IMF WORKING PAPER

WP/96/18

INTERNATIONAL MONETARY FUND

Research Department

The Role of Credit Markets in a Transition Economy with Incomplete Public Information

Prepared by Kenneth Kletzer and Jorge Roldos 1/

Authorized for distribution by Donald J. Mathieson

February 1996

Abstract

In this paper we explore some of the informational problems that constrain the development of credit markets in transition economies. We characterize investment patterns under uncertainty and high costs of entry, when agents learn about the ultimate value of enterprises through production in a Bayesian way. Inefficiencies due to the lack of public information reduce the average return to capital. Under asymmetric information, credit would go to activities that can provide enough co-finance. Credit markets may fail to develop for a while if there is not enough individual wealth to complement credit. Once they operate, credit markets may magnify distortions in equity markets, such as those due to spontaneous privatization. An argument for the sequencing of capital market liberalization is provided.

JEL Classification Numbers:

G10, G21

1/ This project started when Kenneth Kletzer was a Visiting Scholar at the Research Department of the IMF. We would like to thank Donald J. Mathieson for interesting comments and discussions on this topic.

Contents

Summary

A large literature describes constraints to the development of an efficient financial system in transition economies, as well as the sequencing of reforms. Rather than reviewing these constraints and reforms, this paper focuses on how underlying informational problems affect the efficient allocation of capital and credit.

No one knows what enterprises or industries may be viable in the new market environment or what their returns will be. The model in this paper assumes that investment and production are necessary for learning about returns to an enterprise and that re-entry costs for a terminated enterprise are large. Characterizing investment with Bayesian learning and sunk costs of entry and exit suggests two sources of inefficiency. First, activities with negative value are kept alive until they prove to be losers, owing to an option value to shutting them down in the future. Second, some viable activities will be shut down because of poor returns in an early trial period. These inefficiencies are due to incomplete public information, and this type of uncertainty--rather than asymmetric information--distinguishes growth in transition economies from that in market-oriented economies.

Credit market imperfections owing to asymmetric information between borrowers and lenders lead to required co-financing from equity holders. In this environment, credit will be allocated across equally promising activities on the basis of the comparative ability of firms to contribute their own resources. In a well-functioning equity market, resources for co-financing to induce lending will be allocated across firms and industries on the basis of their prior profitability. However, if equity capital is not allocated by a competitive market, the introduction of a credit market can reduce expected welfare.

Indeed, in transition economies resources available to firms are sometimes allocated by nonmarket means, especially in manufacturing industries. Spontaneous privatizations, access to machinery leases and intermediate inputs at negligible prices, and personal connections all imply that the resources needed for complementary self-financing may be inefficiently allocated. These distortions in equity markets, together with the above mentioned inefficiencies owing to public uncertainty, are magnified by a credit market operating under asymmetric information. This result has implications for the sequencing of capital market liberalization. In particular, one might see here an argument for waiting to promote credit market growth until privatization has progressed further and distortions in equity markets have been removed. The result also implies a positive theory of credit-market deepening based on the production and accumulation of information about firms' net returns.

I. Introduction

The development of a private credit market is regarded to be crucial to the transformation of the previously socialist economies to market economies. The effects of policies to enhance the growth and deepening of private capital markets during transition are not well-understood. Whether or not immediate liberalization of credit markets is likely to promote efficiency in the allocation of investment resources across industries or firms is not clear. One alternative to immediate liberalization is to direct the flow of credit to firms and industries while the legal institutions of a market economy and initial reallocation of factors of production takes place. The answer should depend on the optimal sequence of liberalization of capital markets and establishment of mechanisms for enforcing private contracts and regulating transactions.

There exists a large literature that describes the constraints to achieve an efficient financial system in the previously centrally planned economies and also some specific proposals on policy measures and the sequencing of reforms (see for example McKinnon (1991 a,b), Calvo et al. (1993), Blommestein and Spencer (1993), Rostowsky (1994), Mathieson and Haas (1994)). Rather than reviewing those constraints and proposals, in this paper we focus on some of the fundamental informational problems that underlie those constraints and explore how they might affect the efficiency of the allocation of capital and credit.

Our initial premise is that transition of previously centrally planned economies to market economies differs in some important respects from development and industrialization in less-developed mixed economies. One of the characteristics that may be special to transition is that no one knows what enterprises or industries may be viable in the new market environment. Our argument is that policymakers, investors and savers cannot simply look elsewhere to decide which industries should develop and which should perish. Furthermore, in an environment in which every new entrepreneur is learning how to function, information about who is able and who is unable to survive as an entrepreneur is likely to be made revealed to everyone as investments and production are undertaken and successes or failures occur. That is, <u>public</u> ignorance rather than <u>asymmetric</u> information may be very important in a transition economy, and is the relative importance of this type of uncertainty that distinguishes transition economy development from growth in developing primarily market-oriented economies.

This idea draws to a degree from the arguments made by Frydman and Rapaczynski (1991), among others, that the appropriate pattern of industrialization in the ex-Soviet sphere economies probably depends on history. They argue that a successful transition to a market economy must take account of the initial conditions inherited from the old regime, so that institutions as well as industries, cannot be adopted complete from the industrialized market economies.

In this paper, we model the importance of incomplete public information about the viability of enterprises by assuming that the net returns of an enterprise are unknown to everyone, including the managers or owners of a firm (enterprise throughout should be interpreted as either industry or firm). We also assume that investment and production are necessary for learning about those returns to occur, and that failure to invest leads to a loss of the option to continue the activity. That is, we model learning about the ultimate value of enterprises through production in a Bayesian manner and assume that the costs of re-entry for a terminated enterprise are prohibitive. We characterize the optimal pattern of investment to show the kind of inefficiencies that derive from a highly uncertain environment.

