Three Essays on Financial Intermediation, Capital Formation, and Economic Growth and Development

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THREE ESSAYS ON FINANCIAL INTERMEDIATION, CAPITAL FORMATION, AND ECONOMIC GROWTH AND DEVELOPMENT

by

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SECTION I

INTRODUCTION

Achieving faster economic growth and stability is one of the most important policy objectives for macroeconomic policy makers, which continues to be a major challenge. Economic researchers, classical as well as endogenous growth proponents, have been trying to explain different mechanics of economic growth. Some well-known sources that have received much attention are infrastructure, socio-economic and political institutions, technology, research and development (R&D), physical capital and human capital. Neoclassical growth models, such as Solow (1956), Cass (1965), and Koopmans (1965) emphasize physical capital accumulation, population growth and exogenous technological innovation. Because exogenous technological progress determines long-run economic growth, economic policy is largely redundant in neoclassical models. Convergence in per capita income is one of the important results of neoclassical growth models.

Endogenous growth theorists, such as Romer (1986, 1990 and 1994), Grossman and Helpman (1991), Aghion and Howitt (1992), Lucas (1988), and Rebelo (1991) emphasize physical as well as human capital and their productivity. They assume technological innovations are endogenous and derive from externalities in the accrual of capital. Their models often predict permanent effects on economic growth due to changes in certain policy variables. Endogenous growth theorists also argue that externalities, non-rivalry, non-excludability and spillover effects of knowledge and technological innovations allow richer economies to grow faster than the poorer ones.
The role of financial intermediation in capital accumulation and economic growth is entirely abstracted in the mainstream growth literature even though the finance-growth linkage is more than a century old (Bagehot, 1873). The link between finance and economic growth is now an established fact. Like physical capital, human capital and technology, financial intermediation is an important part of the story of economic growth. There is a sizeable literature, such as Wang and Williamson (1998), D. Diamond (1984), Fama (1983), Bencivenga and Smith (1991 & 1998), Hansson and Jonung (1997), King and Levine (1993a & 1993b), Levine and Zervos (1998), Beck et al. (2000), Levine et al. (2000), and Levine (1997, 1999 and 2003) that mainly focus the importance of financial development in enabling capital formation and economic growth.


Given the unresolved evidence, this study investigates the finance-growth linkage theoretically as well as empirically. We present a theoretical model of search and matching equilibrium in financial economies explaining the role of financial
intermediation in capital formation and economic growth. The basic idea is that a lender owns capital and an entrepreneur owns entrepreneurial skill and output is produced when search generates a successful meeting between a lender and an entrepreneur. Our model suggests that autarkic solution is inefficient and sub-optimal in terms of lower investment and output. The introduction of competitive financial intermediation removes most inefficiencies. When we introduce information asymmetry in our model, the outcome is not efficient even in the in presence of financial intermediation. However, the introduction of financial intermediary creates opportunities for higher investment and output by lowering monitoring cost and by increasing the probability of detecting shirking.

The first essay identifies two channels through which financial intermediaries stimulate economic growth. One is the usual capital accumulation channel where the introduction of a financial intermediary generates higher investment and thus higher economic growth. The other one is the efficiency gains where the introduction of financial intermediary reduces frictions, information asymmetry, and monitoring cost, eases contracts and trades and increases the probability of catching shirking, thereby raising productivity and quality of investments. Thus, the efficiency effect is the impact of financial intermediation on economic growth that derives from sources other than increased capital accumulation. Two empirical investigations follow in order to examine two key predictions of the finance-growth literature – financial development causes economic growth and financial development leads to conditional convergence.

The first empirical study investigates the dynamic, particularly long-run, relationship among financial development, investment, and economic growth based on the hypothesis that financial development has long-run impact on investment and
income growth. Quarterly data for 1970:1-2002:3 of real per capita financial development, investment and income growth from a sample of six countries, three from East Asian emerging economies and three from developed OECD economies, are used in this investigation. Blanchard and Quah's (1989) technique of long-run structural vector autoregression (SVAR) is employed to estimate the model. The results of this study suggest that financial development has significant long-run positive effect on both investment and income growth. Out of two channels i.e., quantitative and efficiency effects through which financial development promotes economic growth, results of this essay indicate relatively stronger efficiency gains for the three emerging economies.

The second empirical study investigates the impact of financial development on the implied speed of per capita income convergence using a Panel data framework proposed by Islam (1995). The Least Squares with Dummy Variables (LSDV) based on fixed effects assumption is used on four different samples of 62 non-oil exporting countries during 1960-1990 in this investigation of conditional convergence. Human capital and two proxies for financial development are used as the conditioning variables to examine their relative strength in improving per capita income convergence. The results indicate that financial development is an important factor in closing per capita income gap among countries and financial development is at least as relevant as human capital in expediting per capita income convergence.
SECTION II

ESSAY 1: ROLE OF FINANCIAL INTERMEDIATION IN CAPITAL FORMATION AND ECONOMIC GROWTH:
A SEARCH EQUILIBRIUM MODEL

Background

Growth theorists both classical, such as Adam Smith (1776) and Thomas Malthus (1798), and endogenous, such as Romer (1986 and 1990), Grossman and Helpman (1991), Aghion and Howitt (1992), Lucas (1988), and Rebelo (1991), have been trying to explain different mechanics of economic growth. Some well-known sources from which economic growth is derived are infrastructure, socio-economic and political institutions, technology, research and development (R&D), physical capital and human capital.

Neoclassical growth theorists led by Robert Solow (1956) suggest that physical capital and technology are the main sources of economic growth. Endogenous growth models, such as Romer (1986 and 1990) and Lucas (1988) emphasize physical and human capital and their productivity, and assume that technological innovations are endogenous and derive from externalities in the accrual of capital. In the mainstream growth literature, however, the role of finance in capital accumulation and growth is largely overlooked.

Recent theoretical and empirical work, such as Wang and Williamson (1998), D. Diamond (1984), Fama (1983), Collin (1997), Bencivenga and Smith (1991 & 1998), Hansson and Jonung (1997), King and Levine (1993a & 1993b), and Levine (1997) suggest that financial intermediation is an important part of the story of
economic growth. The focus of these studies is the link between financial development and economic growth. A well-known paper by Ross Levine (1997)\textsuperscript{1} explains how financial intermediary solves the market frictions and creates opportunities for economic growth. He argues that financial intermediaries mobilize savings, allocate resources, exert corporate control, facilitate risk management, and ease trades and contracts by solving market frictions that generate higher production and growth.

We investigate the role of financial intermediation in achieving higher economic growth by identifying two channels through which financial intermediaries stimulate economic growth. One is the usual capital accumulation channel where the introduction of a financial intermediary generates higher investment and thus higher economic growth. The other one is the efficiency gains, the impact of financial intermediation on economic growth that derives from sources other than increased capital accumulation.

In order to see the usual capital accumulation channel, a model of search and matching equilibrium in a financial economies based on some ideas in the search and matching literature – Diamond (1982a), Shapiro and Stiglitz (1984) and Masters (1998) in trade and labor economics – is developed. The basic idea is that a lender owns capital and looks for an entrepreneur who needs capital, and an entrepreneur has production skills and searches for a lender. When a successful meeting occurs output is produced which in turn generates future investable funds, leading to capital accumulation and growth.

Peter Diamond (1981) and Mortensen (1982) used search and matching concepts to explain the mechanisms of bilateral trade and their effects on

\textsuperscript{1} This paper also presents a very important list of literature regarding finance-growth nexus.
decentralized market equilibrium. Following their work, theoretical as well as empirical studies of search and matching problems mushroomed in the various fields of economics. There is now a sizeable literature on search and matching equilibrium in labor economics and trade (e.g., Albrecht and Axell 1984, Lindeboom et al., 1994, Berman 1997, Andolfatto 1996, Coulson et al. 2001, P. Diamond 1982b, 1984 and 1990, Coles and Muthoo 1998, Rubinstein and Wolinsky 1985 & 1987, Rubinstein 1985). The matching process between buyers and sellers in trade or between workers and firms in the job markets is the main focus of these papers.

Peter Diamond (1982a), Bester (1995) and Masters (1998) use search and matching approach to justify intermediaries. They try to model the role of intermediaries in matching two parties, such as workers and employers in Masters, buyers and sellers in Diamond, and lenders and borrowers in Bester. It has been shown in their papers that the solution in presence of an intermediary is Pareto superior in terms of higher employment and transactions. Another literature, such as Wang and Williamson (1998), D. Diamond (1984), Fama (1983), Collin (1996), Bencivenga and Smith (1991 & 1998), Chan (1983), Allen and Santomero (1998) examine the role of intermediation without applying search and matching concepts. Their investigation concerning the role of intermediaries in different economic scenarios produce convincing evidence that intermediaries play a positive role in various economic activities.

Bester (1995) is the only paper, to our knowledge, that investigates the role of financial intermediation using search and matching techniques. The author uses financial intermediary as a delegate for the investors. This generates a commitment advantage and induces more risky investment projects. The bargaining model of the current paper is completely different from that paper in the following ways. The
current study uses completely different setup where bilateral search takes place; the above paper uses only unilateral search. We use financial intermediary as an independent agent to investigate possible sources of inefficiency, whereas the other paper uses intermediary as a delegation for investors only and does not investigate the reasons for inefficiency. Besides, our paper incorporates growth implications in the model and extends the basic model to include information asymmetry.

To facilitate exposition, we briefly describe the key ideas in the two background papers — P. Diamond (1982a) and Masters (1998). Peter Diamond develops a search and matching model to analyze the equilibrium in a barter economy with identical risk-neutral agents where trade is coordinated by a stochastic process. Because of the difficulty of successful trading, he shows that there are multiple steady state rational expectations equilibria where all non-corner solutions are inefficient. He then concludes that in a many-person and many-goods world representing a complex modern economy there will always remain unrecognized and unrealized trading opportunities. A central policy coordinator, by affecting individual production and trade incentives, could influence the outcomes of bilateral trades.

Masters's (1998) assumes two kinds of infinitely lived individuals: workers who are restricted to invest in human capital, and employers (or firms) who are restricted to invest in physical capital. He shows in his Rubinstein bargaining model that the presence of search frictions has adverse impact on employment and investment in physical capital. In this case, the bargaining solution is sub-optimal for both workers and employers. Any attempt that makes matching process easier, such as intermediation, is Pareto improving in terms of higher investment, employment and output.
Model

Basic Assumptions

1. There are total $N (=N_1+N_2)$ number of infinitely lived agents that are exogenously divided into two groups: $N_1$ and $N_2$. Here $N_1 =$ number of lenders and $N_2 =$ number of entrepreneurs. The fraction of lenders and entrepreneurs are given by $n_1 = N_1/N$ and $n_2 = N_2/N$ respectively.

2. The production function $F(k,s)$ is assumed to be strictly increasing, strictly concave, twice differentiable and exhibits constant return to scale that is solely dependent on physical capital, denoted by $(k)$, and production plan, design or skills, denoted by $(s)$. Only lenders can save and invest capital $(k)$, and only entrepreneurs have production or entrepreneurial skills $(s)$. Assume that both inputs are completely durable. There is a one-time cost to acquire inputs, where $C(k)$ and $C(s)$ are the one-time investment cost functions for lender and entrepreneur respectively. The cost function is assumed strictly monotonic and convex. When a lender with capital $(k)$ and an entrepreneur with skill $(s)$ match, output is produced which is given by the production function $F(k,s)$. Assume that the share of output that goes to lender is given by $\phi$ and the remaining share $(1-\phi)$ goes to entrepreneur. All lenders and entrepreneurs are identical, and one lender needs a single entrepreneur to produce.

3. All agents derive utility from their output share, which is given by the discounted value of search minus cost. There is no consumption in this model.

4. There are two distinct states for each individual: matched and unmatched, referring to a match between a lender and an entrepreneur. If a pair – a lender and an entrepreneur – is matched, output is produced instantly after which both agents separate. The arrival rate of opportunities is as follows: an entrepreneur finds an
unmatched lender at rate \( n_1 \) and a lender finds an unmatched entrepreneur at rate \( n_2 \).

In order to explain the role of financial intermediation, we examine agents’ maximization problem under the following two situations:

1. Autarkic Solution and
2. Intermediated Solution

**Autarkic Solution**

**Utility Functions**

Suppose \( u_i \) represents present value of expected lifetime utility of a lender, \( v_{1e} \) and \( v_{1u} \) are present value of a matched and unmatched lender respectively, and \( C(k) \) is the onetime cost. Then \( u_i \) is given by

\[
(1) \quad u_i = v_{1e} + v_{1u} - C(k)
\]

Similarly, the present value of expected utility for a typical entrepreneur is

\[
(2) \quad u_2 = v_{2e} + v_{2u} - C(s)
\]

**Asset Value Equations**

The asset value equation for an unmatched lender is given by

\[
(3) \quad r v_{1u} = n_2 [v_{1e} - v_{1u}]
\]

This means an unmatched lender finds an entrepreneur at rate \( n_2 \) – the fraction of population that has entrepreneurial skills.\(^2\) Collecting terms gives

\[
(4) \quad v_{1u} = \left[ \frac{n_2}{r + n_2} \right] v_{1e}
\]

The asset value equation for a matched lender with her output share \( \phi \) is given by

\(^2\) For what follows, we could set \( n_1 = n_2 = \frac{1}{2} \) without any qualitative change in results. Also, we could model the transition probability as a function of \( n_2 \); this would not change our conclusions.
(5) \( r \cdot v_{1e} = \phi F_d \cdot [v_{1u} - v_{1e}] \)

This assumes that production takes place instantaneously and the lender then becomes unmatched. Collecting terms in \( v_{1e} \) gives

(6) \( v_{1e} = \frac{1}{r + n_2} [\phi F_d + v_{1u}] \)

Equation (4) and (6) can be solved simultaneously as

(7) \( v_{1e} = \frac{r + n_2}{r + n_2 + 1} \phi F_d \quad \text{and} \)

(8) \( v_{1u} = \frac{n_2}{r + n_2 + 1} \phi F_d \)

Here \( F_d \) is the discounted value of production. Substituting \( v_{1u} \) and \( v_{1e} \) into equation (1) gives

(9) \( u_1 = \frac{r + 2n_2}{r + n_2 + 1} \phi F_d - C(k) \)

Similarly, the utility function for a typical entrepreneur who has production skill \( (s) \) is given by

(10) \( u_2 = \frac{r + 2n_1}{r + n_1 + 1} (1 - \phi) F_d - C(s) \)

The bargaining process postulated in this model is similar to that of Rubinstein and Wolinsky (1985) and Masters (1998), where an agent is chosen randomly by nature to look for a partner. The other agent does the same. Acceptance of an offer ends bargaining with the proposed share of output implemented. If the proposal is rejected, a new offer will be made to a new partner in the same fashion. This bargaining game will be repeated until an offer is accepted. As in Trejos and Wright (1995) and Masters (1998), two cases of bargaining equilibrium will be studied in this paper under autarky. One is 'bargaining-without-search' where bargaining will not take place after the first round. The other is 'bargaining-with-search' that allows continuous negotiations.
Bargaining-Without-Search

When there is no search during bargain, the equilibrium solution can be obtained by maximizing respective expected lifetime utility for each agent. A lender and an entrepreneur will choose their capital \( k^a \) and skill \( s^a \) such that

\[
(11) \quad k^a = \arg \max_{k} \left[ u_1 \left( k^a, s^a \right) \right] \quad \text{and} \\
(12) \quad s^a = \arg \max_{s} \left[ u_2 \left( k^a, s^a \right) \right]
\]

Where 'a' denotes autarky. The first order conditions for this equilibrium are obtained by maximizing lifetime discounted expected utility functions [equations (9) and (10)] with respect to \( (k) \) and \( (s) \) respectively

\[
(13) \quad \left[ \frac{r + 2n_2}{r + n_2 + 1} \right] \phi f^k (k^a, s^a) = c^k (k^a) \quad \text{and} \\
(14) \quad \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) f^s (k^a, s^a) = c^s (s^a)
\]

Here \( f^k (.) \) and \( c^k (.) \) are the marginal product and marginal cost of capital, and \( f^s (.) \) and \( c^s (.) \) are marginal product and marginal cost of skill respectively. With equal bargaining power for lender and entrepreneur, it can be shown that the equilibrium output shares for both parties are also equal\(^3\), i.e., \( \phi = (1 - \phi) = 1/2 \). Therefore, \( \left[ \frac{r + 2n_2}{r + n_2 + 1} \right] \phi < 1 \) and \( \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) < 1 \), and equilibrium investment of capital and skill under autarky would be such that \( f^k (k^a, s^a) > c^k (k^a, s^a) \) and \( f^s (k^a, s^a) > c^s (k^a, s^a) \). That is, the equilibrium pair of investments \( (k^a, s^a) \) in ‘bargaining-without-search’ under autarky is inefficient. If \( k^* \) and \( s^* \) are investments that solve

\(^3\) Let \( \phi^1 \) and \( \phi^2 \) be the offer made by the lender and entrepreneur respectively. Given voluntary participation of both agents in bargaining, the solution can be written as: \( \phi = \frac{1}{2} (\phi^1 + \phi^2) \), that is the offer for an output share made by an entrepreneur, in equilibrium, would be equal to average offer made by the lender and entrepreneur. Setting, \( \phi^1 = \phi^2 = \phi \) and given that \( (\phi^1 + \phi^2 = 1) \), it immediately follows that: \( \phi^1 = \phi^2 = \phi = \frac{1}{2} \).
the above problem where marginal product and marginal cost are equal, i.e., \( f^k(k^*,s^*) = c^k(k^*,s^*) \) and \( f^s(k^*,s^*) = c^s(k^*,s^*) \), then \( k^* \) and \( s^* \) would be the efficient investment for capital and skill. We obviously have \( k^* > k^a \) and \( s^* > s^a \).

