FINANCE, ENTREPRENEURSHIP, AND GROWTH:

Theory and Evidence

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Abstract

How do financial systems affect economic growth? We construct an endogenous growth model in which financial systems evaluate prospective entrepreneurs, mobilize savings to finance the most promising productivity-enhancing activities, diversify the risks associated with these innovative activities, and reveal the expected profits from engaging in innovation rather than the production of existing goods using existing methods. Better financial systems improve the probability of successful innovation and thereby accelerate economic growth. Similarly, financial sector distortions reduce the rate of economic growth by reducing the rate of innovation. A broad battery of evidence suggests that financial systems are important for productivity growth and economic development.

A prominent feature of the recent literature on economic growth is a renewed interest in the links between financial institutions and the pace of economic development. On the theoretical side, a new battery of models articulates mechanisms by which the financial system may affect long-run growth, stressing that financial markets enable small savers to pool funds; that these markets allocate investment to the highest return use; and that financial intermediaries partially overcome problems of adverse selection in credit markets.[1/] On the empirical side, researchers have shown that a range of financial indicators are robustly positively correlated with economic growth. [2/] Increasingly, economists are thus entertaining the idea that government policies toward financial institutions have an important causal effect on long-run economic growth.

In traditional development economics, there were two schools of thought with sharply differing perspectives on the potential importance of finance. Economists like Goldsmith [1969], McKinnon [1973] and Shaw [1973] saw financial markets as playing a key role in economic activity. In their view, differences in the quantity and quality of services provided by financial institutions could partly explain why countries grew at different rates. But many more economists accepted Robinson's [1952] view that finance was essentially the handmaiden to industry, responding passively to other factors that produced cross-country differences in growth.[3/] In part, this skeptical view also derived from the mechanics of the neoclassical growth model: many believed that financial systems had only minor effects on the rate of investment in physical capital, and changes in investment were viewed as having only minor effects on economic growth as a result of Solow's [1956, 1957] analyses.

In this paper, we develop an endogenous growth model featuring connections between finance, entrepreneurship, and economic growth suggested by the insights of Frank Knight [1951] and Joseph Schumpeter [1912]. We combine the Knightian role of entrepreneurs in initiating economic activities with two ideas of Schumpeter. First, we build on the well-known Schumpeterian view that innovations are induced by a search for temporary monopoly profits.[4/] Second, we incorporate the less well-known Schumpeterian idea that financial institutions are important because they evaluate and finance entrepreneurs in their initiation of innovative activity and the bringing of new products to market.[5/] Like Schumpeter, we believe the nexus of finance and innovation is thus central to the process of economic growth.

At the center of our theory is the endogenous determination of productivity growth, which is taken to be the result of rational investment decisions. Productivity growth is thus influenced by standard consideration of costs and benefits. In our analysis, financial systems influence decisions to invest in productivity enhancing activities through two mechanisms: they evaluate prospective entrepreneurs and they fund the most promising ones. Financial institutions can provide these research, evaluative and monitoring services more effectively and less expensively than individual investors; they also are better at mobilizing and providing appropriate financing to entrepreneurs than individuals. Overall, the evaluation and sorting of entrepreneurs lowers the cost of investing in productivity enhancement and stimulates economic growth. Financial sector distortions can therefore reduce the rate of economic growth.

Our view of the relevant economic mechanisms is consequently quite different from existing theories, new and old. First, in contrast to traditional development work, we do not require that financial institutions

mainly exert influence via the rate of <u>physical</u> capital accumulation.[6/]
Second, distinct from recent theoretical research, we stress that financial
institutions play an active role in evaluating, managing, and funding the
entrepreneurial activity that leads to <u>productivity growth</u>. Indeed, we
believe our mechanism is the channel by which finance must have its dominant
effect, due to the central role of productivity growth in development.

With this theoretical model as background, we then present various types
of evidence on the links between financial institutions and economic
development. We begin by reviewing the cross-country evidence on links
between financial indicators and economic growth, discussing key results from
our earlier work in this area and undertaking some extensions. Next, we
discuss three sets of evidence about the relationship between financial
institutions and public policy interventions. First, we look at a number of
case studies of how financial indicators have responded to government
interventions designed to liberalize financial markets. Second, we review
recent firm-level studies of the effects of financial sector reforms in two
developing countries. Third, we look at how financial development has been
related to the success of World Bank structural adjustment lending programs.
Taken together, these diverse types of evidence support the view that the
services of financial systems are important for productivity growth and
economic development.

The organization of the paper is as follows. In section I, we articulate
our theory of the links between finance and growth. In section II, we review
a range of evidence on financial institutions and economic growth.

I. Theoretical Linkages Between Financial Markets and Growth

In this section, we develop a theoretical model of the links between finance, entrepreneurship and economic growth. We begin by modeling the process by which financial systems—financial intermediaries and securities markets—authorize particular entrepreneurs to undertake innovative activity. Next, we develop links between innovation and growth. Finally, we determine the general equilibrium of our economy and evaluate the effects of financial sector policies on economic growth.

To study the links between finance and innovative activity, we construct a basic model that highlights the demand for four services of the financial system. First, as in Boyd and Prescott [1986], investment projects must be evaluated to identify promising ones (on this process, see also Diamond [1984]). Specifically, there are large fixed costs of evaluating the projects of prospective entrepreneurs, so that there are incentives for specialized organizations to arise and to perform this task. Second, the required scale of projects necessitates substantial pooling of funds from many small savers, so that it is important for financial systems to mobilize sufficient resources for projects. Third, the outcomes of attempts to innovate are uncertain, so that it is desirable for the financial system to provide a means for individuals and entrepreneurs to diversify these risks. Fourth, productivity enhancement requires that individuals choose to engage in innovative activities rather than produce existing goods using existing methods. Since the expected rewards to innovation are the stream of profits which accrue from being an industry's productivity leader, it is important for the financial system to accurately reveal the expected discounted value of these profits. Thus, the model generates a demand for four financial services: evaluating entrepreneurs, pooling resources, diversifying risk, and

valuing the expected profits from innovative activities. But the model does not focus on the precise form of contracts and institutions that provide these services.

In practice, financial intermediaries commonly evaluate investment projects, mobilize resources to finance promising ones, and facilitate risk management: they thereby provide three of the services highlighted in our model. Thus, in this paper, we assume that these services are provided by integrated organizations which we call financial intermediaries.[7/] For most of the discussion, we also assume that a stock market reveals the expected discounted value of profits from engaging in innovative activities.

In modeling the links between innovation and economic growth, we draw upon the basic theory of endogenous technical change developed by Aghion and Howitt [1992], Grossman and Helpman [1991] and Romer [1990]. Our specific version of this theory involves innovations which permit a specific entrepreneur to produce one of many intermediate products at a cost temporarily lower than that of his rivals. The extent of innovative activity undertaken by society dictates the rate of economic growth.

In focusing attention on the nexus of finance, entrepreneurship and innovation, our model thus stresses that the financial system is a lubricant for the main engine of growth. Better financial services expand the scope and improve the efficiency of innovative activity; they thereby accelerate economic growth. Financial repression, correspondingly, reduces the services provided by the financial system to savers, entrepreneurs and producers; it thereby impedes innovative activity and slows economic growth.

Before presenting the model, it is worth noting that it describes financial intermediaries that mobilize external funds to finance innovative activity. One can, however, view innovative activity as containing two

components: the costly act of creating a worthwhile innovation and the costly act of making this innovation operational on a market scale. Indeed, implementing a good innovation may be much more costly than undertaking experiments and pilot projects to identify and test the value of innovations. In this expanded setting, financial intermediaries might enter the productivity enhancement process only after an innovation has been identified, playing little role in the actual process of innovation. Yet, the efficiency of intermediaries would affect innovative activity, since the rewards to successful innovation depend on actually bringing new or improved products to market. Thus, even though intermediaries finance innovation directly in the model, the main results of the model should also apply to financial systems that participate only in the expansion to a market scale of new products and production methods.

A. A Schumpeterian Model of Financial Intermediation

Our theoretical framework contains the roles for financial intermediaries discussed above, specifically entrepreneurial selection and provision of external finance. We imagine an economy with many individuals. Each has N units of time as an endowment and has (equal) financial wealth, which is a claim to a diversified portfolio of claims on the profits of firms. Some individuals do have special capacity to manage innovative activity in the analysis, but this does not lead them to accumulate differing wealth levels.

1. Entrepreneurial Selection

We assume that some individuals in society intrinsically possess the skills to be potentially capable entrepreneurs. Each potential entrepreneur has the endowment of a project and the skills to capably manage this project with probability α (otherwise the individual has no ability to manage a

project). These capabilities are unknown to both the entrepreneur and intermediary. The actual capacity of an individual to manage a project can be ascertained at a cost of "f" units of labor input: by paying this cost, the evaluator learns whether the individual is either capable or not. (We assume that entrepreneurs cannot evaluate themselves and credibly communicate the results to others.) Thus, under some conditions that we detail below, there is an economic demand for a "rating" activity that will sort potential entrepreneurs. If the market value of a "rated" entrepreneur is "q" and the wage rate is "w", then competition among such organizations requires

(ES) $\qquad \alpha \, q = w \, f$

if there is to be positive output of this rating industry and, more generally, we must have $\alpha q \leq wf$. That is, our <u>entrepreneurial selection</u> condition (ES) requires the expected income from rating prospective entrepreneurs (αq) must equal the cost of that activity (wf).[8]

We treat evaluation activity as requiring only time units and assume that that there are no shifts in the productivity of labor input. This assumption is convenient for our purposes in that it makes it easy to construct a steady state growth model. A useful extension to our analysis would be to model improvements in evaluation technology symmetrically with improvements in the technology for making other products.

2. Financing of Innovative Activity

Each rated entrepreneur requires a total of x labor units (including his own time) to realize a marketable innovation with probability π.[9] This productive activity takes time: "x" labor units must be invested prior to learning about success or failure of the innovative activity.

The value of a successful innovation is that the entrepreneur captures

monopoly profits. In the model developed below, this is the present value of profits earned by the current productivity leader (producing a specific intermediate product at lowest cost). As in Grossman and Helpman [1991], we call this reward the stock market value of the incumbent firm.

Under the technology described above, in x units of labor input (with cost wx) must be invested at the start of the innovation process. The innovative activity has the expected reward $\pi \rho_{t+\Delta t,t} v_{t+\Delta t}$, where $\rho_{t+\Delta t,t}$ is the discount factor at t for cash flows at t+Δt and $v_{t+\Delta t}$ is the future stock market value of being an incumbent firm. For notational convenience, we write this as $\pi \rho v'$ suppressing the time subscripts. Thus, the expected innovation rents to a rated individual innovation firm are given by $\pi \rho v' - w x$. If we add a tax at rate τ on the gross income generated by a successful entrpreneur—the financial intermediary's income stream from its earlier provision of external finance—then the value of a rated entrepreneur is given by the innovation rents specification as:

(IR) $q = (1-\tau) \pi \rho v' - w x.$

If there is long-run constancy of the discount factor (ρ), the entrepreneurial selection (ES) and innovation rents (IR) conditions imply that q, w and v must share common long-term growth rates.

