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Poverty Traps and Financial Development in a Model of Finance and Growth*

By Lutz Arnold**

1. Introduction

This paper aims to illustrate two stylized facts of the growth process: first, *financial development* goes hand in hand with production growth; second, some countries with poorly performing financial markets are caught in *poverty traps* with growth not getting underway. Observations like these have been made, for example, by Gurley and Shaw (1955, p. 522)), who find an upward trend in the proportion of financial assets of commercial banks to GNP over the 1900-1949 period. Similar results are reported in Goldsmith (1969) and McKinnon (1973). More recently, King and Levine (1993) find that the ten-years mean of the ratio of liquid liabilities to GNP, their favourite indicator of financial development, rose from 0.35 during 1965-1975 to 0.42 during 1975-1985 (s. Barro and Sala-i-Martin, 1995, p. 460). Levine (1997, p. 703) sums up: "A growing body of work demonstrates a strong, positive link between financial development and economic growth". In recent years these phenomena have been the focus of a still quickly growing number of papers, of which Galetovic's (1996) is perhaps closest in spirit to ours.

Our starting point is the premise that a formal model dealing with the two stylized facts cited above should do so with truely dynamic analysis: growth of the financial sector should be derived as a property of the transition path converging to a steady-growth equilibrium; and a poverty trap should be the result of unfavourable initial conditions within a setting that allows for steady growth given more favourable endowments. The existing literature does not satisfy this premise. Galetovic's (1996) model, for instance, is confined to steady-state analysis, and it appeals to parameter changes ("an 'industrial revolution'", p. 557) in order to explain the occurrence of a poverty trap.[1] The main theoretical innovation of the present paper consists of de-

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veloping a model which is consistent with the above premise: financial development and the existence of a poverty trap are proved by explicitly dynamic analysis.

We choose to build the simplest possible model consistent with the above premise. Namely, we extend Grossman and Helpman's (1991, ch.3) simple model of growth through R&D to include a simple form of asymmetric information giving rise to costly monitoring. Depending on the shape of the monitoring technology, there will or will not be financial development and poverty traps. Under plausible conditions there will be both. Suppose that monitoring costs are high in the early stages of development because financial intermediaries have little expertise (or because of increasing returns to scale in intermediation, or because of large risk when the economy is small – these interpretations are beyond the scope of our formal model, however). Then, it will turn out, a poverty trap may exist. Suppose further that monitoring costs are increasing in highly developed economies with highly specialized production. This will be seen to be sufficient for financial development. Formally, these results are easily proved following the lines pursued by Grossman and Helpman (1991, appendix 3.2).

The model is introduced in Section 2. Section 3 demonstrates the possible existence of a poverty trap. Section 4 introduces financial development. Section 5 concludes briefly.

2. Model

There is a continuum of length one of identical consumers each endowed with $L > 0$ units of labour and characterized by the utility function $\int_0^\infty e^{-\rho t} \ln c \, dt$, where t is time, $\rho > 0$ is the subjective discount rate, and c is consumption of a homogeneous final good. The final good is produced by perfectly competitive firms from a set of intermediate inputs j according to the constant-returns-to-scale production function $c = [\int_0^A x(j)^\alpha dj]^{1/\alpha}$, where A is the number of intermediates in use, $x(j)$ is the input of intermediate j, and $\alpha \in (0,1)$. Each intermediate good is obtained one-to-one from labour, the only primary factor of production. New intermediates are invented by R&D. It is assumed that imitation is costly and leads to price competition, so that it will not occur in equilibrium. Consequently, there is Chamberlinian monopolistic competition in the intermediate-goods sector.

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[1] This is not intended to be a critique of his approach, which focuses on the interaction of specialization in research and growth, and which is placed in a richer setting than ours including physical capital à la Romer (1990) as well as administrative and disclosure costs in financial intermediation.

