Financial Sector Development & Growth: Re-examining the Nexus

By

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ABSTRACT
The paper tries to delve deeper into the relationship between financial sector development, broadly defined to go beyond financial deepening, and economic growth by using a new database including 65 countries (both industrial and developing ones) over the period 1960-99 and by also exploring new routes regarding the measurement of financial sector development. Empirical results obtained from the estimation of dynamic panel data models using various GMM estimators seem to suggest that financial sector development contributes to economic growth although the magnitude of the impact varies depending inter alia on the level of development (industrial vis-à-vis developing countries).

Key words: Financial sector development, growth, industrial countries, developing countries, dynamic panel data models, GMM estimators.

JEL classification: E44, O16.

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1. Introduction

The overall nexus between finance and economic growth has been the subject of a rather voluminous literature, both theoretical and empirical, which goes back to the seminal contribution by Goldsmith (1969) as well as the money-growth literature of the 1960s, in particular, Gurley and Shaw (1960), Tobin (1965) and Patrick (1966). A further interest in the above relationship appeared in the early 1970s following the influential works of McKinnon (1973) and Shaw (1973) and the associated with financial repression literature.1

The 1990s have witnessed a revived interest in the above relationship although the focus of much of the recent literature on the subject has been on the interaction between financial sector development (broadly defined to go beyond financial liberalization) and economic growth. The turning point was the study by King and Levine (1993a) which relaunched the finance and growth literature by placing a new emphasis on financial depth as an important determinant of the overall growth process, and the study by Wachtel and Rousseau (1995) reporting important evidence on the above relationship from long time series for several countries. Since then a series of studies were published on the finance-growth nexus (Wachtel 2004, provides an excellent discussion). Yet a number of issues remain unresolved and call for further research.

On the empirical front, much of the empirical literature has used cross-section analysis to examine the macroeconomic association between the development of the financial sector of the economy and the long-term growth rate. The cross-section approach has been used by many studies, including Wallich (1969), Fry (1980), Khatkhate (1988), Barro (1991), Roubini and Sala-i-Martin (1992a), Atje and Jovanovic (1993), Quah (1993), King and Levine (1992,1993a) and Pill (1997) among others. However, despite its popularity the cross-section approach adopted in much of the above literature has certain limitations and shortcomings. In terms of measurement problems, country officials sometimes define, collect and measure variables inconsistently across countries (Levine and Zervos, 1996). In addition, the above approach regresses the average data of sampled countries over a certain period, and thus, can only reveal the ‘average effect’ of a variable across countries. However, it is reasonable to expect the effects to be rather different across countries. Furthermore, it is not only likely that the long-run causality may vary across countries but it is also possible that the long-run relationships themselves will exhibit substantial variation (Arestis and Demetriades, 1997).

Another issue of crucial importance as well as of relevance to the above relationship is the measurement of financial sector development. Since there is no concrete definition of financial development, measuring financial sector development is not an easy procedure.

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As argued quite rightly by Bandiera et al. (2000), an ideal index of financial sector development should attempt to measure both the various aspects of the deregulatory and the institution-building process in financial sector development. However, measuring the above aspects is a difficult if not an impossible task. Various measures of financial sector development have been used in empirical work in the recent past. Common measures of financial development used in the literature have been financial depth or selected financial indicators. Financial depth in particular has been used extensively in much of the early as well as recent literature as a measure of financial sector development. However, it could be well argued that when one considers the likely channels through which a more developed financial system helps promote growth it becomes rather evident that, though quite useful and readily available, banking depth (usually measured as M2/GDP or M3/GDP) is unlikely to be a wholly reliable indicator of financial sector development (see Honohan, 2004, for an excellent recent discussion on this issue).

In view of the above discussion, the main purpose of the present paper is to try to contribute to the empirical literature on the relationship between financial sector development and economic growth by adopting a different approach compared to most of the previous studies on the subject. Our contribution has three main elements: Firstly, we use in our empirical analysis a new panel data set composed of 2535 observations from the adjusted data for 65 countries (both developed and developing ones) over the 1960-99 period, which, to the best of our knowledge, is a larger data set than most of the previous studies on the topic. Our database, which is constructed on the basis of the World Bank database (described in detail in Beck et al., 1999), is a fresh attempt to extend and develop the database on financial development and structure. Secondly, the paper is a clear departure from much of the empirical literature on the subject since it employs different measures of financial sector development instead of using only the standard (but at the same time problematic) financial depth indicator; more precisely, we constructed a financial sector development index, using the method of principal components, which was subsequently used in the econometric analysis. Finally, in the econometric analysis we employed relatively recently developed econometric estimators related to the estimation of dynamic panel data models such as the GMM two-step estimator and the GMM system-estimator; furthermore, we conducted sensitivity analysis to test the robustness of the empirical results obtained.

The rest of the paper is organized as follows: section 2 discusses issues related to the measurement of financial sector development, of crucial importance in the present paper, as well as data issues before we proceed with econometric methodology issues and the estimation of the econometric models in section 3. Section 4 concludes the paper.

2. Data Issues

2.1 Measuring Financial Sector Development: Exploring New Routes

As already mentioned, a number of studies have studied the relationship between financial development and economic growth. Nevertheless, the term ‘financial
development’ has not yet received a concrete definition. This is mainly due to the fact that the financial structure is not only quite complicated in an economy, but also has evolved differently in the development process of different countries. Goldsmith (1969) long ago pointed out that “financial development is a change in financial structure; hence, the study of financial development essentially requires information on changes in the financial structure over shorter or longer periods of time. Financial development can be studied either by information on the flows of financial transactions over continuous periods of time or by the comparison of financial structure at different points of time”.