Figure-1 compares the investment of capital under 'bargaining-without-search' with the efficient amount of investment. A similar explanation is applicable for the other input, entrepreneurial skills. This inefficiency can be attributed to an externality – each agent ignores the fact that higher action raises the welfare of the other agent. This is variously known as coordination problem, sharecropper’s problem, and commitment problem. Inefficiency in autarky follows because any increase in investment of either input is Pareto improving (Proposition 1: proof in Appendix-A).

Figure 1: Solution Under Autarky (Where \( K^* > K^a \))

\[ f^k(.) \text{ or } c^k(.) \]

\[ f^s(.) > c^s(.) \]

\[ f^s(.) = c^s(.) \]

\[ c^s(.) \]
Bargaining-With-Search

In order to complete the bargaining model, we need to compare the equilibrium outcome of bargaining-with-search with those of bargaining-without-search as well as the outcome under intermediated equilibrium. Assume a Rubinstein bargaining model where $\phi^1$ and $\phi^2$ are the offers made by the lender and entrepreneur respectively, with $\delta$ length of time between the rounds of bargaining. Given that offers arrive at interval $\delta$, and assuming $n_1=n_2=n=\frac{1}{2}$ for simplification, the value of lender’s share in the search market when the lender is stuck with a single entrepreneur is given by $\phi^2 F_d + r\delta \phi^2 F_d$. Under bargaining-with-search, the lender can continue to search for potential entrepreneurs with the possible output share $= \frac{1}{2} (\phi^1 + \phi^2) F_d + \delta n [v_1 - \frac{1}{2} (\phi^1 + \phi^2) F_d]$. Where $v_1 = v_{1e} + v_{1u}$. In equilibrium, the lender will be indifferent between the two options and the Bellman’s equation is

$$\phi^2 F_d + r\delta \phi^2 F_d = \frac{1}{2} (\phi^1 + \phi^2) F_d + \delta n [v_1 - \frac{1}{2} (\phi^1 + \phi^2) F_d]$$

or,

$$\frac{\delta}{\frac{1}{2} (\phi^1 + \phi^2) F_d - \phi^2 F_d - r\phi^2 F_d - \phi^2 F_d - \frac{1}{2} n(\phi^1 + \phi^2) F_d} = 1$$

Similarly, the Bellman’s equation for an entrepreneur gives us

$$\frac{\delta}{\frac{1}{2} (\phi^1 + \phi^2) F_d - \phi^1 F_d - r\phi^1 F_d - \phi^1 F_d - \frac{1}{2} n(\phi^1 + \phi^2) F_d} = 1$$

Where $v_2 = v_{2e} + v_{2u}$. Since $\phi^1 = (1-\phi^2)$, equation (17) could be written as

$$\frac{\delta}{\frac{1}{2} [(1-\phi^2) + (1-\phi^1)]F_d - (1-\phi^2) F_d - r(1-\phi^2) F_d - \frac{1}{2} n[(1-\phi^2) + (1-\phi^1)]F_d} = 1$$

Limiting $\delta \to 0$ and setting $\phi^1 = \phi^2 = \phi$, it can be shown from equation (16) and (18)
that \(^4\)

\begin{equation}
(19) \quad \phi = \frac{(r + n)F_d + n\nu_1 - n\nu_2}{(2r + 1)F_d}
\end{equation}

Recall that

\begin{equation}
(20) \quad \nu_1 = \nu_{1e} + \nu_{1u} = \left[ \frac{r + 2n}{r + n + 1} \right] \phi F_d
\end{equation}

Substituting (19) in to (20) gives

\begin{equation}
(21) \quad \nu_1 = \frac{(r + 2n)(r + n)F_d}{(r + n + 1)(2r + 1) - n(r + 2n)} - \frac{(r + 2n)(r + n)\nu_2}{(r + n + 1)(2r + 1) - n(r + 2n)}
\end{equation}

Similarly,

\begin{equation}
(22) \quad \nu_2 = \frac{(r + 2n)(r + n)F_d}{(r + n + 1)(2r + 1) - n(r + 2n)} - \frac{(r + 2n)(r + n)\nu_1}{(r + n + 1)(2r + 1) - n(r + 2n)}
\end{equation}

Substituting (21) into the lifetime utility function for lender, we get

\begin{equation}
(23) \quad u_1 = \frac{(r + 2n)(r + n)F_d}{(r + n + 1)(2r + 1) - n(r + 2n)} - \frac{(r + 2n)(r + n)\nu_2}{(r + n + 1)(2r + 1) - n(r + 2n)} - C
\end{equation}

Similarly, the utility function for an entrepreneur can be written as

\begin{equation}
(24) \quad u_2 = \frac{(r + 2n)(r + n)F_d}{(r + n + 1)(2r + 1) - n(r + 2n)} - \frac{(r + 2n)(r + n)\nu_1}{(r + n + 1)(2r + 1) - n(r + 2n)} - C
\end{equation}

Now, the lender’s problem is to choose \( k^a \) and the entrepreneur’s problem is to choose \( s^a \) such that \( u_1 \) and \( u_2 \) are maximized respectively. The first order conditions for these maximization problems are

\begin{equation}
(25) \quad \frac{(r + 2n)(r + n)}{(r + n + 1)(2r + 1) - n(r + 2n)} f^k(k^a, s^a) = c^k(k^a) \quad \text{and}
\end{equation}

\begin{equation}
(26) \quad \frac{(r + 2n)(r + n)}{(r + n + 1)(2r + 1) - n(r + 2n)} f^s(k^a, s^a) = c^s(k^a)
\end{equation}

\(^4\) Limiting \( \delta \to 0 \), setting \( \phi^l = \phi^2 = \phi \), and using equation (16) and (18), we can write

\[ r \phi F_d - n \nu_1 + n \phi F_d = r F_d - r \phi F_d - n \nu_2 + n F_d - n \phi F_d \]

or, \( \phi (2r + 2n)F_d = (r + n)F_d + n\nu_1 - n\nu_2 \), (replacing 2n by 1)

or, \( \phi = \frac{(r + n)F_d + n\nu_1 - n\nu_2}{(2r + 1)F_d} \)
Here \( k^a \) and \( s^a \) are the equilibrium investments in capital and skill under bargaining-with-search. Given that \( n_1 = n_2 = n = \frac{1}{2} \), it is readily observable that

\[
1 > \frac{(r+2n)(r+n)}{(r+n+1)(2r+1)-n(r+2n)} \Rightarrow f^k(.) > c^k(.) \text{ and } f^s(.) > c^s(.) .
\]

Again, the autarkic solution results in inefficient investment of both capital and skill. The autarkic solutions, therefore, are inefficient regardless of the nature of bargaining – the bargaining-without-search or bargaining-with-search. However, the outcome under bargaining-with search is better than bargaining-without search. This is because,

\[
1 > \frac{(r+2n)(r+n)}{(r+n+1)(2r+1)-n(r+2n)} \Rightarrow \frac{r+2n}{r+n+1} (1-\phi).
\]

For example, if we assume that \( r = 0 \), \( \phi = \frac{1}{2} \) and \( n = \frac{1}{2} \), it can be shown that

\[
\frac{(r+2n)(r+n)}{(r+n+1)(2r+1)-n(r+2n)} = \frac{1}{2} \text{ and } \frac{r+2n}{r+n+1} \phi = \frac{1}{3}.
\]

**Intermediated Solution**

Financial intermediation can take different form depending on what the intermediary does. We specify two types of intermediary. First, financial intermediary is a matchmaker, where she matches lenders with borrowers. Other examples of matchmaker are employment agencies that match workers with firm, real estate broker that match home buyers with sellers. Second, financial intermediary is an owner-manager where she is both a manager and the residual profit claimant. General examples of this type of intermediary are investment banks, stock-brokers, and used-car dealers.
When Financial Intermediary is a Matchmaker

Let us consider a situation where financial intermediaries, such as banks and other financial institutions just facilitate the matching process between lenders and entrepreneurs by taking deposits from lenders and providing loans to entrepreneurs in a perfectly competitive environment. Competition among intermediaries, lenders, entrepreneurs, and financial intermediaries take the rental rate of capital**, R_1**, as given. Lender and entrepreneur then lend and borrow at that rate via intermediaries. We assume that the entrepreneur manages and keeps residual profits. Therefore, the problem for the entrepreneur is to choose k and s to maximize

\[ u_2 = F_d - k \cdot R_{id} - C(s) \]

Where, \( R_{id} \) is discounted value of the rental rate. In presence of financial intermediation, we assume neither borrower nor lender is subject to any search friction. In this case, a lender could deposit her capital with a financial intermediary and get return \( R_1 \). Therefore, a lender’s value in the search market would be

\[ rV_j = r(v_{le} + v_{lu}) = k \cdot R_1 \]

or,

\[ v_1 = k \cdot \frac{R_1}{r} = k \cdot R_{id} \]

Substituting \( v_1 = (v_{le} + v_{lu}) \) into equation (1), we get

\[ u_1(k, S) = k \cdot R_{id} - C(k) \]

A lender chooses capital (k) such that

\[ \text{Max}(k) u_1(k, S) = k \cdot R_{id} - C(k) \]

If \( \hat{k} = \hat{k}_s = \hat{k}_d \) and \( \hat{s} \) are equilibrium investments for capital and skill by the lender and the entrepreneur respectively, the first order conditions from equations

---

5 Financial intermediary in our model do not charge any fee, an assumption that can be changed. Here we assume long run zero profit condition.
(27) and (31) are

(32) \( f^k(\hat{k}, \hat{s}) = R_{1d} \)

(33) \( f^s(\hat{k}, \hat{s}) = c^s(\hat{s}) \) and

(34) \( R_{1d} = c^k(\hat{k}) \)

Substitution equation (34) into (32) yields

(35) \( f^k(\hat{k}, \hat{s}) = c^k(\hat{k}) \)

Equation (33) and (35) are market-clearing conditions where investments in both inputs are efficient. Therefore, in presence of financial intermediaries \( \hat{k} = k^* > k^a \) and \( \hat{s} = s^* > s^a \).

A perfectly competitive market for financial intermediation is crucial in generating the efficient allocation condition. If that market is not perfectly competitive, a different kind of inefficiency arises. Here we do not explore distortions that occur due to intermediaries' having market power. Figure 2 compares the investment in capital under autarky with the amount under intermediation. Unlike the solution under autarky, it can be shown that in the equilibrium increased investment by any agent is no longer Pareto improving (Proposition 2: proof in Appendix-A).
Figure 2: Solution Under Autarky and in Presence of Financial Intermediation
(Where $K^* = \hat{k} > K^0$)

\[ f^*(.) \text{ or } c^k(.) \]

When Financial Intermediary is a Manager

Here financial intermediary manages and pays the lender and entrepreneur some predetermined rates of return $R_1$ and $R_2$ for capital and skill respectively, and is the residual profit claimant. Both rates are offered in perfectly competitive markets where all parties take these rates as given. Given that the intermediary’s problem is to choose $k$ and $s$, such that

(36) $\text{Max}_{(k,s)} [F_d - k . R_{1d} - s . R_{2d}]$

In a frictionless world, the lender and the entrepreneur will choose capital and skill respectively such that

(37) $\text{Max}_k u_1 = k . R_{1d} - C(k)$
If \( \hat{k}(= \hat{k}_s = \hat{k}_d) \) and \( \hat{s}(= \hat{s}_s = \hat{s}_d) \) are the equilibrium amounts, the first order conditions are

\[
\begin{align*}
\text{(39)} & \quad f^k(\hat{k}_d, \hat{s}) = R_{1d} \\
\text{(40)} & \quad f^s(\hat{k}_d, \hat{s}_d) = R_{2d} \\
\text{(41)} & \quad R_{1d} = c^k(\hat{k}_s) \quad \text{and} \\
\text{(42)} & \quad R_{2d} = c^s(\hat{s}_s)
\end{align*}
\]

Replacing \( R_{1d} \) and \( R_{2d} \), we get

\[
\begin{align*}
\text{(43)} & \quad f^k(\hat{k}_d, \hat{s}) = c^k(\hat{k}_s) \quad \text{and} \\
\text{(44)} & \quad f^s(\hat{k}_d, \hat{s}_d) = c^s(\hat{s}_s)
\end{align*}
\]

Equations (43) and (44) are identical to those that hold when the financial intermediary is a matchmaker. These conditions imply that \( \hat{k} = k^* > k_a \) and \( \hat{s} = s^* > s_a \) i.e., investment of both inputs under financial intermediation are optimal and higher than in autarky. As the production function is strictly increasing in capital and skill, the output under financial intermediation would also be higher. Therefore, the solution in presence of financial intermediation is superior to the solution under autarky in terms of higher investment and output via capital accumulation channel.

**Law of Motion (LOM) for Capital**

As it is assumed that all agents derive utility from their output share with no consumption, the equilibrium law of motion for capital under autarky and financial intermediation would be, respectively, as follows:

\[
\begin{align*}
\text{(45)} & \quad k_{i+1}^a = \frac{r + 2 n_2}{r + n_2 + 1} \phi F(k_i^a, s_i^a) \\
\text{(46)} & \quad \hat{k}_{i+1} = R_i \hat{k}_i = \phi F(\hat{k}_i, \hat{s}_i) \quad \text{6}
\end{align*}
\]

\(^6\) Here, \( \phi F(\hat{k}_i, \hat{s}_i) \) is the equivalent amount of production shares.
Setting $k_{i+1}^a = k_i^a$ and $\hat{k}_{i+1} = \hat{k}_i$ in the above equations, we can get steady state capital under autarky ($k^{a*}$) and financial intermediation ($\hat{k}^*$) respectively. The equilibrium law of motions and respective levels of steady state capital in both situations are shown in Figure 3 where, $\hat{k}^* > k^{a*}$. As long as the production function $F(k, s)$ is strictly increasing, strictly concave and subject to Inada Condition, there would be a unique and stable steady-state equilibrium. Therefore, the level of output produced under financial intermediation [$F(\hat{k}, \hat{s})$] would be greater than the level of output in autarky [$F(k^a, s^a)$].