The usual knowledge spillover from R&D is present: L_A workers in R&D are able to carry out AL_A/a research projects ($a > 0$). Each project fails with probability $1-\beta$, yielding a zero return, and succeeds with probability β, yielding one new intermediate. Thus $\dot{A} = \beta AL_A/a$, where $\beta \in (0,1)$. It is assumed that innovators are in need of external finance.[2] Whether a project succeeds or fails is costlessly observable only to the innovator himself; other individuals require $f(A) \geq 0$ units of labour in order to monitor one unit of labour in R&D. $f(A)$ is assumed to be continuously differentiable. In particular, potential lenders cannot observe whether or not borrowers are active in the intermediate-goods sector after research, from which they could infer whether the project has succeeded or failed.[3] Since un-monitored innovators will always claim that their projects have failed, every innovator is monitored. It is assumed that this task is performed by financial intermediaries (henceforth called banks) large enough to diversify away all risks. Thus, banks employ $f(A)L_A$ workers and know with certainty that a fraction β of the projects they monitor is successful.[4] We will make specific assumptions on the shape of $f(A)$ below. There is free entry into R&D and into banking.[5]

3. A Poverty Trap

The final-goods sector demands the intermediates with price elasticity $-1/(1-\alpha)$. This induces intermediate-goods producers to charge the markup price w/α, where w is the wage rate. Choosing expenditure on the final good as the numéraire, monopoly profits of each intermediate producer equal $\pi = (1-\alpha)/A$ and employment in the intermediate-goods sector is α/w. Furthermore, the interest rate equals ρ. Let $v(t) \equiv \int_t^\infty e^{-\rho(\tau-t)}\pi(\tau)d\tau$ denote the present value of monopoly profits π and $V \equiv (Av)^{-1}$. Then

2 This rules out the possibility that individuals "save" by conducting R&D on their own. In this case no capital market would exist and no informational problems could arise. An analogous assumption is familiar from search theory, where individuals produce a homogeneous good but must nevertheless barter before consumption can take place (see, for example, Diamond (1982)).

3 Instead of costly imitation, we could assume infinitely-lived patents. Then, additionally, we would have to assume that lenders are unable to observe whether borrowers receive a patent or not. This assumption sounds more stringent. It is adopted, however, by Galetovic (1996, p. 553).

4 The two-outcomes assumption is dispensible. Our results continue to hold if, by contrast, firm i's R&D success is described by $\dot{A}_i = \tilde{\beta}AL_{Ai/a}$, where L_{Ai} is firm i's labour input in R&D and $\tilde{\beta}$ is a non-negative random variable with expectation β distributed identically and independently across firms and across time. (In the main text we treat the special case $\tilde{\beta} = 1$ with probability β and $\tilde{\beta} = 0$ otherwise.) See footnote 6 below.

5 The Grossman-Helpman (1991) model is obtained by setting $f = 0$ and $\beta = 1$. For a detailed exposition of the Grossman-Helpman model, see Arnold (1997a, ch.8).

absence of arbitrage opportunities requires $\dot{v} + \pi = \rho v$ or $g_V = (1-\alpha) V - \rho - g_A$ (g_y denotes the growth rate $\dot{y}/y$ of any variable y).

Banks incur monitoring costs $wf(A)L_A$ in order to channel funds wL_A to innovators. Because of free entry into banking, the sum of these two terms is equal to the present value of firms' repayments to banks. Because of free entry into R&D, banks acquire claims to firms' entire profit stream, whose value is v. Hence, $w[1+f(A)]L_A \geq v\dot{A}$ or, using the R&D technology, $1/w \leq [1+f(A)]aV/\beta$, with equality if $L_A > 0$.[6] Inserting this into the labour-market-clearing condition, $L = [1+f(A)]L_A + \alpha/w$, solving for L_A, and using the R&D technology gives:

$$g_A = \begin{cases} \beta\frac{L/a}{1+f(A)} - \alpha V = \alpha[\psi(A) - V]; & \text{for } V < \psi(A) \\ 0; & \text{for } V \geq \psi(A) \end{cases},$$

where $\psi(A) \equiv (\beta/\alpha)(L/a)/[1+f(A)]$. Substituting for g_A in the no-arbitrage equation yields

$$g_V = \begin{cases} V - \rho - \beta\frac{L/a}{1+f(A)} = V - \chi(A); & \text{for } V < \psi(A) \\ (1-\alpha)V - \rho; & \text{for } V \geq \psi(A) \end{cases},$$

where $\chi(A) \equiv \rho + \beta(L/a)/[1+f(A)] = \rho + \alpha\psi(A)$. These two equations determine the dynamics of the model.