More recently Beck, Demirguc-Kunt, and Levine (1999) presented a comprehensive assessment of the development, structure and performance of the financial sector, and introduced the sources of statistics on the size, activity and efficiency of various financial intermediaries and markets across a broad spectrum of countries and through time. This paper employs some measures of financial sector development suggested by Beck et al. (1999) but in the context of our new dataset.

To capture the measure of size of financial intermediaries we use, in line with Beck et al. (1999), the ratio of deposit money bank domestic assets to deposit money bank domestic assets plus central bank domestic assets (hereafter, Commercial-Central Bank, or CMB). This indicator measures the relative importance of deposit money banks relative to central banks. This indicator is persuasive in as much as central banks lose relative importance as one moves from low to high-income countries, and the other financial intermediaries gain relative importance. Thus a measure of the relative size of financial intermediaries is a useful indicator of development.

As another measure of the size of financial intermediaries Beck et al. (1999) proposed the ratio of liquid liabilities to GDP. In the present paper, Liquid Liabilities (hereafter \( LQ \)) equals currency plus demand and interest-bearing liabilities of banks and other financial intermediaries divided by GDP. Liquid Liabilities has been a typical measure of financial depth, which is the broadest available indicator of financial intermediation, including all financial sectors of central bank assets, deposit money banks assets, and other financial institutions assets.

In order to measure the activity of financial intermediaries, following Beck et al. (1999), we employ the ratio of private credit by deposit money banks and other financial institutions to GDP (hereafter, Private Credit or \( PCR \)). This indicator isolates credit issued to the private sector as opposed to credit issued to governments and public enterprises; thus, it measures the mobilized savings that are channeled to private firms.

These financial variables can capture different aspects of the financial sector development process as compared to a simple financial depth indicator thus they are more appropriate to study the finance-growth relationship. However, we still need an eclectic indicator to capture in a comprehensive way all kinds of changes in financial sector in terms of activity, structure and size, rather than separate variables dealing with single aspects, respectively. In view of this, in this paper we constructed, by using
principal component analysis, a Financial Sector Development Index (hereafter FSDI), which is the linear combination of the financial indicators \( PCR, CMB \) and \( LQ \):

\[
Z_{1t} = a_{1i} \cdot PCR_{it} + a_{2i} \cdot CMB_{it} + a_{3i} \cdot LQ_{it}
\]

where \( Z_{1t} \) is the first principal component and coefficient vector \((a_{1i}, a_{2i}, a_{3i})\) calculated from the time-series data for each country. Hence, FSDI is our main financial sector development indicator to encompass the three financial indicators previously discussed.\(^2\)

2.2 Financial and Other Variables

All raw data for the variables used in the empirical analysis have been obtained from the electronic version 2001 of the IMF’s *International Financial Statistics* and the electronic version 2001 of World Bank’s *World Development Indicators*, except Ethiopia’s GDP data which was obtained from UN’s *Yearbook of National Accounts*. The raw data set covers 65 countries over the period 1960-1999 (40 years), but the time span of data employed after adjustment is 1961-99 (39 years) for 65 countries.\(^3\) The raw data can be distinguished into two main groups: stock variables and flow variables. Whereas stock variables are measured at the end of a period, flow variables are defined relative to a period. This presents problems in measuring both in terms of correct timing and in terms of deflating correctly. To address the above problems a data adjustment process is required.

Regarding data adjustment we used the method proposed by Beck, Demirguc-Kunt and Levine (1999) and Beck, Levine and Loayza (1999). More precisely, we deflated the end-of-year financial balance sheet items \( f \) by the end-of-year consumer price indices (CPI) and also deflated the GDP series by the annual CPI. Then, we computed the average of the real financial balance sheet item in year \( t \) and \( t-1 \) and divided the average by real GDP measured in year \( t \). Accordingly, Private Credit \( (PCR) \) is calculated using IFS data and the following formula:

\[
PCR_{it} = \{(0.5)*[f_{it}/CPI(e)_{it} + f_{i,t-1}/CPI(e)_{i,t-1}]/[GDP_{it}/CPI(a)_{it}]\}
\]

where, \( f \) stands for credit by deposit money banks and other financial institutions to the private sector (IFS lines 22d +42d), \( GDP \) is from IFS (line 99b), \( CPI(e) \) is end-of-period CPI (IFS line 64) and \( CPI(a) \) is the average annual CPI. The \( f \) and end-of-period CPI are either the value for December or, where not available, the value for the last quarter. In

\(^2\) The method of principal components involves transforming the sub-variables into a new set of variables which will be pairwise uncorrelated and of which the first will have the maximum possible variance, the second the maximum possible variance among those uncorrelated with the first, and so forth. This approach has also been used by Demetriades and Luintel (1996), Bandiera *et al.* (2000) and Kelly and Mavrotas (2003) although not in the context of panel data analysis.

\(^3\) See Appendix for a list of countries included in the sample.
case the end-of-period CPI in 1960 and 1961 is not available, the average annual CPI is used. In addition, some data on CPI were estimated using the average annual increase rate of the following 3 years\(^4\), where CPI data in the early 1960s are missing or not available. It is useful to note that the data from 1999 in Euro-zone countries are reported in Euro currency, so the data were converted to the equivalent values in national currency.

Commercial-Central Bank (CMB), which is the ratio of commercial bank domestic assets divided by commercial bank plus central bank domestic assets, is calculated using IFS data and the following formula:

\[
(3) \quad CMB_{it} = DB_{it} / [DB_{it} + CB_{it}]
\]

where \(DB\) is assets of deposit money banks (IFS lines 22a-d) and \(CB\) is central bank assets (IFS lines 12a-d).