Figure 3: Equilibrium Law Of Motion (LOM) for Capital
Some Extensions

When Lenders and Entrepreneurs are Heterogeneous

Initially, we assumed that both lenders and entrepreneurs are homogeneous where one lender (entrepreneur) needs just one entrepreneur (lender) for a successful meeting. Now, suppose there are two types of lenders and entrepreneurs: type-A and type-B. In order to have a successful meeting, lender type-A must meet an entrepreneur of type-A. This heterogeneity can be sector specific or based on specialization. For example, a lender (entrepreneur) who is living in a mega city might not be interested in any rural based lending. Assume that lending (borrowing) contract will not take place, unless a lender (entrepreneur) finds an entrepreneur (lender) of the same kind. In this case, the probability of a successful match would be significantly lower. If \( j \) is the index of heterogeneity, this could be extended up to \( 'N' \) types of lenders and entrepreneurs. Where, \( j = 1, 2, 3 \ldots N \). When \( j = 1 \), all of the lenders and entrepreneurs are considered to be homogeneous. Assuming two types of lenders and entrepreneurs: type-A and type-B, we can write the following:

\[
N_1 = \text{Number of lenders} = N_{1A} + N_{1B} \quad \text{and} \quad N_2 = \text{Number of entrepreneurs} = N_{2A} + N_{2B}
\]

Now, if we assume that \( N_{1A} = N_{1B} \) and \( N_{2A} = N_{2B} \), then the ratio of lender type-A = the ratio of lender type-B = \( \frac{1}{2} n_1 \), and the ratio of entrepreneur type-A = the ratio of entrepreneur type-B = \( \frac{1}{2} n_2 \). To see the role of financial intermediation, given the assumption of heterogeneity, we need to solve the problem of utility maximization under the following two situations:

1. In autarky and
2. In presence of financial intermediary.
Solution Under Autarky

Utility Functions

The utility functions for type-j lender and entrepreneur can be written as

(47) \( u_{ij} = v_{ij} - C(k_j) \)

(48) \( u_{2j} = v_{2j} - C(s_j) \)

Where \( u_{ij} \) is the present value of expected lifetime utility of type-j lender, \( v_{ij} \) is the value of a j-type lender in the search markets, \( C(k_j) \) is the cost function for a j-type lender who invests \( (k_j) \), \( u_{2j} \) is the present value of expected lifetime utility of type-j entrepreneur, \( v_{2j} \) is the value of a j-type entrepreneur in the search markets and \( C(s_j) \) is the cost function for a j-type entrepreneur who invests \( (s_j) \).

Incorporating new arrival rates for lenders and entrepreneurs into the original utility functions, it can be shown that

(49) \( u_i = \left[ \frac{r + n_2}{r + \frac{n_2}{2} + 1} \right] \phi F_d - C(k_j) \)

(50) \( u_{2j} = \left[ \frac{r + n_1}{r + \frac{n_1}{2} + 1} \right] (1 - \phi) F_d - C(s_j) \)

Assume that the cost of capital is same for all lenders i.e., \( C(k_j) = C(k) \) and the cost of skill is also same for all entrepreneurs i.e., \( C(s_j) = C(s) \). If \( k^{a_j} \) and \( s^{a_j} \) are equilibrium amount of investment, the following first order conditions can be obtained

(51) \( \frac{r + n_2}{r + \frac{n_2}{2} + 1} \phi f^k = c^k (k^{a_j}) = c(k) \)

(52) \( \frac{r + n_1}{r + \frac{n_1}{2} + 1} (1 - \phi) f^s = c(s^{a_j}) = c(s) \)

Comparing these first order conditions with equations (13) and (14), it can be shown
that investments by both agents under heterogeneity are less than that of homogeneity assumption\(^7\) i.e., \(k^a_j < k^a\) and \(s^a_j < s^a\). Where, \((k^a)\) and \((s^a)\) are the equilibrium investments by lender and entrepreneur respectively under the assumption of homogenous lender and entrepreneur. Figure 4 compares the equilibrium investments made by lender under the homogeneity and heterogeneity assumptions. The above outcome is under bargaining-without-search. As we observe earlier that the solution under both bargaining-with-search and bargaining-without-search are inefficient and inferior to the intermediated outcome, no discussion on bargaining without search is done.

Figure 4: Solution Under Autarky (Where \(K^* > K^a > K^{a_j}\))

\[
f(.) = c^k(.)
\]

\[
f^k(.) > c^k(.) \quad f^k(.) = c^k(.) \quad c^k(.)
\]

---

\(^7\) Because \(\frac{r + n_2}{r + n_2/2 + 1} < \frac{r + 2n_2}{r + n_1 + 1} < 1\) and \(\frac{r + n_1}{r + n_1/2 + 1} (1 - \phi) < \frac{r + 2n_2}{r + n_2 + 1} (1 - \phi) < 1\)
Solution in Presence of Financial Intermediation

We have seen that the intermediated solution can be solved in two ways: when a financial intermediary is a matchmaker and when a financial intermediary is a manager. Under the assumption of identical agents, we have shown earlier that investments in both inputs are higher and efficient in the intermediated solution. Since the outcome under homogenous agents is better than that of heterogeneous agents and the outcome in presence of intermediaries is better than that of homogenous agents, then intermediated solution must be better than the solution under heterogeneous agents.

When Information is Asymmetric

In our analysis, so far we assumed away information asymmetry. In order to introduce information asymmetry, let us assume that there are some uncertainties to the realization of contracted output. Consider the following utility function for a typical lender:

\[ u_i = v_{le} + v_{lu} - C(k) \]

Suppose, \( p \) is the probability that the output would be exactly same as contracted and \( (1-p) \) is the probability that output would be zero.\(^8\)

Autarkic Solution under Uncertainty

Asset value equations for a lender:

\[ r v_{1u} = n_2[v_{le} - v_{1u}] \]
\[ r v_{le} = [p\Phi_F + v_{1u} - v_{1e}] \]

Equation (54) and (55) can be solved simultaneously as:

---

\(^8\) Zero output is assumed for simplicity, any other output level (less than \( F_d \)) with the probability \((1-p)\) will not change our conclusion.
Substituting $v_{le}$ and $v_{lu}$ into (53) gives

$$u_1 = \left[ \frac{r + n_2}{r + n_2 + 1} \right] p \phi F_d - C(k)$$

Similarly, the utility function for a typical entrepreneur who has production skill is given by:

$$u_2 = \left[ \frac{r + 2n_2}{r + n_1 + 1} \right] p(1-\phi)F_d - C(s)$$

Lender's problem is to choose $(k)$, such that

$$\text{Max}_{(k)} u_1 = \frac{r + 2n_2}{r + n_1 + 1} [p \phi F_d] - C(k)$$

First order condition, yields:

$$\frac{r + 2n_2}{r + n_2 + 1} \phi p = c^k(.)$$

Clearly, $\frac{r + 2n_2}{r + n_2 + 1} \phi p < 1 \Rightarrow f^k(.) > c^k(.)$ and therefore, investment in capital is inefficient. If we compare equation (61) with (13), it is quite obvious that the autarkic outcome under uncertainty would be inferior to the outcome under full information.$^9$ Now, we need to find intermediated outcome with uncertainty.

**Intermediated Solution under Uncertainty**

We know that a financial intermediary can play its role in two ways: as a matchmaker and as a manager. It has been shown earlier that the introduction of an intermediary leads to efficient investment for both inputs regardless the type of roles it plays. In this section of the paper, we will consider financial intermediary just as a matchmaker. Suppose, entrepreneur manages and a residual claimant, pays a rental.

---

$^9$ Because, $\frac{r + 2n_2}{r + n_2 + 1} \phi p < 1 \Rightarrow f^k(.) > c^k(.)$
rate $R_1$ for capital in a perfectly competitive environment. Because of the competitive
nature of the market, all agents take $R_1$ as given. A lender will choose capital and an
entrepreneur will choose both capital and skill such that

$$\text{(62)} \quad \max_{(k)} u_k(k,S) = k.R_1 - C(k)$$

$$\text{(63)} \quad \max_{(k,s)} [ pF_d - k.R_1 - s.R_2 ]$$

If the solution to this problem gives $\hat{k}$ and $\hat{s}$ as the equilibrium investment
for capital and skill then the first order conditions for this problem would be

$$\text{(64)} \quad p f^k(\cdot) = R_{1d}$$

$$\text{(65)} \quad p f^s(\cdot) = R_{2d}$$

$$\text{(66)} \quad R_{1d} = c^k(\cdot)$$

Replacing $R_{1d}$, we can write

$$\text{(67)} \quad p f^k(\cdot) = c^k(\cdot)$$

Note that $p < 1 \Rightarrow f^k(\cdot) > c^k(\cdot) = R_{1d}$ and $f^s(\cdot) > R_{2d}$, which means inefficient
investment in both inputs under asymmetric information even in the presence of
financial intermediation. Inefficiencies, in this case, are only due to production
uncertainty ($p$). If we set $p = 1$, it’s immediately observable that all the inefficiencies
disappear. Given the fact that solution under asymmetric information is not efficient,
a model of entrepreneurial moral hazard is developed. Our model is similar to that of
Shapiro and Stiglitz (1984) where they consider moral hazard on the part of workers.
Under a costly monitoring scenario, our paper attempts to outline two conditions –
voluntary monitoring condition and no shirking condition – to examine the role of
financial intermediation.

Voluntary Monitoring Condition (VMC)

Voluntary Monitoring Condition (VMC) is a condition for a lender where
monitoring is voluntary. In order to derive VMC for a lender, let us consider two
production levels: high = \( F^H \) and low = \( F^L \) where an entrepreneur is responsible for production activities. Also, assume that \( m \) is the monitoring cost, which is an increasing function of matched borrower per lender, and \( b_1 \) is an exogenous project termination rate. Given the possible outcome of the contract, a lender may or may not prefer to monitor an entrepreneur. If a lender monitors, \( F^H \) will be produced with probability \( p_1 \) and \( F^L \) will be produced with probability \( (1-p_1) \). On the other hand, if he decides not to monitor, output \( F^H \) will be produced with probability \( p_2 \) (<\( p_1 \)) and output \( F^L \) will be produced with probability \( (1-p_2) \). Thus, the asset value equations for a lender under both situations are respectively given by

\[
\begin{align*}
rv^m &= \phi [p_1 F^H + (1-p_1) F^L ] - m + b_1 (v_{lu} - v_{le} ) \\
rv^l &= \phi [p_2 F^H + (1-p_2) F^L ] + b_1 (v_{lu} - v_{le} )
\end{align*}
\]

Assuming \( y_1^H = \phi [p_1 F^H + (1-p_1) F^L ] \) and \( y_1^L = \phi [p_2 F^H + (1-p_2) F^L ] \), equation (68) and (69) can be rewritten as

\[
\begin{align*}
(70) \quad v^m_{le} &= \frac{1}{r+b_1} [y_1^H - m + b_1 v_{lu}] \\
(71) \quad v^l_{le} &= \frac{1}{r+b_1} [y_1^L + b_1 v_{lu}]
\end{align*}
\]

Applying VMC i.e., \( v^m_{le} \geq v^l_{le} \) gives

\[
(72) \quad y_1^H \geq m + y_1^L
\]

Here monitoring cost 'm' is an increasing function of matched borrowers per lender, say \( N_{2m} \). Therefore, equation (72) can be rewritten as

\[
(73) \quad y_1^H \geq m (N^*_{2m}) + y_1^L
\]

Equation (73) is an algebraic expression of VMC, which is shown in Figure 5.
Figure 5: Voluntary Monitoring Condition (VMC)

Voluntary Monitoring Condition (VMC)

Monitoring is profitable

Monitoring is not profitable

No Shirking Condition (NSC)

In order to derive an incentive compatible condition for an entrepreneur, let us suppose that an entrepreneur exerts costly effort ‘e’ in order to generate high output $F^H$. We assume that high output occurs with probability $q_1$ and low output occurs with probability $(1-q_1)$. When an entrepreneur shirks ($e=0$), however, she gets output share $(1-\phi)F^H$ with probability $(q_2<q_1)$ and output share $(1-\phi)F^L$ with probability $(1-q_2)$.

In this case, assume that the rate of project termination is given by $(d_2+g_2)$. Here $d_2$ is the natural termination rate and $g_2$ is the probability that an entrepreneur will be caught while shirking, which is a decreasing function of matched borrowers per lender. Given that the project acquisition rate for an entrepreneur is ‘$a_2$’, we can write the following asset value equations.
Equation (74) is discounted lifetime utility of a non-shirker, equation (75) is discounted lifetime utility of a shirker and equation (76) is the discounted utility for an unmatched entrepreneur. The incentive compatibility condition for an entrepreneur not to shirk (NSC) is given by $v_2^N \geq v_2^S$.

Assuming $y_2^H = (1-\phi)[q_1F^H + (1-q_1)F^L]$ and $y_2^L = (1-\phi)[q_2F^H + (1-q_2)F^L]$, equation (74), (75) and (76) could be rewritten as

(77) $v_{2e}^N = \frac{1}{r + d_2} \left[ y_2^H - e + d_2 v_{2u} \right]$

(78) $v_{2e}^s = \frac{1}{r + d_2 + g_2} \left[ y_2^L + (d_2 + g_2) v_{1u} \right]$

(79) $v_{2e}^s = \frac{r + a_2}{a_2} v_{2u}$

Applying (NSC) i.e., $v_2^N \geq v_2^S$ and simplifying, we get

(80) $y_2^H \geq e + \left[ \frac{a_2 + d_2 + r}{a_2 + d_2 + g_2 + r} \right] y_2^L$

Since $g_2$ is an decreasing function of matched borrowers per lender, equation (80) can be rewritten as

(81) $y_2^H \geq e + \left[ \frac{a_2 + d_2 + r}{a_2 + d_2 + g_2 (N_{2m}^-) + r} \right] y_2^L$

Equation (81) is an expression for no shirking condition. The graphical representation of this NSC is shown in Figure 6.
Figure 6: No Shirking Condition (NSC)

In order to see the role of financial intermediation on investment and output, the outcome with and without intermediary needs to be compared. An introduction of a financial intermediary will bring following changes:

A Change in the Monitoring Cost (m)

D. Diamond (1984), Williamson (1996), and Wang and Williamson (1998) argue that a financial intermediary has monitoring and screening cost advantage over individuals. That means with the introduction of financial intermediary the monitoring cost (m) would be lower and as a result the VMC line will shift down creating opportunities for higher output.
A Change in the Probability of Getting Caught (g₂) While Shirking

As a financial intermediary faces lower monitoring cost, it is also feasible to argue that the introduction of financial intermediation will increase the probability of catching entrepreneur (g₂) while shirking (Shapiro and Stiglitz, 1984). As a result, the NSC line will also shift down. Putting both changes together, as shown in Figure 7, the new equilibrium will bring in more opportunities for production.

Therefore, the introduction of financial intermediation creates opportunities for more output and economic growth because of better allocation of resources, lower monitoring cost and higher probability of catching shirking. This helps explain the second channel, the efficiency gains, through which financial intermediation generates higher economic growth.
Summary and Conclusion

The present study is an attempt to explain the role of financial intermediation in capital formation and economic growth. This study uses a model of matching and bargaining to investigate the welfare effects of financial intermediation. This study also explores the role of financial intermediation under entrepreneurial moral hazard. We show that the introduction of financial intermediaries stimulates economic growth because of higher capital accumulation as well as efficiency gains. The main results of this paper are:

Under the assumptions of identical agents, a perfectly competitive environment and no information problem, the amount of investment and output are
sub-optimal in autarky. This sub-optimality in investment and output in autarky remain even if repeated search is allowed. However, when repeated search is allowed, the investment and output are better. This is mainly due to search frictions and an externality in the matching process. The autarkic solution under heterogeneous agents is inferior to that of homogeneous agents in terms of lower investment and output. This is because the assumption of heterogeneous agents induces more frictions in the matching process.

In the absence of information asymmetry, the introduction of financial intermediary in a perfectly competitive environment ensures payment to each factor according to their marginal product. Therefore, investment of capital and skill are Pareto efficient, leading to higher steady state output and economic growth. This is the usual capital accumulation channel where output is higher because of higher investment.

Under entrepreneurial moral hazard, investment is not efficient even in the in presence of financial intermediation. Any attempt that reduces the market frictions eases the search and matching process for both parties and makes possible more investment, output and economic growth. Specifically, the introduction of financial intermediaries reduces market frictions by lowering the monitoring cost and by increasing the probability of detecting shirking. As a result, financial intermediaries create opportunities for more output even in the presence of information asymmetry. This is where the efficiency gains are likely to be large, which derives from financial intermediary creating better allocation of investment resources, possibly via improved matching, monitoring and organization between the lender and borrower.