Assumption 1: $\lim_{A\to\infty} f(A) \equiv f_\infty \geq 0$.

Assumption 2: $g \equiv (1-\alpha)\beta(L/a)/(1+f_\infty) - \alpha\rho > 0$.

Assumption 1 implies that employment in monitoring is proportional to employment in R&D in a growth equilibrium. Assumption 2 is the usual requirement that labour supply is sufficiently large to make R&D profitable. Together, the two assumptions ensure the existence of a steady-state equilibrium with positive growth. For the time being, assume that monitoring costs are decreasing:

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[6] In the more general model with more than two different outcomes, free entry into R&D and limited liability imply that the repayment by an innovator who has borrowed wL_{Ai} equals $v\beta_i AL_{Ai}/a$, where β_i is i's realization of $\tilde{\beta}$, for demand for labour would be unbounded if there were positive profits in some state of nature. (This is in contrast to standard costly-state-verification models such as Diamond (1984), Gale and Hellwig (1985), and Williamson (1987), which instead of free entry assume that investors are monopolists for their projects. We do not have to cope with the interesting issues of optimal debt contracts and credit rationing, which arise in these models.) Free entry into banking requires that the expected repayment $v\beta AL_{Ai}/a$ equals R&D outlays plus monitoring costs, $[1+f(A)]wL_{Ai}$. Together, free entry into R&D and into banking thus yield the same free-entry condition as derived in the main text. Since $\dot{A} = \beta AL_A/a$ follows from the law of large numbers, the above analysis goes through without any qualifications.

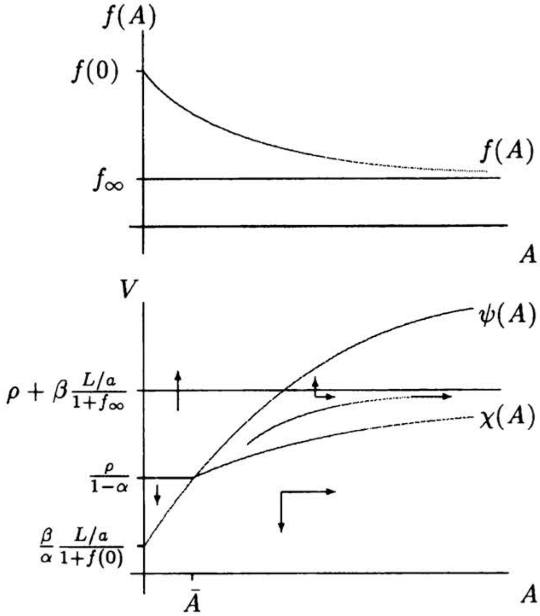

Figure 1: A poverty trap

Assumption 3a: $f'(A) < 0$ *for all* $A \geq 0$.

This assumption states that monitoring costs are relatively high in the early stages of development of the economy (i.e. for low values of A) and drop subsequently (see the upper part of Figure 1). The literal interpretation is that only as banks gain expertise in monitoring innovators, monitoring costs decline. Alternative explanations for the negative relation between monitoring costs and technological knowledge, not captured by the simple model presented here, are increasing returns to scale in banking and decreases in risk in a larger economy.[7] It would also be conceivable that monitoring becomes more difficult in a highly specialized economy, which would imply $f'(A) > 0$ for large values A. This assumption will be made in the next section; for now we assume monotonicity in order to keep the analysis as simple as possible. The next assumption will turn out to be crucial for the existence of a poverty trap. It specifies the precise sense in which monitoring costs have to be high in the early stages of development (i.e. for low values of A) in order for a poverty trap to occur:

[7] In ongoing work, Arnold and Walz (1998) distinguish explicitly between banks' expertise and general technological knowledge in order to compare bank-based and market-based financial systems.