The data on Liquid Liabilities (LQ) is obtained from ‘liquid liabilities (M3) as percent of GDP’ in the World Development Indicators 2001 of the World Bank. If the data from the World Bank were not fully available for the period of 1961-99 we used money and quasi-money (M2), which is calculated using IFS data and the following formula:

\[
(4) \quad LQ_{it} = \{(0.5) *[ m_{it}/CPI(e)_{it} + m_{i,t-1}/CPI(e)_{i,t-1} ]/[GDP_{it}/CPI(a)_{it}]\}
\]

where \(m\) is money (IFS line 34) plus quasi-money (IFS line 35), \(GDP\) (IFS line 99b), \(CPI(e)\) is end-of-period CPI (IFS line 64), and \(CPI(a)\) is the average annual CPI.

As already discussed, the Financial Sector Development Index (FSDI) is calculated as the linear combination of the financial indicators PCR, CMB and LQ by using principal component analysis. Under the assumption of heterogeneity across countries we estimated coefficients of the principal components for each country in our sample.\(^5\)

**The Set of Conditioning Variables**

To explore the link between financial sector development and the growth variables we also use a set of conditioning variables containing the other explanatory variables in the growth model. Under the open economy assumption, the conditioning information set includes the basic input variables, control and policy variables as well as open economy variables.

The basic input variable is related to scale effects i.e. that an expansion of the aggregate labour force, \(L\), raises the per capita growth rate for the economy in the endogenous growth model. In particular, under the assumptions of learning-by-doing and knowledge

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\(^4\) The employed method of estimation is \(\text{CPI}(t) = \text{CPI}(t+1)/(\text{CPI}(t+4) / \text{CPI}(t+1))^{1/3}\).

\(^5\) Thus, for instance, the financial sector development index of Australia is calculated as:

\[
FSDI_{AUS,t} = 0.5297PCR_{AUS,t} + 0.5020CMB_{AUS,t} + 0.5927LQ_{AUS,t}
\]

where the coefficient vector of the first principal component is calculated from the time-series data of Australia.
spillovers, the per capita growth rate would increase over time as the labour force grows over time. We consider a simple neoclassical production function with labour-augmenting technology for firm \(i\); \(Y_i = F(K_i, A_iL_i)\), where \(A_i\) is the index of knowledge available to the firm. Under the assumptions of learning-by-doing and knowledge spillovers\(^6\), the change in each firm’s technology term, \(A_i\), corresponds to the economy’s overall learning and is proportional to the change in the aggregate capital stock, \(K\). Thus, we can replace \(A_i\) by \(K\) in the above equation, and if the production function takes the Cobb-Douglas form, then, output for firm \(i\) is given by:

\[
Y_i = A \cdot (K_i)^\alpha \cdot (KL_i)^{1-\alpha}.
\]

The private marginal product of capital can be obtained by differentiating with respect to \(K_i\), and assuming \(k_i = k\);

\[
\frac{\partial Y_i}{\partial K_i} = A \alpha L^{1-\alpha}.
\]

A firm’s profit can be written as:

\[
L_i \cdot [f(k_i, K) - (r + \delta) \cdot k_i - w]
\]

where \(f(\cdot)\) is the intensive form of the production function (12), \(\delta\) is the depreciation rate, \(r + \delta\) is the rental price of capital and \(w\) is wage rate. Profit maximization and zero-profit condition imply:

\[
\frac{\partial Y_i}{\partial k_i} = f(k, K) = r + \delta, \text{ or } r = \frac{\partial Y_i}{\partial K_i} - \delta
\]

Substituting (15) into the condition for optimization, \(\gamma_c = (1/\theta)(r-\rho)\), then from the Keynes-Ramsey rule:

\[
\gamma_c = (1/\theta) \cdot (A \alpha L^{1-\alpha} - \delta - \rho),
\]

where \(\gamma_c\) equals growth rate, \(\theta\) is the elasticity of marginal utility and \(\rho\) is the rate of time preference. Therefore, this result reflects the positive effect of \(L\) on the private marginal product of capital by satisfying the condition of \(f'(L) >0\), and an expansion of labour force raises the per capita growth rate (Barro and Sala-i-Martin, 1995). Data on the variable representing Scale Effects (SE) are obtained from ‘Labour force, total’ in the World Development Indicators 2001.

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\(^6\) First, learning-by-doing works through each firm’s investment. Specifically, an increase in a firm’s capital stock leads to a parallel increase in its stock of knowledge. Second, each firm’s knowledge is a public good that any other firm can access at zero cost. In other words, once discovered, a piece of knowledge spills over instantly across the whole economy. This assumption allows us to replace \(A_i\) by \(K\).
Control and Open Economy Variables

The control variables employed in the empirical analysis are the two policy variables, i.e. the inflation rate \((INFL)\) and the ratio of government expenditure to GDP \((GEXP)\) as indicators of macroeconomic stability in the growth equation (although the latter could also be viewed as a measure of private sector activity). The data source for both variables is the World Development Indicators. Under the assumption of an open economy, our conditioning information set includes two open economy variables: Openness to Trade \((OTR)\) and Foreign Direct Investment \((FDI)\). The variable \(OTR\) is the sum of exports and imports as share of GDP. Data on Trade Openness are obtained from IFS (IFS lines 90c+98c).

The theoretical foundation regarding the effects of FDI on growth derives from either neo-classical models or endogenous growth models. In neoclassical models of growth, FDI increases the volume of investment and its efficiency, and leads to long-term level effects and medium-term, transitional increases in growth. Endogenous growth models on the other hand consider long-run growth as a function of technological progress, and provide a framework in which FDI can permanently increase the rate of growth in the host economy through technology transfer, diffusion, and spillover effects. The data on \(FDI\) are obtained from ‘Foreign direct investment, net inflows (% of GDP)’ in the World Development Indicators 2001 of the World Bank.

