the explanatory variables other than the lagged dependent variable:

$$y_{it} = \alpha y_{i,t-1} + x'_{i,t-1}\beta + \eta_i + \phi_t + v_{it}, \tag{3}$$

$$i = 1, 2, \dots, 43 \text{ and } t = 2, \dots, 6,$$

where η_i is an unobserved country-specific time-invariant effect not captured by $x_{i,t-1}$, and can be regarded as capturing the combined effects of all time-invariant omitted variables.

ϕ_t captures the global shocks. Recently, a large body of literature has indicated that the existence of common factors, either global, cyclical or seasonal effects, has the potential for causing comovements of variables in the world economy. Since common factors are likely to be partially cancelled out, when the data are averaged, for simplicity, this section only considers common time effects or a single global shock having an identical effect on each cross section unit.

v_{it} is the transitory disturbance term, assumed to satisfy sequential moment conditions of the form

$$E(v_{it}|y_i^{t-1}, x_i^{t-1}, \eta_i, \phi_t) = 0, \tag{4}$$

where $y_i^{t-1} = (y_{i1}, y_{i2}, ..., y_{i,t-1})'$, $x_i^{t-1} = (x_{i1}, x_{i2}, ..., x_{i,t-1})'$.

This assumption implies that (1) the transient errors are serially uncorrelated; (2) x s are predetermined variables with respect to the time varying errors in the sense that $x_{i,t-1}$ may be correlated with $v_{i,t-1}$ and earlier shocks, but is uncorrelated with v_{it} and subsequent shocks; (3) the individual effects are uncorrelated with the idiosyncratic shocks, but correlations between individual effects and lagged y and lagged x are not ruled out; (4) the global shocks are uncorrelated with the idiosyncratic shocks, while correlations between global shocks and lagged y and lagged x are possible.

The assumption on the explanatory variables x s being predetermined rules out a potential endogeneity bias, but allows for feedbacks from the past realizations of y to current x s. This assumption is believed to be appropriate given financial development is potentially both a consequence and origin of private investment, and vice versa[8].

For the stability of the estimated model, the autoregressive coefficient is assumed to lie inside the unit circle, $|\alpha| < 1$.

The coefficient β reflects the existence and direction of Granger causality going from lagged x to y. According to work by Chamberlain [13] and Holtz-Eakin et al. [18] on Granger non-causality tests in the general setting of dynamic panel data estimation, the non-causality hypothesis can be tested by checking, whether the coefficients of the lagged values of the independent variables are zero or the coefficients on the lagged difference of independent variables in the transformed equations are zero, that is, $\beta = 0$. Given the model is stable, a point estimate for the long-run effect can be calculated as follows:

$$\beta_{LR} = \frac{\beta}{(1-\alpha)}.$$

The standard error for the long-run effect can be approximated by using the delta method (for example, Papke and Wooldridge [26]).

This analysis employs the system GMM method, which is proposed by Arellano and Bover [5] and Blundell and Bond [7] to improve upon the Arellano and Bond [4] first-differenced GMM method, which may be plagued with weak instrument problems. There have been a number of methods proposed to estimate dynamic panel data models with a short time dimension, in which first-differencing is used to eliminate the individual effects. Below is Equation (3) in first differences:

$$\Delta y_{it} = \alpha \Delta y_{i,t-1} + \Delta x'_{i,t-1}\beta + \Delta\phi_t + \Delta v_{it}, \tag{5}$$

[8]Caselli et al. [12] treat some variables like the investment rate and population growth rate as predetermined and argue that these variables are potentially both causes and effects of economic growth.

$$i = 1, 2, \ldots, 43 \text{ and } t = 3, \ldots, 6,$$

where $\Delta y_{it} = y_{it} - y_{i,t-1}$, $\Delta x_{i,t-1} = x_{i,t-1} - x_{i,t-2}$, $\Delta\phi_t = \phi_t - \phi_{t-1}$, and $\Delta v_{it} = v_{it} - v_{i,t-1}$.