Assumption 4: $(1-\alpha)\beta(L/a)/[1+f(0)] < \alpha\rho$.

The dynamics of the model is depicted in the lower part of Figure 1. $g_A > 0$ below $\psi(A)$, which is increasing due to Assumption 3a. $g_A = 0$ on and above $\psi(A)$. Consider first the no-growth region above $\psi(A)$. Here, the $g_V = 0$-locus is given by the horizontal line $V = \rho/(1-\alpha)$, which is located above $\psi(A)$ for A small due to Assumption 4. Next, consider the positive-growth region below $\psi(A)$. Here, $g_V = 0$ for $V = \chi(A)$. $\chi(A)$ is increasing and approaches the horizontal line $V = \rho + \beta(L/a)/(1+f_\infty)$ as $A \to \infty$. Let $\bar{A}$ denote the intersection of $\psi(A)$ and $\chi(A)$: $\psi(\bar{A}) = \chi(\bar{A}) = \rho + \alpha\psi(\bar{A})$ or $\psi(\bar{A}) = \rho/(1-\alpha)$. As already mentioned, $\psi(0) < \rho/(1-\alpha)$. Furthermore, from Assumption 2, $\lim_{A\to\infty}\psi(A) > \rho/(1-\alpha)$. Together with monotonicity of $\psi(A)$, it follows that $\bar{A}$ is uniquely determined. $\psi(\bar{A}) = \chi(\bar{A}) = \rho/(1-\alpha)$ implies continuity of the $g_V = 0$-locus. In the $g_A > 0$-region, $g_V > 0$ (< 0) above (below) $\chi(A)$. Letting A_0 denote the historically given initial number of intermediates, we have:

Proposition 1: For $A_0 > \bar{A}$, the unique perfect-foresight equilibrium is characterized by the trajectory approaching $\chi(A)$. g_A converges to g as defined in Assumption 2.

Divergent paths can be ruled out as equilibrium candidates with the arguments put forward in Grossman and Helpman (1991, p. 61): first, suppose $V(0)$ is such that the economy starts above the trajectory converging to $\chi(A)$. Then at some date $t < \infty$ it enters the $g_A = 0$-region, and we have $V \to \infty$, while A is constant. Constancy of A implies $\pi(\tau) = (1-\alpha)/A(t)$ for all $\tau \geq t$. It follows that $v(t) = (1-\alpha)/[\rho A(t)]$, i.e. $V(t) = \rho/(1-\alpha)$. This contradicts $V \to \infty$. Second, consider paths below the steady-growth path. Here, $A \to \infty$, while $V \to 0$. $g_A > 0$ implies $\pi(\tau) < \pi(t)$ for all $\tau > t$. Consequently, $v(t) < (1-\alpha)/[\rho A(t)]$ or $V(t) > \rho/(1-\alpha)$, contradicting $V \to 0$.

Thus, the only trajectory consistent with rational expectations is the one converging to $\chi(A)$. It follows that, $\lim_{t\to\infty} V(t) = \lim_{A\to\infty}\chi(A) = \rho + \beta(L/a)/(1+f_\infty)$. Inserting this expression into the expression for g_A proves that g_A converges to g. The more effectively monitoring is performed (the smaller f_∞), the larger the long-run growth rate.[8] More interestingly:

Proposition 2: For $A_0 \leq \bar{A}$, the unique perfect-foresight equilibrium entails $V = \rho/(1-\alpha)$ and $g_A = 0$.

Again, this can be seen from Figure 1: if $V(0) \neq \rho/(1-\alpha)$, then either $V \to \infty$ with A constant or $V \to 0$ with $g_A > 0$. As shown above, both config-

[8] Sala-i-Martin (1997, p. 182) points out that empirically there is no significant relation between growth and financial sophistication. Following Arnold (1998), this can be rationalized in an extension of the present model including endogenous human capital (see Arnold (1997b)). Poverty traps, however, cannot be analyzed in this latter model.

urations are inconsistent with rational expectations. Thus, the only rational-expectations equilibrium involves $V(t) = \rho/(1-\alpha)$ and $A(t) = A_0$ for all $t \geq 0$.