3. Econometric Methodology and Results

3.1 Empirical Model

Static panel data models analyse the impact of financial development on growth at a certain time period. However, it might seem more persuasive to argue that financial development affects economic growth over a number of periods, and growth responds to financial development with a time lag. This is quite plausible in our analysis with regard to financial and monetary variables. We consider the following simple distributed-lag model:

\[
Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \ldots + \epsilon_t.
\]

where \(Y\) denotes economic growth and \(X\) represents a set of financial variables and the other independent variables. For the sake of simplicity we can introduce the Koyck approach that the \(\beta\)'s are all of the same sign and decline geometrically as \(\beta_i = \beta_0 \delta^i (i = 0,1,2\ldots)\), where \(0<\delta<1\). The result implies that current and recent financial developments are expected to affect the current growth rate more heavily than ones in the distant past. In line with the Koyck transformation, we take:

\[
Y_t = \alpha (1-\delta) + \delta Y_{t-1} + \beta_0 X_t + \nu_t
\]

where \(\nu_t = u_t - \delta u_{t-1}\). For our analysis with panel data we rewrite equation (11) to specify an autoregressive panel data model as follows:
\[ y_{it} = y_{i,t-1} \delta + X_{it} \beta_k' + \varepsilon_{it}, \]
\[ \varepsilon_{it} = \mu_i + v_{it}, \]
\[ k = 2, \ldots, K; i = 1, \ldots, N; t = 1, \ldots, T \]

where \( y \) represents per capita real GDP growth, \( X \) is a \((K-1) \times 1 \) row vector of the ‘independent’ variables which includes \( FSDI, SE, GEXP, INFL, OTR, FDI \), \( \delta \) is a scalar, \( \beta \) is the \((K-1) \times 1 \) column vector of the slope parameters, \( \mu_i \) is an unobserved country-specific time-invariant effect which allows for heterogeneity, and \( v_{it} \) is the disturbance term.

Economic relationships are dynamic in nature, and one of the advantages of dynamic panel data models is that they allow the researcher to delve deeper into the dynamics of adjustment. The dynamic relationship is characterized by the presence of lagged dependent variables among the regressors. However, the inclusion of a lagged dependent variable among the regressors causes autocorrelation problems since the lagged dependent variable is correlated with the error term. This renders the OLS estimator biased and inconsistent even if the error terms are not serially correlated. For the fixed effects estimator, the within groups transformation wipes the individual effects, but \((y_{i,t-1} - y_{i,t-1})\) will still be correlated with \((v_{i,t} - v_{i})\) even if the \( v_{it} \) are not serially correlated. This is because \( y_{i,t-1} \) is correlated with \( v_{it} \) by construction. The same problem occurs with the random effects GLS estimator. In view of the above problems and in order to obtain consistent and efficient estimators for dynamic panel data models, in the present paper we use the econometric methodology developed by Arellano and Bond (1991), Arellano and Bover (1995), Ahn and Schmidt (1995) and Blundell and Bond (1998).

### 3.2 Two-step GMM Difference Estimator

Arellano and Bond (1991) have proposed a methodology for obtaining more efficient estimators once the model has been differenced, by using all the orthogonality conditions that exist between the lagged values of \( y_i \) and the disturbances \( v_{it} \). They suggest that, if the \( X_{it} \) are strictly exogenous in the model with exogenous variables, the moment conditions are:

\[(13) \quad E(y_{i,t-s} \Delta v_{it}) = 0; \text{ for } t = 3, \ldots, T \text{ and } 2 \leq s \leq t-1 \]
\[(14) \quad E(X_{is} \Delta v_{it}) = 0; \text{ for } t = 3, \ldots, T \text{ and } 1 \leq s \leq T. \]

and the valid instruments are \( Z_i = diag[y_{i1}, \ldots, y_{is} X_{i1}', \ldots, X_{iT}'] \). \((s = 1, \ldots, T-2)\). That is,

\[
Z_i = \begin{bmatrix}
[y_{i1} X_{i1}'] & 0 \\
y_{i2} X_{i2}' & [y_{i1} y_{i2} X_{i1} X_{i2}'] \\
\vdots & \vdots \\
0 & [y_{i1} \ldots y_{iT-2} X_{i1} \ldots X_{iT}']
\end{bmatrix}
\]
Using these instruments we obtained the empirical results based on the one-step GMM estimator reported in Table 1. The results show that most one-step estimates are insignificant.

On the other hand, when we relax the assumption of strict exogeneity of the explanatory variables, and adopt instead the assumption that all the explanatory variables are weakly exogenous, the valid instruments set is now:

\[ Z_i = \text{diag} [y_{i1}, ..., y_{is}, X_{i1}', ..., X_{is+s-1}'], (s = 1, ..., T-2). \]

In this case the moment conditions are:

\[(13, \text{again}) \quad E(y_{i,t-s} \Delta v_{it}) = 0; \text{ for } t = 3, ..., T \text{ and } 2 \leq s \leq t-1 \]

\[(15) \quad E(X_{i,t-s} \Delta v_{it}) = 0; \text{ for } t = 3, ..., T \text{ and } 1 \leq s \leq t-1. \]

Using this set of instruments we performed the GMM estimation and obtained the two-step GMM estimator results also reported in Table 1. The two-step estimates for \( Y_{t-1}, \) \( FSDI, \) \( GEXP, \) \( INFL \) become significant at the 1% level. The improvement (as compared to the one-step results) is due to minimizing the asymptotic variance, resulting in more efficient GMM estimators.\(^7\)

### 3.3 GMM System Estimator

Blundell and Bond (1998) have argued that, when the lagged dependent and the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. The instruments’ weakness has repercussions on both the asymptotic and small-sample performance of the difference estimator. As the variables’ persistence increases, the asymptotic variance of the coefficients obtained with the difference estimator rises, so that the asymptotic precision of this estimator deteriorates.\(^8\) Furthermore, according to Griliches and Hausman (1986), differencing may exacerbate the bias due to errors in variables by decreasing the signal-to-noise ratio, so that the simple difference estimator may be affected by measurement errors (Levine, Loayza and Beck, 2000). In order to deal with these concerns, Blundell and Bond (1998) suggest the use of Arellano and Bover’s (1995) system estimator, which reduces the potential biases and imprecision associated with the usual difference estimator.