The current section of this dissertation, thus, identifies two channels through which financial intermediaries stimulate economic growth. One is the usual capital
accumulation channel where the introduction of financial intermediary generates higher capital and thus higher economic growth. The other one is the efficiency gains where the introduction of financial intermediary reduces frictions, information asymmetry, and monitoring cost, eases contracts and trades and increases the probability of catching shirking, thereby raising productivity and the quality of investments.
SECTION III

ESSAY 2: FINANCE-GROWTH NEXUS: A STRUCTURAL VAR APPROACH

Background

The existence of correlation between financial development and economic growth is well established both at the theoretical and empirical levels. After Bagehot (1873) and Schumpeter (1911), the issue of finance-growth linkage was again focused by Gurley and Shaw (1955). They outlined a co-evolution of the real and financial sectors without attributing any specific direction of causation. Goldsmith (1969), the first empirical study in the literature of finance-growth linkage, finds evidence of strong correlation between financial development and economic growth in his cross-country study. Evidence of a strong correlation between financial development and economic growth in their studies led him to conclude that a well-developed and better functioning financial system supports faster economic growth.

The existence of correlation between financial development and economic growth, however, does not necessarily recognize whether financial development causes economic growth or other way around. Thus, recent studies in this literature attempt to identify the cause and effect of the relationship between financial development and economic growth. The relationship between financial development and economic growth could be explained from two opposite directions. One is based on the supply side view of the economy that suggests financial development causes economic growth. Financial development could generate higher income through two

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distinct channels: the usual capital accumulation and efficiency gains. A recent survey by Levine (2003) strongly acknowledges two channels through which finance may influence economic growth. Our first essay also identifies the capital accumulation and efficiency gains channels theoretically. King and Levine (1993a), Levine and Zervos (1998), and Beck et al. (2000) find evidence that financial development has significant positive impact on output through both channels.

Authors from the demand side view postulates that economic development promotes financial development by creating additional demand for financial services\(^\text{11}\). They argue that economic development generates additional opportunities for financial services and hence establishes a more developed financial sector. According to their view economic growth leads and finance follows.

The existing literature on finance-growth linkage does not provide a satisfactory conclusion about the direction of causality. To address this controversy, a long-run SVAR model following Blanchard and Quah's (1989) technique is used to examine the dynamic relationship between financial development and economic growth empirically. Under the long-run SVAR model, we assume that financial development causes economic growth. Our long-run restrictions do not allow any long-run influence of investment and income growth on financial development. However, they allow us to investigate the short-run dynamics among financial development, investment and income growth through VDCs and IRFs. Quarterly data during 1970:1-2002:3 on real per capita financial development, investment and income growth for three emerging and three OECD countries are used in this investigation.

In the finance-growth literature, the contribution of Ross Levine is very significant. He presents a comprehensive survey of the finance-growth relationship in his 1997 JEL paper and argues in favor of the view that financial development promotes economic growth. Theoretical papers, such as Bencivenga and Smith (1991), Diamond (1984), Williamson (1996), and Wang and Williamson (1998) explain various channels through which financial development aids economic growth. Bencivenga and Smith (1991) develop an overlapping generations (OLG) endogenous growth model where the introduction of financial intermediaries changes the composition of agent’s choice of capital and liquid asset in such way that is growth promoting. They argue that financial intermediaries have economies of scale advantage over individuals in that financial intermediaries could maintain capital and liquid asset combination in a more predicable manner.

Diamond (1984) and Williamson (1996) in their models of delegated monitoring show that financial intermediaries have monitoring cost advantage over individuals. In a model of adverse selection with delegated screening by Wang and Williamson (1998) where ex-post screening is costly, it has been shown that by circumventing replications of costly monitoring and by diversifying portfolio of loans, financial intermediaries can improve market outcome significantly. We have shown in our model of search equilibrium under asymmetric information – moral hazard on part of the entrepreneur that financial development is growth promoting. Because of cost and scale advantage, financial intermediaries create opportunities for more investment activities that generate higher income and output growth.

Cross-country empirical studies, such as King and Levine (1993a), Levine (1997 & 1999), Levine and Zervos (1998), Rajan and Zingales (1998), Beck et al.
(2000) and Levine et al. (2000) predict that the causal relationship goes from financial development to economic growth i.e., financial development causes economic growth. They believe in the Schumpeterian view that financial intermediaries lead economic development. As the introduction of financial intermediaries reduces transaction costs (Diamond, 1984 and Williamson, 1996), information asymmetries, market frictions (Bester, 1995; Levine, 1997 and Section II of this dissertation) and pools risk (Wang and Williamson, 1998), they argue that a well-developed financial system may assist in mobilizing savings, facilitates investment, and thus contributes toward higher economic growth. They try to address the main drawbacks associated with Goldsmith's (1969) study and identify the direction of causality between finance and economic growth.

King and Levine (1993a) use data from 80 developing countries over the period 1960-1989 to investigate the consistency of the Schumpeterian view and the findings of Goldsmith (1969). They use correlation and regression in their cross-country investigation and find that various measures of financial development are strongly correlated with real per capita GDP growth and with other measures of economic activity, such as physical capital accumulation and productivity. Levine and Zervos (1998) investigate the empirical relationship between various measures of market liquidity and economic growth. Their findings indicate that stock market liquidity and banking development are both significantly correlated with capital accumulation, productivity and economic growth. In line with the findings of other cross-country studies, Fry (1978 & 1997) suggests that financial conditions have a significant influence on saving and economic growth. He also argues that financial liberalization promotes economic growth.

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Levine (1999) examines if the legal environment helps improve the financial system and if financial development has any impact on economic growth. By extending the work of King and Levine (1993b), he shows that countries with improved legal and regulatory environments have better financial system and experience faster economic growth. Rajan and Zingales (1998) examine the impact of financial development on firms that are dependent on external finance. In doing so they use a cross-country sample and find that firms that are relatively more dependent on external finance grow faster in countries with more-developed financial markets.

Beck et al. (2000) investigate the empirical association between financial development and economic growth. They also try to pinpoint the impact of financial development on the sources of economic growth, such as factor productivity growth, physical capital accumulation and private savings. They use an instrumental variable estimator and a panel technique that controls for possible endogeneity problem and for country specific effects. The outcomes of their study indicate that financial development has strong positive impact on economic growth and factor productivity growth. Levine et al. (2000) find evidence that a better legal system and accounting standards tend to promote better financial intermediaries and thereby faster economic growth. Fase and Abma (2002) also find evidence of causality that runs from financial development to economic growth in their cross-country study of 9 emerging economies. In general, studies that are based on cross-country observations seem to produce evidence in favor of the Schumpeterian view, where financial development promotes economic growth.

Studies based on time series, such as Demetriades and Hussein (1996), Hansson and Jonung (1997), Luintel and Khan (1999), and Shan et al. (2001) are dominated by evidence of bi-directional causality. However, Choe and Moosa (1999)
using Granger Causality tests on Korean data and Xu (2000) using multivariate VAR on 41 developing countries find evidence that financial development promotes economic growth.

Demetriades and Hussein (1996) conduct a series of causality tests between financial development and real GDP in 16 developing countries. Their findings surprisingly provide very little evidence in support of the view that financial development causes economic development. They find considerable evidence of reverse causality where actually economic development causes financial development. They also find substantial evidences of bi-directional causality. Their conclusion, however, concerning the finance-growth relationship is mostly country specific and bi-directional. Shan et al. (2001) also finds similar results in their study of 9 OECD countries and China. Their findings provide little support for the finance view but give strong support for reverse and bi-directional causality. The bi-directional causality is also dominant in Luintel and Khan (1999), where the authors investigate the long-run relationship between financial development and income growth in 10 developing countries based on multivariate VAR.

Hansson and Jonung (1997) examine finance-growth relationship for Sweden during the period 1834-1991. The results of their study indicate a two-way interaction rather than any one-way causal relationship between financial development and economic growth. Their findings suggest that the relationship between financial development and economic growth for Sweden is time specific. They find evidence that financial development causes economic growth during 1890-1939, which does not hold for the rest of the sample period.

Robinson (1952) and some recent papers, such as Deveraux and Smith (1994), Jappelli and Pagano (1994), Singh (1997), Arestis and Demetriades (1997) and Singh
and Weisse (1998) show that financial development does not always promote economic growth. They argue that economic growth may promote financial development depending on the stage of economic development. In contrast to the previous literature, they claim that economic development generates additional demand for financial services and hence establishes a more developed financial sector. According to their view economic growth leads and finance follows.

Some other papers including Gurley and Shaw (1955), Greenwood and Jovanovic (1990), Galetovic (1996), and Bencivenga and Smith (1998) observe an inextricable link between financial development and economic growth. They predict a joint evolution of the real and financial sectors during the growth process. They argue that at the initial stage of economic development ‘finance follows economy’. After a certain threshold level of economic development, financial intermediaries emerge and economy starts to benefit from the financial sector. In this sense, the evolution of financial and economic development is jointly determined.

Some recent studies, such as Deidda and Fattouh (2002) and Rousseau and Wachtel (2002) dispute any linear or monotonic relationship between financial development and economic growth. They observe a non-linear relationship between financial development and economic growth. Deidda and Fattouh (2002) present a simple OLG model with risk averse agents and costly financial transactions that predicts an ambiguous effect of financial development on the economy at low levels of development and positive effect as development proceeds. They apply a threshold regression model to King and Levine’s (1993a) data and find that there is no significant relationship between financial development and economic growth for low-income countries but significantly positive relationship for high-income countries. Based on the outcome of a series of rolling panel regressions Rousseau and Wachtel’s
(2002) study identifies an inflation threshold level in order for an effective association between financial development and economic growth. They use data on 84 developing countries during 1960-1995 and find that financial development does not promote any economic growth when inflation exceeds the threshold. The association between financial development and economic growth is significantly positive only when inflation is about 6% to 8% below threshold level. They also observe that financial development has strong positive impact on economic growth under disinflations.

Given the evidence and predictions of the existing literature, it is difficult to come up with a clear view concerning the causal relationship between financial development and economic growth. Co-evolution of financial development and economic growth where they are jointly determined seems to be the most reasonable candidate in explaining their relationship. In this respect both the financial and economic development are simultaneously determined.

Without disputing the idea of co-evolution of financial development and economic growth, we believe that initially the action has to start somewhere. Therefore, we along with some other authors\(^\text{13}\), argue that at the initial stage of development economy leads and finance follows. When financial sector is well organized, it starts to contribute towards economic growth and development. This interaction process between financial development and economic growth runs forever. It could be argued that in the short-run economic development causes financial development and in the long-run financial development leads economic development. This relationship between financial development and economic growth could be modeled and investigated appropriately with the help of the long-run SVAR

\(^{13}\) Greenwood and Jovanovic (1990), Galetovic 1996, and Bencivenga and Smith (1998) and Deidda and Fattouh (2002)
technique. Accordingly, Blanchard and Quah’s (1989) long-run SVAR technique is used in the current investigation of finance-growth relationship.

Methodology

Sims’s (1980) seminal work introduces an unrestricted VAR model that allows feedback and dynamic interrelationships across all the variables in the system and appears to be highly competitive with the large-scale macroeconometric models in forecasting and policy analysis. The unrestricted VAR models assume that each variable in the system is endogenous and does not impose any a priori restrictions. The VAR models, however, impose contemporaneous restrictions based on recursive or Cholesky ordering. This makes difficult to reconcile VARs with the economic theory that could provide any meaningful interpretations of the estimated parameters.

In order to overcome the above difficulties with the standard unrestricted VAR models, some studies, such as Bernanke (1986), Blanchard and Watson (1986) and Sims (1986) introduce short run structural vector autoregression (SVAR) model that imposes contemporaneous structural restrictions. Shapiro and Watson (1988) and Blanchard and Quah (1989), on the other hand, develop an alternative SVAR method that allows long-run structural restrictions. Their long-run SVAR model does not impose any contemporaneous restrictions, but it allows the researcher to determine short-run dynamics in the data. As one of the main objectives of this paper is to investigate long-run relationship between financial development and economic growth, Blanchard and Quah’s (1989) technique of long-run structural model is employed assuming financial development has long-run impact on investment and income growth.

A structural VAR model for a simple multivariate simultaneous equation
system can be stated as follows\textsuperscript{14}. If $y_t$ is a vector of variables of interest\textsuperscript{15}, 'A' is a matrix of structural parameters, and 'B' is a matrix of contemporaneous responses of endogenous variables to the unobserved structural shocks ($\varepsilon_t$) then a multivariate simultaneous system of equations can be expressed as

\begin{equation}
Ay_t = D(L)y_{t-1} + B\varepsilon_t,
\end{equation}

Where $D(L)$ is a matrix of lagged coefficients with $p$th order polynomial in the lag operator $L$. Pre-multiplying by $A^{-1}$, equation (82) gives us the following reduced form equation system

\begin{equation}
y_t = A^{-1}D(L)y_{t-1} + A^{-1}B\varepsilon_t,
\end{equation}

Assuming $A^{-1}D(L) = \beta(L)$, we can get the following standard VAR representation

\begin{equation}
y_t = \beta(L)y_{t-1} + \varepsilon_t,
\end{equation}

Here $\varepsilon_t$ is the vector of reduced form innovation with $- \text{iid} [0, E[\varepsilon_t\varepsilon_t'] = \Sigma_\varepsilon]$ and

\begin{equation}
\varepsilon_t = A^{-1}B\varepsilon_t.
\end{equation}

Letting $G = A^{-1}B$, we can write

\begin{equation}
E[\varepsilon_t\varepsilon_t'] = \Sigma_\varepsilon = GE[\varepsilon_t\varepsilon_t']G' = G\Sigma_\varepsilon G'
\end{equation}

Here $\Sigma_\varepsilon = E[\varepsilon_t\varepsilon_t']$ is the variance-covariance matrix of structural innovations.

Equation (85) and (86) explain the relationship between observed reduced form innovations ($\varepsilon_t$) and unobserved structural innovations ($\varepsilon_t$) through the composite of structural coefficient matrix and the matrix of contemporaneous response of endogenous variables to the unobserved structural shocks. Equation (84) can be rewritten as

\begin{equation}[(I - \beta(L)L)y_t = \varepsilon_t,
\end{equation}

or,

\begin{equation}y_t = (I - \beta(L)L)^{-1}\varepsilon_t,
\end{equation}

\textsuperscript{14} Consult Enders (1995) for details.

\textsuperscript{15} Blanchard and Quah's (1989) long-run SVAR technique requires all variables in the system be stationary.
Letting \((1 - \beta(L)L)^{-1} = C(L)\) and \(e_i = A^{-1}B\epsilon_i = G\epsilon_i\), yields
\[(87) \ y_t = C(L)G\epsilon_t,\]
Equation (87) is moving average representation (MAR) for the standard VAR model where \(C(L)\) represents the estimated accumulated response to the reduced form shocks \((e_t)\) and \(G\) represents the relationship between the regression residuals and the structural shocks. Substituting \(L=1\), we can write
\[(88) \ y_t = C(1)G\epsilon_t, \text{ and}\]
\[(89) \ E(yy') = C(1)G\Sigma\epsilon G'C(1)',\]
Here \(C(1)G\) is the long-run response matrix to structural shocks and each element of that matrix is sum of coefficients over a certain time horizon. In order to identify any long-run response, we need to impose a certain number of restrictions on \(C(1)G\) and \(\Sigma\epsilon\) matrices. Assuming \(\Sigma\epsilon\) is an identity matrix, the long-run response matrix, \(C(1)G\), needs \(n(n-1)/2\) additional restrictions to be exactly identified.

Identifying Restrictions

This paper investigates the long-run relationship between financial development and economic growth, particularly the long-run impact of financial development on investment and income growth. Accordingly, a system of equations based on the hypothesis that financial development has long-run impact on investment and income growth is specified. In order to impose a set of economically meaningful identification restrictions on the data, consider the following production function
\[(90) \ Y = F(K,L)\]
Here, \(Y\) is real output, \(K\) is capital and \(L\) denotes labor. Assuming constant returns to scale and dividing equation (90) by \(L\), we get the following intensive form production
function
(90) \(y = f(k)\)

In growth form
(91) \(g_y = h(g_k)\)

Here \(g_y\) and \(g_k\) are the growth rates in real per capita output and capital respectively.