The next step introduces a credit market characterized by imperfections that are recognized to be important for market economies. The managers/ owners of an enterprise have an informational advantage over its creditors. Asymmetric information in the models we adapt from the theory of credit market imperfections leads to a role for complementary self-financing of indivisible investments. Lenders desire co-insurance by the equity holders of firms to mitigate against the agency problems that arise with hidden information.

Our arguments suggest that a deregulated credit market in this environment will allocate credit across a priori equally promising activities on the basis of the comparative ability of firms to contribute their own resources toward investment. With an existing market for equity finance (for example, by venture capitalists or a stock market), the resources needed for co-financing purposes to induce lending will be allocated across firms and industries on the basis of their prior profitability. In that case, credit markets are no more inefficient, given the information constraints, than anywhere else. However, if equity capital is not allocated by a competitive market, then the introduction of a credit market can reduce expected welfare. The distortions in equity markets are magnified by a credit market operating under asymmetric information.

In the post-socialist economies, it has been observed that the resources available to firms are allocated by non-market means, especially in manufacturing industries. Spontaneous privatizations, access to machinery leases from the state enterprises that firms spawn from and the importance of personal connections all imply that the resources needed for complementary self-financing are not efficiently allocated using a priori public or private information.

The implications of our model about the relationship between firm resources and loan flows to it can be extended to a heterogenous economy. The co-insurance aspect of lending implies that industries that require small initial investments to develop or have short gestation lags with high rates of return will tend to grow disproportionately fast during transition. That is, we expect the investment in the service or trade sectors will be relatively rapid, as has been observed. The addition of the model is that investment in such industries is likely to keep expanding ahead of the rest

as they accumulate the resources to complement lending and further expansion. There will be sustained bias towards those sectors until the owners of the income earned in them can invest it in equity shares in other industries.

The models we discuss have implications for the sequencing of capital market liberalization and development of other market institutions. In particular, one might provisionally see an argument here for waiting to promote credit market growth until privatization has progressed further in favor of directed credit policies. It also implies a positive theory of credit market deepening based on information production and accumulation. Initially, a private credit market may not even function if the levels of individual wealth needed for co-financing are too low. As self-financed or equity financed investment occurs and information about the viability of certain firms and industries is revealed to the economy as a whole, credit transactions begin and deepening takes place with the accumulation of information about who does well in the new institutional environment.

This provisional theory of endogenous capital market deepening through the accumulation of information contrasts with the recent theoretical literature on credit market deepening and endogenous growth. The models in that literature stress the existence of non-convexities in the intermediation process (see, for instance, Greenwood and Jovanovic (1990)) and the role of intermediaries in risk diversification and asset transformation. In the type of model we discuss, sunk entry and exit costs to productive investment--rather than intermediation--are relevant and it is the accumulation of information--rather than that of physical capital --that leads to an increase in the efficiency of investment. Putting this mechanism into an endogenous growth model should also yield the positive feedbacks between physical investment and the growth of intermediation with consequent increases in the efficiency of resource allocation.

The plan of our paper is as follows. In the next section we summarize the main features of transition economies and confront them with the insights from the literature on financial intermediation and growth. In section III, we discuss models of investment under uncertainty and sunk costs when there is learning over time about the ultimate value of different activities. Imperfections in credit markets are introduced in sections IV and V, to conclude with some policy implications and issues for further research.

II. Transition Economies, Financial Intermediation and Growth

The obstacles faced by economies on transition from central planning to a market regime are numerous. However, many of these constraints are quite different from the ones experienced by a developing economy growing under an already established set of market-based rules. Consequently, we argue in this section that, although relevant at some stage, the implications of the literature on financial intermediation and growth are not particularly useful for the issues related to transition economies.

1. Some features of transition economies

The major constraints faced by economies in transition are macroeconomic instability, a highly uncertain legal and regulatory environment and the difficulties associated with an effective privatization process. The first two constraints are best summarized by the following paragraph from a survey on private manufacturing in St. Petersburg (Webster and Charap, 1993):

> "Entrepreneurs faced a particularly uncertain and risky environment, characterized by a high rate of inflation, continually changing relative prices, and unpredictable interest rates and exchange rates --all of which obscured the economic signals necessary for properly functioning markets. The legal and regulatory framework was chaotic, constantly shifting and poorly administered; and corruption, lawlessness and isolation were pervasive. The inadequacy of the banking system was a constant source of problems."

The importance of the privatization issue and the main difficulties associated with it have been widely discussed (see for instance, Frydman and Rapaczynski, (1991) and (1993), Borensztein and Kumar (1991), Schleifer and Vishny, (1992)). The first authors stress the importance of establishing an adequate structure of corporate control that replaces the former bureaucratic control, and the inherent difficulties in designing that institutional framework. They also underscore the importance of the initial conditions:

> "Unfortunately, spontaneous development of the institutional arrangements is not a solution. The East European economies are not virgin territory, where capitalism could develop over a long period of time, starting with small owner-controlled enterprises that could gradually expand into larger and more complicated units." (Frydman and Rapaczynski, 1991, p.12).

Finally, the efficiency costs and risks involved in the spontaneous privatizations that have occurred--to different degrees--in Eastern Europe and the FSU are of special relevance. 1/ In particular, since under this kind of privatization the assets are not obtained through a competitive bid, it is likely that the managers who end up controlling them are not going to be the most competent ones. Furthermore, as the ownership stake that workers get in these transactions is typically large, efficient layoffs and wage control needed for the restructuring of enterprises might be precluded.

1/ Shleifer and Vishny (1992) describe how the process of spontaneous privatization evolved from the reselling at market prices of goods bought at controlled prices, to the transfer of assets through leasing and sale at negligible prices, and more recently to worker-manager buyouts at book values. Although spontaneous privatizations have been pervasive in Russia, they have occurred at some degree in other PCPEs.

2. Financial intermediation and growth

The role of financial intermediaries is associated with the reduction of transaction costs, the diversification of risks and the production of information (see surveys by Gertler(1988), Bhattacharya and Thakor(1994)). Financial intermediaries perform the third function by operating a technology for evaluating and monitoring loans, allowing them to improve the transformation of savings into investment.