The sequential moment conditions above imply that all lagged values of y_{it} and x_{it} dated from $t-2$, and earlier are suitable instruments for the differenced values of the original regressors, $\Delta y_{i,t-1}$ and $\Delta x_{i,t-1}$. While the first-differenced 2SLS estimator due to Anderson and Hsiao [2, 3] uses y_{it-2} and x_{it-2}, the first-differenced GMM estimator uses all lagged values of y_{it} and x_{it} dated from $t-2$ and earlier. The moment conditions for errors in differences, on which the first-differenced GMM estimator is based can be written as,

$$E\left[\begin{pmatrix} y_i^{t-2} \\ x_i^{t-2} \end{pmatrix}(\Delta y_{it} - \alpha\Delta y_{i,t-1} - \Delta x'_{i,t-1}\beta - \Delta\phi_t)\right] = 0, \tag{6}$$

$$t = 3, \ldots, 6,$$

where $y_i^{t-2} = (y_{i1}, y_{i2}, \ldots, y_{i,t-2})'$ and $x_i^{t-2} = (x_{i1}, x_{i2}, \ldots, x_{i,t-2})'$.

Blundell and Bond [7] argue that in the standard AR(1) model, when the time series becomes highly persistent in the sense that "the value of the autoregressive parameter approaches unity or the variance of the individual effects increases relative to the variance of the disturbances", the lagged values of the series may be weak instruments for first differences. The first differenced GMM estimator employing these weak instruments has been found to have poor finite sample properties in terms of bias and imprecision.

To tackle the weak instruments problem, Arellano and Bover [5] and Blundell and Bond [7] develop a "system GMM" estimator.[9] Essentially, a

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[9]Alonso-Borrego and Arellano [1] propose the symmetrically-normalised GMM estimator and the limited information maximum likelihood estimator. Recently, Kruiniger [20] has developed the Maximum likelihood estimator and Newey and Windmeijer [25] have proposed the new variance estimator for the generalized empirical likelihood estimator.

mean stationarity assumption on initial conditions are considered in the sense that the mean of the distribution of the initial observations coincides with the mean of the steady-state distribution of the process. For the multivariate autoregressive model, Blundell and Bond [8] show that a sufficient condition for the additional moment conditions to be valid is the joint mean stationarity of the series.

For this context, the additional mean stationarity condition of (y_{it}, x_{it}) enables the lagged first-differences of the series (y_{it}, x_{it}) dated $t-1$ as instruments for the untransformed equations in levels. In addition to the moments for errors in differences described before, the system GMM estimator, denoted by SYS-GMM, is also based on the additional moments for errors in levels as follows,

$$E\left[\begin{pmatrix} \Delta y_{i,t-1} \\ \Delta x_{i,t-1} \end{pmatrix}(y_{it} - \alpha y_{i,t-1} - x'_{i,t-1}\beta - \phi_t)\right] = 0, \qquad (7)$$

$$t = 3, \dots, 6.$$

As suggested by Blundell and Bond [7], combining the first-differenced equations using suitably lagged levels as instruments, with levels equations using suitably lagged first-differences as instruments, the SYS-GMM estimator is expected to have much smaller finite sample bias and greater precision in the presence of persistent data.

Apart from the orthogonality conditions (6) and (7) stated above, the SYS-GMM estimator also makes use of the following moments for the period-specific constants due to the existence of global shocks:

$$E(\Delta y_{it} - \alpha \Delta y_{i,t-1} - \Delta x'_{i,t-1}\beta - \Delta\phi_t) = 0, \qquad (8)$$

$$t = 3, \dots, 6.$$

To avoid the possible over fitting bias associated with using the full Arellano and Bond [4] instrument set, this analysis uses restricted instrument sets suggested by Bowsher [11], who proposes to selectively reduce the number of moment conditions for each first-differenced equation. More specifically, we only use lagged values of y_{it} and x_{it} from $t-2$ to $t-4$ as instruments. Accordingly, for SYS-GMM estimators, the number of orthogonality conditions reduces to 31 in total, so that, there are 24 overidentifying restrictions. Another way to avoid the possible over fitting bias is the introduction of two additional versions of SYS-GMM discussed below.

4. Empirical Results

This section presents the SYS-GMM estimates for Equations (1) and (2). Two additional versions of SYS-GMM are also considered in order to circumvent over fitting, and the possibility that the mean stationarity assumptions may be incorrect. While SYS-GMM-1 only uses $\Delta y_{i,t-1}$ as instruments in levels, SYS-GMM-2 only uses $\Delta x_{i,t-1}$ as instruments in levels. The OLS and within group estimates are also reported. Conventional wisdom has revealed that, although both of them are inconsistent for short panels, the OLS and WG estimates of the first order autoregressive parameter act as two extremes of the interval, in which a consistent estimate of this parameter is expected to lie.[10]