Following the neoclassical tradition, we assume constant growth rate of capital in the steady state. Thus, we write
(92) \(\dot{g}_k = \frac{\dot{k}}{k} = \alpha\)

Where \(\alpha\) is a constant. Setting per capita real investment \(I = \dot{k}\) yields
(93) \(I = \alpha k\)

In growth form
(94) \(g_I = g_k\)

Inserting \(g_I\) into equation (91)
(95) \(g_y = h(g_I)\)

Equation (95) represents a standard neoclassical growth equation where output growth is a function of investment growth in the long-run steady state equilibrium.

Since our objective is to examine the long-run influence of financial development on investment and income growth, we postulate that the introduction of financial intermediaries in the production process induces long-run impact on income growth through two distinct channels. One is the quantitative impact, the positive impact of financial development on income growth via investment growth. This is the standard capital accumulation channel creating growth. The other is the efficiency effect, the impact of financial development on income growth that derives from sources other than increased capital accumulation. Financial development mitigates risk (Wang and Williamson 1998), lowers transaction costs (Diamond, 1984 and Williamson, 1996),

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improves information asymmetries & market frictions (Bester, 1995; Levine, 1997 and Section II of this dissertation), and enables higher quality investments (Greenwood and Smith, 1997). In the long-run, therefore, financial development leads to higher investment and income. Accordingly, incorporating the growth of financial development \((g_F)\) in the production process, we can write the following equations

\begin{align*}
g_t &= u(g_F) \\
g_y &= h[u(g_F)] \text{ or } g_y = v(g_I, g_F)
\end{align*}

The long-run causal relationship among financial development, investment and income growth can be expressed as either \(g_F \Rightarrow g_I \Rightarrow g_y\) or \(g_F \Rightarrow g_y\) representing the two channels – capital accumulation and efficiency gains of financial development. Based on the functional relationship specified in equations (96) and (97), we can impose the following long-run restrictions on the reduced form residuals.

\begin{align*}
e_t^g &= e_{1t} \\
e_t^y &= A_{21}e_t^g + e_{2t} \\
e_t^y &= A_{31}e_t^g + A_{32}e_t^g + e_{3t}
\end{align*}

Here \(e_t^i\) is the estimated residual of \(i^{th}\) equation from standard VAR model and \(e_{it}\) is the structural shocks from the \(i^{th}\) variable in the system. According to the above system, the variables in the vector \(y_t\) of equation (88) are set in such a way that: (i) a structural shock to financial development (i.e., \(e_{1t}\)) has long-run effect on the growth of financial development itself. (ii) structural shocks to financial development as well as investment (i.e., \(e_{1t}\) and \(e_{2t}\)) have long-run effect on the investment growth, and finally (iii) structural shocks to financial development, investment, and income (i.e., \(e_{1t}, e_{2t}\) and \(e_{3t}\)) have long-run effect on income growth. The restrictions imposed in the above system of equations are similar to that of Cholesky ordering. This paper imposes long-run restrictions based on the hypothesis that financial development has
long-run impact on investment and income growth whereas Cholesky ordering imposes only contemporaneous restrictions. Note that the above long-run restrictions would not allow us to have any long-run impact of investment and income growth on financial development. However, they allow us to determine the short-run dynamics among the variables in the system via VDCs and IRFs. Using the above long-run structural restrictions and econometric specification, we can write the following system

\[
\begin{bmatrix}
  g_{x(t)} \\
g_{t(t)} \\
g_{y(t)}
\end{bmatrix} = \begin{bmatrix}
  \theta_{11}(1) & 0 & 0 \\
  \theta_{21}(1) & \theta_{22}(1) & 0 \\
  \theta_{31}(1) & \theta_{32}(1) & \theta_{33}(1)
\end{bmatrix} \begin{bmatrix}
  \epsilon_{x(t)} \\
  \epsilon_{t(t)} \\
  \epsilon_{y(t)}
\end{bmatrix}
\]

In more compact form

\[(102) \quad \gamma_t = \theta(1)\epsilon_t\]

Where \(\theta(1)\) is the long-run response matrix to structural shocks with three exclusion restrictions. Each element of this matrix, \(\theta_{ij}(1)\), is the sum of coefficients over a certain time horizon and could be interpreted as the long-run response of the \(i^{th}\) variable to one standard deviation structural shocks to the \(j^{th}\) variable. For example, \(\theta_{21}(1)\) captures the long-run response of investment growth (2\(^{nd}\) variable) to one standard deviation structural shocks to the growth of financial development (1\(^{st}\) variable).

Blanchard and Quah’s (1989) technique of SVAR is employed to estimate the long-run response matrix and to generate VDCs and IRFs. The estimated parameters of the long-run response matrix provide information about long-run influence of financial development on investment and income growth. The VDCs and IRFs help identify the short-run dynamic relationship among the variables in the system. Because developed countries are relatively closer to their potential income level than

\[16\] Note that three restrictions make a 3-variable SVAR system just identified.
developing countries, we expect relatively stronger response of investment and income growth due to financial shocks for the three developing countries.

Data

Quarterly data from International Monetary Fund’s CD-ROM on International Financial Statistics (IFS) during 1970:1-2002:3 on real per capita financial development, investment and income growth for a sample of six countries are used in this investigation. To examine the long run influence of financial development on investment and economic growth, three of the most well known emerging economies are selected. In order to compare the outcome of three emerging economies, a sample of three well-known OECD countries is also included in this investigation. This helps us identify the relative nature of the finance-income relationship between the two groups—developing vs. developed. Three East Asian emerging economies are Malaysia, Singapore, and Thailand and three OECD economies are Australia, Canada, and the USA. A pair of three-variable long-run structural vector autoregression (SVAR) models along with their VDCs and IRFs is estimated for each country using Blanchard and Quah’s (1989) long-run SVAR technique.

Various financial indicators could be used as proxy for financial development. In line with the existing literature, two alternative financial indicators, such as domestic credit to the private sector or total deposits are used as proxies for financial development. Credit, deposits, investment and income are denoted in real per capita terms. Data on credit are taken from line 32d and deposits are calculated by adding line 34 and 35 and by subtracting line 14a of the IFS CD-ROM. Data on price level, investment, income and population are taken from lines 64, 93e+93i, 99b.p and 99z.

One is credit, investment, and income and the other is deposit, investment, and income.
respectively of the CD-ROM\textsuperscript{18}.

Preliminary Data Analysis

Blanchard and Quah's (1989) technique of long-run SVAR requires all variables to be stationary. We need to make sure that all the variables in the system are stationary. Accordingly, a series of unit root tests, such as Dickey and Fuller (DF, 1981), Phillips and Perron (PP, 1988), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS, 1992) are used to determine the order of integration for each series. The results\textsuperscript{19} of unit root tests indicate that all of the variables are I(1) in log levels and I(0) in the first difference. Accordingly, all of the variables are used in their first differenced form. The lag length in the initial VAR estimation is decided by the likelihood ratio (LR) tests.

Empirical Results

In order to examine the finance-growth relationship a long-run response matrix, VDCs and IRFs are computed\textsuperscript{20}. The estimated parameters of the long-run response matrix provide information about long-run influence of financial development on investment and income growth. It also allows us to see if investment growth has any long-run impact on income growth. The VDCs and IRFs, on the other hand, provide information about the short-run dynamics among financial development, investment and income growth.

\textsuperscript{18} Since IFS dose not have quarterly data on population and for some countries on GDP, quarterly data for those series are generated through interpolation using SAS.

\textsuperscript{19} Results of the unit root test are not reported here but are available on request.

\textsuperscript{20} The standard errors of VDCs and confidence bands of IRFs are generated by 1000 Monte Carlo simulations. The program used to generate VDCs, IRFs, and their standard errors are provided by Prof. Mark Wheeler.
Long-run Response

The estimated parameters of long-run response matrix are reported in Table 1. The first half of this table reports estimated parameters of the long-run response matrix when credit is used as an indicator of financial development and the second half of the table reports the same when deposit is used instead. Each column of Table 1 contains estimated parameters for each country. Table 1 indicates that financial development has a significant positive impact on investment and income growth particularly for the three emerging economies. Investment has a long run growth effect on income also for these countries. For the 3-OECD countries, the impact of financial development on investment and income growth is not so convincing. For Canada only, we observe positive impact on investment and income growth due to financial shocks. For Australia, there is no significant long-run response of investment growth due to deposit shocks, and for the USA a positive investment shock does not have any significant impact on income growth.

Relative magnitudes of the estimated parameters indicate that developing countries have relatively stronger response than those of developed countries. Between the two alternative measures of financial development, credit generates relatively larger impact on investment and income. Therefore, the estimated parameters of the long run response matrix for the three emerging economies support the hypothesis that financial development has long run impact on investment and income growth. For the three OECD countries, however, we do not observe any particular pattern. Furthermore, between the two channels through which financial development promotes economic growth, we observe the presence of both capital accumulation and efficiency effects, where the efficiency impact for the three emerging economies is stronger.
Variance Decompositions (VDCs)

Unlike the long-run response matrix, VDCs allow us to identify short-run dynamics among the variables in the system. Tables 2-7 contain VDCs with the estimated standard errors for each variable and each country over 5-year time horizon. The VDCs, as shown in Table 2, indicate that the forecast error variance of credit growth is mostly explained by itself. For the developing countries, however, investment growth seems to be another important factor in explaining the variation of credit. With the exception of Singapore, income growth does not have any significant contribution in explaining credit variance. For Singapore, income growth explains around 17% of forecast error variance of credit only after 8 quarters. A similar pattern in the forecast error variance of deposit growth is also found where deposits explain around 60%-89% of its own error variance (Table 5). Investment growth does not have any predictability for deposit growth at all. Income growth explains around one fifth of forecast error variance in deposit growth for Malaysia and Singapore starting from eighth quarter. Therefore, both measures of financial development seem to be evolving exogenously. This finding is pretty much in line with our long-run restrictions and prior expectations.
Table 1
Estimated Parameters of Long-Run Response Matrix

When credit is the measure of financial development

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>1. Long–run response of investment growth to one standard deviation structural shocks to credit growth</td>
<td>0.052*** (0.008)</td>
<td>0.057*** (0.004)</td>
<td>0.060*** (0.008)</td>
<td>0.008** (0.005)</td>
<td>0.029*** (0.005)</td>
<td>0.041*** (0.006)</td>
</tr>
<tr>
<td>2. Long–run response of income growth to one standard deviation structural shocks to credit growth</td>
<td>0.012*** (0.002)</td>
<td>0.021*** (0.001)</td>
<td>0.027*** (0.002)</td>
<td>0.005*** (0.001)</td>
<td>0.008*** (0.001)</td>
<td>0.014*** (0.001)</td>
</tr>
<tr>
<td>3. Long–run response of income growth to one standard deviation structural shocks to investment growth</td>
<td>0.011*** (0.001)</td>
<td>0.003*** (0.001)</td>
<td>0.015*** (0.001)</td>
<td>0.006*** (0.001)</td>
<td>0.012*** (0.001)</td>
<td>-0.001 (0.001)</td>
</tr>
</tbody>
</table>

When deposit is the measure of financial development

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Long–run response of investment growth to one standard deviation structural shocks to deposit growth</td>
<td>0.019** (0.007)</td>
<td>0.029*** (0.006)</td>
<td>0.057*** (0.009)</td>
<td>-0.002 (0.004)</td>
<td>0.029** (0.005)</td>
<td>0.029*** (0.006)</td>
</tr>
<tr>
<td>2. Long–run response of income growth to one standard deviation structural shocks to deposit growth</td>
<td>0.009*** (0.002)</td>
<td>0.005*** (0.002)</td>
<td>0.024*** (0.002)</td>
<td>0.003*** (0.001)</td>
<td>0.008*** (0.001)</td>
<td>0.011*** (0.001)</td>
</tr>
<tr>
<td>3. Long–run response of income growth to one standard deviation structural shocks to investment growth</td>
<td>0.016*** (0.001)</td>
<td>0.018*** (0.001)</td>
<td>0.018*** (0.002)</td>
<td>0.006*** (0.001)</td>
<td>0.013*** (0.001)</td>
<td>0.0002 (0.001)</td>
</tr>
</tbody>
</table>

Notes:
1. First entry in each cell is the point estimates of the long-run response of variable $i$ to one S.D. structural shocks to variable $j$ and figures in the parenthesis are standard errors.
2. *** = Significant at 1% level and ** = significant at 5% level.
3. Optimal lag length is decided based on Likelihood Ratio (LR) test statistic (each test at 5% level). Figures in the square bracket [ ], next to country’s name, are the optimal lag length for the respective country.
The VDCs of investment growth are reported in Tables 3 and 6 when credit and deposits respectively are the proxies for financial development. Table 3 indicates that investment growth significantly explains most of its own error variance. Financial development as measured by the credit growth is also an important factor in explaining the error variance of investment growth. For Malaysia and Singapore, credit explains more than 50% of investment variation. For Canada, income growth appears to be important element for the forecast error variance in investment growth.

The VDCs, as shown in Tables 4 and 7, indicate that financial development again is an important factor in explaining forecast error variance of income growth with a few exceptions. For Thailand, Australia and Canada investment growth explains a significant portion of forecast error variance in income growth. Income growth is also very helpful in predicting its own path except for Singapore and Canada.

Therefore, in line with our prior expectations and imposed restrictions, we observe that (i) most of the forecast error variance in financial development is explained by itself; (ii) growth of investment and financial development are two important factors in explaining forecast error variance of investment growth; and finally (iii) income, financial development and investment growth are important factors in predicting future income growth.
Table 2

Variance Decompositions of Finance (Credit) Growth

<table>
<thead>
<tr>
<th>1. As explained by finance (credit) growth</th>
<th>Malaysia</th>
<th>Singapore</th>
<th>Thailand</th>
<th>Australia</th>
<th>Canada</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time horizons (quarters)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>41.33**</td>
<td>35.99**</td>
<td>68.62**</td>
<td>90.40**</td>
<td>80.69**</td>
<td>91.93**</td>
</tr>
<tr>
<td></td>
<td>(17.65)</td>
<td>(10.67)</td>
<td>(18.20)</td>
<td>(9.06)</td>
<td>(15.43)</td>
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Notes:
1. Monte Carlo (1000) simulated standard errors are reported in the parenthesis.
2. ** Implies point estimates are statistically significant at 5% level assuming that the estimates are asymptotically normally distributed.
Table 3

Variance Decompositions of Investment Growth

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Notes:
1. Monte Carlo (1000) simulated standard errors are reported in the parenthesis.
2. ** Implies point estimates are statistically significant at 5% level assuming that the estimates are asymptotically normally distributed.
Table 4

Variance Decompositions of Income Growth

1. As explained by finance (credit) growth

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Notes:
1. Monte Carlo (1000) simulated standard errors are reported in the parenthesis.
2. ** Implies point estimates are statistically significant at 5% level assuming that the estimates are asymptotically normally distributed.
## Table 5

Variance Decompositions of Finance (Deposit) Growth

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### Table 6

Variance Decompositions of Investment Growth

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<td>20</td>
<td>34.38**</td>
<td>54.24**</td>
<td>40.78**</td>
<td>38.80**</td>
<td>15.90</td>
<td>60.67**</td>
</tr>
<tr>
<td></td>
<td>(12.73)</td>
<td>(14.55)</td>
<td>(10.24)</td>
<td>(14.25)</td>
<td>(8.05)</td>
<td>(9.70)</td>
</tr>
</tbody>
</table>

Notes:
1. Monte Carlo (1000) simulated standard errors are reported in the parenthesis.
2. ** Implies point estimates are statistically significant at 5% level assuming that the estimates are asymptotically normally distributed.
Impulse Response Functions (IRFs)

Like variance decomposition (VDC), impulse response function (IRF) is another way to identify short-run dynamics among financial development, investment and income growth. The impulse response for each variable up to 24th quarters is shown in Figures 8-25 with ± 2 standard deviations confidence bands (95%) generated by 1000 bootstrap Monte Carlo simulations. A response is considered significant when ± 2 standard deviations (S.D.) confidence bands do not contain zero line.

Figure 8 indicates that credit growth responds positively and significantly for a considerable period to its own shocks for all countries. The initial response of deposit growth to its own shocks (Figure 17) is also positive and significant for all sample countries. Figures 12 and 21 represent impulse response of investment growth to its own shocks when credit or deposit is used as the indicator of financial development. The estimated IRFs indicate that there is a positive and significant response of investment growth to its own shocks with an indication of relatively stronger and longer-lived response for the emerging economies. Figures 16 and 25 contain the response of income growth to its own shocks, which are significantly positive initially for all sample countries with the exception of Canada. The response of income growth to its own shocks is insignificant at all time horizons for Canada.