In view of this, in what follows we employ the GMM system estimator for the estimation of the model using again the same dataset. Arellano and Bover (1995) present an estimator that combines the regression in differences with the regression in levels. The instruments for the regression in differences are the same as above, and the moment conditions in equations (13) and (14) apply to the first part of the system, \( i.e., \) the regression in differences. The instruments for the regression in levels are the lagged

\(^7\) It has been shown that the asymptotic standard errors associated with the two-step estimates are generally around 30% lower than those associated with one-step estimates (Arellano and Bond, 1991).

\(^8\) They show the result of Monte Carlo experiments, namely, that the weakness of the instruments produces biased coefficients in small samples. This bias is exacerbated with the variables’ over time persistence, the importance of the specific-effect, and the smallness of the time-series dimension.
differences of the corresponding variables. The additional moment conditions in the second part of the system, i.e., the regression in levels, are given as follows:

\[(16) \quad \mathbb{E}[(\Delta y_{i,t-s} \cdot \varepsilon_{it}) = 0; \text{ for } s = 1,\]

\[(17) \quad \mathbb{E}[(\Delta X_{i,t-s} \cdot \varepsilon_{it}) = 0; \text{ for } s = 1,\]

where \( \varepsilon_{it} = \mu_i + v_{it} \). Thus, the additional valid instruments \( Z_{yi} = \text{diag} [\Delta y_{i1}, \ldots, \Delta y_{iT-1}] \) are available for \( y_{t-1} \). Under the assumption of strict exogeneity of the explanatory variables, \( Z_{zi} = [X_{i1}', \ldots, X_{iT-1}'] \), where \( X_{it} = X_{it} - \bar{X}_i \) and \( \bar{X}_i = \frac{X_{it}}{T} \), are additional valid instruments for the second equation of the transformed system. Therefore, the range of choices for valid instruments for the explanatory variables are \( Z_{xi} = [X_{i1}', \ldots, X_{iT-1}', \bar{X}_i', \ldots, \bar{X}_{iT-2}'] \), which is a Breusch, Mizon and Schmidt (BMS) - type estimator.

The moment conditions in equations (13), (14), (16) and (17) can be expressed more compactly as:

\[(18) \quad E(Z_{si}' q_i) = 0,\]

where:

\[
Z_{si}' = \begin{bmatrix} Z_{di} & 0 \\ 0 & Z_{li} \end{bmatrix}, \quad q_i = \begin{bmatrix} \Delta \varepsilon_i \\ \varepsilon_i \end{bmatrix}
\]

with \( Z_{di} = \text{diag} [y_{i1}, \ldots, y_{iT}, X_{i1}', \ldots, X_{iT-1}'] \), \( (s = 1, \ldots, T-2) \) and \( Z_{li} = \text{diag} [\Delta y_{i2}, \ldots, \Delta y_{iT-1}] \). Using these moment conditions with the GMM procedure, we can obtain the system estimator. The system GMM estimator is a combination of the GMM differenced estimator and a GMM levels estimator. This combination is linear for the system GMM estimators which are given by:

\[(19) \quad \left( \begin{array}{c} \delta \\ \beta \end{array} \right) = (q'Z_{s}Z_{s}^{-1}Z_{s}'q'^{-1})^{-1}(q'Z_{s}Z_{s}^{-1}Z_{s}'q)\]

In this case we use the instrument set of \( Z_{di} = \text{diag} [y_{i1}, \ldots, y_{iT-2}, X_{i1}', \ldots, X_{iT-2}'] \) and \( Z_{li} = \text{diag} [\Delta y_{i2}, \ldots, \Delta y_{iT-1}] \) to obtain the empirical results also reported in Table 1.

Overall, the reported results are satisfactory. All the coefficients for independent variables are statistically significant at the 1% level, except \( GEXP \) which significant at the 10% level. The coefficient for the financial variable \( FSDI \) is positive, and all the other estimates have the expected signs. The value of \( R^2 \) is also very high.
Table 1: GMM Estimation Results (Full Sample)

<table>
<thead>
<tr>
<th>Dependent variable y_it</th>
<th>Regressors</th>
<th>GMM-diff</th>
<th>System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>GMM1</td>
<td>GMM2</td>
</tr>
<tr>
<td>y_{i,t-1}</td>
<td>0.392325</td>
<td>0.516243</td>
<td>0.471444</td>
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<tr>
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<td>(0.0361)</td>
<td>(0.0000)</td>
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<td>FSDI</td>
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<td>0.042388</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>(0.8869)</td>
<td>(0.7206)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>GEXP</td>
<td>-0.926085</td>
<td>-1.088344</td>
<td>-0.069733</td>
</tr>
<tr>
<td></td>
<td>(0.0810)</td>
<td>(0.0001)</td>
<td>(0.0932)</td>
</tr>
<tr>
<td>INFL</td>
<td>-0.001866</td>
<td>-0.001827</td>
<td>-0.000166</td>
</tr>
<tr>
<td></td>
<td>(0.2043)</td>
<td>(0.0038)</td>
<td>(0.0018)</td>
</tr>
<tr>
<td>OTR</td>
<td>-0.014773</td>
<td>-0.005337</td>
<td>0.126457</td>
</tr>
<tr>
<td></td>
<td>(0.8889)</td>
<td>(0.8846)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>FDI</td>
<td>0.000299</td>
<td>0.000687</td>
<td>0.003675</td>
</tr>
<tr>
<td></td>
<td>(0.8590)</td>
<td>(0.2765)</td>
<td>(0.0005)</td>
</tr>
<tr>
<td>Sargan</td>
<td>45.03[734]</td>
<td>35.23[734]</td>
<td>37.44[734]</td>
</tr>
<tr>
<td>Dif-Sargan</td>
<td>-</td>
<td>-</td>
<td>37.44[37]</td>
</tr>
<tr>
<td>Serial</td>
<td>-0.2258(a)</td>
<td>0.1834(b)</td>
<td></td>
</tr>
<tr>
<td>Correlation</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0.0001(b)</td>
<td>0.5821(b)</td>
<td></td>
</tr>
<tr>
<td>RMSE</td>
<td>0.0164</td>
<td>0.0218</td>
<td>0.7817</td>
</tr>
<tr>
<td>no. of Obs.</td>
<td>2535</td>
<td>2535</td>
<td>2535</td>
</tr>
</tbody>
</table>