Three specification tests are conducted to address the consistency of SYS-GMM estimator, which mainly depends on the validity of the instruments. The first is a serial correlation test, which tests the null hypothesis of no first-order serial correlation and no second-order serial correlation in the residuals in the first-differenced equation. The second is a Sargan test of overidentifying restrictions, which is used to examine the overall validity of the instruments by comparing the moment conditions with their sample analogue. A finite sample correction is made to the two-step covariance matrix using the method due to Windmeijer [28]. The third is a difference Sargan test, denoted by Diff-Sargan, proposed by Blundell and Bond [7], which examines the null hypothesis of mean stationarity for the SYS-GMM estimator. This statistic, called an incremental Sargan test statistic, is the difference between the Sargan

[10]Bond et al. [9] and Bond [10] illustrate that in principle, the first-differenced GMM estimates for the AR(1) coefficient should lie between the within group estimates (being downwards biased), and the OLS estimates (being upwards biased) from a straightforward pooled regression.

statistics for first-differenced GMM and SYS-GMM. It would be asymptotically distributed as a χ^2 with k degrees of freedom, where k is the number of additional moment conditions.

Table 1. Does private investment cause financial development? 1970-1998 (5-year-average data)

Dependent Variable FD_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$FD_{i,t-1}$	0.880	0.597	0.806	0.741	0.578
	[16.46]***	[8.32]***	[8.87]***	[6.87]***	[2.82]***
$PI_{i,t-1}$	2.785	5.091	5.286	6.745	3.779
	[5.08]***	[5.62]***	[4.27]***	[4.58]***	[2.21]**
*M*1 (*p*-value)			0.00	0.00	0.05
*M*2 (*p*-value)			0.89	0.92	0.69
Sargan (*p*-value)			0.36	0.24	0.44
Diff-Sargan (*p*-value)			0.87	0.76	1.00
Granger Causality (*p*-value)	0.00	0.00	0.00	0.00	0.03
LR effect point estimate	23.21	12.63	27.22	26.02	8.96
(Standard error)	[9.70]**	[2.84]***	[12.53]**	[9.04]***	[7.61]
Observations	212	212	212	212	212

Notes: 43 developing countries. Robust t statistics in brackets below point estimates. *, **, *** significant at 10%, 5%, 1%, respectively. The system GMM results are two-step estimates with heteroskedasticity-consistent standard errors and test statistics; the standard errors are based on finite sample adjustment of Windmeijer [28]. The *M*1 and *M*2 test the null of no first-order and no second-order serial correlation in first-differenced residuals. The Sargan tests, the overidentifying restrictions for GMM estimators, asymptotically x^2. The Diff-Sargan tests, the null of mean stationarity for system GMM estimators, in which SYS-GMM uses standard moment conditions, while SYS-GMM-1 only uses lagged first-differences of FD dated $t-1$ as instruments in levels and SYS-GMM-2 only uses lagged first-differences of PI dated $t-1$ as instruments in levels. The Granger causality test is used to examine the null hypothesis that private investment doesn't Granger-cause financial development. LR measures, the long-run effect of private investment on financial development. Its standard error is approximated using the delta method.

Table 1 presents the results for causality going from private investment to financial development. The OLS level and within group estimates for the lagged dependent variable form an interval, in which the system GMM estimates fall. The specification tests for three versions of SYS-GMM indicate that, we can reject the null that the error term in first differences exhibits no first-order serial correlation and cannot reject the hypothesis that there is no second-order serial correlation. The Sargan tests in three models do not signal the instruments are invalid. The difference Sargan for SYS-GMM cannot reject the null of the additional moment conditions being valid. These results indicate that every model from column 3 to column 5 is well-specified and the SYS-GMM estimator is indeed more preferable to the first-differenced GMM estimator for this context. SYS-GMM estimates provide strong evidence for the positive impact of private investment on financial development. This result is supported by the Granger-non-causality test, which clearly rejects the null hypothesis, suggesting that there is a causal effect going from private investment to financial development. The long run (LR) effect estimate of SYS-GMM indicates that this effect tends to persist into the long run. The SYS-GMM-1 estimates further confirm the findings, while SYS-GMM-2 estimates supports for the short-run effect only, but not the long-run effect. Moreover, SYS-GMM and SYS-GMM-1 estimates indicates that a high degree of persistence exists in the averaged data.