Important developments from the literature on financial intermediation recently have been incorporated into endogenous growth theories to model the relationship between financial deepening and growth. Greenwood and Jovanovic (1990) study a model in which financial intermediaries produce information by sampling risky projects to distinguish an aggregate productivity shock from idiosyncratic credit risk. Because financial intermediation incurs fixed costs, growth in the rest of the economy leads to larger participation in the intermediated credit market, and to higher aggregate returns and productivity growth. In their model, physical capital accumulation drives the growth process. As income growth is enhanced by intermediation through its promotion of efficiency in the allocation of capital, higher wealth leads to an increase in the growth of intermediaries which in turn leads to ever higher income growth. Although in their model information is produced in each period, there is no role for the accumulation of information that would follow from a learning process over time.

Another framework in which financial intermediaries provide savers with a distribution of returns that has both a higher mean return and lower risk is based on the idea that agents do not have access to markets for the insurance against liquidity risk. Bencivenga and Smith (1991) show that banks can increase the productivity of investment both by directing savings to illiquid, high-return projects, and by reducing the resource waste implicit in the early liquidation of that kind of projects. Their model is based on that of Diamond and Dybvig (1983) in which intermediaries invest in illiquid projects pooling the savings of households with idiosyncratic liquidity demands.

Other models directly assume that monitoring and/or transactions costs are reduced over time and they show how this increases growth. In Boyd and Smith (1992), improvements in the technology for acquiring information lead to reductions in the degree of credit rationing and in interest differentials, promoting a more efficient allocation of investment. Bencivenga, Smith and Starr (1992) prove that exogenous improvements in the transactions technology also could lead to an increase in the level of investment and a shift towards more illiquid investments.

The formal models of capital deepening and endogenous growth analyze interesting and important channels through which financial intermediation reinforces and is reinforced by growth. Although increasing returns and risk diversification are important aspects of intermediation, the absence of

well-established regulatory and ownership structures in transition economies calls for the analysis of other aspects. In particular, the theoretical literature on intermediation and growth does not model the role of the accumulation of information on the risk-return characteristics of firms and/or sectors for the growth of both the financial sector and the rest of the economy. The absence of information about the economic viability of different productive activities and the role of intermediation to reveal it are likely to be critical for the development of financial markets in transition economies: these economies entirely lack track-records on the performance of different firms and/or on the relative profitability of different sectors under the new and evolving institutional framework.

Our analysis on the accumulation of information capital shares some features with the model studied by Atkeson and Kehoe (1993). They use the industry evolution framework of Jovanovic (1982) to obtain a quantitative estimate of the slump generated by the radical transformation of a formerly centrally planned economy. In that framework, information is accumulated about the quality of matches between individuals and different technologies, but not on the inherent qualities of either the manager or the technology. Furthermore, they do not study the interaction of investment decisions under uncertainty with the functioning of financial intermediaries. It is from that interaction that we get our main results. In particular, we find that the usual problems of asymmetric information found in developed credit markets may magnify the distortions described in the previous section and they may even prevent the emergence and development of those markets in transition economies.

III. Information Accumulation and Investment with Sunk Costs

In this section, we discuss optimal investment decisions in a simple model in which information about the ultimate value of investments in particular sectors of the economy is revealed only as production takes place over time. This model attempts to represent the production side of an economy where all agents have very limited information about the impact of economic reforms on the viability of individual industries. It is well-known that in the transformation of a previously centrally-planned economy, relative prices are likely to fluctuate widely and undergo rapid changes and that it is very hard to pick winners in such a highly uncertain environment with a particular composition of existing stocks of human and physical capital that is not replicated in current market economies.

The model we discuss is a highly stylized model of production under uncertainty with prohibitive sunk costs of entry. In such an environment, the value of an enterprise includes an option value to shutting it down in the future. Even though all agents are risk-neutral, when the expected present value of all future net revenues is negative it may not be optimal to shut down an enterprise that can only be restarted by incurring a sunk cost. The literature proves this in a large number of models, so that we

assume away many aspects of investment to emphasize only the effect of improving public information with production over time. 1/

We assume that the prior distribution over the net revenues of each firm is the same for all firms and for all agents. This captures the idea that no one knows which production activities are superior to others. 2/ If no investment occurs in some period, we assume that the firm is forced to shut down and that the sunk costs of re-entry are infinite. This could be the case in a richer model in which firms are updating their capital stock or innovating in technique, so that shutting down a firm or industry for a while causes it to get ever further behind.

We begin with a simple representation of how learning about the ultimate viability of existing industries or enterprises may affect investment by assuming that the variance of the prior on mean returns is reduced exogenously. We then move on to discuss how that variance would be endogenously reduced as agents learn in a bayesian way from their production and investment decisions over time.

1. Exogenous reduction in uncertainty

Consider a model where output in period t is produced using inputs invested in period t-1, and the value of net output in period t is random. We assume that input requirements each period are fixed and constant--normalized to one for simplicity. 3/ The mean of the distribution of the flow of net revenues is a characteristic of the enterprise and is not known to any agent. Net revenues are independently and identically distributed at every time. For example, suppose that the distribution of net revenues is normal with unknown mean but that the variance is known and everyone has a common prior normal distribution over the mean. 4/ Past realizations of net revenues are used to estimate the true mean in a Bayesian way. As the mean of net revenues--given the posterior distribution of observers--converges towards its true value, it is assumed that the variance of its posterior estimate shrinks towards zero.

1/ Dixit and Pindyck (1994) thoroughly cover the recent analytical work on investment under uncertainty with entry and exit costs.

2/ Modifying the environment to allow for the point that some enterprises are known to be poor prospects by assuming a non-uniform prior is straightforward.

3/ In this set-up, the role for credit markets is to provide working capital, that is, to allow firms to pay for inputs used after the outputs produced from them are realized.