Notes: (i) Parentheses report p-values of t-statistics. (ii) Sargan test reports the $\chi^2$-statistic with degrees of freedom in [  ]. (iii) Serial correlation tests: (a) $m_2$ statistic; the null hypothesis is that the errors in the first-differenced regression exhibit no second-order serial correlation; their signs indicate the sign of the estimated autocorrelation coefficients in the residuals; (b) p-value of t-statistics of coefficient for $v_{t-2}$ in regressing $v_t$ on $v_{t-1}$, $v_{t-2}$, and $X$. (iv) RMSE: root mean squared error. (v) The estimates were derived using RATS.

3.4 Robustness Checks (Sensitivity Analysis)

The consistency of the GMM estimator depends on whether lagged values of $Y$ and $X$ are valid instruments in the growth regression. To address this issue, first, we consider a Sargan test of overidentifying restrictions which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. The relevant test statistic is given by:
\[ S = \Delta v' Z \left[ \sum_{i=1}^{N} Z'_i (\Delta v)_i Z_i \right]^{-1} Z' \Delta v \text{ asy } \sim \chi^2(p-k) \]

where \( p \) refers to the number of moment conditions and \( k \) is the number of parameters to be estimated. In general, under the null that the moment conditions are valid, \( S \) is asymptotically chi-squared distributed with \( p-k \) degrees of freedom.

Ahn and Schmidt (1995) show that the maximum number of orthogonality conditions for GMM estimation is \( T(T-1)/2 + (T-2) \), which represents all the moment conditions implied by the assumptions that the \( \nu_{it} \) are uncorrelated among themselves and with \( \mu_i \) and \( \gamma_{i0} \). The \( T(T-1)/2 \) moment conditions are the orthogonality conditions of \( E(\nu_{it} \Delta \nu_{it}) = 0 \) in the first-differenced equation, while \( (T-2) \) is the orthogonality conditions of \( E(\nu_{it} \Delta \nu_{it}) = 0 \) in the level equation.\(^9\) The 1 percent critical value for the chi-squared distribution even with 100 df is 135.81. Hence, the null of hypothesis that the instruments are valid is not rejected at any level of significance.

For the system estimators, the Difference Sargan (DS) tests are also used to test the validity of the level moment conditions that are utilized by the system estimators. The DS statistic is obtained as the difference between the \( S \)-statistic in the system model and that in the differenced model. DS is asymptotically chi-squared distributed with \( (p_s-k)-(p_d-k) \) degrees of freedom under the null that the level moment conditions are valid. In our case the relevant statistic \( DS = 37.44 \) with 37 df \((p-value = 0.4488)\) thus, it does not reject the null hypothesis at any level.

Arellano and Bond (1991) have proposed a test for the hypothesis that there is no second-order serial correlation for the disturbances of the first-differenced equation. The test is important because the consistency of the GMM estimator relies on the assumption that \( E[\Delta \nu, \Delta \nu_{t-2}] = 0 \). The \( m_2 \) test statistic of Arellano and Bond (1991) takes the form:

\[
(21) \quad m_2 = \left[ \hat{v}^{-2}, \hat{v}^* \right] \hat{v}^{-1/2} \sim N(0,1),
\]

where \( v \) is a vector of residuals, \( v^{-2} \) is the vector of residuals lagged twice, and \( \hat{v}^* \) is the vector of trimmed \( v \) to match \( v^{-2} \). This test statistic is the standardised second-order residual autocovariances (Bond, 2002). In the present paper we calculate the value of the statistic expressed as \( m_2 = \text{cov}(\hat{v}^{-2}, \hat{v}^*) / \text{var}(\hat{v}) \). The test results do not reject the null of no second-order serial correlation in all cases\(^{10}\). In addition, we test the null hypothesis by using the \( t \)-statistic of coefficient for \( v_{t-2} \) in regression \( v_t \) on \( v_{t-1}, v_{t-2} \) and \( X \). The result

\(^9\) When the homoskedasticity restriction is available, the number of moment conditions is \((T-2)\). However, we allowed the error term to be heterogeneous in our specification, so that, there are \( T(T-1)/2 \) restrictions in the first-differenced equation and \( T-2 \) in the level equation. Hence, in our case of \( T=39 \), the number of df for the two-step GMM difference estimators is \( p-k = (39 \times 38)/2 + 7 = 734 \), and that for the system estimators is \( p-k = [(39 \times 38)/2 + 37] - 7 = 771 \).

\(^{10}\) In the case of GMM system estimator we obtained \( m_2 = 0.1838 \) with the significance level 0.4270 \((=0.8541/2)\) in the normal distribution i.e. 0.4270 exceeds the significance level of \( \alpha=0.10 \), and the null of no second order serial correlation is not rejected.
shows that the coefficient for $v_{t-2}$ is statistically insignificant in the relevant regression for the GMM system estimator, supporting the fact that $v_t$ is uncorrelated with $v_{t-2}$.