Response of investment growth to credit and deposit shocks is shown in Figures 9 and 18 respectively. The response of investment growth to credit shock is positive in all developing countries and in one of the three OECD countries in the initial few quarters. The response of investment growth to deposit shocks, on the other hand, is initially positive in Singapore and Thailand, which is statistically insignificant in all the other countries. A comparison of the IRFs of investment
growth due to financial shocks implies that the response in developing countries is relatively longer-lived and stronger than in developed countries.

Figures 10 and 19 contain the response of income growth to financial shocks. Figure 10 indicates that the impulse response of income growth to credit shocks is positive for all the emerging economies for a considerable period. With the exception of Singapore, income growth also responds positively to deposit shocks. For Singapore, income growth does not have any significant response to deposit shocks. The response of income growth for the developed countries is mixed. Income growth responds positively to credit shocks for Canada and to deposit shocks for the USA only. It is also readily observable that the response of income growth for developing countries is relatively stronger and longer-lived than those of developed countries. For developed economies, the response of income growth is either insignificant or very short-lived to credit or deposit shocks. Therefore, financial development has a positive short run impact on investment and income growth for the three emerging economies.

Impulse response of income growth to investment shocks is shown in Figures 13 and 22. Figure 13 contains the response of income growth when credit is the indicator of financial development and Figure 22, on the other hand, contains the response of income growth when deposits are used instead. Figure 13 indicates that there is a delayed positive response of income growth to investment shocks for Malaysia and Thailand and no significant response for Singapore. There is an initial positive response of income growth to credit shocks for Australia and Canada. For the USA, on the other hand, income growth responds negatively to the credit shocks in the very first quarter. Figure 22 indicates that income growth responds positively to the investment shocks for all sample countries with the exception of the United
For Malaysia and Thailand, we observe some sort of delayed response of income growth to investment shocks and the response is insignificant at all time horizons for the USA.

The IRFs discussed in the previous three paragraphs capture the supply side story of finance-growth linkage that produce a convincing evidence of short-run impact of financial development on investment and income growth. To see the demand side short-run dynamics, we examine IRFs of credit and deposit growth to investment and income shocks. These are discussed in the following two paragraphs.

Figures 11 and 20 report impulse response of credit and deposits growth to investment shocks. Other than Australia, response of credit growth to investment shocks is negative in the initial quarter for all sample countries. The response is insignificant at all time horizons for Australia. There is a delayed positive response of credit growth to investment shocks for Malaysia and Singapore. With the exception of Singapore and Canada, the response of deposit growth to investment shocks is insignificant for all sample countries. For Singapore, there is a negative response in the 1st quarter and zero afterwards and for Canada, there is a positive response in the 5th quarter only.

Impulse responses of credit and deposit growth to income shocks are shown in Figures 14 and 23 respectively. Response of credit growth to income shocks is zero at all time horizons for all sample countries but Singapore. For Singapore, the response of credit growth is negative in the very 1st quarter only. The response of deposit growth to income shocks is always insignificant for 3-OECD countries (see Figure 23). There is a positive response in the 3rd quarter for Malaysia, in the 1st quarter for Singapore, and in the 5th quarter for Thailand.

Figure 15 reports the response of investment growth to income shocks when
credit is the proxy for financial development and Figure 24 reports the same when deposits are used instead. The IRFs of these figures imply that there is no significant response of investment growth to income shocks with the exception Canada. In the very first quarter, there is a negative response of investment growth for Canada. The outcome of the IRFs, as discussed above, does not match the demand side argument that asserts a positive short-run impact of investment and income growth on financial development. Therefore, we do not find enough support of the short-run reverse causality that runs from income to financial development.
Figure 8: Impulse Response of Credit Growth to Credit Shocks

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Figure 9: Impulse Response of Investment Growth to Credit Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA
Figure 10: Impulse Response of Income Growth to Credit Shocks

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Figure 11: Impulse Response of Credit Growth to Investment Shocks

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Figure 12: Impulse Response of Investment Growth to Investment Shocks
Figure 13: Impulse Response of Income Growth to Investment Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure 14: Impulse Response of Credit Growth to Income Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure 15: Impulse Response of Investment Growth to Income Shocks
Figure 16: Impulse Response of Income Growth to Income Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure 17: Impulse Response of Deposit Growth to Deposit Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure 18: Impulse Response of Investment Growth to Deposit Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure 19: Impulse Response of Income Growth to Deposit Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure-20: Impulse Response of Deposit Growth to Investment Shocks
Figure 21: Impulse Response of Investment Growth to Investment Shocks
Figure 22: Impulse Response of Income Growth to Investment Shocks.
Figure 23: Impulse Response of Deposit Growth to Income Shocks
Figure 24: Impulse Response of Investment Growth to Income Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Figure-25: Impulse Response of Income Growth to Income Shocks

Malaysia

Australia

Singapore

Canada

Thailand

USA

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Summary and Conclusion

This paper investigates the relationship between financial development and economic growth, particularly the long-run impact of financial development on investment and income growth. A system of equations based on the hypothesis that financial development has long-run impact on investment and income growth is estimated. Blanchard and Quah's (1989) long-run SVAR technique is employed to estimate the long-run response matrix and to compute VDCs and IRFs. The estimated parameters of the long-run response matrix provide information about long-run influence of financial development on investment and income growth. The VDCs and IRFs provide short-run dynamics among financial development, investment and income. Quarterly data during 1970:1-2002:3 of real per capita financial development, investment and income growth from a sample of six countries are used in this investigation.

The estimates of long-run response matrix, particularly for the three emerging economies, imply that financial development has long-run impact on investment and income growth. Investment growth also has long-run positive impact on income growth. We observe relatively stronger response of investment and income growth due to financial shocks for the three emerging economies. For the three OECD countries, however, there is no particular pattern in the long-run response of investment and income growth to financial shocks.

We argue that introducing financial development in the production process induces two distinct channels through which financial development leads to economic growth. One is the usual quantitative impact, the positive effect of financial development on income growth via investment growth. The other is the efficiency impact, representing other effects of financial development on income growth. Our
study suggests stronger efficiency gains in the three emerging economies compared to their OECD counterparts.

The estimates of VDCs indicate that most of the forecast error variance in financial development is explained by itself. It is also an important factor in predicting the variation in investment and income growth. In line with the findings of VDCs, the results from IRFs indicate that a positive shock to financial development has a positive impact on investment and income growth. Income growth responds positively to investment shocks as well. The positive response of investment and income growth is relatively stronger and longer-lived for the 3-emerging economies than for the 3-OECD countries. These findings are very much in line with the supply side view of finance-growth relationship where causality runs from finance to income. The findings of this paper do not provide much support to the demand side view that income drives financial development.

Based on the findings of this paper, we conclude, at least for the 3-emerging economies, that financial development is an important factor for investment and income growth both in the short-run and long run. Our long-run restrictions do not allow any long-run influence of income and investment on financial development. However, they allow us to investigate the short-run dynamics among financial development, investment and income growth. The results of this paper, interestingly, provide very little support for the view that investment and income growth have short run impact on financial development.
SECTION IV

ESSAY 3: FINANCIAL DEVELOPMENT AND INCOME CONVERGENCE:
A PANEL DATA APPROACH

Background

The issue of convergence in per-capita income has drawn a lot attention from theoretical and empirical researchers during the last twenty years. Convergence in per-capita income is one of the main results of neoclassical growth models, such as Solow (1956), Cass (1965), and Koopmans (1965). Their models have some special features – exogenous technological change, diffusion of technology and diminishing returns to capital – that generate convergence in per capita income.

Endogenous growth models however, such as Romer (1986, 1990 and 1994), Grossman and Helpman (1991), Aghion and Howitt (1992), Lucas (1988), and Rebelo (1991) strongly dispute the possibility of convergence. They try to explain different mechanics of economic growth by dropping some of the basic assumptions of neoclassical model – exogenous technological change and the availability of similar technological opportunities in all countries – and show that economic growth is an endogenous process, not determined exogenously. As a result, such models predict permanent effects on economic growth due to a change in certain policy variables and, therefore, do not support convergence in per-capita income. Endogenous growth theorists argue that externalities, non-rivalry, non-excludability and spillover effects of knowledge and technological innovations allow richer economies to grow faster than the poorer ones.

In the literature of economic growth and development, the role of finance in
capital accumulation and economic growth is largely ignored. Like physical capital, human capital and technology, financial development is an important part of the story of economic growth as investigated by different theoretical and empirical studies, such as Wang and Williamson (1998), D. Diamond (1984), Fama (1983), Bencivenga and Smith (1991 & 1998), Hansson and Jonung (1997), King and Levine (1993a & 1993b), and Levine (1997, 1999 and 2003). The main focus of these studies is the link between financial development and economic growth. A well-known paper by Ross Levine (1997) explains how financial intermediary solves market frictions and creates opportunities for economic growth. He argues that financial intermediaries mobilize savings, allocate resources, exert corporate control, facilitate risk management, and ease trades and contracts by solving market frictions that generate higher production and growth. We also believe that financial development is an important factor contributing to economic growth and it is influential in the study of cross-country income convergence.

The issue of convergence particularly 'conditional convergence' in per-capita income follows given the neoclassical growth models' assumption of an identical aggregate production function for all the countries. This is a very strong assumption and difficult to reconcile in cross-country investigation of convergence. Given the fact that the aggregate production functions across nations are different, testing cross-country income convergence would be misleading unless such differences in cross-country aggregate production functions are allowed.

Efforts have been made to reconcile the identical aggregate production function phenomenon by controlling some key economic factors, such as infrastructure, socio-economic and political institutions, technology, research and development (R&D), physical capital and human capital. An important study by
Mankiw, Romer and Weil (1992) tests cross-country convergence by controlling cross-country differences in investment, growth of the working age population, and school enrollment. But under the framework of single cross-country regressions such an effort is not enough because of the possibility of non-identical production functions across countries. A recent work by Goddard and Wilson (2001) shows that cross-country single equation convergence regression would not be meaningful if there is any heterogeneity in the steady state values across countries.

A recent study by Islam (1995) outlines a dynamic panel data approach to deal with the issue of convergence given cross-country differences in production functions. The author argues that a panel data framework can allow for such differences in production functions in the form of country specific effects. The evidence from Goddard and Wilson's (2001) Monte Carlo study also supports the claim of panel data superiority over single cross-country regressions framework.

Various socio-economic and institutional indicators, such as capital accumulation, knowledge, preferences, technology, R & D, human capital and financial development could be used as conditioning variables. A most commonly used conditioning variable is human capital, as in Barro (1989), Mankiw, Romer and Weil (1992) and Islam (1995). Barro (1990) and a recent paper by Bajo-Rubio (2000) use the role of public sector, particularly government spending, in per capita income convergence. The role of financial sector, however, is ignored in the existing literature of conditional convergence. We use financial development as well as human capital as the conditioning variables in investigating convergence. We also examine the relative strength of human capital and financial development in improving per capita income convergence based on a panel data framework.
The empirical evidence regarding convergence is mixed and depends on the modeling aspects, assumptions and the nature of sample data. Papers by Baumol (1986), Dowrick and Nguyen (1989), Barro and Sala-I-Martin (1991, 1992, and 1995), Mankiw, Romer and Weil (1992), Cashin and Sahay (1996), Taylor (1999), and Martin and Mitra (2001) that are basically cross-section studies find evidence in support of convergence across nations or across regions of a nation while Romer (1986) and DeLong (1988) dispute existence of cross-country convergence. A panel data study by Islam (1995) finds convincing evidence in favor of cross-country income convergence. Convergence is difficult to see, however, in time series studies, such as Bernard and Durlauf (1995 and 1996), Campbell and Mankiw (1989), and Quah (1992). This is because the time series technique is mostly testing deterministic convergence, which is a stricter version of convergence.

Baumol (1986) uses Madison's data from 1870-1979 to test convergence among 16 industrialized countries. He regresses output growth over 1870-1979 on a constant and initial income to show evidence of convergence. De Long (1988) questions this evidence of convergence and argues that sample selection bias and measurement errors plague Baumol's findings. Dowrick and Nguyen (1989) investigate convergence for the OECD economies and examine if such convergence could be explained by differences in the rate of growth of factor intensities or by total factor productivity catch-up. They use the cross sectional definition of convergence ($\beta$-convergence) and find evidence of income convergence among the OECD economies that are dominantly accounted by the differences in TFP catch-up and in some cases by the differences in the rate of growth of factor intensities.

The contributions of Barro and Sala-I-Martin (1992, 1995) in the existing
empirical literature on convergence are important. Their studies are based on the cross-section approach and favor convergence. They test convergence across the states of the United States, the prefectures of Japan and across the regions of eight European countries and find that $\beta$-convergence is the norm even without conditioning on either saving, population or human capital. They also analyze the trends in net migration and find some evidences, though inconclusive, that net migration has some role in the convergence story.

Taylor (1999) finds evidence of convergence in an alternative neoclassical setting termed 'open-economy factor accumulation model' that allows capital and labor migration. Mankiw, Romer and Weil (1992) also find evidence of conditional convergence when they control for investment, growth of the working age population, and school enrollment. Likewise, another recent cross-section study by Martin and Mitra (2001) also finds evidence of convergence across nations or across regions of a nation. Islam (1995) reformulates the cross-country regression equation of Mankiw, Romer and Weil (1992) into a dynamic panel model with individual country specific effects. The estimates of his panel data procedure generate a faster conditional convergence rate across countries, which is very much in line with the prediction of the neoclassical models. The author uses human capital as a conditional variable and finds evidence that it improves the speed of convergence.

Along with the other literature in finance-growth linkage, we argue that financial development is an integral part of the story of economic growth. Following Islam’s (1995) Panel data framework, this paper investigates the importance of financial development in per capita income convergence. We use human capital as well as financial development as the conditioning variables to examine their relative strength in improving convergence.
Theoretical Background and the Model

Convergence in per capita income is one of the main features of the neoclassical growth model. Conditional convergence states that in the long-run all economies will converge to their own steady state conditional on some other related factors, such as saving and population growth rates while absolute convergence requires no condition. This means that adjusting for differences in savings and population growth rates, the lagging economies tend to grow faster than the richer ones and should eventually catch up in the long-run. This is often referred to as $\beta$-convergence. A group of countries is said to exhibit $\beta$-convergence if there exist a negative relationship between per capita income and subsequent growth rate in per capita income over the next several years. To get a better understanding of $\beta$-convergence, consider the following equation:

$$y_{i,t} = \alpha + \beta y_{i,0} + \epsilon_{i,t}$$

Where, $\hat{y}_{i,t}$ = Average income per capita growth rate in $i^{th}$ economy over period 0-t, and $y_{i,0}$ = Initial per capita income in $i^{th}$ economy. A negative value of $\beta$ in the above regression equation confirms the presence of income convergence ($\beta$-convergence) across the nations under consideration.

On the other hand, the convergence concept related to time series investigation is known as $\sigma$-convergence. A group of economies is said to exhibit $\sigma$-convergence if per capita income deviations among the economies in that group tend to decline or approach zero over time. This paper uses the concept of $\beta$-convergence conditional on cross-country differences in human capital or/and financial development.