4/ The assumption of a known variance is convenient at this stage as we are assuming no asymmetric information. Later on it will be assumed that managers/owners can control the variance (or the riskiness) of the project with their own actions.

The expected net flow of returns to current investment at time t is given by $R(x_t)$, where x_t is a summary statistic of the past observations of realized returns to investment. In this case, x is the mean of the prior distribution of net revenues at time t given past realizations of x. To approximate common learning about the true expectation of net returns to production, let time be continuous, and let the infinitesimal random increment in x be given by the Brownian motion, $dx = v(t)\, dz$, where z is a zero mean and unit variance Weiner process. That is, assume that the rate of change in x has zero mean and its variance is a monotonically decreasing function of time. 1/

Assume that the opportunity cost of investment is the given world rate of interest facing a small open economy for simplicity's sake. The objective function for an investor in the absence of capital market distortions is given by the expected present value of net revenue flows under the initial prior distribution over the true mean. This is just

$$V_o = E\left\{\int_o^\infty R(x_t)\, e^{-rt}\, dt \,|F_o(x)\right\} \tag{1}$$

where $F_o(x)$ is the c.d.f. for the prior distribution at time 0. The optimal program maximizes the larger of (1) and zero subject to the constraint that shutting down and achieving a discounted return of zero is always possible. At every time, the agent chooses whether or not to invest and can always achieve a value of zero so that the optimized value of her program, V(x), at every time must be non-negative. Since x is not independent over time, it may not be optimal to stop investing when the present value of expected net revenues is zero because waiting a bit longer allows more information about future returns to be revealed. The investor can always close down the activity later, realizing zero value at that time.

Finding the optimal policy is a variant of the problem of optimally choosing when to abandon an activity with prohibitive re-entry costs with a state variable following a continuous time Brownian motion with constant mean and variance. 2/ There will be an optimal stopping rule determined by the smooth pasting condition. The value function in that case exceeds the discounted sum of expected net revenues given the current value of x by the value of the option of waiting to shut down, which is an increasing

---

1/ Note that this is not the formulation that we get for the Bayesian learning versions of the next section, where the variance is a function of the realizations of net returns.

2/ Our introduction of exogenously diminishing variance over time does not change the qualitative results for the problem with constant variance derived in the recent theoretical work on investment under uncertainty (Dixit and Pindyck, 1994).

function of the variance, v(t). 1/ Reducing v(t) lowers the option value, so that the value of the constant variance problem approaches the maximum of the current expected net revenue discounted over the infinite horizon and zero.

Three possibilities arise with respect to the value of different activities and investment/production choices. The first is that the initial value of the optimal program is negative for the given prior. In this case, expected net revenues for the enterprise are negative and their present value is larger in absolute value than the value of the option of shutting it down later. Therefore, for the given prior distribution, it is efficient to abandon the particular investment. The second is that the initial value of the activity is positive (whether expected net revenues are negative or not) and the true mean is negative. In this case, the enterprise will be shut down in finite time with probability one. The value of the optimal program becomes negative with probability one as the sample mean approaches the true mean and the option value goes to zero as the variance diminishes. In the third case, the true mean of net returns is positive. For given priors, it is possible that the enterprise will be shut down in the optimal solution to the programming problem. Since the mean is not known, poor initial realizations will reduce the value of continuing. As the expected net revenues decrease with a decline in x as t progresses and the option value falls as the variance diminishes with t, stopping will eventually become optimal.

There are two sources of inefficiency due to public uncertainty about the true present value of the enterprise. The first is that investment activities with negative true opportunity cost are kept alive until they eventually prove to be losers. The second is that some truly viable activities will never be uncovered before they show positive social value because of poor realizations of returns in an early trial period. These are both welfare losses due to uncertainty and not to market imperfections.

2. Endogenous learning

We next turn our attention to some simple learning models that will eventually cull out activities with negative value as the variance of the estimated mean returns is endogenously reduced. These learning processes do not strictly fit the framework above, since the variance of the estimate of net returns to investment depends on the observations made by agents, not just on time. However, the qualitative implications for investment remain the same.

1/ This set-up could be extended to a model of capital accumulation and firm growth. If sunk costs of investment were also added, then the option to wait to invest would come into play in addition to the option to wait to abandon the activity altogether.

The distribution of net revenue in a given industry is unknown, but a common prior distribution on its mean is held by every agent. As production and investment take place over time, observations of outcomes lead investors to update their prior beliefs on expected revenues to form a posterior distribution which they employ as the next period's prior. Bayes' rule is used to update the beliefs and we show in what follows how this learning process endogenously reduces the variance of the mean estimates and with it the option value to shut down the firm.

We present two examples of learning processes which will serve as the underlying public learning coexisting respectively with each one of the cases of asymmetric information to be discussed in the following sections. For concreteness, we use standard results on conjugate distributions to calculate the posterior distribution of firm revenues. The first example, used in the moral hazard example of Section IV, assumes that net revenues are drawn from a normal distribution over the entire real line. In this case, we assume that the variance is known but the mean is not and the common prior distribution over mean net revenues is normal with mean a and variance b^2. The true mean for R is given by m and the known variance of R is v^2. The mean and variance of the posterior distribution after the sequence of realizations of revenues $(R_1, R_2, \ldots, R_T)$, are given by

$$a_T = \frac{v^2 a + T b^2 \bar{R}_T}{v^2 + T b^2} \tag{2}$$

and

$$b_T^2 = \frac{v^2 b^2}{v^2 + T b^2} \tag{3}$$

respectively (see, for instance, DeGroot, 1989).

The mean of the prior distribution used to make the optimal decision whether or not to continue investing each period converges to the true mean as the variance of the distribution over the unknown characteristic of the enterprise (given by (3)) approaches zero. If the enterprise is ultimately unprofitable in the new environment, then it will be shut down in the optimum as the variance and option value go to zero. If it is profitable, then this will eventually be learned, unless a sufficiently long string of initial poor outcomes is observed so that the activity is shut down inefficiently.