External finance of innovative activity is a central element of the model for two reasons. First, the labor requirements of innovation are assumed to be much larger than just the entrepreneur's time (i.e., x is much bigger than one). This makes it likely, though not certain, that the entrepreneur's wealth would be insufficient to cover wage payments to the other members of his "firm." Second, in the equilibrium studied below, the risk of innovation success is entirely diversifiable, so that reliance on any amount of internal

finance is inefficient. Hence, the financing of innovative activity takes the form of a large intermediary providing the certain income streams to all members of an innovation team (including the entrepreneur).

3. Equilibrium Financial Intermediation

Combining the two equilibrium conditions for financial intermediation activity, entrepreneurial selection (ES) and innovation rents (IR), we find that equilibrium in the <u>financial intermediation</u> sector requires:

(FI) $\qquad \pi \, \rho \, v' = a(\tau) \, w$

where the coefficient $a(\tau) = (\frac{f}{\alpha} + x)/(1-\tau)$ reflects the combination of two influences. First, the full labor requirement of an innovation project, $a(0) = (\frac{f}{\alpha} + x)$, includes evaluation resources per funded project (f/α) as well as direct labor requirements (x). Second, τ includes both explicit financial sector taxes and implicit taxes arising from financial sector distortions.

4. Rational Stock Market Valuations

Previously, we noted that an innovation at date t permits the innovator to capture a stream of rents equal in value to the stock market valuation of the incumbent monopolist. Correspondingly, such an innovation inflicts a capital loss on the stockholders of the currently dominant firm. These prospective capital losses are built into rational stock valuations.

Let v_t denote the market value—prior to distribution of dividends δ_t—of a representative incumbent firm. In the general equilibrium constructed below, industries do not differ in the level of their leader's stock price, so it is sufficient to consider a representative industry. Further, in the full model, each industry is small relative to (certain) aggregate wealth and, hence, the risk of capital losses due to a rival firm's innovation success is

diversifiable: securities are priced as if individuals were risk neutral.

Hence, the equilibrium condition for holding a share of stock from t to t+Δt is

(SM) $(1-\Pi) \, \rho_{t+\Delta t,t} \, v_{t+\Delta t} = v_t - \delta_t.$

The left hand side of (SM) is the expected discounted value of the future stock value, taking into account the probability of capital losses; the right hand side is the "ex dividend" firm value. In this expression and below, the symbol Π represents the probability that some entrepreneur will successfully innovate: for investors in a security, this is the relevant probability of a capital loss. Our assumption is that the probability of an innovation in a specific industry is simply proportional to the number of individual entrepreneurs seeking to improve that product, so that if there are "e" participants then $\Pi = \pi e.$ 10/

5. The Stock Market and Financial Intermediaries

In our model, stock markets play two roles. First, stock markets reveal the value of firms as determined by the analyses of rational investors. Second, stock markets provide a vehicle for pooling the risks of holding claims on established firms: on a balanced portfolio of all stocks, an investor gains a certain portfolio return.

Interpreting our model as that of a developed country, it is natural to view our financial intermediary as a venture capital firm, funding start-up innovative activity, in exchange for (most of) the firm's stock. When the venture capital firm learns whether a specific entrepreneur has produced a marketable innovation or has not, it then sells off the shares on a stock market. However, as this interpretation makes clear, a formal stock exchange

need not exist, although we do require that property rights be clearly defined and enforced. For example, the venture capital firm could be part of a larger financial conglomerate that provides the risk pooling and firm valuation which is given by the stock market in our model.

That is, our model identifies important financial services like project evaluation, risk pooling, and valuation of risky cash flows; it does not focus on the precise form of contracts and institutions that provide these services. This is important since it indicates that the basic concepts in the model apply to countries with diverse financial systems.

B. A Schumpeterian Model of Technical Progress

We now develop a Schumpeterian model of technical progress based on Grossman and Helpman [1991]. Like those authors, we consider an economy with a continuum of products, indexed by ω on the interval $0 \leq \omega \leq 1$, which are subject to technical improvement. Each innovation moves a particular product's technology one step along a ladder with steps j=0,1,.... realizing levels Λ^j with $\Lambda > 1$. Inventions are cost-reducing as in Aghion and Howitt [1992] and apply to an intermediate product as in Romer [1990]. As in Grossman and Helpman [1991], the timing of individual innovations is random but the aggregate economy evolves deterministically.

1. Intermediate Product Technology

The production technology for the leading firm in industry ω at ladder position j is $y_t(\omega) = A_t(\omega) \, n_t(\omega) = \Lambda^j \, n_t(\omega)$, where $y_t(\omega)$ is physical output of intermediate product ω, $A_t(\omega)$ is the level of productivity at date t in industry ω, and $n_t(\omega)$ is the level of labor input. Thus, at wage rate w_t, unit cost is $w_t n_t(\omega)/y_t(\omega) = w_t/A_t(\omega) = w_t/\Lambda^j$, i.e., unit cost is raised by wages and lowered by higher productivity.

2. Final Goods Production

The goods subject to technical innovation are assumed to be intermediate inputs into the production of a single final good, C. Letting $z(\omega)$ be the quantity of input ω demanded, the production technology for this good is $C = \exp([\int_0^1 \log(z(\omega))\, d\omega])$, which is the continuum analog of the standard Cobb–Douglas production function with constant returns-to-scale imposed.[11/] Notice that the production function for the final good is time-invariant, so that all technical progress is embodied in intermediate products: this makes consumption a natural numeraire in our economy. Given that the price of intermediate product ω is $p_t(\omega)$, factor demands are $z_t(\omega) = C_t/p_t(\omega)$, assuming the numeraire is consumption (so $\int_0^1 p(\omega)z(\omega)\, d\omega = 1$ for $C = 1$).

3. Pricing of Intermediate Products

As in Grossman and Helpman [1991], we assume that there is a unique lead firm in industry ω which prices its product at its rival's unit costs, leading to a gross markup Λ over the lead firm's unit cost, $p_t = \Lambda\, w_t /A_t(\omega)$. The producer of intermediate product ω earns a stream of profits $\delta_t(\omega) = p_t(\omega)y_t(\omega) - w_t n_t(\omega)$. Given the pricing rule, profits are simply $\delta_t(\omega) = m\, w_t n_t(\omega)$, with $m=(\Lambda-1)$ being the net markup. (We carry along this separate notation for the markup so that we may later see how it influences the nature of the growth process separately from the size of a productivity step, Λ.) In product market equilibrium, labor allocations are invariant across sectors, $n_t(\omega) = n_t$, which is a conventional result in Cobb–Douglas economies. Thus, profits in all sectors are identical, $\delta_t(\omega) = m\, w_t n_t$.

For the general equilibrium analysis below, only a reduced form of the industry equilibrium given productivity is important. In particular, we

carry along the finding that the profit flow is $\delta_t = m \, w_t n_t$: the present value of these profits is the reward to success in innovation.

4. Aggregate Productivity Growth

Our framework has a natural measure of the aggregate state of productivity, $A_t = \exp(\int_0^1 \log(A_t(\omega)) \, d\omega$. This aggregate permits us, for example, to derive a reduced form "production function" for final consumption goods as $C_t = A_t \, n_t$, so that long-term consumption and productivity growth rates are equal. At the industry level, the dynamics of productivity are:

$$A_{t+\Delta t}(\omega) = \begin{cases} A_t(\omega) \, \Lambda & \text{with probability} \quad (\Pi) \quad \Delta t \\ A_t(\omega) & \text{with probability} \quad (1-\Pi) \, \Delta t \end{cases}$$

for $0 \leq \omega \leq 1$. For small time intervals, the aggregate then obeys $dA_t/dt = A_t \, \Pi \, \lambda$, where $\lambda = \log(\Lambda)$ is the continuously compounded rate of productivity growth which occurs when innovation is certain in each industry ($\Pi=1$). More generally, our measure of the economy's growth rate, γ, is the common growth rate of consumption and the productivity aggregate. Since the innovation probability Π is directly related to the number of entrepreneurs (or scale of labor input devoted innovation), $\Pi = \pi \, e$, the growth rate is as well.[12/]

C. General Equilibrium

Our analysis of general equilibrium splits the problem into two parts. First, we discuss linkages between interest rates and growth rates that arise in market equilibrium on the side of production. Our framework enables us to describe how financial market distortions and efficiency affect this tradeoff. Second, we discuss the implications of optimal choice of consumption over time for the preference-side relation between growth and

returns. Then, we put these components together in a general equilibrium analysis.

1. Production-Side Linkages Between Returns and Growth

Three market equilibrium conditions determine the production-side relationship between growth and returns: the financial intermediation equilibrium condition (FI), the stock market equilibrium condition (SM) and the labor market equilibrium condition (LM).

Financial Equilibrium Conditions: The specific versions of the first two equilibrium conditions that we use are the relevant conditions for short periods (continuous time):

(FI) $\qquad \pi \, v_t = a(\tau) \, w_t$

(SM) $\qquad dv_t/dt = \Pi \, v_t - \delta_t + r_t \, v_t$

where r_t is the instantaneous real interest rate prevailing between t and $t + \Delta t$, i.e., $\rho_{t+\Delta t, t} = \exp(r_t \, \Delta t)$ and dv_t/dt is the time derivative of the stock price. As above, these conditions describe a representative industry. Moving to continuous time has some advantages in terms of the simplicity of results and their comparability to the literature, but comes at a cost of not having financial intermediary interest rates enter in the condition (FI).[13/]

Labor Market Equilibrium: The labor market equilibrium condition is given by the requirement that

(LM) $\qquad n + a(0) \, e = N$

where $n = \int_0^1 n(\omega) \, d\omega$ is the total quantity of labor allocated to production of intermediates, $a(0)e$ is the quantity of labor allocated to intermediation and innovation, and N is the total stock of available labor.