Table 2. Does financial development cause private investment? 1970-1998 (5-year-average data)

Dependent Variable: PI_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$PI_{i,t-1}$	0.744	0.232	0.521	0.490	0.424
	[14.04]***	[3.12]***	[4.27]***	[3.75]***	[3.00]***
$FD_{i,t-1}$	0.008	0.010	0.015	–0.008	0.022
	[2.09]**	[1.67]*	[2.32]**	[0.85]	[2.11]**
$M1$ (p-value)			0.00	0.01	0.01
$M2$ (p-value)			0.34	0.51	0.26
Sargan (p-value)			0.50	0.40	0.31
Diff-Sargan (p-value)			0.83	0.75	0.48
Granger Causality (p-value)	0.04	0.10	0.03	0.40	0.04
LR effect point estimate	0.03	0.01	0.03	–0.02	0.04
(Standard error)	[0.01]**	[0.01]*	[0.01]**	[0.02]	[0.01]**
Observations	198	198	198	198	198

Notes: 43 developing countries. The Granger causality test is used to examine the null hypothesis that financial development doesn't Granger-cause private investment. See Table 1, for more notes.

In Table 2, we turn to whether financial development Granger causes private investment. The specification tests indicate that the models associated with three types of SYS-GMM are well specified. More specifically, we can reject no first-order serial correlation, but cannot reject the hypothesis that there is no second-order serial correlation. Sargan tests and difference Sargan tests suggest that neither the instruments and mean stationarity conditions are invalid. Both SYS-

GMM and SYS-GMM-2 show a positive causal effect going from financial development to private investment, not only in the short-run but also in the long-run.

Both SYS-GMM-1 in Table 1, and SYS-GMM-2 in Table 2 produce consistent findings with their counterparts, respectively. However, using the lagged first-differences of PI dated $t-1$ as instruments in levels, SYS-GMM-2 in Table 1, and SYS-GMM-1 in Table 2 do not confirm the findings by their respective SYS-GMMs, especially, the latter, perhaps suggesting that the moment conditions using lagged first-differences of PI dated $t-1$ may not contain much information.

The SYS-GMM-1 and SYS-GMM-2 above potentially serve as the robustness tests to the SYS-GMM in two tables. In addition, a set of experiments are conducted to test, whether the above findings are robust to various model specifications. We firstly consider including GDP per capita in logs and trade openness separately as additional regressors, with results reported on Tables 3 and 4, respectively. Secondly, we introduce the second lags of dependent variable and independent variable into the related models and report the results in Table 5.

Table 3. Robustness test -- GDP in log included (5-year-average data)

A. Does private investment cause financial development? 1970-1998

Dependent Variable: FD_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$FD_{i,t-1}$	0.879	0.427	0.753	0.638	0.693
	[15.21]***	[5.46]***	[6.38]***	[6.14]***	[3.78]***
$PI_{i,t-1}$	2.744	3.845	5.692	6.007	4.679
	[4.17]***	[4.25]***	[6.70]***	[4.65]***	[3.13]***
$LGDP_{it}$	0.014	2.215	0.634	0.972	1.240
	[0.12]	[4.41]***	[1.30]	[1.73]*	[2.11]**
*M*1 (*p*-value)			0.00	0.00	0.02
*M*2 (*p*-value)			0.99	0.80	0.46
Sargan (*p*-value)			0.51	0.35	0.30
Diff-Sargan (*p*-value)			0.98	1.00	0.71
Granger Causality (*p*-value)	0.00	0.00	0.00	0.00	0.00
LR effect point estimate	22.61	6.71	23.04	16.58	18.26
(Standard error)	[11.89]*	[1.81]***	[10.81]**	[5.41]***	[11.57]
Observations	212	212	212	212	212

B. Does financial development cause private investment? 1970-1998

Dependent Variable: PI_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$PI_{i,t-1}$	0.698	0.186	0.512	0.498	0.352
	[10.95]***	[2.39]**	[5.19]***	[5.01]***	[3.28]***
$FD_{i,t-1}$	0.007	0.004	0.004	–0.013	0.012
	[1.74]*	[0.55]	[0.54]	[1.36]	[1.43]
$LGDP_{it}$	0.016	0.081	0.092	0.095	0.103
	[1.60]	[1.88]*	[3.34]***	[1.19]	[3.08]***
*M*1 (*p*-value)			0.00	0.00	0.01
*M*2 (*p*-value)			0.40	0.47	0.26
Sargan (*p*-value)			0.45	0.27	0.46
Diff-Sargan (*p*-value)			0.88	0.67	0.97
Granger Causality (*p*-value)	0.08	0.58	0.59	0.18	0.16
LR effect point estimate	0.02	0.00	0.01	–0.03	0.02
(Standard error)	[0.01]*	[0.01]	[0.01]	[0.02]	[0.01]
Observations	198	198	198	198	198

Notes: Log GDP is included in the models to test the robustness of the findings of Tables 1 and 2. See Table 1, for more notes.