The second example, used in the model of project evaluation in Section V, assumes that two realizations of net revenues are possible, zero with true probability (1-p) and R with true probability p. The parameter p is unknown exante, and the common prior distribution over p is uniform on the interval [0, 1]. Using Bayes' rule, a standard result on conjugate distributions gives the posterior over p after T observations of net revenue as a beta distribution with the partial distribution function

$$f(p) = \frac{\Gamma(a+b)}{\Gamma(a)\Gamma(b)} p^{a-1}(1-p)^{b-1}, \quad \text{for } 0<p<1 \tag{4}$$

for $0<p<1$, where $a = 1 + z$, and $b = 1 + T - z$. The variable z represents the number of successes in the T observations; that is, the number of times net revenues were R. The mean of the posterior is given by

$$E_T(p) = \frac{1+z}{2+T} \tag{5}$$

and the variance is given by

$$Var_T(p) = \frac{(1+z)(1+T-z)}{(2+T)^2(3+T)} \tag{6}$$

As for the normal distribution, the variance is diminishing in the number of observations T, confirming the convergence of the mean of the prior distribution to the true mean return.

IV. Inefficient Information Production with an Imperfect Credit Market

In the social optimum for a collection of enterprises for which we have no a priori information about the viability of each in the new environment, inputs would be supplied to each firm at the outset if the expected value using the uniform prior distribution for the representative firm is non-negative. Unless firms finance their inputs out of retained earnings, this requires the existence of some form of credit arrangements. We now consider how credit markets might allocate resources across firms leading to departures from the social optimum in the case of asymmetric information between borrowers and lenders.

1. Credit markets under symmetric information

To support an efficient allocation in a competitive equilibrium, long-term contracts may be needed between suppliers and users of the input. This

is because part of the returns to production are due to learning. The value of the representative firm may be positive on the initial date even though the expected one-period net revenue is negative. This is because we learn which firms to shut down over time so that the expected net revenues of remaining firms rises. A competitive supplier would have to realize these future returns in exchange for supplying inputs early on unless the pool of enterprises existing at the start is of high enough quality so that uniformly expected net revenues are non-negative.

Introducing private lenders may not pose a problem for doing this with certain institutions, provided borrowers and lenders share the same information set (regardless of how small this is at the beginning of the transition). For example, a lender of the input on the first date may write a long-term agreement under which payments are made in later successful states if the next period's outcome is unsuccessful. Suppose that a lender writes a simple one-period contract under which the firm pays S if the investment is successful next period. The value S times the expected probability of success equals $(1+r)$, the opportunity cost to the lender. In this case, efficiency will fail if S exceeds the revenue realized in the successful state. An alternative contract offered at date 1 is one that specifies a payment to be made if the outcome is successful on date 1 and payments to be made in later successful periods if it is unsuccessful on date 1. In these events, new inputs are supplied with loans requiring lower payments in successful states since as successes occur, posterior expected net revenues rise. Such a process could be done with implicit contracting guided by a series of renegotiable standard debt contracts since bankruptcy is equivalent to shutting down a firm.

2. Credit markets under asymmetric information

It is well understood that, under asymmetric information, the social optimum will not be attainable with private lending. We are interested in how the existence of credit market imperfections would affect the process of public learning through production and industry survival sketched in the previous section. Before that, we make some simplifying assumptions in terms of the types of contracts and intermediaries that operate in the credit market.

There is a large literature on the form of optimal lending contracts in the presence of asymmetries of information. We do not need to repeat this analysis to make our point. We assume that conventional one-period debt contracts are used to set the terms of finance of working capital. These can be justified, following Townsend (1978), Diamond (1984) and Gale and Hellwig (1985), by assuming that the realized output of a borrower can only be observed by the lender at a positive cost. These contracts set the gross interest (principal plus net interest) which is paid if realized revenues exceed it. If revenue falls short of the gross interest owed, then all of the realized revenues are paid to the lender.

There is also a large literature that addresses the question of what gives rise to intermediation. As discussed in Section II.2, three roles are important: intermediaries operate technologies for evaluating firm projects and monitoring the actions of the firm, they diversify risks for savers across indivisible investments and they transform illiquid assets into liquid liabilities when savers have stochastic demands for liquidity. Increasing returns to scale play an essential role in the endogenous formation of intermediaries.

In the model we sketch below, we consider only a credit market, leaving out the additional machinery needed to endogenize the creation of intermediaries. We also do not explicitly assume costly verification of outcomes, but instead make this assumption implicitly by assuming that standard one-period debt contracts with limited liability for the borrower govern exchange between creditors and investors/producers. 1/

The model is an extension of the first learning model above that allows for private information about the distribution of returns to investment on top of common uncertainty about the pool of project return distributions from which investors choose. We let the investor control the riskiness of the project by choosing the variance of the distribution of returns. Potential lenders know the investor's objective function, but cannot observe the choice made. Therefore, lenders cannot contract on the choice of project (variance of the normal distribution), and the investor chooses across mean-preserving spreads of the distribution of net returns. As shown by Stiglitz and Weiss (1981), if the borrower can choose the distribution when choosing the project for investment unobserved by the lender, then the borrower has incentives to choose riskier projects that reduce the lender's expected returns.

Both lenders and the investors are assumed to be risk-neutral. The investor maximizes the present value of her net revenues minus the gross interest on her loan for outcomes in which net revenues exceed the gross interest obligation plus a concave function of the variance of net returns. This function represents the technology available to her to influence the riskiness of the project. The investor can take more care, putting in effort at a positive cost, to reduce the risk of her investment, but she faces increasing costs to variance reduction. At the other end, there are limits on her incentives to raise the riskiness of her investment under a one-shot debt contract with limited liability. The second assumption is included so that she has a determinate solution to the problem of finding her optimal level of risk when she borrows investment resources.