Consider the following Cobb-Douglas production function with labor augmenting technological progress:

$$Y_t = (K_t)^{0} (A_t, L_t)^{1-a} ; 0<\alpha<1$$
Where $Y_t = \text{real output}$, $K_t = \text{real capital}$, $L_t = \text{labor}$ and $A_t = \text{level of technology or effectiveness of labor at time } t$. Assume that this production function is subject to Inada condition and exhibits constant return to scale. Dividing both sides of the equation (104) by $(A_t L_t)$ yields the following intensive form of the production function:

\begin{equation}
(105) \quad \hat{y}_t = (\hat{k}_t)^a
\end{equation}

Assume that labor and technology grow exogenously\footnote{$L_t = L_0 e^{nt}$ and $A_t = A_0 e^{gt}$ Where $L_0$ and $A_0$ are the initial levels of labor and knowledge.} at rates $n$ and $g$, the capital per effective labor can be expressed as

\begin{equation}
(106) \quad \hat{k}_t = s\hat{y}_t - (n + g + \delta)\hat{k}_t
\end{equation}

Where, $s$ and $\delta$ are the savings and depreciation rates respectively. Assuming $\hat{k}_t^*$ is the steady state level of capital per effective labor, equation (106) can be solved in the steady state as

\begin{equation}
(107) \quad \hat{k}_t^* = \left[\frac{s}{(n + g + \delta)}\right]^{1/(1-a)}
\end{equation}

Substituting equation (107) into the production function and taking natural logarithm of both sides gives

\begin{equation}
(108) \quad \ln \left[\frac{Y_t}{L_t}\right] = \ln(A_0) + gt + \frac{a}{1-a} \ln(s) - \frac{\alpha}{1-\alpha} \ln(n + g + \delta)
\end{equation}

Setting $\ln(A_0) + gt = a + \epsilon$, equation (108) can be rewritten as

\begin{equation}
(109) \quad \ln \left[\frac{Y_t}{L_t}\right] = a + \frac{\alpha}{1-a} \ln(s) - \frac{\alpha}{1-\alpha} \ln(n + g + \delta) + \epsilon
\end{equation}

An augmented form of this equation is used by Mankiw, Romer and Weil (1992) in their cross-country investigation of convergence. In order to make this equation usable under panel data framework Islam (1995) makes the following changes.

Assuming $\hat{y}^*$ is the steady state level of income per effective labor and
approximating around the steady state gives

\begin{equation}
\frac{d \ln \hat{y}_t}{dt} = \lambda [\ln \hat{y}^* - \ln \hat{y}_t]
\end{equation}

Where \( \lambda = (n+g+\delta)(1-\alpha) \) is the speed of convergence. Equation (110) is differential equation, which can be solved as

\begin{equation}
\ln \hat{y}_{t2} = (1-e^{-\lambda \tau}) \ln \hat{y}^* + e^{-\lambda \tau} \ln \hat{y}_{t1}
\end{equation}

Where \( \hat{y}_{t1} \) is initial income per effective labor and \( \tau = (t_2-t_1) \). Note that the steady state level of income per effective labor is assumed constant over \( t_2-t_1 \) and given by

\begin{equation}
\hat{y}^* = \frac{\alpha}{1-\alpha} \ln(s) - \frac{\alpha}{1-\alpha} \ln(n+g+\delta)
\end{equation}

Inserting equation (112) into (111), we have

\begin{equation}
\ln \hat{y}_{t2} = (1-e^{-\lambda \tau}) \frac{\alpha}{1-\alpha} \ln(s) - (1-e^{-\lambda \tau}) \frac{\alpha}{1-\alpha} \ln(n+g+\delta) + e^{-\lambda \tau} \ln \hat{y}_{t1}
\end{equation}

In terms of per capita income, equation (113) can be rewritten as

\begin{equation}
\ln y_{t2} = (1-e^{-\lambda \tau}) \frac{\alpha}{1-\alpha} \ln(s) - (1-e^{-\lambda \tau}) \frac{\alpha}{1-\alpha} \ln(n+g+\delta) + e^{-\lambda \tau} \ln y_{t1} + (1-e^{-\lambda \tau}) \ln A_y + g(t_2-e^{-\lambda \tau} t_1)
\end{equation}

Setting \( (1-e^{-\lambda \tau}) \ln A_y + g(t_2-e^{-\lambda \tau} t_1) = \mu_{it} \),

\begin{equation}
(1-e^{-\lambda \tau}) \frac{\alpha}{1-\alpha} = \beta, \quad e^{-\lambda \tau} = \gamma,
\end{equation}

\( \ln y_{t1} = \ln y_{it} \),

\( \ln y_{t1} = \ln (y_{i,t-1}) \) and

\( (g+\delta) = 0.05 \) \(^{22}\), equation (111) then can be written as

\begin{equation}
\ln (y_{it}) = \mu_{it} + \gamma \ln (y_{i,t-1}) + \beta \ln(s) - \beta \ln(n+0.05) + \epsilon_{it}
\end{equation}

Incorporating conditioning variables (CV), equation (115) can be expressed as

\begin{equation}
\ln (y_{it}) = \mu_{it} + \gamma \ln (y_{i,t-1}) + \beta \ln(s) - \beta \ln(n+0.05) + \sum_j \theta \ln (C V_{j,i}) + \epsilon_{it}
\end{equation}

Islam's (1995) uses this equation in his study of panel data. His main argument in using panel data framework versus single cross-country regression is the

\(^{22}\) Same magnitude is also used in Mankiw, Romer and Weil (1992) and in Islam (1995).
possibility of non-identical production functions across countries and correlation between the constant term ($\mu_i$) and other explanatory variables. He argues that some of the right hand side variables, such as savings and population growth rates could be affected by the constant term that includes technology, resource endowments, institutions etc. He uses two alternative estimation procedures to handle the above situation. One of which is the Least Squares with Dummy Variables (LSDV) based on fixed effects assumption that captures individual country specific effects. A Monte Carlo study by Islam (1995) shows that the LSDV based on fixed effects assumption perform very well under the above situation even with a small sample. Because of the presence of lagged dependent variable and the possibility of correlation between the constant term and explanatory variables, random effects estimation procedure would not be suitable. Therefore, we use LSDV based on fixed effects assumption to examine the importance of financial development in expediting per capita income convergence.

Data

Four different samples of 62 countries, such as 14 low-income countries, 20 lower middle-income countries, 12 upper middle-income countries, 16 high-income countries are selected based on the availability of data. Real GDP per capita, gross domestic savings as a ratio of GDP, population growth and two alternative measures of financial development, such as domestic credit to the private sector and deposits as a ratio of GDP during 1960-1990 at 5 years interval are used in this study. When current real GDP per capita is in $t=1965$, the lagged real GDP per capita is in $(t-1)=1960$. All other variables are averages over each 5-year interval staring from 1960-1965. Accordingly, we have six data points: 1965, 1970, 1975, 1980, 1985, and 1990.

---

23 Excluding the oil-exporting countries
for each variable. The definitions of the variables and their sources are stated in the Appendix-B.

Empirical Results

Testing conditional convergence requires some conditioning variables that are believed to be important for cross-country differences in steady state per capita income. Various socio-economic and institutional indicators could be used as conditioning variables. Islam's (1995) and Mankiw, Romer and Weil (1992) use human capital as a conditioning variable in their study of convergence. We use financial development as well as human capital as the conditioning variables in this study of convergence. In order to see the contribution of financial development in cross-country income convergence, we use four sets of sample countries: low income, lower middle income, upper middle income, and high-income countries. Six alternative models are estimated by the Least Squares with Dummy Variables (LSDV) based on fixed effects assumption for each sample. A series of Chow test\(^4\), as reported in Table 8, imply that estimating separate equations for each sample are justified. The results of Chow test indicate that the null hypothesis of same coefficient vectors across four different samples is rejected at 1% level in all the cases.

\(^4\) See Greene (2000, pp. 287-293) for more details on Chow test.
Table 8
Estimated Results of Chow Test

<table>
<thead>
<tr>
<th>Model</th>
<th>Estimated F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F1(16,324) = 3.14***</td>
</tr>
<tr>
<td>2</td>
<td>F2(20,320) = 2.57***</td>
</tr>
<tr>
<td>3</td>
<td>F3(20,320) = 3.22***</td>
</tr>
<tr>
<td>4</td>
<td>F4(20,320) = 3.09***</td>
</tr>
<tr>
<td>5</td>
<td>F5(24,316) = 2.67***</td>
</tr>
<tr>
<td>6</td>
<td>F6(24,316) = 2.66***</td>
</tr>
</tbody>
</table>

Notes:
1. Figures in the parenthesis are the degrees of freedom in the numerator and denominator respectively
2. *** = Significant at 1% level

The estimated results for a total of 30 models are reported in Tables 9-12. Each table contains seven columns. Of which column 1 contains the list of right hand side variables and some other important parameters and columns 2 to 7 contain estimates of parameters from six different alternative models. The results of F-test under the null of no fixed effects across countries are rejected in all cases indicating that LSDV based on fixed effects assumption is appropriate. The implied speed of convergence λ is calculated from the estimated coefficient of $\ln(y_{i,t-1})^{25}$. A positive and statistically significant value of λ in all cases confirms the existence of conditional convergence for all sample countries. An estimated value of λ (%) implies how much gap between initial per capita income and steady state per capita income.

---

25 A point estimate of λ can be obtained from the point estimate of γ, the coefficient of $\ln(y_{i,t-1})$. Where $\gamma = e^{-2\tau}$. Therefore, $\lambda = -\ln(\gamma)/\tau$. 

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will be closed each year.

Table 9 reports the estimated value of implied speed of convergence ($\lambda$) along with other structural parameters for 14 low-income countries. Results indicate that the speed of convergence without any conditional variable is 0.049 (column 2) meaning 4.9% of the gap between initial and steady state per capita income for low income countries will be eliminating each year. The speed of convergence in the presence of human capital, credit and deposits, as reported in column 3-5, are 4.8%, 5.0% and 5.4% respectively. These estimates imply that the inclusion of human capital does not seem to be helpful in improving convergence speed for low-income countries. However, the inclusion of financial development (credit or deposits) appears to be important in improving convergence speed for these countries.

Table 10 contains the estimated parameters for 20 lower middle-income countries. The speed of convergence in presence of human capital, credit and deposits are 8.0%, 7.1% and 7.2% respectively against 6.0% without any conditional variable indicating relatively faster speed of convergence in presence of each conditional variable. Unlike low-income countries, the inclusion of human capital generate faster convergence rate for lower middle-income countries. Columns 6 and 7 report estimated parameters in presence of human capital and one of the proxy for financial development indicating further improvement in the speed of convergence 8.9% or 8.8% versus 8.0% in the presence of human capital alone.

Similar type of results are also observed for 12 upper middle income countries (Table 11) where the speed of convergence without any conditional variable, in presence of human capital, credit and deposits are given by 9.2%, 9.5%, 13.9% and 11.2% respectively. The speed of convergence, on the other hand, in presence of human capital and credit is given by 13.2% and in presence of human capital and
deposits is given by 11.8%. Thus, each of the conditioning variables for upper middle-income countries is helpful in expediting the speed of convergence. Table 12 reports the results for 16 high-income countries where each of the conditioning variables improves the speed of convergence in per capita income with the exception of deposits. Like other cases, the inclusion of credit in presence of human capital further improves the speed of convergence for 16 high-income countries as well.

Other structural parameters are seems to be consistent with the previous literature, Islam (1995) in particular. Savings elasticity of income is positive and significant as expected in all the cases ranges from 8.0% to 38%. Income elasticity with respect to population growth is negative and significant in most of the cases ranges from 12% to 23%. For lower middle and high-income countries, however, it is not statistically significant.
Table 9
Results for 14 Low-Income Countries Under Fixed Effects (1960-1990)

<table>
<thead>
<tr>
<th>Dependent variable: ln(yu,t)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant term</td>
<td>1.34*** (0.43)</td>
<td>1.31*** (0.48)</td>
<td>1.35*** (0.44)</td>
<td>1.50*** (0.43)</td>
<td>1.32*** (0.49)</td>
<td>1.49*** (0.48)</td>
<td></td>
</tr>
<tr>
<td>ln(y_(t-1))</td>
<td>0.78*** (0.07)</td>
<td>0.79*** (0.07)</td>
<td>0.78*** (0.07)</td>
<td>0.76*** (0.07)</td>
<td>0.77*** (0.08)</td>
<td>0.75*** (0.08)</td>
<td></td>
</tr>
<tr>
<td>ln(s)</td>
<td>0.08*** (0.02)</td>
<td>0.09*** (0.03)</td>
<td>0.08*** (0.03)</td>
<td>0.09*** (0.03)</td>
<td>0.08** (0.03)</td>
<td>0.08*** (0.03)</td>
<td></td>
</tr>
<tr>
<td>ln(n+0.05)</td>
<td>-0.23** (0.10)</td>
<td>-0.21** (0.11)</td>
<td>-0.23** (0.10)</td>
<td>-0.21** (0.10)</td>
<td>-0.18 (0.12)</td>
<td>-0.19 (0.11)</td>
<td></td>
</tr>
<tr>
<td>ln(human)</td>
<td>-0.02 (0.03)</td>
<td>0.01 (0.03)</td>
<td>-0.04 (0.04)</td>
<td>-0.03 (0.05)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(credit)</td>
<td>0.01 (0.03)</td>
<td>0.04 (0.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(deposit)</td>
<td>-0.03 (0.04)</td>
<td>0.01 (0.06)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implied λ</td>
<td>0.049*** (0.017)</td>
<td>0.048** (0.019)</td>
<td>0.050*** (0.019)</td>
<td>0.054*** (0.019)</td>
<td>0.052*** (0.020)</td>
<td>0.057*** (0.20)</td>
<td></td>
</tr>
<tr>
<td>Years*</td>
<td>14.27</td>
<td>14.58</td>
<td>14.01</td>
<td>13.05</td>
<td>13.54</td>
<td>12.32</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. $\lambda = -\ln(\gamma)/\tau$ is the speed of convergence where $\gamma$ is the coefficient of ln(y(t-1)) and $\tau = 5$ (the number years between t and t-1).
2. $\Delta = $ Number of years required to close $\%$ of income gap (70/$\lambda$).
3. ***, ** = Statistically significant at 1%, and 5% respectively.
4. Figures in the parenthesis () are standard errors and figures in the square brackets [ ] are the degrees of freedom in the numerator and denominator respectively.
Table 10

Results for 20 Lower Middle-Income Countries Under Fixed Effects (1960-1990)

<table>
<thead>
<tr>
<th>Dependent variable: $\ln(y_{it})$</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant term</td>
<td>1.47***</td>
<td>1.92***</td>
<td>1.62***</td>
<td>1.65***</td>
<td>2.02***</td>
<td>2.05***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.51)</td>
<td>(0.39)</td>
<td>(0.42)</td>
<td>(0.51)</td>
<td>(0.53)</td>
<td></td>
</tr>
<tr>
<td>$\ln(y_{i,t-1})$</td>
<td>0.74***</td>
<td>0.67***</td>
<td>0.70***</td>
<td>0.70***</td>
<td>0.64***</td>
<td>0.64***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.08)</td>
<td>(0.06)</td>
<td>(0.07)</td>
<td>(0.08)</td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>$\ln(s)$</td>
<td>0.22***</td>
<td>0.23***</td>
<td>0.22***</td>
<td>0.22***</td>
<td>0.23***</td>
<td>0.24***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>$\ln(n+0.05)$</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
<td>0.03</td>
<td>0.04</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>$\ln(human)$</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td>0.05</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td></td>
<td></td>
<td></td>
<td>(0.06)</td>
<td>(0.07)</td>
<td></td>
</tr>
<tr>
<td>$\ln(credit)$</td>
<td></td>
<td>0.05</td>
<td></td>
<td></td>
<td>0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.04)</td>
<td></td>
<td></td>
<td>(0.04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\ln(deposit)$</td>
<td></td>
<td></td>
<td>0.06</td>
<td></td>
<td></td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.05)</td>
<td></td>
<td></td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>Implied $\lambda$</td>
<td>0.060***</td>
<td>0.080***</td>
<td>0.071***</td>
<td>0.072***</td>
<td>0.089***</td>
<td>0.088***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.023)</td>
<td>(0.017)</td>
<td>(0.019)</td>
<td>(0.025)</td>
<td>(0.025)</td>
<td></td>
</tr>
<tr>
<td>Years $^*$</td>
<td>11.74</td>
<td>8.75</td>
<td>9.88</td>
<td>9.66</td>
<td>7.87</td>
<td>7.95</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>F-value for no Fixed effects[dof]</td>
<td>2.68***</td>
<td>2.82***</td>
<td>2.75***</td>
<td>2.82***</td>
<td>2.88***</td>
<td>2.96***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[19, 94]</td>
<td>[19, 91]</td>
<td>[19, 93]</td>
<td>[19, 82]</td>
<td>[19, 90]</td>
<td>[19, 79]</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. $\lambda = -\ln(\gamma)/\tau$ is the speed of convergence where $\gamma$ is the coefficient of $\ln(y_{i,t-1})$ and $\tau = 5$ (the number years between $t$ and $t-1$).
2. $^*$ = Number of years required to close $\frac{3}{4}$ of income gap ($70/\lambda$).
3. ***, ** = Statistically significant at 1%, and 5% respectively.
4. Figures in the parenthesis () are standard errors and figures in the square brackets [] are the degrees of freedom in the numerator and denominator respectively.