In Table 3A, with GDP in log every model is still well-specified. Both SYS-GMM and SYS-GMM-1 estimates indicate the positive short-run and long-run effects of private investment on financial development. SYS-GMM-1 estimates also show a positive effect of GDP in log on financial development. SYS-GMM-2 estimates find that both *PI* and LGDP are significantly positively associated with *FD* in the short-run, but not in the long-run. In Table 3B, with GDP in log in the models SYS-GMM and SYS-GMM-2 estimates suggest that GDP in log enters the models significantly, while *FD* is no longer significant. GDP in log seems to pick up the short-run effects of financial development on private investment.

Table 4. Robustness test – OPENC lncluded (5-year-average data)

A. Does private investment cause financial development? 1970-1998

Dependent Variable: FD_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$FD_{i,t-1}$	0.863	0.565	0.734	0.764	0.478
	[15.15]***	[7.86]***	[8.31]***	[6.78]***	[3.22]***
$PI_{i,t-1}$	2.699	4.206	4.759	7.494	2.713
	[4.85]***	[4.36]***	[3.09]***	[4.21]***	[1.93]*
$OPENC_{it}$	0.124	0.746	0.603	–0.143	1.305
	[0.80]	[2.41]**	[1.28]	[0.23]	[3.50]***
*M*1 (*p*-value)			0.01	0.00	0.06
*M*2 (*p*-value)			0.92	0.90	0.90
Sargan (*p*-value)			0.32	0.25	0.36
Diff-Sargan (*p*-value)			0.25	0.09	0.30
Granger Causality (*p*-value)	0.00	0.00	0.00	0.00	0.06
LR effect point estimate	19.67	9.68	17.88	31.74	5.20
(Standard error)	[7.87]**	[2.59]***	[8.47]**	[14.33]**	[3.73]
Observations	212	212	212	212	212

B. Does financial development cause private investment? 1970-1998

Dependent Variable: PI_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$PI_{i,t-1}$	0.742	0.228	0.455	0.340	0.305
	[13.87]***	[2.82]***	[3.61]***	[2.24]**	[2.38]**
$FD_{i,t-1}$	0.008	0.010	0.013	–0.010	0.019
	[1.80]*	[1.60]	[1.75]*	[0.80]	[2.13]**
$OPENC_{it}$	0.002	0.004	0.018	0.071	0.029
	[0.15]	[0.14]	[0.55]	[1.00]	[0.83]
*M*1 (*p*-value)			0.01	0.01	0.02
*M*2 (*p*-value)			0.33	0.39	0.21
Sargan (*p*-value)			0.24	0.36	0.15
Diff-Sargan (*p*-value)			0.10	0.13	0.03
Granger Causality (*p*-value)	0.07	0.11	0.09	0.43	0.04
LR effect point estimate	0.03	0.01	0.02	–0.01	0.03
(Standard error)	[0.02]*	[0.01]	[0.01]*	[0.02]	[0.01]**
Observations	198	198	198	198	198

Notes: Trade openness (OPENC) is included in the models to test the robustness of the findings of Tables 1 and 2. See Table 1, for more notes.

In Table 4A, when *OPENC* is included the SYS-GMM estimates continue to show a positive effect of private investment on financial development, not only in the short-run, but also in the long-run. The model for SYS-GMM-1 is not well-specified. The SYS-GMM-2 estimates find that both *PI* and *OPENC* have been found to exert significantly positive effects on financial development in the short-run, but not in the long-run. In Table 4B, SYS-GMM estimates suggest that the inclusion of *OPENC* doesn't change the significantly positive effect of financial development on private investment, in both the short-run and the long-run.