If the investor has her own resources available to invest and self-finances her inputs, then she maximizes

---

1/ We also leave aside enforcement problems, which seem to be quite pervasive in transition economies and may lead to the co-existence of "group" banks and "narrow" banks (see Dooley, Haas and Mathieson, 1995).

$$V_T^B(v^2) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} R\, f(R)\, dR\, dF_T \; - \; (1+r) \; - \; g(v^2) \tag{7}$$

with respect to v^2. 1/ This yields the first-order condition

$$\frac{dV_T^B}{dv^2} = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} R\, \frac{df(R)}{dv^2}\, dR\, dF_T \; - \; g'(v^2) \; = \; 0 \tag{8}$$

for an efficient choice of v^2.

On the other hand, if she borrows all of her input, then she maximizes

$$V_T^B(v^2; s) \; = \int_{-\infty}^{\infty}\int_{(1+s)}^{\infty} [\, R - (1+s)\,]\, f(R)\, dR\, dF_T \; - \; g(v^2) \tag{9}$$

with respect to v^2--where s is the gross rate of interest charged by the lender--giving the first-order condition

$$\frac{dV_T^B}{dv^2} \; = \int_{-\infty}^{\infty}\int_{(1+s)}^{\infty} [\, R - (1+s)\,]\, \frac{df(R)}{dv^2}\, dR\, dF_T \; - \; g'(v^2) = 0 \tag{10}$$

As the nature of the debt contract limits her share of the downside risks, she makes a riskier choice under (9) than under (7). If the opportunity cost of investment is high enough, then the lender will make a negative return for any choice of gross interest charged since raising the interest rate induces ever riskier investment choices and credit-rationing results with this borrower excluded from the market.

More generally, assume that the investor has access to own resources in at least the amount w and receives a loan of (1-w). The problem for the investor is to maximize

---

1/ Note that F_T corresponds to the c.d.f. for the prior distribution at time T, as introduced in (1) and with the mean and variance defined in (2) and (3).

$$V_T^B(v^2; s,w) = \int_{-\infty}^{\infty}\int_{(1+s)(1-w)}^{\infty} [R - (1+s)(1-w)]\, f(R)\, dR dF_T - (1+r)w - g(v^2) \quad (11)$$

with respect to v^2. This yields the necessary condition

$$\frac{dV_T^B}{dv^2} = \int_{-\infty}^{\infty}\int_{(1+s)(1-w)}^{\infty} [R - (1+s)(1-w)]\, \frac{df(R)}{dv^2}\, dR dF_T - g'(v^2) = 0 \quad (12)$$

for an optimal choice of the variance.

The lender is aware of the borrower's incentives to control the variance of the project. She will then set the interest rate s to maximize her expected returns

$$V_T^L = \int_{-\infty}^{\infty}\int_{-\infty}^{(1+s)(1-w)} R\, f(R)\, dR dF_T + \int_{-\infty}^{\infty}\int_{(1+s)(1-w)}^{\infty} (1+s)(1-w) f(R)\, dR dF_T - (1+r)(1-w) \quad (13)$$

subject to the trade-off faced by the borrower--as summarized by (12). This optimizing behavior yields the result that the optimum value for the lender's returns is increasing in w, i.e. the more resources the borrower contributes to the project, the better aligned her choice of the riskiness of the project with the lender's objective. 1/

In this decentralized economy, whether or not an enterprise receives a loan in the first period depends on the resources it can muster on its own. In an economy with private wealth and enforcement of equity contracts, these resources could be raised by selling equity shares in the firm's profits. Without venture capitalists free to invest in enterprises with legal protection of their contractual rights or a well-developed stock market, the viability of an enterprise will not depend solely on the prior probability that it is likely to succeed in a market economy. It will also depend on the initial level of wealth as loans and investment resources will go to those firms that are able to self-finance a large part of their investment.

1/ This result also requires that competition drives the lender's profits--subject to the investor's optimal choice of the variance--to zero.

In the successor states of the Soviet Union, for example, access to such resources is widely reported to be gained on an insider-outsider basis. 1/ Surveys indicate that managers and ex-managerial and ex-professional employees of state and ex-state enterprises are able to arrange equipment leases with their old enterprises on an informal market inaccessible to outsiders. The spontaneous privatization of activities previously undertaken by state-owned enterprises is another avenue through which accumulated private surpluses can be acquired to use for complementing loans.

The introduction of credit finance, in an economy with an allocation of equity finance poorly reflecting expected marginal returns to equity and where trade in the own resources of firms is restricted, implies that some activities with equal (or better) a priori prospects will not survive in favor of ones that happen to have access to the resources of and subsidies received by state and ex-state enterprises. In the credit market model discussed in this section, the accumulation of surpluses will tend to rise with the own resources of the firm, w, as this would allow access to credit and further expand those activities. This implies that retainable earnings available for further investment in a richer model would further distort the allocation of loans toward such firms in the absence of other advantages. 2/

V. An Alternative Model with Project Evaluation

In this section, an alternative model of the credit market with learning is discussed. The simple model adapts the agency costs one of Bernanke and Gertler (1990) so as to provide another illustration from the literature on credit markets with private information. The result that co-financing would magnify the distortions from equity allocations is restated in a framework that allows for a different--and more realistic --set of borrower actions. Rather than leading to an increase in the riskiness/variance of the project undertaken, the agency problem that emerges in the Bernanke and Gertler framework is that borrowers are insufficiently selective in their choice of projects as they incur an up-front evaluation cost. We briefly review how the learning process--i.e., the endogenous reduction in public uncertainty--operates in this framework, and then move on to show how that learning process interacts with the private information that the manager acquired through its evaluation efforts.

1/ See the discussion in Section II.1, as well as Webster and Charap (1993) and Schleifer and Vishny (1992).

2/ Note that we do not develop the dynamics of profits and the possibility of retained earnings. The accumulation of resources through profits for self-financing of investments should affect the optimal policies of firms.