Finally, we test the predictive accuracy of the system estimator and the two-step estimator by using the RMSE (the root mean squared error):

$$RMSE = \sqrt{\frac{1}{T^0} \sum (y_i - \hat{y}_i)^2}$$

where $T^0$ is the number of periods being forecasted. As reported in Table 1, the RMSE for the system estimator is 0.4212, while that of two-step estimator is 0.8302. Thus, the GMM system estimator performs more precisely than the two-step estimator.

### 3.5 Economic Prediction from the Dynamic Model

The above results seem to suggest a statistically significant impact of the financial sector development indicator on per capita GDP in a dynamic panel data setting. Let us interpret the economic meanings of the above results. The interpretation is based on the GMM system estimator results.

Our central variable, namely financial sector development ($FSDI$) is positively associated with economic growth. Recall that in the dynamic model (12), the coefficient of the lagged dependent variable $\delta$ postulates the speed of adjustment which represents lag effects. The financial development in past periods affect growth rate in the current period with geometrically declining influences as $\beta_00.4714^i (i = 0,1,2,...)$. In other words, if we consider polynomials in the lag operators $D(L), A(L), B(L)$ as:

$$D(L) = A(L)^{-1}B(L) = d_0 + d_1L + d_2L^2 + d_3L^3 + ...$$

then $A(L) = 1 - 0.4714L$, $B(L) = \beta_0$. The impulse response functions will be $d_0 = \beta_0$, $d_1 = 0.4714\beta_0$, $d_2 = 0.4714d_1$, $d_3 = 0.4714d_2$ and so on. Thus, the proceeding traces through the effects on growth of a one time innovation in ‘independent’ variables.

In the case of $FSDI$, $\beta_0 = 0.2101$. This suggests that 1 unit increase of $FSDI$ will affect the growth rate by 0.2101% increase in the current period, then one period later it will cause a 0.099% increase, two periods later 0.0466%, three periods later 0.022%, four periods later 0.0104%, and so on. These effects of the financial ‘shocks’ on the real output for the full sample of 65 countries are plotted in Figure 1. From this dynamic property, we can see that a change in financial sector development does not affect real growth rate with one-shot effect, but exerts persistent sizable impacts on growth within the context of a distributed-lag pattern.
Figure 1: Impulse Response Functions of $Y$ on $FSDI$ (based on GMM system estimator results)

3.6 Does the Level of Development Matter?

It would be rather reasonable to assume different impacts of financial sector development on growth between developed and developing countries. To test this hypothesis we divided the full sample into two sub-groups of 24 industrial countries and 41 developing countries and obtained the regression results reported in Table 2 using the GMM system estimator.
**Table 2: Estimation Results for Industrial and Developing Countries (GMM System Estimator)**

<table>
<thead>
<tr>
<th>Dependent variable $y_{it}$</th>
<th>GMM System Estimator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industrial</td>
<td>Developing</td>
</tr>
<tr>
<td>$y_{i,t-1}$</td>
<td>0.0895</td>
<td>0.5407</td>
</tr>
<tr>
<td></td>
<td>(0.6212)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>$FSDI$</td>
<td>0.1599</td>
<td>0.2184</td>
</tr>
<tr>
<td></td>
<td>(0.0005)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>$\ln SE$</td>
<td>1.0672</td>
<td>0.1054</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0000)</td>
</tr>
<tr>
<td>$GEXP$</td>
<td>0.5376</td>
<td>-0.1365</td>
</tr>
<tr>
<td></td>
<td>(0.0989)</td>
<td>(0.0006)</td>
</tr>
<tr>
<td>$INFL$</td>
<td>-0.0011</td>
<td>-0.0001</td>
</tr>
<tr>
<td></td>
<td>(0.0924)</td>
<td>(0.0238)</td>
</tr>
<tr>
<td>$OTR$</td>
<td>0.4636</td>
<td>0.0560</td>
</tr>
<tr>
<td></td>
<td>(0.0000)</td>
<td>(0.0048)</td>
</tr>
<tr>
<td>$FDI$</td>
<td>0.0017</td>
<td>0.0020</td>
</tr>
<tr>
<td></td>
<td>(0.3976)</td>
<td>(0.1062)</td>
</tr>
</tbody>
</table>

$R^2$                         | 0.74                 | 0.76               |

Notes: (i) Parentheses report $p$-values of $t$-statistics. (ii) The estimates were derived using RATS.

In view of these results, the impulse response functions of $y$ on the financial indicator for the two country groups are plotted in Figure 2.
As shown in Figure 2, in the developed country group $FSDI$'s influence on $Y$ will peter out quickly, whereas in the developing country group distant past values of $FSDI$ will have considerable impacts on $Y$. The mean lag is 1.098 for the developed country group and 2.177 for the developing country group. In addition, the magnitude of the coefficient for developing countries 0.2184 is larger as compared to 0.1599 for industrial countries. Hence, the results seem to suggest that the effect of financial sector development in developing countries is more persistent and larger than those in industrial countries. In other words, if a gap occurs between finance and economic growth, in industrial countries the gap will be filled up more quickly and the equilibrium will be restored within a relatively shorter period of time as compared to the case of developing countries.