The Stock Market and Growth: If the interest rate is constant, as it will be in the general equilibrium below, stock prices will grow with dividends (at the rate of productivity growth γ). Imposing $dv_t/dt = \gamma v_t$, the stock market equilibrium condition may be written as:

$$v = \frac{\delta}{r-\gamma+\Pi}.$$

Treating r, δ, and Π as fixed, this expression has the familiar implication that an increase in the growth rate raises the stock market value, since it increases the stream of future dividends. In our general equilibrium setting, this familiar result is tempered by two other considerations. First, when more resources are allocated to innovation and the economy consequently grows faster, there is a higher probability of successful innovation (a higher Π) and therefore a higher probability that existing equity holders will suffer a capital loss. That is, since the growth rate γ is given by $\Pi \lambda$, a higher innovation probability is associated with faster growth (for a given size of innovation λ). Second, when more resources are allocated to innovation and the economy consequently grows faster, lower profits are earned by intermediate good producers since there is a smaller scale of their industries. These two considerations imply the full effect of the growth rate on the stock market is ambiguous.[14/]

The Production-Side Relation: Combining the financial intermediation, stock market and labor market equilibrium conditions with the requirement that the aggregate innovation probability is $\Pi=\pi e$ and $\delta_t = m\, w_t n$, we can determine a "production side" relationship between the growth rate and the real interest rate in the model's steady state (which it is always in). Since the financial intermediation equilibrium condition (FI) is $v = a(\tau)\, w$, we can implicitly define a production-side relation:

(PS) $\quad a(\tau) = \pi \dfrac{\delta/w}{r-[(\lambda-1)/\lambda]\gamma} = \pi \dfrac{mn}{r-[(\lambda-1)/\lambda]\gamma}$

where $\lambda = \log(\Lambda)$. Using $\Pi=\pi e$, $n + a(0) e = N$, and $\gamma = \Pi \lambda$, (PS) may be written as the line

(PS)' $\quad r = \{1 - \dfrac{1}{\lambda} - \dfrac{m}{\lambda} (1-\tau)\} \gamma + \{\dfrac{m}{\lambda} (1-\tau)\} \bar{\gamma},$

where $\bar{\gamma}$ is the maximum feasible growth rate, defined by $\bar{\gamma} = (N\lambda\pi/a(0))$.[15/]

An implication of (PS)' is that financial sector tax hikes lower the real return (r) associated with any particular growth rate (γ), which may be derived as follows. First, when the growth rate is at its maximum, $\gamma=\bar{\gamma}$, then the interest rate is $r(\bar{\gamma}) = (1 - \dfrac{1}{\lambda})$ for all tax rates, so that changes in τ rotate the (PS)' locus through this point. Second, when growth is zero, $\gamma=0$, $r(0) = \dfrac{m}{\lambda}(1-\tau)$, so that an increase in financial sector taxation (τ) lowers the intercept on the r axis. Hence, at any give γ, there is an unambiguous inverse relationship between the real return, r, and the tax rate τ.

By contrast, the slope of the production-side relation is of ambiguous sign, which derives from the ambiguous long-run effect of growth on the stock market.[16/]

2. Preference-Side Linkages Between Returns and Growth

We close our model by describing the saving behavior of an immortal family with a time separable utility function, $U_t = {}_o\!\int^\infty u(c_{t+s}) e^{-\nu s} ds$, and a momentary utility given by $u(c_t) = [c_t^{(1-\sigma)} - 1]/[1-\sigma]$. In this utility specification, there are two parameters which describe intertemporal preferences: the intertemporal elasticity of substitution in consumption, $1/\sigma$, and the pure rate of time preference, ν.

The preference-side relationship between the real return and the growth

rate is then given by:

(F) $\gamma = [r-\nu]/\sigma$.

Hence, as stressed by Fisher [1930], there is a positive relationship between the rate of return and the growth rate; the strength of this relationship is determined by the intertemporal elasticity of substitution.

3. The Equilibrium Growth Rate

The market equilibrium growth rate satisfies (PS) and (F). Solving these equations yields:

(MG) $\qquad \gamma = [\frac{m}{\lambda} \bar{\gamma} (1-\tau) - \nu]/[\sigma - 1 + \frac{1}{\lambda} + \frac{m}{\lambda} \bar{\gamma} (1-\tau)]$.

As in endogenous growth models with perfect competition, this market equilibrium growth rate depends on aspects of preferences and technology. It is higher if individuals discount the future less (lower ν) or are more willing to substitute through time (lower σ). The growth rate is also higher if the economy is more productive (in the sense of a higher maximum feasible growth rate $\bar{\gamma}$). Reflecting the imperfect competition features of the model, growth depends positively on the extent of markups (m) and negatively on the extent of capital losses which innovation inflicts on investors $(\frac{1}{\lambda})$.

D. The Financial Sector and Economic Growth

We now use our framework to study links between the financial sector and economic growth.

1. Growth Effects of Financial Sector Distortions

Many financial sector policies effectively involve the taxation of gross income from financial intermediation and, thus, involve shifts in our parameter τ holding fixed the other parameters of the model. In practice,

such financial taxes come in many forms. Chamley and Honohan [1990] discuss many examples of explicit financial sector taxes (including taxes on gross receipts of banks, value added taxes, taxes on loan balances, taxes on financial transactions, and taxes on intermediary profits). They also define and measure implicit or quasi-taxes on financial intermediaries (including non-interest bearing reserve requirements, forced lending to the government and to state enterprises, and interest ceilings on various loans and deposits. Chamley and Honohan [1990] show that total financial intermediary taxation in some African countries amounted to seven percent of gross domestic product (GDP) during the 1980s. Similarly, Giovannini and de Melo [1993] find that financial intermediary taxes—especially implicit taxes—were above two percent of GDP for many countries.

Figure 1 demonstrates the implications of increases in financial sector distortions—the explicit or implicit taxes captured by τ—on the real return and the growth rate. (For concreteness, we have drawn the production-side relation as downward sloping, but this is inessential to the effects considered here). Increases in these taxes raise the full cost of innovation, $a(\tau)$, shifting down the production-side relation. That is, the higher cost of evaluating and financing entrepreneurs means that there is a lower rate of return at any given growth rate. Hence, these interventions lead to a lower market equilibrium growth rate.

Our model can also be used to explore the growth effects of increases in the efficiency of the financial sector, such as a decrease in the time cost of evaluation (f). Such improvements in efficiency increase the real rate of return at each growth rate in Figure 1 and thus lead to a higher growth rate.

2. Financial Sector Responses to Other Interventions

Our model also indicates that other public sector interventions—like changes in corporate profits taxes or shifts in the enforcement of property rights—can affect the growth rate. Each of these may be viewed as a change in the "markup" parameter: higher profit taxes or poorer property rights would lead to lower values of m. As in the previous section, higher taxes or poorer property rights would shift in the production-side relation in Figure 1, leading to a decline in growth.

Further, each of these interventions leads to a decline in the size of the financial sector in our model: with a lower return to innovation, less evaluation of entrepreneurs and external finance of projects is required. Specifically, lower returns to innovation cause entrepreneurs to demand fewer financial services. Thus, developments in the innovative and productive sectors affect financial development.

These two findings are important for the empirical investigation which we conduct below. The first finding indicates that other economic factors besides finance are likely to be important for growth, so that we explore the robustness of our empirical results to inclusion of a range of other variables thought to influence the growth rate. The second finding indicates that there is a simultaneous determination of economic growth and the scale of the financial sector, which prompts us to use simultaneous equations methods in parts of our empirical work. But it also indicates that the responsiveness of an economy to policy changes will depend on the how well its financial markets work.

II. Empirical Linkages Between Financial Markets and Growth

We use four kinds of evidence to evaluate the theory's predictions regarding the links between financial development and growth. First, we review and extend King and Levine's [1993] analysis of 80 countries over the 1960-1989 period (we subsequently refer to this earlier work as KL). Second, we evaluate five countries' experiences with financial sector reforms. Third, we review firm-level evidence on the allocative effects of financial reforms. Finally, we investigate how success of general policy reforms depends on financial development.

The evidence from each empirical approach corresponds well with the theoretical perspective developed above. The cross-country econometric results suggest that financial services are importantly linked to economic growth and productivity improvements. Further, the level of financial development predicts future economic growth and future productivity advances. The case studies indicate that the aggregate measures of financial development used in the broad cross-country analysis move in predictable ways following identifiable financial policy reforms. This finding suggests a link between financial sector policies and long-run growth given the cross-country results. Moreover, firm-level studies indicate that financial liberalization tends to increase the funding of more efficient firms at the expense of less efficient firms. Finally, after controlling for a variety of initial conditions, the initial level of financial development is positively associated with the beneficial effects of nonfinancial policy reforms; when nonfinancial policy changes are accompanied by financial reform, success tends to be even greater. Thus, the efficacy of other policy reforms depends on the financial system as suggested by our model.

A. Cross-Country Analysis of Financial Development and Economic Growth

We begin by considering the cross-country relationship between various indicators of economic sector development and indicators of the pace of economic development.

1. Indicators of Financial Development and Economic Growth

In the model, financial intermediaries provide financial services: they evaluate prospective entrepreneurs and fund projects with relatively good chances of success. To measure these financial services, we use four indicators of financial development constructed by KL. First, we use a measure of the overall size of the formal financial intermediary sector that equals the ratio of liquid liabilities to GDP and call this variable DEPTH.[17/] Liquid liabilities equal currency held outside of the banking system plus demand and interest bearing liabilities of banks and nonbank financial intermediaries. The assumption behind this measure is that the size of the financial sector is positively correlated with the provision of financial services.

Since DEPTH may not accurately reflect the provision of financial services, we try to isolate those financial intermediaries which are more likely to provide the services suggested by theory. Our second financial development indicator, BANK, equals the ratio of deposit money bank domestic assets to deposit money bank domestic assets plus central bank domestic assets. Banks seem more likely to provide the types of financial services emphasized in our model than central banks, so that higher values of BANK should correspond to more financial services and higher levels of financial development. Although there are problems with BANK, banks are the main non-central bank financial intermediary internationally, and BANK will

augment the first financial development indicator, DEPTH.

A financial system which simply funnels resources to the public sector or state owned enterprises is unlikely to be providing the types of financial services examined in the theoretical part of this paper. Thus, we design the third and fourth financial indicators to measure to whom the financial system is allocating credit. PRIVATE equals credit issued to private enterprises divided by credit issued to central and local governments plus credit issued to public and private enterprises. PRIV/Y equals credit issued to private enterprises divided by GDP. Higher values of PRIVATE reflect a redistribution of credit from public enterprises and government to private firms. Higher values of PRIV/Y indicate more credit to the private sector as a share of GDP. Thus, if financial sector interactions with the private sector are more indicative of the provision of productivity-enhancing financial services than financial sector interactions with the public sector, higher values of PRIVATE and PRIV/Y should indicate greater financial development. Along with DEPTH and BANK, PRIVATE and PRIV/Y should help characterize the degree of financial development.[18/]

To examine the channels through which financial development may be linked to long-run growth, we decompose real per capita GDP growth into two components: the rate of physical capital accumulation and everything else. Specifically, let y equal real per capita GDP, k equal the real per capita physical capital stock, x equal other determinants of per capita growth, and α is a production function parameter, so that $y = k^{\alpha} x$. Taking logarithms and differencing yields GYP $= \alpha(GK) + PROD$, where GK is the growth rate of the real per capita physical capital stock and PROD is the growth rate of everything else. We measure GYP and GK directly, set $\alpha = 0.3$ and define PROD, for productivity growth, as GYP $-\alpha(GK)$. If GK accurately reflects

changes in physical capital and assuming that the average hours worked per
worker is relatively stable when averaged over many years, PROD should
provide a reasonable conglomerate indicator of technology growth, quality
advances, and improvements in the employment of factor inputs.[19/]   These
concepts correspond well with the theoretical model, where improvements in
the allocation of society's resources improve the innovation rate. We also
use the ratio of gross domestic investment to GDP, INV, to measure physical
capital accumulation.

Thus, we study the relationship between the four financial development
indicators – DEPTH, BANK, PRIVATE, PRIV/Y – and the four growth indicators –
GYP, GK, INV, and PROD. Table 1 provides summary statistics on the four
growth indicators and the four financial development indicators for 77
countries averaged over the 1960–1989 period. There exists a wide range of
values across countries. For example, Korea enjoyed an average annual real
per capita growth rate of 6.6 percent from 1960 through 1989, while real per
capita GDP actually fell at an annual rate of 1.2 percent in Niger.
Similarly, the average value of DEPTH in Switzerland was 1.13, while the
corresponding figure in Rwanda was 0.11. The correlations show that each
financial indicator is positively and significantly correlated with each
growth indicators at the 0.01 significance level and (b) the financial
indicators are highly correlated with each other. Financial development is
strongly linked to economic growth.