Suppose that each enterprise invests one unit of input at date t-1 to produce $R > 1$ units of output at date t with probability p and zero units with probability (1-p). As before, we assume that the opportunity cost of the input is (1+r). The probability of success p is not known to anyone, and we assume that there is no prior information about the value of p for any firm and that p for any given firm can be any value between zero and one. Therefore, for each firm the prior distribution over p is the uniform distribution over the unit interval.

Each period, the realized output of every firm that is still operating is publicly observed. Agents use this information to update the prior distribution over p using Bayes' rule. From equations (5) and (6) the posterior mean and variance for p after observing outcomes for T periods are given by

$$E_T(p) = \frac{1+z}{2+T} \quad , \quad \text{and}$$

$$Var_T(p) = \frac{(1+z)(1+T-z)}{(2+T)^2(3+T)} \quad ,$$

respectively, where z equals the number of trials for which net revenues were equal to R. The optimal policy is again a simple stopping rule, and we see that any enterprise for which $1+r > pR$ will be shut down in finite time with probability one. As before, a firm with positive true expected net return may not survive depending on the history of draws or the value of r and R.

Assume now that each period a given firm can undertake to invest in a project that yields R with probability $p + q$, where the sum $p + q$ is restricted to be less than or equal to one. To a creditor or to the managers of the firm, the distribution of p is the common posterior obtained by observing output realizations. The distribution of q is known to all, but only the managers of the firm learn q before investing. To do so, they incur fixed costs of evaluating the project available for the given date. They then decide whether or not to invest given the sum of q and the current prior expectation of p. Since the firm's creditors do not know q, there is an asymmetry of information.

We again assume that the firm may have resources of its own to invest along with funds lent by its creditors. Self-financing is denoted by w and s is the interest rate charged by the bank. The problem for the firm is to maximize

$$V_T^B = [E_T(p) + q_T][R - (1+s)(1-w)] - (1+r)w - e \tag{14}$$

with respect to whether to invest or not, given that it has evaluated the project incurring the fixed cost e. We assume that if it does not evaluate the project, then the return is zero with probability one. The evaluation stage can be interpreted broadly (see Bernanke and Gertler, 1990), and in the case of transition economies it could include initial efforts to restructure a previously state-owned enterprise.

A project is undertaken if the expected probability of success is at least as great as $Ep + \tilde{q}$, where $\tilde{q}$ is the reservation value that the entrepreneur chooses for that decision and it is defined by

$$[E_T(p) + \tilde{q}_T][R - (1+s)(1-w)] = (1+r)w \tag{15}$$

Assume that intermediaries are competitive, so that they earn zero expected profits, given the prior over p and the distribution of q. They recognize that the firm will invest in a project in a given period if $Ep + q$ is at least as great as $Ep + \tilde{q}$. From the bank's zero profit condition, we know that the gross interest that the bank charges the firm is given by

$$(1+s)\left[E_T(p)\int_{\tilde{q}}^{1} dF(q) + \int_{\tilde{q}}^{1} q\, dF(q)\right] = (1+r)\left[\int_{\tilde{q}}^{1} dF(q)\right] \tag{16}$$

where the revenues on the left-hand-side include the expected value of q (recall that only the firm's managers know the true value of q).

In the social optimum (i.e., without private information), investments would be undertaken up to the point where $[Ep + q^*]R = (1+r)$, with the expectation taken with respect to the current prior distribution of p. This holds if $w = 1$, but for $w < 1$ the minimum value of q accepted by the firm is lower than q^*. If $w = 0$, then zero expected profits for the intermediary implies that the expected return of the firm is negative. This can be seen from noting that maximization of the firm's expected value with respect to $\tilde{q}$ implies that (once (18) is substituted into (17)):

$$[E_T(p) + \tilde{q}_T]\left[R - (1+r)\left(\frac{\int_{\tilde{q}_T}^{1} dF(q)}{E_T(p)\int_{\tilde{q}_T}^{1} dF(q) + \int_{\tilde{q}_T}^{1} q\, dF(q)}\right)\right] = 0 \qquad (17)$$

which in turn means (going back to (16)) that the expected profits to the firm

$$V_T^B(\tilde{q}) = -e \qquad (18)$$

are negative. Under this circumstances, entrepreneurs who have incurred the evaluation cost will choose a reservation value of q lower than the socially optimal one. A reservation value of q lower than q* implies that some entrepreneurs will undertake projects with negative present value. The agency costs generated by this asymmetry of information are minimized by requiring the entrepreneur to co-finance the project. As in Bernanke and Gertler (1990), there is a positive value of co-financing (say, w^*, for any given Ep), such that loans are only made if the firm's own contribution is larger. For $w < w^*$, a credit market fails to exist.

With learning, Ep will be rising for some enterprises and with it the amount of wealth invested in them, while for others both are declining. As before, the allocation of credit across enterprises for which the initial information about value is the same depends on their comparative abilities to self-finance part of their investments. If that ability is the result of a distorted allocation of equity capital, the credit market could magnify and/or propagate that distortion through the co-financing used to mitigate the agency problem.

V. Conclusion

A highly uncertain environment, together with a peculiar composition of physical and human capital stocks, make the economies in transition quite different from developing, market-oriented economies. Making inferences of which firms/sectors will develop successfully with such little information is extremely difficult and requires a learning process during which the average productivity of investment will be low. Our characterization of the investment process with Bayesian learning and sunk costs of entry and exit suggests the existence of two sources of inefficiency. The first is that activities with negative value are kept alive until they eventually prove to be losers, due to the existence of an option value to shutting them down in the future. The second is that some truly viable activities will be shut

down due to a string of poor realizations of returns in an early trial period.

These inefficiencies are due to a lack of public information that can only be accumulated as production and investment take place. When these insights from the investment process under uncertainty are combined with the ones from the functioning of credit markets under asymmetric information, we find that its likely that credit markets may fail to develop for a while. The average level of private wealth may not be enough to satisfy the need for complementary self-finance of indivisible projects. This would mean that growth may have to be self-financed at the initial stages of the transition, as suggested by McKinnon (1991).