Proposition 2 is our first central result: given that monitoring costs are high for small A (in the sense of Assumption 4), if A_0 is sufficiently small ($A_0 \leq \bar{A}$), then the economy is in a poverty trap: even though a steady state with positive growth exists, growth does not get underway.[9]

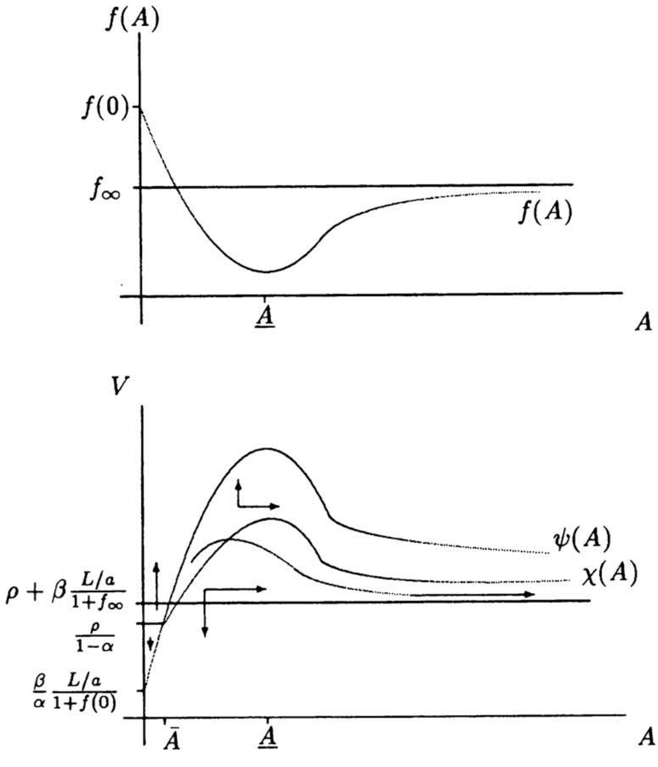

Figure 2: A poverty trap and financial development

[9] A poverty trap can arise in the Grossman-Helpman model without monitoring costs if the accumulation of technological knowledge is characterized by increasing marginal returns to knowledge (i.e. if the marginal returns are small when the knowledge base is small; see Grossman and Helpman (1991, pp. 77 - 78)). A referee has pointed out the formal similarity of this model and ours. The economic mechanisms at work are quite different, however.

4. Financial Development

We define the size of the financial sector as the amount of credit outstanding. Since banks acquire claims to firms' entire profit streams, credit outstanding is equal to the aggregate firm value, $Av \equiv V^{-1}$. Note that, by our choice of numéraire, GNP (as measured by the value of final-goods production) equals unity. Therefore, V^{-1} is also the size of the financial sector relative to GNP. In this section, we narrowly define *financial development* as an increase in the size of the financial sector relative to GNP, i.e. as an increase in V^{-1}, during the transition to steady-state growth.[10] With these definitions, the steady state described in Proposition 1 has a disturbing property: as is evident from Figure 1, V^{-1} *declines* monotonically on the equilibrium trajectory, thus indicating a steady contraction of the financial sector relative to GNP – financial development is not conceivable along the equilibrium path. In this section, it is shown that financial development may occur under different assumptions about the monitoring technology.[11] Replace Assumption 3a with:

Assumption 3b: For some $\underline{A} > 0, f'(A) < (=, >)\ 0$ *for* $A < (=, >)\ \underline{A}$.