2. Contemporaneous Financial Development and Growth

Using cross–country regressions, KL evaluate the strength of the partial
correlation between each growth indicator and each financial indicator using
the average value of the growth and financial indicators over the same time

period, 1960–1989. Specifically, KL regress GYP on the logarithm of initial income (LYO), the logarithm of the initial secondary school enrollment rate (LSEC), and each financial development indicator. They also include the ratio of trade (exports plus imports) to GDP (TRD), the ratio of government spending to GDP (GOV), and the average inflation rate (PI) to enlarge the conditioning information set. KL find that every financial indicator is significantly related to every growth indicator at the 0.05 significance level. (An illustrative regression based on KL is presented in Table 2, regression 1). Thus, consistent with our model, the regression evidence indicates a strong link between financial development and long–run growth.

3. Initial and Predetermined Financial Development and Growth

Our model suggests that improvements in the provision of financial services will promote future economic growth and future technological innovation. The model also suggests a reverse channel of causation where distortions in the innovative sector lower the demand for financial services and retard financial development. In this paper, we are not seeking to fully characterize the dynamic relationship between financial services and growth. Instead, we want to shed some light on whether improvements in the financial sector can generate improvements in living standards. In particular, we investigate whether cross–country regressions provide a basis for believing that financial sector policy reforms can stimulate increases in long–run growth rates.

Three forms of aggregate analysis suggest that the predetermined or predictable component of financial development is related to future growth. First, KL show that countries that had high values of DEPTH in 1960 grew faster, had higher rates of physical capital accumulation, higher investment

rates, and more rapid rates of technological advancement over the 1960-1989 period than countries with less developed financial systems in 1960 after controlling for many factors (See regression 2 in Table 2).[20] Second, KL find that countries with well developed financial systems in 1960, 1970, and 1980 enjoyed faster rates of per capita gdp and productivity growth over the next ten years using pooled cross-section, time-series data. Third, in this paper we extend the KL analysis by using instrumental variables to evaluate whether the predictable component of the financial indicators are significantly related to the economic growth indicators. For instruments, we use LYO, LSEC, the initial values of GOV, PI, and TRD, and the initial values of the financial indicators. We allow for unobserved decade effects on the world-wide growth average rate: we permit the regression constants to differ across decades but restrict these constant to be equal across countries within a decade. Throughout, we restrict the slope parameters to be equal across periods and countries.[21]

Table 3 summarizes the three stage least squares (3SLS) results. The predictable components of financial depth, the relative importance of banks as opposed to central banks, and the ratio of private credit to GDP are positively and significantly related to each growth indicator. The predictable component of financial development tends to be _very_ strongly associated with growth and the sources of growth.

The results on the predictable components of financial development are fairly stable across a wide range of econometric specifications, including changes in the set of other explanatory variables, in the subsamples of countries, and in the subintervals of the full sample period. First, inclusion of continent dummies or of the change in the terms of trade tends to strengthen the results; adding political stability indexes, population

growth, or GDP growth rates from the previous decade does not alter the conclusions. Second, the findings are essentially the same for just developing countries, for just Sub-Saharan African countries, or just non-Sub-Saharan African countries. Omitting outliers also does not affect the results. Third, there is considerable stability when we use decade average data. The results for the 1960s and the 1980s are similar to results in Table 3; for the 1970s only LLY and PRIV/Y enter with significant coefficients in the 3SLS growth results.

C. Case Studies

The cross-country regressions use financial development indicators, not measures of executable policies. In this subsection, we show that financial sector reforms in Argentina, Chile, Indonesia, Korea, and the Philippines were associated with increases in our financial development indicators (using the careful financial sector analyses in Bisat, Johnston, and Sundararajan [1992]). While these reform episodes differ in terms of design and speed, there are basic similarities. Prior to reform, the government typically exerted a heavy hand in directing credit, setting interest rates, regulating the activities of existing financial institutions and restricting the emergence of new financial institutions. Reform involved the liberalization and relaxation of these controls and restrictions.

Table 4 provides pre-reform and post-reform values of financial development indicators.[22/] The financial development indicators tend to rise following financial reforms. BANK, PRIVATE, and PRIV/Y rise in all cases except one. Financial depth, DEPTH, rises in Indonesia, Korea, and the Philippines and remains fairly stable in Argentina and Chile. Furthermore, the ratio of currency held outside of banks to bank deposits, CURRENCY, falls

during every financial reform program. Since drops in CURRENCY often
indicate an increase in the level of financial intermediation, this
additional indicator further suggests that financial reforms increase the
public's use of the formal financial sector. Also, during every reform
episode except one, the real interest rate (REAL-RATE) rises: since
liberalization typically involves the removal of interest rate ceilings, an
increase in real interest rates may be used to measure the realization of
advertised reforms. Thus, all of these indicators suggest that changes in
financial sector policies are predictably associated with changes in
aggregate measures of financial development.

However, three of the countries suffered financial crises after the
financial reforms. Between March 1980 and March 1981, Argentine authorities
liquidated financial institutions holding about 20 percent of total deposits.
In Chile, by 1983, almost 20 percent of commercial bank and finance company
loans were in default. In the mid-1980s, the Philippine authorities had to
move 30 percent of the banking system's assets, which were nonperforming, to
a government agency. Behind each crisis lies an unhealthy mix of financial
liberalization combined with explicit or implicit official deposit guarantees
and insufficient supervision. For example, in Argentina the weakest
institutions offered the highest deposit interest rates, while on-site
inspections by the Central Bank fell from 23 percent of banks before the
reforms to 10 percent in 1981. Thus, while our financial indicators are
positively associated with these particular financial reforms, it is also
clear that the broad indicators do not indicate whether the underlying
financial reforms are sustainable.

Furthermore, the available financial indicators may miss important
developments. For example, in Korea, nonbank financial intermediaries

flourished during the mid-1980 financial liberalization. Nonbank credit grew from 18 percent of GDP in 1980 to 38 percent of GDP in 1988, while bank credit remained a constant share of GDP during this period. Thus, within our broad cross-section study, we are unable to include financial institutions other than banks: the case studies suggest that this may be a quantitatively important omission for some countries.

D. Firm Level Studies of Financial Reform and Credit Allocation

Our theoretical model predicts that financial reforms should alter the flow of credit: more efficient firms should get a larger fraction of credit, and less efficient firms should get a smaller fraction of credit. A recent World Bank research project discussed in Caprio [1994], sheds light on this mechanism. In particular, individual studies by Jaramillo, Schiantarelli and Weiss [1993], Harris, Schiantarelli, and Siregar [1992], and Siregar [1992] use firm level panel data to examine the effects of financial sector reform in Ecuador and Indonesia on the allocation of credit.

To study the efficiency with which Ecuador and Indonesia allocate credit, these authors estimate a production function on firm level data and then compute the distance that each firm lies from a production possibility frontier (defined by the most efficient firms). Firms closer to the frontier have higher "technical efficiency."[23/] Based on a panel of several hundred Ecuadorian firms, "... ceteris paribus, there has been an increase in the flow of credit accruing to technically more efficient firms, after liberalization, controlling for other firms' characteristics." (Caprio, et. al., [Chapter 5, 1994]). The authors provide considerable evidence that the results are robust to different production function specifications and estimation procedures. Furthermore, data on about two hundred Indonesian

firms shows that credit flowed to more efficient firms following financial
liberalization. Thus, financial liberalization was associated with a
re-direction of the flow of credit to more efficient firms. This coincides
with predictions of our model that financial intermediaries "add value" by
improving the selection and funding of entrepreneurs.

E. Structural Adjustment and Financial Development

The model implies that the impact of nonfinancial, growth-promoting
policy reforms will be greater if a country has a higher level of financial
development, since it then may more effectively respond to a growth stimulus.
The model also predicts that when financial liberalization accompanies
nonfinancial policy reforms, the effect on growth will be greater than if
financial reforms are not also undertaken. In practice, the effects of
financial and nonfinancial policy reforms on growth will depend on many
factors, including precisely which policies change, the order and speed of
these changes, and the condition of the economy as a country initiates policy
alterations. Instead of formally evaluating the interaction of the effects
of various policy reforms on growth, we present suggestive evidence regarding
the interplay between financial development, general policy reforms, and
economic growth. Our hope is that this scrap of evidence will stimulate more
detailed studies on this important topic.

In particular, we study whether the success of countries that engaged in
intensive structural adjustment during the late 1980s depended on (a) the
initial level of financial development and (b) financial liberalization
during the reform episode. We define success in terms of the growth rate of
per capita GDP. We define intensive structural adjustment in terms of the
World Bank's Third Report on Adjustment Lending. The Report classifies 27

nations as "intensive adjustment lending" (IAL) countries during the second half of the 1980s. This group is defined as countries which received at least two structural adjustment loans or three adjustment loans of any type (either structural or sectoral) between 1986 and 1990. These adjustment operations focused on trade liberalization, agricultural policy reforms, fiscal policy changes, on the removal of restrictive regulatory practices, and on public enterprise reform. Sometimes structural adjustment lending contained conditions on financial sector policy reforms. The Report shows that IAL countries grew faster in the late 1980s than other countries (those which did not receive any adjustment lending or countries which received only limited adjustment lending). Furthermore, the Report shows that IAL countries tended to implement policy reforms: public sector deficits fell, trade restrictions eased, black market premia fell, internal relative prices moved toward world levels, and IAL countries divested public companies.[24/]

1. Growth and Initial Financial Development

When we divide the IAL countries by measures of the level pre—reform financial development, we find that this single indicator gives a good guide to the success or failure of the reforms. In particular, figure 2 shows that IAL countries with high initial DEPTH (above average in 1985) grew much faster over the next five years than IAL countries with low initial DEPTH (below average in 1985).

One potential problem in interpreting these results is that our simple procedure does not account for the effect of growth determinants other than financial development. Consequently, we repeat the experiment using growth residuals from the regression of per capita GDP growth on initial income, initial secondary school enrollment, the initial ratio of government spending

to GDP, the initial ratio of international trade to GDP, and the initial inflation rate. Importantly, we find that IAL countries with faster than predicted growth (positive residuals) tended to be IAL countries with initially well developed financial systems (above average DEPTH in 1985). We conclude that successful structural adjustment tends to be positively associated with the initial level of financial development.[25/]

2. Economic Growth and Financial Sector Growth

Figure 3 shows that IAL countries with above average financial development over the 1985-90 period — countries where DEPTH grew faster than average — grew much faster than IAL countries with below average DEPTH. After controlling for other growth determinants, we find that IAL countries with faster than predicted growth tended to be IAL countries with financial systems that grew relatively rapidly. Successful structural adjustment tends to be positively associated with an increased pace of financial development.