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Table 11

Results for 12 Upper Middle-Income Countries Under Fixed Effects (1960-1990)

<table>
<thead>
<tr>
<th>Dependent variable: ln(y_{it})</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant term</td>
<td>1.97***</td>
<td>2.02***</td>
<td>2.61***</td>
<td>2.26***</td>
<td>2.53***</td>
<td>2.34***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
<td>(0.51)</td>
<td>(0.50)</td>
<td>(0.56)</td>
<td>(0.52)</td>
<td>(0.60)</td>
<td></td>
</tr>
<tr>
<td>ln(y_{i,t-1})</td>
<td>0.63***</td>
<td>0.62***</td>
<td>0.50***</td>
<td>0.57***</td>
<td>0.52***</td>
<td>0.55***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.08)</td>
<td>(0.08)</td>
<td>(0.09)</td>
<td>(0.08)</td>
<td>(0.10)</td>
<td></td>
</tr>
<tr>
<td>ln(s)</td>
<td>0.34***</td>
<td>0.35***</td>
<td>0.38***</td>
<td>0.35***</td>
<td>0.38***</td>
<td>0.35***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.07)</td>
<td>(0.08)</td>
<td>(0.07)</td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>ln(n+0.05)</td>
<td>-0.13**</td>
<td>-0.12**</td>
<td>-0.14**</td>
<td>-0.12**</td>
<td>-0.15**</td>
<td>-0.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td>(0.06)</td>
<td></td>
</tr>
<tr>
<td>ln(human)</td>
<td>0.02</td>
<td></td>
<td>-0.05</td>
<td></td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td></td>
<td>(0.10)</td>
<td></td>
<td>(0.12)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(credit)</td>
<td></td>
<td>0.10***</td>
<td></td>
<td>0.10***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.03)</td>
<td></td>
<td>(0.03)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(deposit)</td>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.05)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implied (\lambda)</td>
<td>0.092***</td>
<td>0.095***</td>
<td>0.139***</td>
<td>0.112***</td>
<td>0.132***</td>
<td>0.118***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.026)</td>
<td>(0.031)</td>
<td>(0.030)</td>
<td>(0.032)</td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td>Years*</td>
<td>7.65</td>
<td>7.36</td>
<td>5.04</td>
<td>6.25</td>
<td>5.29</td>
<td>5.93</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>F-value for no Fixed effects [dof]</td>
<td>3.87***</td>
<td>3.68***</td>
<td>4.57***</td>
<td>3.89***</td>
<td>4.43***</td>
<td>3.26***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[11, 57]</td>
<td>[11, 56]</td>
<td>[11, 55]</td>
<td>[11, 45]</td>
<td>[11, 54]</td>
<td>[11, 44]</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. \(\lambda = - \ln(\gamma)/\tau\) is the speed of convergence where \(\gamma\) is the coefficient of ln(y_{i,t-1}) and \(\tau = 5\) (the number of years between \(t\) and \(t-1\)).
2. \(\Delta = \text{Number of years required to close } \frac{Y_{z} - Y_{z}}{70/\lambda}\).
3. ***, ** = Statistically significant at 1%, and 5% respectively.
4. Figures in the parenthesis () are standard errors and figures in the square brackets [] are the degrees of freedom in the numerator and denominator respectively.

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Table 12
Results for 16 High-Income Countries Under Fixed Effects (1960-1990)

<table>
<thead>
<tr>
<th>Dependent variable: ln(yit)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant term</td>
<td>1.48***</td>
<td>1.51***</td>
<td>1.53***</td>
<td>1.48***</td>
<td>1.55***</td>
<td>1.52***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.22)</td>
<td>(0.24)</td>
<td>(0.22)</td>
<td>(0.24)</td>
<td>(0.22)</td>
<td></td>
</tr>
<tr>
<td>ln(yi,t-1)</td>
<td>0.84***</td>
<td>0.79***</td>
<td>0.82***</td>
<td>0.85***</td>
<td>0.77***</td>
<td>0.79***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.04)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.05)</td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>ln(s)</td>
<td>0.08***</td>
<td>0.09***</td>
<td>0.08***</td>
<td>0.08***</td>
<td>0.09***</td>
<td>0.09***</td>
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</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>ln(n+0.05)</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.20</td>
<td>-0.01</td>
<td>-0.01</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.20)</td>
<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.01)</td>
<td></td>
</tr>
<tr>
<td>ln(human)</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td>0.18</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td></td>
<td></td>
<td></td>
<td>(0.12)</td>
<td>(0.12)</td>
<td></td>
</tr>
<tr>
<td>ln(credit)</td>
<td></td>
<td>0.02</td>
<td></td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.04)</td>
<td></td>
<td>(0.04)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(deposit)</td>
<td></td>
<td></td>
<td></td>
<td>-0.03</td>
<td>-0.04</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implied (\lambda)</td>
<td>0.036***</td>
<td>0.048***</td>
<td>0.040***</td>
<td>0.032***</td>
<td>0.051***</td>
<td>0.046***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.010)</td>
<td>(0.008)</td>
<td>(0.006)</td>
<td>(0.012)</td>
<td>(0.010)</td>
<td></td>
</tr>
<tr>
<td>Years (^a)</td>
<td>19.71</td>
<td>14.54</td>
<td>17.72</td>
<td>21.67</td>
<td>13.70</td>
<td>15.17</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>F-value for no Fixed effects [dof]</td>
<td>3.34***</td>
<td>3.28***</td>
<td>2.56***</td>
<td>3.10***</td>
<td>2.71***</td>
<td>3.26***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[15, 72]</td>
<td>[15, 71]</td>
<td>[15, 71]</td>
<td>[15, 71]</td>
<td>[15, 70]</td>
<td>[15, 70]</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. \(\hat{\lambda} = -\ln(\gamma)/\tau\) is the speed of convergence where \(\gamma\) is the coefficient of \(\ln(y_{i,t-1})\) and \(\tau = 5\) (the number years between \(t\) and \(t-1\)).
2. \(^a\) = Number of years required to close \(\frac{1}{2}\) of income gap \((70/\hat{\lambda})\).
3. ***, ** = Statistically significant at 1%, and 5% respectively.
4. Figures in the parenthesis () are standard errors and figures in the square brackets [] are the degrees of freedom in the numerator and denominator respectively.
Summary and Conclusion

Islam (1995) shows how a panel data framework could improve the results of various coefficients' estimates and convergence speed of neoclassical growth model over single cross-country regression as estimated by Mankiw, Romer and Weil (1992). Both papers find convincing evidence that inclusion of human capital as a conditioning variable improves the speed of convergence significantly. The contribution of financial development in the issue of income convergence seems to be an important factor, which is not explored before. We believe that financial development is an intrinsic part of economic development and could contribute significantly in achieving income convergence across countries.

We observe faster speed of convergence in presence of human capital and financial development as proxied by credit or deposits. The fastest speed of convergence for upper-middle income countries ranges from 9.2% to 13.9% per year i.e., half of the gap between the initial and the steady state level of income will be eliminated in 5-8 years. The slowest speed, on the other hand, is observed for high-income countries ranges from 3.2% to 5.1% per year i.e., half of the gap between the initial and the steady state level of income will be eliminated in 15-22 years. These findings imply that, given the presence of conditional variables, the upper middle-income countries are likely to be relatively homogenous than the other sample countries. The introduction of conditioning variables closes the gap between initial and the steady state per capita income relatively faster for the upper middle-income countries than the other sample countries.

On average, however, this study gives an estimate of convergence at around 7.0% per year, which is pretty much in line with the findings of Islam (1995) and the
theoretical prediction of the neoclassical model. Note that none of the studies based on single equation cross-country regression could produce an estimate of convergence speed close to the theoretical prediction. For example, Mankiw, Romer and Weil (1992, Table-V, p.426) produces conditional convergence of 1.37%, 1.82% and 2.03% per year for non-oil, intermediate and OECD countries respectively, which is way smaller than the theoretically predicted rate of 5.0%. The improvement in conditional convergence in the panel data studies is because of introducing time dimension and individual country effects in the data.

The results as reported in Tables 9-12 indicate that the contribution of financial development in improving convergence is very robust. We observe faster convergence speed for all sample groups in presence of financial development. The contribution of human capital, on the other hand, is not so convincing for low-income countries. For low-income countries, it does not contribute at all to per capita income convergence. This could imply a threshold per capita income level at which human capital improves convergence.

The findings of this paper, therefore, suggest that financial development is an important factor in closing per capita income gap among countries. A comparison of the relative contribution of human capital and financial development indicates that financial development in presence of human capital usually expedites convergence (with one exception when deposits proxy financial development for high-income countries). Therefore, financial development is at least as relevant as human capital in expediting per capita income convergence.

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26 Assuming 1/3 is the GDP share of physical capital and \((n+g+\delta)=0.08\), it can be shown that convergence speed \((\lambda)=5.0\%\) (see Barro and Sala-I-Martin (1995) pp. 36-38 for more details). Islam (1995) predict an average of 6% convergence per year.

SECTION V

OVERALL SUMMARY AND CONCLUSION

Every nation wants to have higher and sustainable economic growth. Nevertheless, we observe huge cross-country income differences. Explaining cross-country differences in per capita income is one of the fascinating issues that have drawn a lot attention from growth economists. Some well-known sources of economic growth are infrastructure, socio-economic and political institutions, technology, research and development (R&D), physical capital and human capital. The role of financial intermediation in capital formation and economic growth is largely ignored in the mainstream growth literature. Like physical capital, human capital and technology, financial development is an important part of the story of economic growth. This dissertation attempts to investigate the finance-growth linkage theoretically as well as empirically. It contains three essays explaining the link between financial development and economic growth.

The first essay is a theoretical model of search and matching equilibrium in financial economies explaining the role of financial intermediation in capital formation and economic growth. It investigates the role of financial intermediation in capital formation and economic growth using a matching and search equilibrium model. We show better outcomes in terms of higher investment and output in presence of financial intermediaries with or without information asymmetry. This essay identifies two channels through which financial intermediaries stimulate economic growth. One is the usual capital accumulation channel where the introduction of financial intermediary generates higher capital and thus higher
economic growth. The other one is the efficiency gains where the introduction of financial intermediary reduces frictions, information asymmetry, and monitoring cost, eases contracts and trades and increases the probability of catching shirking, and enhances productivity and the quality of investments. Thus, the efficiency effect is the impact of financial intermediation on economic growth that derives from sources other than increased capital accumulation. Two empirical investigations, the second and the third essays, follow to examine two key predictions of the finance-growth literature: (i) Financial development causes economic growth and (ii) Financial development expedites conditional convergence.

The second essay investigates empirically the dynamic, particularly long run, relationship among financial development, investment, and economic growth. This essay confirms the presence of both quantitative and efficiency effects on income growth with an indication of relatively stronger efficiency gains for the three emerging economies. The third essay investigates the impact of financial development, particularly the relative strengths of financial development and human capital, on the implied speed of per capita income convergence. The findings interestingly suggest that financial development is at least as relevant as human capital in expediting per capita income convergence.

Financial intermediation stimulates economic growth through two distinct channels: one by increasing investment and the other one by reducing frictions and addressing the commitment and information problems. Financial development is an important factor for investment and income growth both in the short-run and long-run. Causality runs from finance to income growth and there is very little evidence of reverse causality. Financial development is an important factor in expediting cross-country per capita income convergence.
Appendix A

Propositions
Proposition 1: An increase in investment of either input in autarky is Pareto improving.

Proof: The utility functions for the lender and the entrepreneur in equilibrium under autarky are given by

(A1) \[ u_1 = \left[ \frac{r + 2n_2}{r + n_2 + 1} \right] \phi F_D(k, s) - C(k) \]

(A2) \[ u_2 = \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) F_D(k, s) - C(s) \]

Assume that there is an infinitesimal positive change in the equilibrium levels of investment i.e., \((dk, ds) \geq (0,0)\). Taking total differentiation with respect to \(k\) and \(s\), it can be shown\(^{28}\) that

(A3) \[ \frac{du_1}{ds} = \left[ \frac{r + 2n_2}{r + n_2 + 1} \right] \phi f_1'(k^*, s^*) > 0 \]

(A4) \[ \frac{du_2}{dk} = \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) f_1'(k^*, s^*) > 0 \]

These two conditions imply that any positive action by an entrepreneur (lender) increases the utility of lender (entrepreneur). Since, an increase in lender's (or entrepreneur's) input does not increase their own utility but their partner's, the solution is one where investments in capital and skill are sub-optimal.

Proposition 2: Increased investment \((k\) or \(s\)) is no longer Pareto improving in the intermediated equilibrium.

Proof: Under financial intermediation, the utility and the profit functions for

\(^{28}\) From equation (A1), \[ du_1 = \left[ \frac{r + 2n_2}{r + n_2 + 1} \right] \phi f_1'(k^*, s^*) dk + \left[ \frac{r + 2n_2}{r + n_2 + 1} \right] \phi f_1''(k^*, s^*) ds - c(k) dk \]

Using F.O.C. (equation 13), \[ \frac{du_1}{ds} = \left[ \frac{r + n_2}{r + n_2 + 1} \right] \phi f_1'(k^*, s^*) > 0 \]

From equation (A2), \[ du_2 = \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) f_1'(k^*, s^*) dk + \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) f_1''(k^*, s^*) ds - c'(s) ds \]

Using F.O.C. (equation 14), \[ \frac{du_2}{dk} = \left[ \frac{r + 2n_1}{r + n_1 + 1} \right] (1 - \phi) f_1'(k^*, s^*) > 0 \]
lender and entrepreneur are given by

(A5) \[ \text{Max}(k) u_1 = k \cdot R_1d - C(k) \]

(A6) \[ \text{Max}(k, s) u_2 = Fd - k \cdot R_1d - C(s) \]

Taking total differentiation with respect to \((k)\) and \((s)\), it can be shown\(^{29}\) that

(A7) \[ \frac{du_1(.)}{ds} = 0 \]

(A8) \[ \frac{du_2(.)}{dk} = 0 \]

Any action by an entrepreneur (lender) does not have any impact on either utility. The above conditions imply that the investment of capital as well as skill under financial intermediation is efficient and optimal.

\(^{29}\) From (A5), \(du_1(.) = R_1dk - c^f(.)dk \Rightarrow [R_1c^f(.)]dk\).

Using F.O.C.(26), \([R_1c^f(.)] = 0\).

Therefore, \(du_1(.)/dk = 0\) or \(du_1(.)/ds = 0\).

From (A6), \(du_2(.) = f^f(.)dk - R_1dk + f^f(.)ds - c^f(.)ds \Rightarrow du_2(.) = [f^f(.) - R_1]dk + [f^f(.) - c^f(.)]ds\).

Using F.O.C.s.(27) and (26), \(du_2(.)/dk = 0\) and \(du_2(.)/ds = 0\).
Appendix B

Data and Variable Definitions
GDP Per Capita (y)

GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 1995 U.S. dollars. Source: World Development Indicators CD-ROM 2001.

Gross Domestic Savings as a Percentage of GDP (s)

Gross domestic savings are calculated as GDP less final consumption expenditure (total consumption). Source: World Development Indicators CD-ROM 2001.

Annual Population Growth (n)

Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship—except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin. Source: World Development Indicators CD-ROM 2001.

Credit to Private Sector as a Percentage of GDP (Credit)

Credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable that establish a claim for repayment. Source: World Development Indicators CD-ROM, 2001.
Total Deposits as a Percentage of GDP (Deposits)

Total deposits as a percentage of GDP (deposits) is calculated by adding line 34 (narrow money) and line 35 (quasi-money), subtracting line 14a (currency outside bank) and dividing by line 99b (GDP). Source: International Financial Statistics (IFS) CD-ROM, 2003, IMF.

Human Capital (Human)

Finally, the proxy for human capital (human) is constructed by the authors (Robert Barro and J.W. Lee, 1993 and 1996) as the average schooling years in the total population over age 25 based on census data and other related information where the quality and quantity of education for each country are taken into account. This variable is available at five-year interval during 1960-1990 that forces us to limit our whole data set to the same time span. Source: Robert Barro and J.W. Lee (1993 and 1996).


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