According to Assumption 3b, monitoring costs are U-shaped, as illustrated in the upper panel of Figure 2. I.e. monitoring costs are relatively high both in the early stages of development (A small), when banks have not yet gained significant expertise in monitoring innovators, and for highly advanced economies with strongly diversified investment opportunities (A large). The dynamics of the model is illustrated in the lower part of Figure 2. As in Figure 1, there is a no-growth region on and above $\psi(A)$. $\psi(A)$ has a maximum at $\underline{A}$, where $f(A)$ has its minimum. In the no-growth region, the $g_V = 0$-locus is given by $V = \rho/(1-\alpha)$, which is located above $\psi(A)$ for A small due to Assumption 4. In the $g_A > 0$-region, $g_V = 0$ for $V = \chi(A) = \rho + \alpha\psi(A)$, which, like $\psi(A)$, has a maximum at $\underline{A}$. There continues to exist a unique intersection $\bar{A}$ of $\psi(A)$ and $\chi(A)$. This can be seen as follows. $\bar{A}$ is determined by $\psi(\bar{A}) = \chi(\bar{A}) = \rho + \alpha\psi(\bar{A})$, i.e. $\psi(\bar{A}) = \rho/(1-\alpha)$. As mentioned above, $\psi(A) < \rho/(1-\alpha)$ for A small. Moreover, as in Section 3, $\psi(A) > \rho/(1-\alpha)$ for A large by virtue of Assumption 2. Finally, from Assumption 3b, the slope of $\psi(A)$ changes its sign only once, at $\underline{A}$. Consequently, $\psi(A)$ cannot fall below $\rho/(1-\alpha)$ once it is above it. This proves that

[10] This is only one possible definition. Goldsmith (1969, p. 37), for instance, defines financial development as "change in financial structure". However, the notion employed here is close to the King-Levine (1993) definition mentioned in the introduction.

[11] This illustrates that, as pointed out by Gurley and Shaw (1955, p. 517), "[A]ccumulation of debt is part of the growth process, but the rate of accumulation is not related by a simple constant to the rise in wealth and income".

$\bar{A}$ is uniquely determined (see Figure 2). As in Section 3, $\psi(\bar{A}) = \chi(\bar{A}) = \rho/(1-\alpha)$ implies continuity of the $g_V = 0$-locus. As $A \to \infty$, the $g_V = 0$-locus becomes horizontal because of Assumption 1. The trajectory converging to $\chi(A)$ is characterized by the long-run growth rate $g_A = g$, which is positive due to Assumption 2.

Suppose $A_0 > \bar{A}$. Then the only trajectory consistent with rational expectations is the path converging to $\chi(A)$, since all other paths diverge with either $V \to \infty$ and A constant or $V \to 0$ and $g_A > 0$. Moreover, the convergent path is falling, at least when A has become sufficiently large. Hence V^{-1} rises during the transition to the steady state, at least during the final stages of the transition:

Proposition 3: If $A_0 > \bar{A}$, then there is a unique steady-growth equilibrium with growth rate $g_A = g$ as defined in Assumption 2. The transition to the steady state is characterized by financial development.

Now suppose $A_0 \leq \bar{A}$. If $V \neq \rho/(1-\alpha)$, rational expectations are violated since the economy displays the above-mentioned pattern of divergence. But if $V = \rho/(1-\alpha)$, then growth will not get underway:

Proposition 4: For $A_0 \leq \bar{A}$, the unique perfect-foresight equilibrium entails $V = \rho/(1-\alpha)$ and $g_A = 0$.

Thus, a poverty trap continues to exist: there is a steady-growth solution with financial development paralleling consumption growth, but if inherited knowledge is scarce and monitoring costs are high with scarce knowledge, then this growth path cannot be reached, and the economy rests in stagnation.

5. Conclusion

This paper has demonstrated the possible existence of a poverty trap within a truely dynamic framework. At the same time, financial development prevails as a property of the transitional dynamics of the model.

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Zusammenfassung

Diese Arbeit entwickelt ein einfaches Wachstumsmodell, in dem die Existenz einer Armutsfalle sowie die Entwicklung des Finanzsektors im Rahmen einer vollständigen dynamischen Analyse untersucht werden.

Abstract

A stylized model of finance and growth is developed in which the occurrence of poverty traps and financial development is explicitly derived from a consideration of transitional dynamics.

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