III. Conclusion

This paper articulates a new mechanism by which financial systems influence long-run economic growth. In our model, financial systems affect the entrepreneurial activities that lead to productivity improvements in four ways. First, financial systems evaluate prospective entrepreneurs and choose the most promising projects. Second, financial systems mobilize resources to finance promising projects. Third, financial systems allow investors to diversify the risk associated with uncertain innovative activities. Fourth, financial systems reveal the potential rewards to engaging in innovation, relative to continuing to make existing products with existing techniques. Thus, a more-developed financial system fosters productivity improvement by choosing higher quality entrepreneurs and projects; by more effectively

mobilizing external financing for these entrepreneurs; by providing superior vehicles for diversifying the risk of innovative activities; and by revealing more accurately the potentially large profits associated with the uncertain business of innovation. In these ways, better financial systems stimulate economic growth by accelerating the rate of productivity enhancement.

There is much empirical support for this view. We reviewed a range of evidence concerning the links between financial sector development and growth, including cross-country regressions and case studies of the microeconomic and macroeconomic effects of financial sector and other policy reforms. We find support for the core idea advanced in our model: better financial systems stimulate faster productivity growth and growth in per-capita output by funneling society's resources to promising productivity enhancing endeavors. Our findings suggest that government policies toward financial systems may have an important causal effect on long-run growth.

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NOTES

1/ The recent theoretical literature develops a variety of economic connections between finance and growth. Greenwood and Jovanovic [1990] highlight the fact that financial markets pool the funds of small savers and allocate capital to its highest valued use. Bencivenga and Smith [1991] stress that financial institutions provide liquidity to small savers, thus permitting a reallocation of funds to illiquid higher return technologies. Boyd and Smith [1992] indicate how financial institutions may partly mitigate the effects of adverse selection. Levine [1991] and Saint Paul [1992] indicate that stock markets provide portfolio diversification which can stimulate growth. Pagano [1993] provides an overview of the modern literature; Greenwood and Smith [1993] give a detailed survey.

2/ Recent empirical studies of finance and growth include Degregorio and Giudotti [1992], Gelb [1989], Gertler and Rose [1991], King and Levine [1993a,b], and Roubini and Sala-i-Martin [1992]. See also The World Development Report [1989].

3/ Robinson's skepticism about the importance of financial factors for growth is echoed in more recent articles by Lucas [1988] and Stern [1989].

4/ Recent research has developed models which embed Schumpeterian ideas of "creative destruction" in general equilibrium frameworks, following Shleiffer [1986]. Our research draws heavily on recent endogenous growth models in the class developed by Aghion and Howitt [1992], Romer [1990] and most closely, Grossman and Helpman [1991].

5/ We view innovative activity broadly: in addition to invention of new products, we include enhancement of existing products; costly adoption of technology from other countries; and production of an existing good using new production or business methods.

6/ Our formal model takes this view to an extreme since it abstracts entirely from the mechanics of physical capital formation.

7/ We believe that evaluation, mobilization, and risk diversification are frequently bundled together as activities of a single financial intermediary because evaluation yields information, previously unknown by both evaluator and entrepreneur, which has important proprietary value. Bhattacharya [1992] discusses aspects of the optimal structure of financial intermediaries in settings with proprietary information.

8/ Throughout, we presume that costly selection is an equilibrium outcome. However, this assumed economic viability requires some restrictions on the technologies of the model economy. The alternative to costly evaluation is to simply invest funds in "unrated" entrepreneurs. Under this strategy, one has expected profits of $\alpha \pi (\rho v') - x w$ since labor costs are paid for both capable and other entrepreneurs. Economic viability of selection requires that rewards to the evaluation strategy, $\alpha q - w f = \alpha [\pi \rho v' - x w] - f w$, exceed the rewards to such blind investment, i.e., $\alpha q - w f > \alpha \pi (\rho v') - x w$. This condition simply requires that the expected net savings in labor costs from evaluation, $f - \alpha x$, exceed the labor costs of blind investment, or $x > \alpha x + f$. We assume that evaluation costs are sufficiently small that this condition always holds in our analysis.

9/ Appendix A explores a setup which makes the innovation probability a function of the scale of resources, $\pi(x)$.

10/ This is a standard assumption in growth models, but it is worth noting that it requires a form of coordination among the participants in the research process. A physical analogy may be aid in discussing the nature of the coordination implicitly assumed. Suppose that one has lost a watch somewhere along the side of a football field (of unit length) and has S searchers each of whom can search an interval of length ϕ within a given time period. Assume further that $S\phi < 1$ so that there is never a possibility of a certain outcome. If the searchers are allocated so that there is no overlap in the intervals searched, the the probability that one is successful (and only one may be) is $\Phi = S \phi$. But if the searchers are allocated randomly along the side of the field, then the probability is $\Phi = 1-(1-\phi)^S$, since $(1-\phi)$ is the probability of failure for an individual and $(1-\phi)^S$ is the probability that there are no successes from S draws of the binomial (see, e.g., Feller, [1968, p.148]).

11/ The standard production function would be $C = \exp [\sum_{h=1}^{H} \nu_h \log(y_h)]$, with $\sum_{h=1}^{H} \nu_h = 1$ and $v_h = \frac{1}{H}$ for the symmetric product case. Factor demands are obtained by minimizing cost, $_0\int^1 p(\omega) y(\omega) d\omega$, subject to a given production level at $\underline{C}$. The relevant first order conditions are,

$$p(\omega) = \Psi \frac{1}{y(\omega)} \quad \exp {_0\int^1} \log (y(\omega)) d\omega = \frac{\Psi}{y(\omega)} \underline{C},$$

where Ψ is the multiplier on the production constraint. Requiring that $\Psi=1$ (treating consumption as numeraire) we find that factor demands are $y(\omega) = \underline{C}/p(\omega)$ as reported in the main text.

12/ To derive the continuous time version of (FM), we proceed as follows. First, we write the equilibrium condition as $\pi \, \rho_{t+\Delta t, t} \, v_{t+\Delta t} \, \Delta t = a(0) \, w_t \, \Delta t$, which involves the fact that we are measuring innovation probabilities and wage rates on a "per period" basis while we change the period length. Then, we drive $\Delta t \to 0$, the discounted stock price simply becomes v_t and other aspects of the equation are unchanged.

To derive the continuous time version of the condition (SM), we proceed as follows. As above, we write the specification with Δt as a variable:

$$(1 - \Pi \, \Delta t) \, \rho_{t+\Delta t, t} \, v_{t+\Delta} = v_t - \delta_t \, \Delta t$$

Then we set $\rho_{t+\Delta t, t} = \exp(-r_t \, \Delta t)$, so that r_t is a per period return:

$$(1 - \Pi \, \Delta t) \, v_{t+\Delta} = [v_t - \delta_t \, \Delta t] \exp(r_t \, \Delta t).$$

Then, we reorganize the condition as follows:

$$(v_{t+\Delta t} - v_t)/\Delta t = \Pi \, v_{t+\Delta t} - \delta_t \exp(r_t \, \Delta t)$$
$$+ \frac{1}{\Delta t} [\exp(r_t \, \Delta t) - 1] \, v_t.$$

Taking limits as $\Delta t \to 0$ and using $\lim\limits_{\Delta t \to 0} \frac{1}{\Delta t} [\exp(r_t \, \Delta t) - 1] = r_t$, we arrive at the expression reported in the text.

13/ Appendix B considers the determination of optimal productivity growth using this aggregative framework.

14/ These two channels can be explored formally as follows. First, we know that growth and capital losses are linked by $\gamma = \lambda \, \Pi$. Hence, we can write $v = \delta / [r - \phi \, \gamma]$ with $\phi = (\lambda - 1)/\lambda$. Since $\Lambda > 1$, we know that $\lambda = \log(\Lambda)$ is a positive number. But λ may be either greater than or less than one depending on the size of productivity steps. If it is smaller than unity, then it follows that $\phi < 0$ and the real stock price declines with the growth rate (when real dividends are held fixed). Second, profits in each industry are $\delta = m w n$. Given the labor market equilibrium condition, $N = n + a(0) \, e$, as well as the link between entrepreneurship and the growth rate, $\gamma = \lambda \, \pi \, e$, we find profits are negatively related to growth, $\delta(\gamma) = m \, w \, (N - \theta \gamma)$, with $\theta = \lambda \pi / a(0)$.

15/ This growth rate obtains if all labor is allocated to innovative activity (including the screening of prospective entrepreneurs).

16/ The specification (PS)' implies that τ and $\bar{\gamma}$ exert different effects in Figure 1 below. Increases in τ rotate the (PS) curve leaving intact the point with $r=\phi\bar{\gamma}$ and $\gamma=\bar{\gamma}$, i.e., the position in which all resources are allocated to innovative activity. Increases in $\bar{\gamma}$, by contrast, shift the (PS) locus up in a parallel fashion.

17/ See King and Levine [1993] for a description of the data sources.

18/ As in Gelb [1989], we also examined a measures of a very repressed interest rate—average real interest rates of less than negative five percent over extended time periods—but this indicator was not robustly linked to growth (see King and Levine [1992a]).

19/ To construct productivity growth, we use Benhabib and Spiegel's [1992] physical capital stock estimates. We could not get complete, comparable data on the average number of hours worked per worker for the countries in our data set. We obtain similar results using the change in real per capita GDP divided by investment as an alternative measure of "productivity."

20/ The results also hold using pooled cross—section, time—series data with variables averaged over each decade, using various subsets of countries, or when including continent dummy variables, and with White's heteroskedastic consistent standard errors. Working in the style of Levine and Renelt [1992], King and Levine [1993] alter the conditioning information set by using various combinations of variables such as population growth, changes in the terms of trade, the number of revolutions and coups, the number of assassinations, the level of civil liberties, the standard deviation of inflation, domestic credit growth, the standard deviation of domestic credit growth, etc.

21/ To test for country effects (as opposed to continent effects), we subtracted the 1960–1989 mean of each variable from its value in each decade, computed the 3SLS results, and did a Hausman—type test to determine whether the coefficients on the two sets of results are significantly different from one another. This amounts to including dummy variables for each country and testing whether the coefficients on the financial indicators change. We find that the coefficients are not significantly different, which implies that we are not missing crucial country specific effects. However, numerous coefficients change noticeably, but the standard error in the means—removed—regression is such that means—removed coefficients are frequently less than one standard error away from the values in Table 3. Thus, there may be some important country specific effects that we are missing. As Easterly, et. al. [1992] show, real per capita GDP growth varies much more across decades than the economic indicators used to explain growth. Put differently, it will be difficult for cross—country growth regressions to explain fully a country's growth experience because much of growth seems rooted in country specific characteristics that are difficult to capture

using available data on many countries over long time periods. The first stage results indicate that the best predictor of the average level of financial development is past financial development. This emphasizes the relative lack of time series variability in the explanatory variables we are using to explain growth.

22/ The term "post-reform" is a sight misnomer since policy changes continued during these years.

23/ See the individual papers for detailed discussion of the procedure.

24/ The Report also notes that adjustment takes years, and there may be significant recessions during the adjustment. The poor seem to benefit the most in the longer run from structural adjustment but may suffer as the economy adjusts.

25/ These results hold when using the other financial development indicators BANK, PRIVATE, and PRIV/Y. Also, those results hold when using the values in 1980 to compute the initial state of financial development.