Apart from the financial variables (of central importance to the study), we can derive some tentative economic implications on the basis of the results obtained in connection with the conditioning information set of variables. As far as scale effects are concerned, the estimated coefficient of $SE$ seems to suggest the existence of scale effects, that a 1 percent increase in the effective labour force leads on average to about a 0.1652 percent increase in the real output in the current period, and then affects it with geometrically declining effects, namely, 0.0779 percent one period later, 0.0368 percent two periods later, 0.0173 percent three periods later, and so on. Thus, the finding suggests that per capita growth has a positive linkage with the scale effect, and responds to a change in the labour force with time lags. Endogenous growth theories imply some benefits from larger scale. In particular, if there are significant setup costs at the country level for inventing or adapting new products or production techniques, then larger economies would perform better. The variable $SE$ is logarithmic, thus its coefficient indicates the output elasticity of
labour force. When we run regressions by splitting the full sample into two country groups, the estimated coefficient for $SE$ of the industrial country group is 1.0672, which is larger than 0.1054 of the developing country group. This seems to suggest that the output elasticity of labour force in industrial countries is higher than in developing countries.

Government expenditure plays an important role in the growth process and it could affect economic growth positively or negatively. Our results show that the full sample country group is associated with a negative estimate for government expenditure in the dynamic models. However, it is interesting that, when we split the full sample into two country groups, the industrial country group reveals a positive effect, whereas the developing country group appears with a negative effect concerning government expenditure.

The relationship between inflation and economic growth is more complex because inflation affects economic growth indirectly through real money balances in saving or investment functions, rather than directly. Our empirical results seem to suggest that for the full sample the estimated coefficient on $INFL$ is negative, as shown in Table 1. The finding supports the argument that inflation has a negative effect on growth, even if the magnitude of the impact is quite small. This seems also to be the case when we split the sample into the two country groups of developed and developing countries.

Turning to the open economy variables used in the study, the estimated coefficient of $OTR$ is significantly positive: 0.1246 in the case of the full sample. When we divide the full sample into two sub-groups to capture potentially different effects related to different levels of development, the estimated coefficients of $OTR$ are 0.4636 and 0.0560 for industrial and developing countries, respectively. It is notable that the magnitude of coefficient for industrial countries is much larger than that of developing countries. This result tells us that foreign trade affects GDP much more in industrial countries than in developing countries; thus, it is closely related to economic growth. In the case of foreign direct investment, the estimated coefficient of $FDI$ is significantly positive: 0.0036 for the full sample. It means that foreign direct investment influences positively real per capita growth in the dynamic process. However, for the sub-groups of developing and industrial countries the reported results are rather inconclusive since $FDI$ enters insignificantly in both cases, even if the coefficient turns to be positive as expected.

4. Concluding Remarks

The paper tried to delve deeper into the relationship between financial sector development, broadly defined to go beyond financial deepening, and economic growth by using a new database including 65 countries (both industrial and developing ones) over the period 1960-99 and by also exploring new routes regarding the measurement of financial sector development. Empirical results obtained from the estimation of dynamic panel data models using various GMM estimators (including the GMM system estimator) seem to suggest that financial sector development contributes to economic growth although the magnitude of the impact varies depending inter alia on the level of development (industrial vis-à-vis developing countries).
Our results seem also to indicate that the effect of financial sector development in developing countries is more persistent and larger than those in industrial countries. In other words, if a gap occurs between finance and economic growth, in industrial countries the gap will be filled up more quickly and the equilibrium will be restored within a relatively shorter period of time as compared to the case of developing countries. We also found that that per capita GDP growth has a positive linkage with scale effects and responds to a change in the labour force with time lags. Empirical results in line with a priori expectations were also derived regarding the impact of open economy variables used in the study and inflation. Our findings seem also to be robust in view of the sensitivity analysis we carried out.

 Needless to say, the reported findings are far from conclusive regarding the above relationship at the world global level since an even larger database would be essential covering most countries in the world before we ended up with robust policy conclusions. Other factors that may also insert the picture such as institutions may improve our overall understanding on how financial sector development really works in industrial and developing countries. Furthermore, the available empirical evidence seems to provide policy makers with inadequate advice regarding the sequencing of financial sector developments (Wachtel 2004). Experimenting with industry and firm data may be also rewarding regarding the above relationship (a route already taken by some recent studies in this area)\(^{11}\). These are important challenges for future research on the finance-growth nexus.

 Finally, an important issue calling for further research is related to the overall finance-growth-poverty reduction relationship of relevance to many developing countries undertaking a series of reforms in their financial sector, in particular, illuminating the channels through which financial sector development can contribute to the overall development process and poverty-reducing growth (Green et al., 2003).

\(^{11}\) See Wachtel (2004) for an insightful discussion.
REFERENCES


## APPENDIX

### Countries included in the sample (65)

#### Developed Countries (24)
1. Australia  
2. Austria  
3. Belgium  
4. Canada  
5. Cyprus  
6. Denmark  
7. Finland  
8. France  
9. Germany  
10. Greece  
11. Iceland  
12. Italy  
13. Ireland  
14. Japan  
15. Luxembourg  
16. Malta  
17. Netherlands  
18. Norway  
19. New Zealand  
20. Portugal  
21. Sweden  
22. Switzerland  
23. United Kingdom  
24. United States

#### Developing Countries (41)

##### Africa (15)
25. Burundi  
26. Cameroon  
27. Cote d'Ivoire  
28. Ethiopia  
29. Gabon  
30. Ghana  
31. Kenya  
32. Morocco  
33. Niger  
34. Nigeria  
35. Rwanda  
36. Senegal  
37. Sierra Leone  
38. South Africa  
39. Tanzania

##### Middle East (2)
40. Egypt  
41. Iran

##### Asia and Pacific (10)
42. Fiji  
43. India  
44. Indonesia  
45. S. Korea  
46. Malaysia  
47. Nepal  
48. Pakistan  
49. The Philippines  
50. Sri Lanka  
51. Thailand

##### South America (14)
52. Colombia  
53. Costa Rica  
54. Dominican Rep.  
55. Ecuador  
56. El Salvador  
57. Guatemala  
58. Haiti  
59. Honduras  
60. Jamaica  
61. Mexico  
62. Panama  
63. Paraguay  
64. Trinidad and Tobago  
65. Venezuela