Table 5. Robustness test -- 2 lags (5-year-average data)

A. Does private investment cause financial development? 1970-1998

Dependent Variable: FD_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$FD_{i,t-1}$	1.076	0.492	0.683	0.564	0.383
	[10.18]***	[5.07]***	[4.46]***	[2.95]***	[1.36]
$FD_{i,t-2}$	–0.194	–0.179	–0.216	–0.174	–0.079
	[1.67]*	[1.94]*	[1.54]	[1.17]	[0.67]
$PI_{i,t-1}$	3.647	4.767	5.735	7.524	5.605
	[3.75]***	[4.20]***	[2.85]***	[2.87]***	[2.88]***
$PI_{i,t-2}$	–1.118	3.385	3.305	3.983	2.812
	[1.00]	[2.88]***	[1.88]*	[2.55]**	[1.76]*
$M1$ (p-value)			0.02	0.09	0.37
$M2$ (p-value)			0.53	0.84	0.77
Sargan (p-value)			0.21	0.16	0.23
Diff-Sargan (p-value)			0.64	0.60	0.88
Granger Causality (p-value)	0.00	0.00	0.00	0.00	0.01
LR effect point estimate	21.5	11.87	16.96	18.89	12.09
(Standard error)	[11.94]*	[2.48]***	[6.36]**	[5.79]***	[5.52]**
Observations	169	169	169	169	169

B. Does financial development cause private investment? 1970-1998

Dependent Variable: PI_{it}	OLS	WG	SYS-GMM	SYS-GMM-1	SYS-GMM-2
$PI_{i,t-1}$	0.692	0.087	0.506	0.565	0.402
	[8.34]***	[0.99]	[4.24]***	[3.88]***	[2.82]***
$PI_{i,t-2}$	0.086	–0.081	–0.090	–0.038	–0.064
	[0.99]	[0.93]	[0.84]	[0.34]	[0.64]
$FD_{i,t-1}$	0.010	0.016	0.022	–0.003	0.027
	[1.30]	[2.09]**	[1.96]*	[0.25]	[2.08]**
$FD_{i,t-2}$	–0.004	0.002	–0.005	–0.002	–0.004
	[0.50]	[0.28]	[0.81]	[0.25]	[0.58]
*M*1 (*p*-value)			0.03	0.05	0.06
*M*2 (*p*-value)			0.14	0.16	0.08
Sargan (*p*-value)			0.61	0.47	0.45
Diff-Sargan (*p*-value)			0.54	0.27	0.25
Granger Causality (*p*-value)	0.20	0.03	0.09	0.73	0.10
LR effect point estimate	0.03	0.02	0.03	–0.01	0.03
(Standard error)	[0.02]	[0.01]**	[0.01]**	[0.03]	[0.01]**
Observations	155	155	155	155	155

Notes: AR(2) models are considered to test the robustness of the findings of Tables 1 and 2. See Table 1, for more notes.

In Table 5, we investigate the causality with AR(2) models. Models for SYS-GMM and SYS-GMM-1 in both Tables 5A and 5B are well-specified, as supported by the specification tests. Both SYS-GMM and SYS-GMM-1 estimates in Table 5A continue to support the first lag of *PI* to enter the models significantly; in addition, the second lag of *PI* is also observed to be significantly associated with financial development. The second lag of *FD* has been found insignificant in the models. The SYS-GMM estmates in Table 5B show that the first lag of *PI* remains significantly positive, however, the second lag of the *FD* and *PI* are insignificant.

At least, the robustness tests suggest that the inclusion of trade openness in the models doesn't affect the pattern of the findings in Tables 1 and 2, and nor does the inclusion of second lags of dependent variable and independent variable in the models.

In summary, by using the system-GMM estimation method on averaged data over 1970-1998, and controlling for the possibility of endogeneity bias and omitted variable bias, this analysis finds that the positively significant causation exists in both directions between private investment and financial development for 43 developing countries. It also indicates a high degree of persistence in the averaged data. The findings are robust to various estimation methods and model specifications.

5. Conclusion

This paper aims to investigate the causality between aggregate private investment and financial development. Using a panel data set with 43 developing countries over 1970-98, the analysis conducts system GMM estimation on data for 5-year averages, indicating positive causal effects going in both directions and a high degree of persistence in the averaged data of private investment and financial development. The paper implies that private investment is both an engine and a follower of financial development, and vice versa.

The finding in terms of a positive effect of private investment on financial development has rich implications for the development of financial markets. It may also shed light on a possible channel through which other variables drive financial development, for example, the effect of democracy and political stability on the speed of financial development (Girma and Shortland [16]). The finding on better financial development leading to a private investment boom contributes to the existing body of research on the links between financial development and economic growth, by suggesting that financial development may enhance economic growth through a private investment boom. This finding suggests that financial markets may well be the channel through which macroeconomic volatility or downturn leads to declines in private investment, which is consistent with what has happened during the 2007-2009 financial crisis.

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