Table 1: Properties of Growth and Financial Indicators

A. Summary Statistics: 1960-1989

	MEAN	Standard Deviation	Minimum	Maximum
GYP	0.019	0.016	-0.012	0.066
GK	-0.003	0.014	-0.032	0.028
INV	0.203	0.052	0.092	0.318
PROD	0.020	0.013	-0.007	0.059
DEPTH	0.364	0.217	0.106	1.132
BANK	0.715	0.172	0.235	0.979
PRIVATE	0.598	0.172	0.176	0.920
PRIVY	0.256	0.185	0.037	1.119

B. Contemporaneous Correlations: 1960-1989

	GK	INV	PROD	DEPTH	BANK	PRIVATE	PRIVY
GYP	0.77	0.58	0.98	0.56	0.44	0.37	0.50
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
GK		0.65	0.64	0.69	0.56	0.49	0.65
		[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
INV			0.50	0.54	0.59	0.49	0.48
			[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
PROD				0.47	0.36	0.30	0.41
				[0.001]	[0.002]	[0.008]	[0.001]
DEPTH					0.59	0.45	0.82
					[0.001]	[0.001]	[0.001]
BANK						0.79	0.63
						[0.001]	[0.001]
PRIVATE							0.68
							[0.001]

[p-values in brackets]

GYP   = Real per capita GDP growth rate
GK   = Real per capita capital stock growth rate
INV   = Ratio of investment to GDP
PROD   = GYP - (0.3)*GK
DEPTH   = Ratio of liquid liabilities to GDP
BANK   = Deposit bank domestic credit divided by deposit bank domestic credit
          plus central bank domestic credit
PRIVATE = Ratio of claims on nonfinancial private sector to domestic credit
PRIVY   = Gross claims on the private sector to GDP

Table 2

Growth and Financial Depth

Independent Variable	(1)	(2)
C	0.029*** (0.007)	0.040*** (0.007)
LYO	-0.008*** (0.003)	-0.013*** (0.003)
LSEC	0.008*** (0.002)	0.011*** (0.002)
Index of Civil Liberties	0.001 (0.001)	0.001 (0.001)
Number of Revolutions	-0.012* (0.007)	-0.006 (0.008)
Number of Assassinations	-0.001 (0.001)	-0.001 (0.003
DEPTH average 1960-1989	0.029*** (0.007)	
DEPTH in 1960		0.028*** (0.007)
R^2	0.52	0.55
Observations	92	63

(standard errors in parentheses)

Dependent variable: GYP - Average Annual Real per capita GDP growth 1960-1989

*   significant at 0.10 level
**   significant at 0.05 level
*** significant at 0.01 level

LYO   = log of initial real per capita GDP in 1960
LSEC = log of secondary school enrollment rate in 1960

Table 3

Growth and Financial Indicators
Pooled Cross-Section Time-Series: Three Stage Least Squares

Dependent Variable	LLY	BANK	PRIVATE	PRIVY
GYP	0.035*** (0.006) [0.001]	0.036*** (0.011) [0.001]	0.014 (0.010) [0.184]	0.035*** (0.009) [0.001]
R^2:	0.47	0.39	0.33	0.54
GK	0.027*** (0.005) [0.001]	0.034*** 0.009) [0.001]	0.011 (0.008) [0.187]	0.032*** (0.008) [0.001]
R^2:	0.48	0.54	0.42	0.51
INV	0.064*** (0.018) [0.001]	0.010*** (0.031) [0.002]	0.055** (0.026) [0.044]	0.060** (0.028) [0.035]
R^2:	0.27	0.18	0.24	0.32
PROD	0.030*** (0.007) [0.001]	0.035*** (0.011) [0.003]	0.005 (0.010) [0.660]	0.028** (0.011) [0.012]
R^2:	0.39	0.40	0.22	0.47

(standard errors in parentheses)
[p-values in brackets]

Observations = 169

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

GYP   = Real per capita GDP growth rate
GK   = Real capital stock per capita growth rate
INV   = Ratio of investment to GDP
PROD   = GYP - (0.3)*GK
DEPTH   = Ratio of liquid liabilities to GDP
BANK   = Deposit bank domestic credit divided by deposit bank
           domestic credit plus central bank domestic credit
PRIVATE = Ratio of claims on nonfinancial private sector to domestic credit
PRIVY   = Gross claims on the private sector to GDP

Other explanatory variables: log of initial income, log of initial secondary
school enrollment rate, ratio of government expenditures to GDP, inflation rate,
and ratio of exports plus imports to GDP.

Instruments: Decade dummy variables, log of initial income, log of initial
secondary school enrollment rate, initial ratio of government expenditures to
GDP, initial inflation rate, and initial ratio of exports plus imports to GDP,
and the initial value of the financial indicator.

Table 4

Before and After Financial Sector Reform

Country	BANK	PRIVATE	PRIVY	DEPTH	CURRENCY	REAL-RATE
Argentina (1974-1976)	0.41	0.41	0.17	0.22	0.45	-44.70
Argentina (1978-1980)	0.81	0.59	0.16	0.21	0.26	-14.13
Chile (1970-1973)	--	--	0.08	0.18	0.31	< 0
Chile (1977-1981)	0.45	0.64	0.28	0.17	0.19	8.80
Indonesia (1978-1982)	0.53	0.40	0.09	0.15	0.38	-3.61
Indonesia (1984-1989)	0.63	0.51	0.18	0.19	0.22	8.97
Korea (1978-1980)	0.75	0.70	0.29	0.30	0.13	-0.94
Korea (1983-1985)	0.80	0.74	0.43	0.36	0.07	6.58
Philippines (1975-1979)	0.77	0.72	0.22	0.22	0.13	-2.09
Philippines (1981-1984)	0.72	0.65	0.29	0.26	0.12	-3.03[1]

[1] If 1984 value of -19.40 is omitted, the average annual real deposit interest rate over the 1981-1983 period is 2.33.

Figure 1
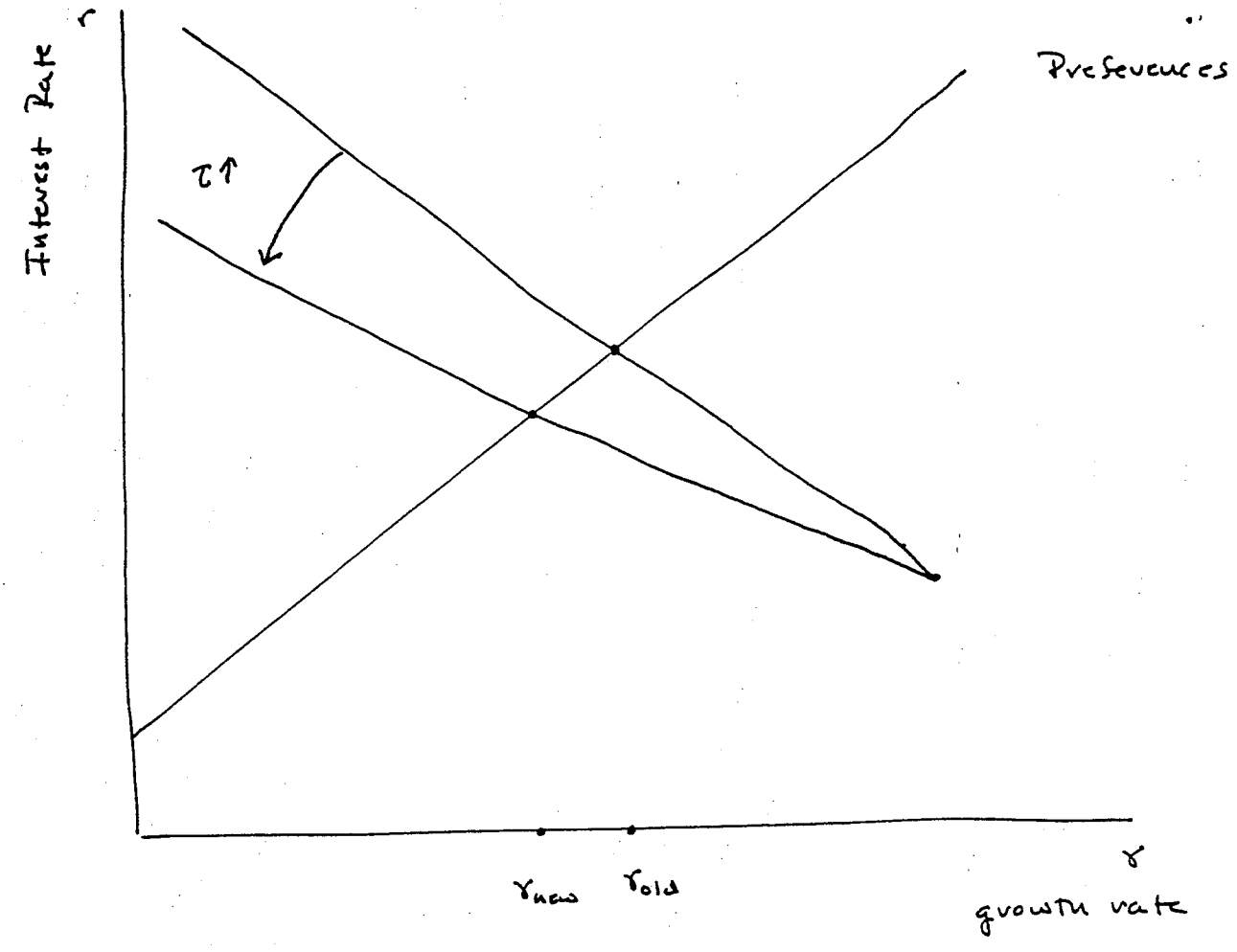
Effects of Financial Sector Distortions