Moreover, if distortions exist in the allocation of equity, they will be magnified by credit markets. This is due to the fact that credit will be allocated to firms that are able to provide accumulated surpluses or capital for complementing loans. If those surpluses and/or capital goods result from subsidized inputs or from leases/purchases from the state at negligible prices, it is not clear that credit is going to be directed to the most efficient activities and/or entrepreneurs. It is important then that equity capital be allocated by a competitive market and that transferability restrictions on the privatized assets are minimized. Unless privatization reaches the large industrial enterprises, the surpluses generated in small industries with low capital requirements and in the service sector will attract credit to those sectors leading to a sustained bias in their development.

Although the restructuring of the banking system should proceed as fast as possible (see Blommestein and Spencer, 1993), our analysis suggests that the removal of distortions in equity markets should precede the promotion of credit market growth. Calvo and Kumar (1993) also suggest that equity markets can play an useful role in the transformation process and that they should be developed relatively quickly. They also present some evidence that firms used more equity than debt to finance growth in developing countries as compared to developed countries. As we have argued above, it seems that the role of equity finance should not be downplayed and that privatization might have to progress enough for credit markets to grow without magnifying equity market distortions.

If we embed the mechanism discussed in this paper in an endogenous growth model, we would obtain that the development of equity markets would precede that of credit markets. This sequence would go against the traditional sequence, that suggests that bank lending would be developed first, followed by stock and bond markets, and finally by credit for consumption and insurance markets (see Pagano, (1993)). Also, once equity accumulation reaches a threshold, credit would start to grow gradually and financial intermediaries would be the optimal institutions to accumulate the information (i.e., track-records) capital that would hand-in-hand with the accumulation of physical capital. These issues are left for further research.

References

Atkeson, Andrew and Patrick J. Kehoe, "Industry Evolution and Transition: The Role of Information Capital," Federal Reserve Bank of Minneapolis, Staff Report # 162, (1993).

Bernanke, Ben and Mark Gertler, "Financial Fragility and Economic Performance," Quarterly Journal of Economics, (February 1990).

Bencivenga, Valerie R. and Bruce D. Smith, "Financial Intermediation and Endogenous Growth," Review of Economic Studies 58, (1991).

Bencivenga, Valerie R., Bruce D. Smith and Ross M. Starr, "Liquidity of Secondary Capital Markets: Allocative Efficiency and the Maturity Composition of the Capital Stock," mimeo, (1992).

Bhattacharya, Sudipto and Anjan V. Thakor, "Contemporary Banking Theory," Journal of Financial Intermediation, (forthcoming 1994).

Blommestein, Hans J. and Michael G. Spencer, "The Role of Financial Institutions in the Transition to a Market Economy," IMF Working Paper WP/93/75, (October 1993).

Borensztein, Eduardo and Manmohan S. Kumar, "Proposals for Privatization in Eastern Europe," IMF Staff Papers 38, (June 1991).

Boyd, John H. and Bruce D. Smith, "Intermediation and the Equilibrium Allocation of Investment Capital," Journal of Monetary Economics 30, (1992).

Calvo, Guillermo A., Manmohan S. Kumar, Eduardo Borensztein and Paul R. Masson, "Financial Sector Reforms and Exchange Rate Arrangements in Eastern Europe," Occasional Paper # 102, IMF, (February 1993).

DeGroot, Morris H. "Probability and Statistics," 2nd edition, Addison-Wesley Publishing Co., 1989.

Diamond, Douglas W., "Financial Intermediation and Delegated Monitoring," Review of Economic Studies, 51, (1984).

Diamond, Douglas W. and P.H. Dyvbig, "Bank Runs, Deposit Insurance and Liquidity," Journal of Political Economy 91, (June 1983)..

Dixit, Avinash K. and Robert S. Pindyck, Investment under Uncertainty, Princeton University Press, (1994).

Dooley, Michael, Richard D. Haas and Donald J. Mathieson, "Credit Markets in Transition Economies," mimeo, International Monetary Fund (1995).

Frydman, Roman and Andrzej Rapaczynski, "Privatization and Corporate Governance in Eastern Europe," mimeo, (April 1991).

_____ , "Privatization in Eastern Europe: Is the State Withering Away?" Finance and Development, (June 1993).

Gale, Douglas and Martin Hellwig, "Incentive-compatible Debt Contracts I: The one period problem," Review of Economic Studies, (October 1985).

Gertler, Mark, "Financial Structure and Aggregate Economic Activity," Journal of Money, Credit and Banking, (August 1988).

Greenwood, Jeremy and Boyan Jovanovic, "Financial Development, Growth and the Distribution of Income," Journal of Political Economy 98, (October 1990).

Jovanovic, Boyan, "Selection and the Evolution of Industry," Econometrica 50, (1982).

Mathieson, Donald J. and Richard D. Haas, "Establishing Monetary Control in Financial Systems with Insolvent Institutions," IMF PPAA/94/10 (1994).

McKinnon, Ronald I., "Financial Control in the Transition from Classical Socialism to a Market Economy," Journal of Economic Perspectives 5, (1991).

Rostowsky, Jacek, "Systematic Requirements for Monetary Stability in Eastern Europe and the Former Soviet Union," IMF Working Paper WP/94/24 (February 1994).

Shleifer, Andrei and Robert W. Vishny, "Privatization in Russia: First Steps," mimeo, (February 1992).

Stiglitz, Joseph and Andrew Weiss, "Credit Rationing in Markets with Imperfect Information," American Economic Review 71, (1981).

Townsend, Robert M., "Optimal Contracts and Competitive Markets with Costly State Verification," Journal of Economic Theory 21, (1979).

Webster, Leila and Joshua Charap, "A Survey of Private Manufacturers in St. Petersburg," mimeo, The World Bank, (May 1993).