Figure 2

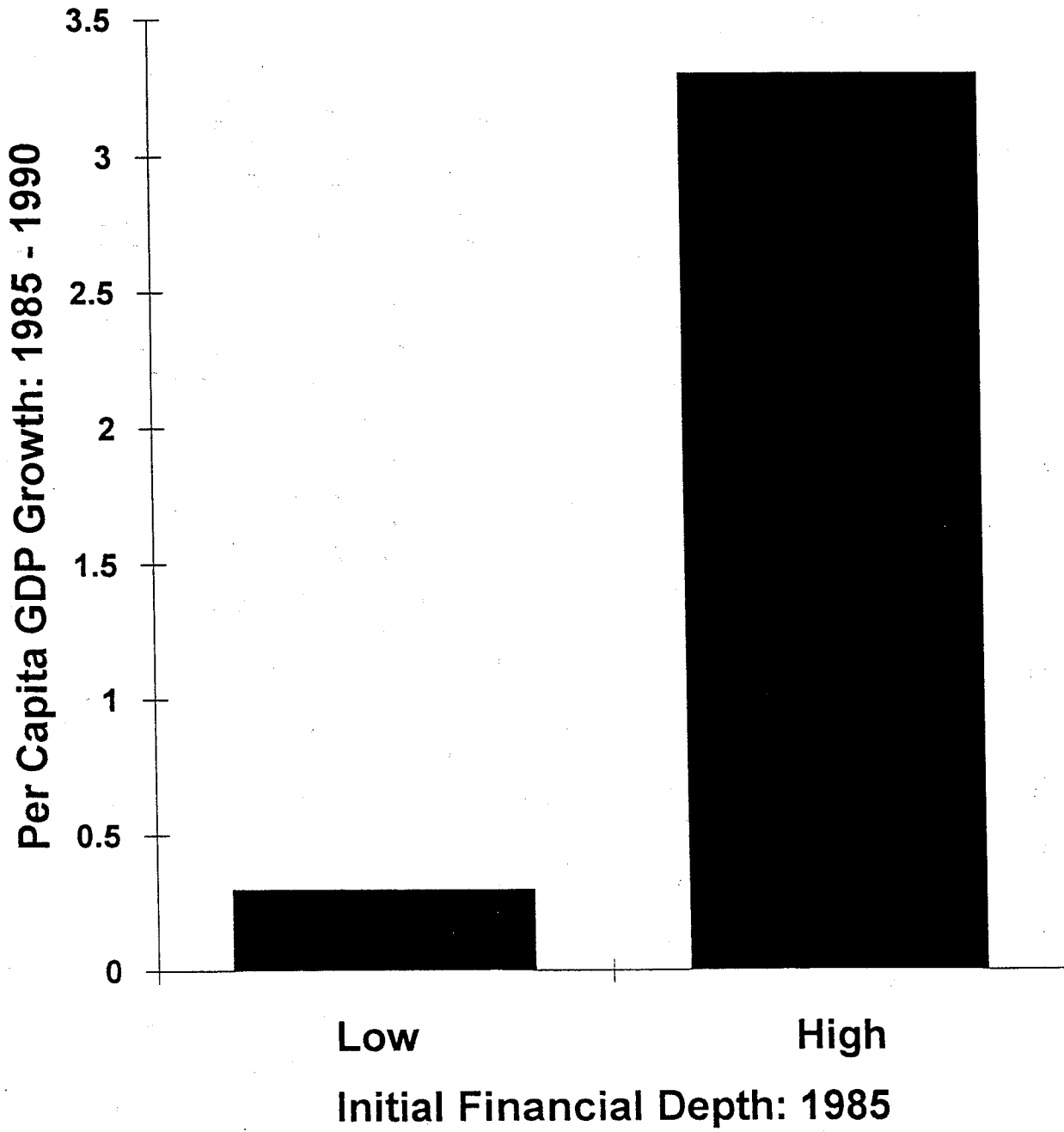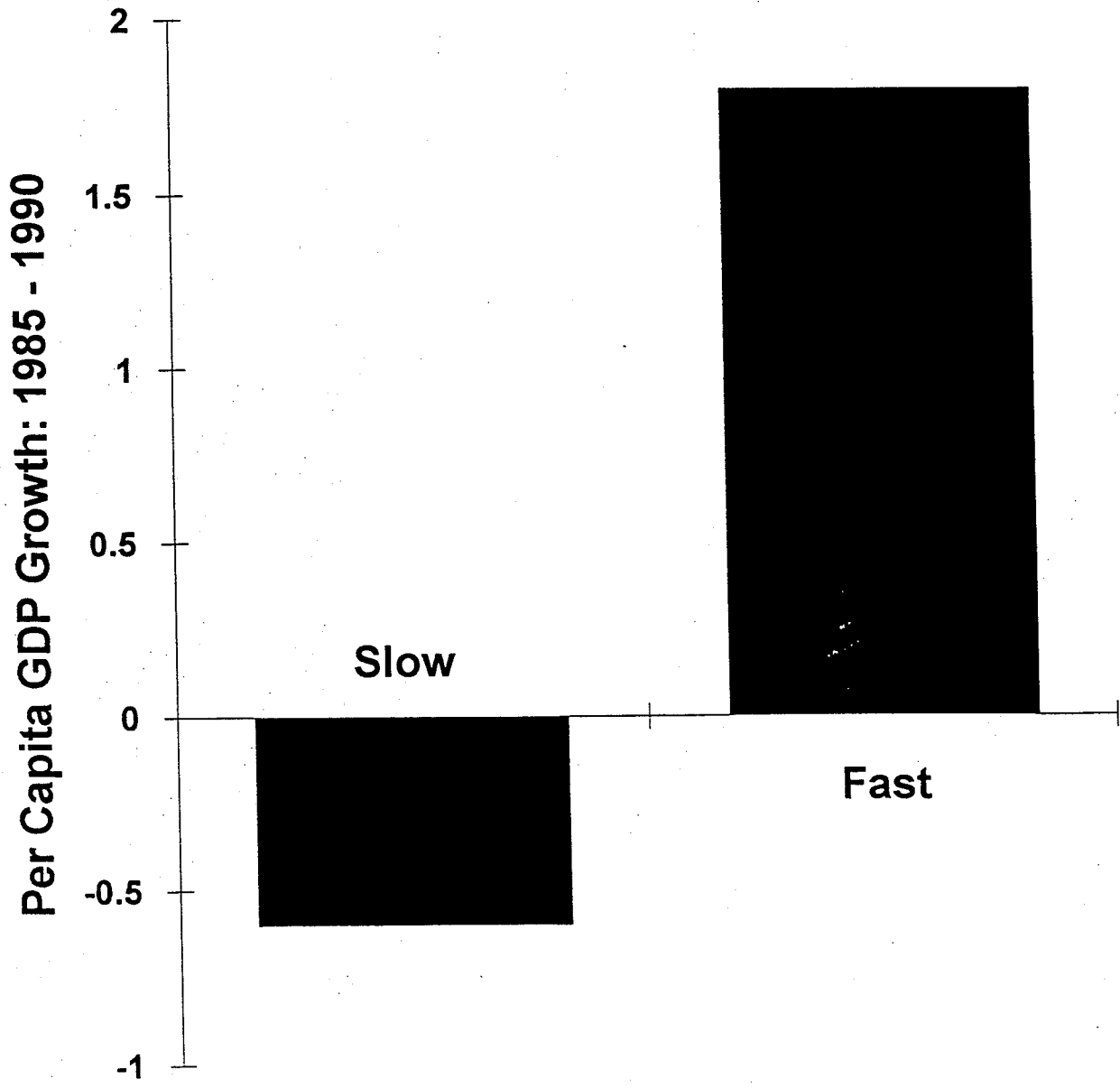# Initial Financial Development and Structural Adjustment

Per Capita GDP Growth: 1985 - 1990

Low   High

Initial Financial Depth: 1985

Figure 3

Financial Development and Structural Adjustment

Appendix A:

Endogenous Scale of Innovative Activity

We have taken as exogenous the scale of innovative activity conducted by an individual entrepreneur. However, we can easily extend the analysis to consider the endogenous determination of the scale of innovative activity by assuming that the probability of successful innovation is an increasing, strictly concave, twice continuously differentiable function of the resources allocated to the firm, $\pi = \pi(x)$. We denote the first and second derivatives of the π function by $D\pi$ and $D^2\pi$: strict concavity implies that $D\pi > 0$ and $D^2\pi < 0$. We assume that no innovation is possible without input, $\pi(0) = 0$, and that small, initial amounts of input have large effects on innovation probabilities $D\pi(0) = \infty$.

In undertaking this extension, we can also highlight an additional set of effects on growth which may arise from the effects of financial distortions on the scale of innovation activity. Nevertheless, the nature of the equilibrium we described in the main text—including the tax interventions we considered—are not affected by this extension because the optimal scale of the firm is invariant to the interventions considered there.

The economics of the combined finance and innovation sector may be understood by considering an industry in which firms face a fixed cost of entry (e.g., a licensing fee) and then have a diminishing returns to scale production function. At any given relative price of the industry's product (measured in terms of input costs), an individual firm can determine its optimal scale and this action generates a flow of rents (the level of which depends positively on the relative price). Competitive entry implies that the flow of rents just offsets the fixed cost: the relative price adjusts to satisfy this requirement, so that there is a horizontal supply curve for the

industry at a specific price. Further, taxation of output in the industry simply raises that supply price by the same amount, leaving invariant the optimal scale of the individual firm. Hence, changes in the tax rate τ simply leave invariant the scale of individual innovation firms.

The components of our industry work as follows. When the scale of the innovative firm, x, is a choice variable for the entrepreneur it will be selected to maximize the value of innovation rents,

$$q(x) = \pi(x) \ (1-\tau) \ \rho \ v' - w \ x.$$

Profit maximization implies that marginal expected benefit, $D\pi(x) \ (1-\tau) \ \rho \ v'$, equal expected marginal cost w. (In deriving this expression, we assume that the individual innovator is small enough so that his actions are presumed to have no effect on the stock market value via the capital loss, i.e., Π is invariant to π). Hence the optimal scale of the innovation firm will depend positively on the ratio $\kappa = (1-\tau) \ \rho v'/w$, which rises with the stock price v' and with declines in wages or in interest rates. We describe this optimal scale of the individual firm by the function $x(\kappa)$: its exact form depends on the characteristics of the $D\pi$ function, which is the marginal product function for this activity.

The level of the innovation rents may be written as $q = \pi \ (1-\tau) \ \rho \ v' - w \ x$ = $w[\kappa\pi(x(\kappa)) - 1]$, so that increases in κ lead to increases in innovation rents. Indeed, locally, the response of $q(\kappa)/w$ to κ is the same as in the fixed scale case that we explored earlier. That is, the profit maximization condition involves setting partial derivative of $(q/w) = \kappa \ \pi(x) - x$ with respect to x equal to zero: this is $\kappa \ D\pi(x)-1 = 0$. This implies that there is a positive derivative of $x(\kappa)$. The effect of a change in κ on (q/w) is

$$\frac{\partial(q/w)}{\partial\kappa} = \pi(x) - [D\pi(x) -1]\frac{\partial x}{\partial\kappa} = \pi(x)$$

so that, to a first order approximation, this measure of innovation rents displays the same relationship to κ irrespective of the elasticity of scale x with respect to the price κ. Further, there is a positive second derivative of the (q/w) function with respect to the price κ

$$\frac{\partial^2 (q/w)}{\partial \kappa^2} = D\pi(x)\, \frac{\partial x}{\partial \kappa} > 0.$$

The financial intermediary's costly evaluation provides the "fixed cost" element of the problem. From above, the entrepreneurial selection condition implies that

(ES)' $q(\kappa)/w = f/\alpha.$

The "relative price" $\kappa = (1-\tau)\, \rho\, v'/w$ adjusts so that (ES)' is satisfied.[1] Thus, costly entrepreneurial selection establishes an equilibrium level of innovation rents. If the tax rate τ increases, then stock prices (v'/w) will rise sufficiently so that κ will be unchanged. Hence, increases in τ do not affect the scale of individual innovation units, although they have the effect of increasing the cost of innovation. Hence, a higher τ reduces the size of the finance and innovation industries.

This analysis also indicates that other financial sector distortions—such as the featherbedding of employees in ways that increased "f"—would alter the scale of the innovation firms. In particular, increases in f would lead to (inefficient) increases in the scale of innovation firms and increases in the price κ. Hence, increases in "f" would retard growth.

---

[1]That is, given that q/w is zero at $\kappa = 0$ and increasing, there is some level of κ at which q/w = f/α.

Appendix B:

Optimal Growth of Aggregate Productivity
in the Schumpeterian Model

In this appendix, we discuss two related topics. First, we consider measurement of aggregate productivity in the model economy. Second, we consider the optimal growth of productivity in this economy.

The Dynamics of the Productivity Aggregate

As specified in the main text, the aggregate state of productivity is $A_t = \exp(\int_0^1 \log(A_t(\omega))\, d\omega)$. This aggregate is a natural one given the Cobb–Douglas production function for consumption, $C_t = \exp(\int_0^1 \log(z_t(\omega))\, d\omega)$ and the equilibrium rules for production of intermediates, $z_t(\omega) = A_t(\omega)\, n_t$. It thus makes it possible to express a "production function" for consumption goods as $C_t = A_t\, n_t$. Later on, we will describe the optimal growth of our model economy in terms of the evolution of this technology aggregate.

The individual components of this aggregate obey the dynamic equations

$$
A_{t+\Delta t}(\omega) = \begin{cases} A_t(\omega)\,\Lambda & \text{with probability } (\Pi)\ \Delta t \\ A_t(\omega) & \text{with probability } (1-\Pi)\ \Delta t \end{cases}
$$

for $0 \le \omega \le 1$. For a fixed length of time (Δt), the evolution equation for aggregate productivity thus is:

$$
\begin{aligned}
\log(A_{t+\Delta t}) &= \int_0^1 \log(A_{t+\Delta t}(\omega))\, d\omega \\
&= \{\Pi\ (\log(A_t)+\log(\Lambda)) + (1-\Pi)\ \log(A_t)\}\Delta t.
\end{aligned}
$$

Hence, $\log(A_{t+\Delta t}/A_t) = \Pi\log(\Lambda)\ \Delta t$ and by driving $\Delta t \to 0$, we obtain

$$
dA_t/A_t = \Pi\ \lambda
$$

where we define $\lambda = \log(\Lambda)$.

The Real Return and Optimal Growth

It is useful to consider the optimal growth solution for our aggregative model, which is obtained by maximizing utility subject to the resource constraints, $C_t = A_t n_t$, $dA_t/dt = A_t \lambda \pi e_t$, and $n_t + a(0) e_t = N$. Combining these equations, we can generate a single resource constraint:

(RC) $\theta C_t + dA_t/dt = \bar{\gamma} A_t$,

where $\theta = \lambda \pi/a(0)$ and $\bar{\gamma}$ is the maximum feasible growth rate, $\bar{\gamma} = N \theta$. Hence, the optimal growth version of our model has a linear technology structure, consistent with the general framework that Rebelo [1991] uses to discuss the effects of various policy distortions on the growth process. Solving for the optimal growth rate, we find that

(OG) $\gamma^* = [\bar{\gamma}-\nu]/\sigma$

so that $\bar{\gamma}$ plays the role of the constant rate of return. Some discussions of the effect of finance on development, such as Greenwood and Jovanovic [1990], Roubini and Sala-i-Martin [1992], and King and Levine [1992b], consider the effect of financial distortions essentially as they effect returns in a setting such as this. Such analyses assume that other markets are functioning efficiently while finance is distorted. In our context, this would amount to considering a taxation of resources allocated to innovative activity, so that we would modify the return to $\bar{\gamma}(1-\tau) = N \lambda \pi/a(\tau)$.

Appendix C:

Additional Detail on Growth Equilibria

In this appendix, we discuss some aspects of the equilibrium depicted in Figure 1 of the text in greater detail. There are five related topics.

1. Existence of Equilibrium: Restrictions on the Utility Function

In any unbounded growth model, there must be restrictions on the utility function so that it does not take on infinite values for feasible growth paths. In our model, the relevant condition is that discounting dominate growth in momentary utility, i.e., that

(C-1) $\nu > (1-\sigma)\ \gamma$.

Generally, this condition will involve a combination of restrictions on preferences (σ,ν) and on feasible growth rates (γ), although it is possible to just restrict preferences in some special cases (e.g., log utility, $\sigma=1$).

Condition (C-1) also implies that the interest rate exceeds the growth rate, which may be seen by combining it with the Fisherian rearrangement of the first-order condition ($r = \sigma\gamma + \nu$) which results in $r > \gamma$.

Our economy can take on growth rates $0 \leq \gamma \leq \bar{\gamma}$. Hence, it follows that preferences must be restricted to assure that (C-1) is always satisfied as we induce changes in growth rates from other sources (e.g., from policy):

(C-2) $\sigma > 1 - [\nu/\bar{\gamma}]$.

We impose this condition throughout our analysis.

2. The Production-Side Relation

We next consider some topics related to the production-side relation.

(i) *Resources Consumed By Growth:* There is an inverse relationship between the scale of intermediate product industries, as indexed by labor input (n), and the rate of growth (γ). This relation is derived using the labor market equilibrium condition; the relation between individual and aggregate innovation probabilities $\Pi = \pi$ e; the relation between growth and innovation $\gamma = \Pi\lambda$; and the definition of the maximum feasible growth rate, $\bar{\gamma}$ = $\lambda\pi N/a(0)$:

(C-3) $n = N - a(0) \ e = N - a(0) \ (\Pi/\pi) = N - [a(0)/(\lambda\pi)] \ \gamma = (N/\bar{\gamma}) \ [\bar{\gamma} - \gamma]$.

Hence, there is a negative effect of growth γ on labor input, n.

(ii) *The Long Run Partial Effect of Growth on the Stock Market:* In a steady-state, the stock market is given by:

(C-4) $(v/w) = [\dfrac{mn}{(r - \gamma - \Pi)}] = \dfrac{mn}{(r - \phi\gamma)}$

where $\phi = (\lambda-1)/\lambda$. This expression is positive so long as the "modified discount factor" $r - \phi\gamma$ is positive, which is implied by $r-\gamma > 0$ for positive growth rates because $\phi = 1 - (\frac{1}{\lambda})$.

There are three components of the partial effect of growth on the stock market, which may be broken out as:

(C-5) $\dfrac{\partial(v/w)}{\partial\gamma} = \dfrac{\partial}{\partial\gamma} \ [\dfrac{mn}{(r - \gamma - \Pi)}]$

$= [\dfrac{mn}{(r-\gamma-\Pi)^2}] + [\dfrac{m}{(r - \gamma - \Pi)}] \ \dfrac{\partial n}{\partial\gamma} - [\dfrac{mn}{(r-\gamma-\Pi)^2}] \ \dfrac{\partial\Pi}{\partial\gamma}.$

That is, there is the standard positive effect of growth on the stock market, to which is added negative effects arising from increased probability of capital losses and declines in the scale of profits. (These latter two

effects are negative because $\partial\Pi/\partial\gamma = (1/\lambda)$ and $\partial\Pi/\partial\gamma = -N/\bar{\gamma})$.

A more convenient expression for this partial derivative arises if we first substitute (C-3) into (C-4) to produce $(v/w) = [mN/\bar{\gamma}]\ [\bar{\gamma} - \gamma]/[r-\phi\gamma]$ before taking the derivative:

(C-6) $\quad \dfrac{\partial(v/w)}{\partial\gamma} = - [mN/\bar{\gamma}]\ (r - \phi\ \bar{\gamma})\ /\ [r - \phi\gamma]^2,$

which has the sign of $-(r-\phi\bar{\gamma})$. This indicates that consolidation of the three effects discussed above does not result in an unambiguous sign for the derivative, even when we require a positive modified discount factor $(r - \phi\gamma > 0)$ since $r-\phi\bar{\gamma} = r-\phi\gamma + \phi\ (\gamma-\bar{\gamma})$ is of ambiguous sign.

(iii) *The Slope of the Production–Side Locus*: The (PS) condition is that $a(\tau) = \pi\ (v/w)$. Hence, using (C-4) and the definition of $a(\tau) = a(0)/(1-\tau)$, we can write the (PS) condition as:

(C-7) $\quad \dfrac{a(0)}{1-\tau} = [\pi mN/\bar{\gamma}]\ \dfrac{(\bar{\gamma} - \gamma)}{(r - \phi\gamma)}.$

Recalling that $\bar{\gamma} = \lambda\pi N/a(0)$, we get that $r - \phi\ \gamma = (1-\tau)\ (\tfrac{m}{\lambda})\ (\bar{\gamma} - \gamma)$ and, upon rearrangement of terms that:

(C-8) $\quad r = (1-\tau)\ (\tfrac{m}{\lambda})\ \bar{\gamma} + \{\phi - (\tfrac{m}{\lambda})(1-\tau)\}\ \gamma$

Thus, the partial derivatives of the production side locus are:

$$\partial r/\partial\gamma \quad = \{\phi - (\tfrac{m}{\lambda})(1-\tau)\} \quad = \{1 - (\tfrac{1}{\lambda}) - (\tfrac{m}{\lambda})(1-\tau)\}$$

$$\partial r/\partial(1-\tau) = (\tfrac{m}{\lambda})\ (\bar{\gamma} - \gamma)$$

The former is ambiguous in sign for the two reasons discussed in connection with the effect of stock market on the growth rate: a higher growth leads to greater expected capital losses, $(\tfrac{1}{\lambda})$, and to a smaller scale of resources allocated to intermediate goods production, so that profit flows decline with

growth, $(\frac{m}{\lambda})(1-\tau)$. The effect of the tax wedge $(1-\tau)$ on the interest rate, at a given growth rate, is positive for $\gamma < \bar{\gamma}$.

Note further that we can write the production side locus as:

$$(C-8)' \quad r - \phi \bar{\gamma} = \{\phi - (\frac{m}{\lambda})(1-\tau)\} (\gamma - \bar{\gamma}).$$

Since $\gamma \leq \bar{\gamma}$, $r - \phi \bar{\gamma}$ takes on the sign of $-\{\phi - (\frac{m}{\lambda})(1-\tau)\}$. Hence, if growth has a positive long-run effect on the stock market $(r-\phi\bar{\gamma} < 0)$, then there is a positive slope to the production-side relation $\{\phi - (\frac{m}{\lambda})(1-\tau)\} > 0$.

3. The Equilibrium Growth Rate

Combining (C-8) with the condition (F), $r = \sigma\gamma+\nu$, we find that the equilibrium growth rate satisfies

$$\sigma\gamma+\nu = (1-\tau) (\frac{m}{\lambda}) \bar{\gamma} + \{\phi - (\frac{m}{\lambda})(1-\tau)\} \gamma$$

or that

$$(C-9) \quad \gamma = \{(1-\tau) (\frac{m}{\lambda}) \bar{\gamma} - \nu\}/\{\sigma - \phi + (\frac{m}{\lambda})(1-\tau)\},$$

which is the result reported in the main text as equation ( ).

4. The Existence of A Positive Growth Rate

The derivation of (C-9) makes use of the fact that two lines must cross in the plane, but does not require that the intersection point has $r > 0$ and $\gamma > 0$. To assure this, we need to restrict the intercepts of the (F) and (PS') lines. Since (F) specifies that $r = \sigma \gamma + \nu$, its slope in γ, r space is σ and its intercept is ν. The slope of (PS)' is given above as $\{\phi - (\frac{m}{\lambda})(1-\tau)\}$ and its itercept is $(1-\tau) (\frac{m}{\lambda}) \bar{\gamma}$. Hence, the numerator of (C-9) is the slope of (PS)' minus the slope of (F) and the denominator of (C-9) is the intercept of (F) minus the slope of (PS)'. The restrictions are as follows: