TITLE: Entry Without Exit: Economic Selection Under Socialism

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Entry Without Exit:  
Economic Selection Under Socialism

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Abstract

We examine the process of economic selection under socialism with a dual intent. First, we dispel an important misconception about the nature of selection when an economy is centrally planned by demonstrating that industries in reforming economies are characterized by a remarkable degree of heterogeneity, possibly due to differences in managerial skills and experience. This heterogeneity provides evidence that industrial ministers evaluated the trade-offs implicit in the allocation of resources across firms within a sector, presumably with the goal of minimizing economic costs. Recognition of this heterogeneity is essential in the conduct of economic reform, in particular, in the treatment of enterprises in the process of privatization.

Second, we use our model of selection under socialism to generate predictions about the empirical relationship between size and performance. We argue that this relationship can be used as a practical guide to identifying less productive enterprises in reforming economies, one that does not rely on the use of questionable price data. Our approach also suggests that intra-sectoral restructuring may be as important as inter-sectoral restructuring in improving economic performance in transition economies. Using a simple model of economic selection under socialism, we demonstrate that, even in the absence of exit, inefficient firms will tend to be allocated less resources than efficient ones. This tendency generates an industrial structure that is bi-modal in nature, one in which inefficient firms agglomerate at one end of the size spectrum and efficient firms agglomerate at the other end. We suggest that this characteristic of the size distribution of firms in reforming economies can be used to identify less productive firms.
Entry Without Exit:
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1.0 Introduction
The role of entry and exit in economic growth has been increasingly emphasized in both the theoretical and empirical literature. Economic efficiency and growth are seen to arise as a consequence of opportunities for organizational experimentation combined with a mechanism that selects those forms best suited to the economic needs of society. Entry and exit are seen as vital external checks that offset the tendencies for organizations to ossify. New organizations are also seen, in the new growth literature, as vital for the efficient exploitation of specialization. Indeed, some economists argue that the essential difference in the economic performance of capitalism and socialism rests in the possibilities they provide for creating new organizational forms and destroying inadequate ones (Schumpeter 1950, Nelson and Winter 1982, chapter 15, Murrell 1991).

Restrictions on entry and exit of enterprises are, perhaps, the defining characteristics of socialism, as practiced in the former Soviet Union and Eastern Europe. While experimentation existed, it was carefully guided and limited by the central authority in the economy. Further, economic criteria did not always predominate over political criteria in the selection of organizations best suited for efficiency and growth. The unwillingness of economic leaders in these countries to commit to a program of liquidating less efficient enterprises limited the availability of funds to efficient and potentially more dynamic enterprises and, more generally, distorted the industrial structure compared to what would be observed in a market economy. In this paper, we examine the process of economic selection under socialism with a dual intent.

First, we wish to dispel an important misconception about the nature of selection when an economy is centrally planned. Most economists argue that, within a given sector, state-owned enterprises were essentially homogenous. The "folk model" that most economists employ in this regard is the cookie-cutter model. In this model, a minister is assigned the responsibility of building a new industry. The minister studies the set of technologies available to produce the product, in particular, to identify the efficient scale of production within a centrally planned setting. After this efficient scale is identified, the minister uses the cookie cutter to carve out a set of identical factories at the chosen scale to satisfy expected demand.

In contrast, we find that industries in reforming economies are characterized by a remarkable degree of heterogeneity, possibly due to differences in managerial skills and experience. Some enterprises grew over time; other contracted. Certainly, enterprises grew at very different rates. This heterogeneity provides evidence that industrial ministers evaluated the trade-offs implicit in the allocation of resources across enterprises within a sector, presumably with the goal of minimizing
economic costs. Recognition of this heterogeneity is essential in the conduct of economic reform, in particular, in the treatment of enterprises in the process of privatization.

In this context, we wish to provide a practical guide to identifying less productive enterprises in reforming economies. Such a guide is important, because the balance sheets of state-owned enterprises may be very poor guides to their viability in a market economy. With property rights relatively undefined, asset prices are ambiguous, and this reduces the usefulness of value data. Economists engaged in the design of privatization programs are frustrated by the complexity of evaluating the profitability of state enterprises in an environment in which asset prices do not confer information about value. Our approach, by exploiting size-performance relationships, avoids the need to use price data.

Using a simple model of economic selection under socialism, we demonstrate that, in the absence of exit, unprofitable enterprises will be reduced in size to their minimum scale, while profitable enterprises will be expanded to their maximum capacity. This tendency generates an industrial structure that is bi-modal in nature, one in which inefficient enterprises agglomerate at one end of the size spectrum and efficient enterprises agglomerate at the other end. We argue that this result is important for thinking about the restructuring process in former socialist economies. We argue that this characteristic of the size distribution of enterprises in reforming economies can be used to identify less productive enterprises.

Our approach suggests a fundamentally different way to view the restructuring process. According to the conventional view, socialist economies overbuilt some sectors (e.g., heavy industry) and ignored others. The essence of the transition is then to overturn this inter-sectoral investment pattern. No doubt this captures one aspect of the transition. It ignores, however, the role of intra-sectoral reallocation. Our model suggests that many sectors may be burdened with an uncompetitive fringe of inefficient enterprises. A key part of the restructuring process will then involve eliminating these enterprises. It suggests that *intra*-sectoral restructuring may be as important *inter*-sectoral restructuring for improving economic performance.

Of course, this result must be qualified. First, the strength of our inferences is greatest for industries that are mature and in which a uniform technology is used by all enterprises. Second, smaller enterprises must be labelled as less productive in the context of central planning. The process of selection that we describe is a process that sorts enterprises based on their productivity in an economy that is centrally planned, where the features that generate productivity might be different than in a market economy. For example, a director that is able to operate effectively in a centrally
planned setting may not be able to operate equally as successfully in a market setting. However, if the different types of directors are distributed randomly across enterprises, then the relationships we predict in this paper should persist even into the transition.

This paper contains four sections, in addition to this introduction. In the next section, we present a review of the literature on the process of selection under socialism. In particular, we focus on the seminal contribution of Jovanovic (1982), who describes the process of industry evolution when markets are perfectly competitive. This review provides an important benchmark for evaluating the efficiency implications of the process of selection under socialism.

In section 3, we present a simple model of entry and exit under socialism. This model captures the important institutional differences between selection under socialism and capitalism, in particular, the centralization of entry, growth, and exit decisions and the absence of both objective measures of the opportunity costs of assets and exit. Section 4 discusses the implications of our model for the industrial structure of Russia, and consequently, for the conduct of economic reform. The final section presents implications of our research for the conduct of economic reform.

2.0 Economic Selection Under Capitalism

The literature on industrial dynamics in market economies focuses on the relationship between the characteristics of firms and their success; in particular, on the relationship between the size of firms and their growth rates. Early studies, such as Simon and Bonini (1958) and Pashigian and Hymer (1962), found the growth rates of firms to be independent of their size (hence firms grow proportional to their size), a relationship known as Gibrat’s law. Later work indicates that smaller firms have larger and more variable growth rates, and seem to have greater failure rates as well (Mansfield 1962).

Recent work in industrial dynamics is based on the framework developed by Jovanovic (1982). He constructed a model of "noisy selection" based on heterogeneity in firm efficiency. Firms, in Jovanovic’s model, differ in size not due to the fixity of capital, but, rather, because some firms discover, over time, that they are more efficient than others. Their decisions to grow, contract, or even exit are based on their ability to discern their true level of productivity.

In the wake of Jovanovic, more recent empirical work has focused on the interaction of growth and failure of firms, and has studied the role of plant size, ownership characteristics, and the age of the plant in their determination (Dunne, Roberts, and Samuelson 1989, Pakes and Ericson 1988). These studies use large panel data sets to track the evolution of industries. Such data sets, which include observations on specific firms in a cross-section of industries over time, are important
because they enable researchers to observe the behavior of plants that fail as well as those that survive. Dunne, Roberts, and Samuelson, for example, use the *Census of Manufactures* to trace the behavior of manufacturing plants in the United States. They report that both the failure rate of plants and the growth rate of non-failing plants decline with age.\(^1\)

Our model of economic selection under socialism follows the approach taken by Jovanovic, with three important differences. First, we assume that the responsibility for selection falls on an industrial minister. Thus, decisions related to entry, growth, and exit are centralized. Second, we assume that there is no extra-sectoral measure of the opportunity costs of deploying assets, so that comparisons of productivity are solely intra-sectoral. Finally, we assume that governments might be paternalistic, so that exit might not be observed. We evaluate the effect of these differences on the anticipated pattern of industrial dynamics.

One goal implicit in our research is the comparison of the process of selection under capitalism and socialism. In this context, we assume that the distribution of initial enterprise characteristics is independent of a country's economic system, but that the selection process that governs the survival, growth, and failure of enterprises is determined precisely by that system.\(^2\)

Thus, the selection mechanism that operates in a given economy determines the distribution of enterprises with respect to size and age and other enterprise characteristics. In the next section, we present a simple model of how this process of selection might work under socialism.

### 3.0 The Model

In this section, we present a simple model of entry and exit under socialism. We assume that the economy is planned centrally using a three-tier industrial structure. At the top of the hierarchy, central planners guide industrial growth and decline using a system of mandatory output targets aggregated to the sectoral level. Planners communicate these sectoral targets to industrial ministers, who, in turn, disaggregate and assign them to particular enterprises. In this capacity, industrial

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\(^1\)Ericson and Pakes (1989) extend the literature on industrial dynamics by considering decisions that firms can make to effect their efficiency. Unlike the Jovanovic model, in which the efficiency of any firm is given at birth, Ericson and Pakes assume that firms can undertake research and development to improve their efficiency over time. This feature provides an even richer dynamic structure, and the model is implemented empirically in Pakes and Ericson (1988).

\(^2\)Since Jovanovic considers a model of a single economy, he assumes that there is a given distribution of plant efficiency. For comparative purposes, we must make assumptions about how this distribution varies across systems. We choose to assume that the distribution of initial characteristics is invariant to the system so that we can focus solely on the effects of the selection mechanism.
ministers might be required to create new or liquidate existing enterprises.

Specifically, suppose central planners assign to an industrial minister the task of producing the sequence of output targets given by $Q = \{Q_1, Q_2, \ldots, Q_T\}$, where $Q_t$ measures the output target assigned to a given sector for delivery in period $t$. We assume that central planners provide the minister with this sequence \textit{ex ante}, prior to any production. We also assume that industry output is non-storable.

Prior to each period, the minister must decide how to allocate production among new and existing enterprises to minimize expected costs. The minister must assign to each enterprise $i$ at time $t$ an output target, denoted $x_{it}$, where the number of potential enterprises is finite and denoted by $N$. We assume that technological and organizational constraints determine the minimum and maximum operating scales of enterprises, where $\underline{x}$ denotes the minimum scale of production for every enterprise and $\bar{x}$ its maximum capacity.

The minister's objective, then, is to minimize costs by selecting enterprises for entry, growth, contraction, and liquidation. We denote $c_{it}$ as the cost of producing $x_{it}$. This cost might include incentive provisions for the director and workers of enterprise $i$, although, for simplicity, we assume that the enterprise always fulfills its production target. We also assume that the measurement of costs might be based on the shadow values of inputs, rather than their explicit costs. Official prices rarely capture the full economic cost of using inputs. For example, many inputs are acquired through barter or may be under valued given their priority in the economy. An ambitious minister is likely to consider the full implications of his or her allocation decision and its effect on the course of his or her career.

For notational convenience, we index potential enterprises from 1 to $N$ and assume that $c_{it}$ is zero when $x_{it}$ is zero (i.e., prior to entry or after exit, exclusive of exit costs). In this case, we can represent the industrial minister's problem in any period $j$ as:

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3 We assume that the minister internalizes the cost of exit, but not of building new enterprises. We need the former to model the effects of the absence of exit under socialism. This seems plausible, since a minister that shuts down an enterprise will not escape the political consequences of this, which will likely have a deleterious impact on future promotions. Because the presence of exit costs are sufficient to reduce entry, we ignore explicit entry costs throughout. Moreover, they are not a systemic difference between capitalism and socialism.

4 In general, one would expect that the minimum and maximum production scales would be time dependent. We ignore this in developing the model, because it add little to the economic issues. It is, however, an important issue for empirical testing, as it would affect what happens to the empirical size distribution of enterprises over time.
\[
\min_{\{x_u\}} \sum_{i=1}^{N} \sum_{t=j}^{T} E_i[c_{it}]
\]

subject to:

\( (i) \sum_{i=1}^{N} x_u \geq Q_t \)

\( (ii) x_u \in [\underline{x}, \bar{x}] \)

where \( E_i[c_{it}] \) is the expected cost of producing \( x_{it} \) evaluated at the beginning of period \( j, j=1, \ldots, T \).

The first constraint in (1) insures that the minister will fulfill his target.\(^5\) The second constraint defines the range of feasible output levels. We note that output targets in any period \( t > j \) represent the minister’s expectation of the output target he or she will assign and not an actual obligation passed down to the enterprise.

The essential idea of our model is that industrial ministers choose to allocate resources within their domain in a rational manner. This is a key assumption of the model, and as such is worthy of comment. Contrary to our assumption, it is often argued, ministers assign resources across enterprises based on politics. This may be an important criterion. But, it is important to remember that the minister is also a subordinate in a hierarchy. As such, the minister must satisfy plans to achieve bonuses and promotion. Given that resources are limited, this should induce the minister to allocate resources in a manner that maximizes the surplus available.\(^6\) As long as the minister must satisfy superiors, it seems farfetched that he would make allocation choices that lower performance.

Hence, we argue that cost minimization is the natural criteria to use.

Clearly, the information burden placed on an industrial minister is greater than that placed on owners of competitive enterprises in capitalist economies. While the capitalist owner can make entry,

\(^5\) We assume, for the sake of convenience, that the minister has no incentive to overfulfill the plan. This greatly simplifies the proofs.

\(^6\) The view that the minister is the proper maximizing unit in the Soviet economy was emphasized by Granick (1980).
growth, and exit decisions based on a comparison of his or her enterprise's costs to the opportunity
cost of the enterprise's assets, the lack of a capital market makes a similar valuation impossible for
the socialist minister. The minister in a socialist setting must evaluate the value of an enterprise not
against an extra-sectoral measure, but relative to the value of other enterprises within this sector.\footnote{Even if planners offered criteria for making inter-sectoral evaluations it is clear that ministers
would ignore them. It is always in the minister's interest to keep funds in his own sector, rather than
return them to the planner.}

While we have utilized strong assumptions to simplify this comparison, it is nevertheless more
complex than under capitalism. Further, the lack of economy-wide standards of evaluation reduces
the likelihood that resources will be deployed efficiently across sectors.

We presume heterogeneity among enterprises, that is, that enterprises differ in their levels of
productivity. The source of these differences might be technological or they might reflect different
natural endowments (e.g., location). Alternatively, heterogeneity among enterprise directors might be
the primary source of cost differences across enterprises. For most of our analysis, we assume that
the minister cannot identify the source of differences in productivity among enterprises.

We assume that neither the enterprise director, nor the minister know the true level of
productivity of an enterprise upon its birth. They learn of an enterprise's true productive potential
only over time as a consequence of observing its history of production costs.\footnote{Alternatively, we could have assumed that the enterprise director knows the true level of
productivity of his or her enterprise, but the industry minister does not. Under these circumstances,
the enterprise director might use this information asymmetry for personal advantage. However, we
expect the gains to this strategy to be largely in the short term: over time, the industry minister will
use incentive strategies to more clearly determine the true level of productivity of the enterprise.
Thus, if we assume that the incentive costs of eliciting information from the enterprise director is
included in the industry minister's calculation of enterprise costs, then this alternative assumption is
imbedded in our more simple model.}

We assume that neither the enterprise director, nor the minister know the true level of
productivity of an enterprise upon its birth. They learn of an enterprise's true productive potential
only over time as a consequence of observing its history of production costs. We assume that the
true productivity of an enterprise is drawn from a known distribution, which is identical for all
enterprises.

The problem for the minister, then, is to determine the point at which an enterprise's
performance is sufficiently indicative of its true productivity. If an enterprise is discovered to be
sufficiently unproductive, then the minister might consider firing its management and workers,
liquidating its assets, and, if demand is sufficient, replacing it with a new enterprise. However, we
assume that closing an enterprise entails some fixed cost $k$, which is identical for all enterprises. This
cost might include the economic costs of foreclosure as well as the political and social costs of
unemployment. Thus, the introduction of $k$ provides a mechanism for us to introduce possible paternalistic behavior by the state.

We capture these features in our model using a cost function that is linear in output. While this function is specific, we believe it possesses some features that make it a natural choice for our analysis. First, in any given period, the enterprise's expected marginal cost of production is constant over all levels of feasible production and is equal to its average cost of production. This assumption of constant intra-period costs greatly simplifies the information burden placed on industrial ministers. Comparisons of production costs across enterprises can be made independent of their levels of production. Also, the assumption of constant costs conforms in reality to the typical minister's view of an enterprise's production function. Ministers in such countries as the former Soviet Union relied on fixed production coefficients as an aid in planning, which, in an environment of fixed prices, corresponds to constant costs.

We assume that the true productivity of the enterprise is determined at birth by a draw of $\theta$ from the set $\Theta$ of possible productivity levels, where a higher $\theta$ indicates lower productivity. This distribution of true productivities among the potential enterprises is normal with mean $\mu_\Theta$ and variance $\sigma_\Theta^2$. The parameters of this distribution are known to the minister, although he or she does not know the true productivity of any enterprise with certainty. Let $\theta_i$ be a measure of the true productivity of enterprise $i$ and $\varepsilon_{it}$ indicate random error. Then, we can define $\phi_{it}$ as a measure of the observed productivity of enterprise $i$ at time $t$, where $\phi_{it} = \Theta_i + \varepsilon_{it}$. We assume that $\varepsilon_{it}$ has mean zero and variance $\sigma_\varepsilon^2$. In this case, the cost function in any period, except the period in which the enterprise is closed, is given by:

$$c_{it} = x_{it} \phi_{it}$$

(2)

If an enterprise is liquidated prior to time $T$, then its cost in the period following its last period of production is $k$ and zero in every period thereafter.

To maximize the objective function in (1), the minister must calculate at the beginning of each period $j$ the expected marginal cost of production for each enterprise for every time $t$. That is, for each enterprise, he or she must estimate $E_j[\phi_{ij}]$ given information about the distributions of $\theta$ and $\varepsilon$ and the historic performance of the enterprise. We assume that the minister uses a Bayesian decision rule that minimizes the loss associated with squared deviations from the mean. In this case, the
Bayes' solution,\(^9\) conditional on the mean of observed marginal costs to time \(t\), reveals that the expected marginal cost of an enterprise at time \(t\) \((t \geq j)\) is given by:

\[
E[\Phi_{it} | \hat{\mu}_j] = \left( \frac{\sigma_a^2}{\sigma_e^2 + \rho} \right) \hat{\mu}_j + \left( \frac{\sigma_e^2}{\sigma_e^2 + \rho} \right) \mu_{\Theta}
\]  

\[(3)\]

where \(\rho = j - v\) is the number of periods since entry, and

\[
\hat{\mu}_j = \frac{1}{j - v - 1} \sum_{j' = v}^{j - 1} \phi_{iz}
\]

\[(4)\]

Note that the Bayes' solution is a weighted average of the sample mean \(\hat{\mu}_{ij}\) and the prior mean \(\mu_{\Theta}\). Equation (3) implies that as \(t\) increases (as enterprises age) the relative weight on the sample mean increases. As \(t\) approaches infinity, the conditional expectation approaches the sample mean.

We begin our formal analysis of our model with propositions that describes how industrial ministers select the number of enterprises to build at the beginning of period \(1\). To facilitate our exposition, we introduce three simple concepts.

**Definition 1**: Enterprise \(i\) is considered, in period \(j\), to be *active* in period \(t\) if its expected level of production in period \(t\), \(E_j[x_{it}]\),\(^10\) is positive.

**Definition 2**: An enterprise is considered to be *slack* in period \(t\), if the output target in period \(t\) can be fulfilled by enterprises with lower expected costs. Specifically, in period \(j\), consider the set of active enterprises, \(i\), at time \(t\). Let \(\psi\) represent the set of active enterprises whose

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\(^{10}\) \(E_j[x_{it}]\) is the conditional expectation in period \(j\) of output in period \(t\). Hence, the expectation is conditional on information as of period \(j\).
expected marginal cost of production is less than or equal to enterprise r’s at time t.\textsuperscript{11} Then, enterprise r is expected, at time j, to be slack in period t if:

\[ Q_t \leq \sum_{i \in \pi} E_j[x_\pi] \]

\textbf{Definition 3:} An active enterprise is expected, in period j, to be redundant if it is expected to be slack in all periods from j to T.

We now characterize the output levels of active enterprises. Notice that the minister’s decision will depend on what is expected to happen to output targets over time. It seems natural to assume that the minister expects these targets to either increase, decrease, or remain constant. We consider each in turn.

\textbf{Proposition 1:} If an enterprise is expected, at time j, to be redundant, then it should not be built at time j.

\textbf{Proof:} The minister does not need the output of an enterprise that is redundant to meet current and future output targets. Let \( \pi \) be the set of non-redundant enterprises at time j. Now, suppose the minister creates an additional enterprise. Let \( p \) be the probability that, for this new enterprise, \( e, \theta_{e} > \mu_{\theta} \). If \( p > 0 \), then expected costs rise. But, \( p \) must be greater than zero because the variance of \( \theta \) is positive.

It seems obvious that a minister will not want to build a redundant enterprise, but this proposition plays an important role in what follows. Notice that if a minister builds a new enterprise, it means that the output targets can be re-allocated across enterprises. An enterprise becomes redundant, essentially, when such a re-allocation raises costs, because it induces enterprises to deviate

\textsuperscript{11} An enterprise may have the same expected marginal cost as enterprise r, but still be included in the set of active enterprises because its production is needed to fulfill the target. How the minister makes the choice between these enterprises ("breaks the tie") is not important to our analysis, and we ignore it.
from levels of production.\footnote{Notice also that the assumption of risk-neutrality on the part of the minister plays a role here. A risk-averse minister may choose to build a redundant enterprise for its option value in case of a surge of demand in the future. Thus, if the minister has extra funds today, he may make such an investment. Adding risk aversion would greatly complicate the analysis, and we cannot foresee any important insights that will be derived from this.}

Notice that the proof of proposition would be self-evident if we included some positive costs of building a new enterprise. To keep the model simple, we have ignored the cost of funds to the minister, and, in particular, any differential in the costs of building new enterprises versus investing in existing enterprises. Most likely, the former is more expensive. This would easily generate a bias against the creation of new enterprises. In order to avoid the appearance of "cooking" the results, we have ignored these issues.

\textbf{Proposition 2:} If the aggregate output sequence $Q$ is \textit{non-increasing}, then, in period $j = 1$, the minister creates $n$ enterprises, where $n = Q_1 / \bar{x}$.\footnote{We assume that $n$ and all similar numbers are rounded up to the nearest whole number.}

\textbf{Proof:} Suppose the minister creates less than $n$ enterprises. Then, constraint (i) of equation (1) would be violated for $j = 1$. Now, suppose the minister creates more than $n$ enterprises, say $n + 1$ enterprises. Because $E_j[\phi_{it}] = \mu_Q$ for all $i$ and $t$, the additional enterprise is slack in period $j$. Because $Q$ is non-increasing, the enterprise is expected to be slack in all later periods. Thus, the additional enterprise is expected, in period $j$, to be redundant.

\textbf{Proposition 3:} If the aggregate output sequence $Q$ is \textit{increasing}, then, in period $j = 1$, the minister creates a minimum of $\bar{n}$ enterprises and a maximum of $\bar{n}$ enterprises, where $\bar{n} = \min\{Q_1 / \bar{x}, Q_T / \bar{x}\}$, and $\bar{n} = \max\{Q_1 / \bar{x}, Q_T / \bar{x}\}$.

\textbf{Proof:} Suppose the minister created less than $\bar{n}$ enterprises. Then, constraint (i) of equation (1) is violated for $j = 1$. Now, suppose that the minister created more than $Q_T / \bar{x}$ enterprises, say $(Q_T / \bar{x}) + 1$ enterprises. Because $E_j[\phi_{it}] = \mu_Q$ for all $i$ and $t$, the addition does not decrease the expected cost of production over time and is redundant. Therefore, equation (1) is not satisfied.
Next, we consider two propositions that describe conditions under which the minister will choose to close an enterprise. The first proposition describes a sufficient condition for exit derived from considerations of supply, while the second describes a sufficient condition derived from considerations of demand.

**Proposition 4:** Consider enterprises at time $j$. Let $c_{ej}$ represent the cost of production of a new entrant at time $j$. Then, the following condition is sufficient to warrant the creation of a new enterprise and the exit of enterprises.

$$E_j[\phi_s] > \mu_e + \frac{k}{(T-j+1)x}$$

**(6)**

**Proof:** To satisfy equation (1), the minister will replace enterprise $s$ with a new enterprise if and only if:

$$\sum_{t=j}^{T} E_j[c_{xl}] > \sum_{t=j}^{T} E_j[c_{el}] + k$$

**(7)**

The minister will drive the output target of an enterprise that is a candidate for replacement to $x$. Then, the minister will replace enterprise $s$ with a new enterprise if and only if:

$$\sum_{t=j}^{T} E_j[\phi_s x] > \sum_{t=j}^{T} E_j[\phi_e x] + k$$

**(8)**

Now, $E_j[\phi_{ij}] = E_j[\phi_{i,j+1}] = \ldots = E_j[\phi_{i,T}]$ for all $i$. Also, $E_j[\phi_{ej}] = \mu_e$. Substitute these expressions into (7) and simplify, and we obtain (6).

Note that, in general, the minister is more likely to close an unproductive enterprise earlier than later in the planning horizon. The larger the difference between $T$ and $j$, the smaller the role that the exit cost $k$ plays in determining the conditions for exit. As $T-j$ falls, the expected savings in each period from creating a new enterprise must rise to compensate for the cost of liquidating the old enterprise.

**Corollary:** The higher the exit cost $k$, the less likely new entry will be observed.
This corollary suggests that entry is deterred under socialism for reasons other than those traditionally believed. Conventionally, it is argued that industrial ministers tended to create fewer enterprises than in a capitalist economy because it allowed them to economize on the cost of collecting and processing data. While we do not dispute the importance of this argument, we suggest that, in addition, ministers refrained from creating enterprises because they recognized that they would be unable to liquidate enterprises discovered to be unproductive.

**Proposition 5**: Suppose that \( k = 0 \) and that, at time \( j \), an enterprise is expected to be redundant. Then, it should be closed.

**Proof**: The proof is identical to that of proposition 1, since, with \( k = 0 \), there is no difference between closing an enterprise or not building one.

Notice that for very small \( k \) the minister will still choose to close down redundant enterprises. Exit occurs as long as the costs due to mis-allocation of output targets across enterprises exceeds \( k \). As \( k \) increases, however, the likelihood that redundant enterprises are shut down decreases. In an economy with large \( k \), we would expect redundant enterprises to remain open. Hence, an uncompetitive fringe of enterprises is the result of high exit costs. Notice that this also implies that other enterprises are producing at sub-optimal levels. This implication of high exit costs has important consequences for economic reform, which we discuss below.

**Corollary**: Suppose that \( k = 0 \) and that, at time \( j \), an enterprise is expected to be slack.

Then, if the aggregate output sequence \( Q \) is non-increasing, the enterprise should be closed.

The corollary to Proposition 5 describes terms of exit when the sequence of industry targets is non-increasing. If this sequence is increasing, then the minister might want to keep an enterprise open that is temporarily slack. For example, an enterprise might be very productive relative to a new entrant, but not relative to other existing enterprises. In this case, the minister might choose to operate the enterprise at its minimum capacity, if, in later periods the demand for industry output will rise. Of course, the minister will only do so if the benefits in later periods are expected to outweigh current costs.
Definition 4: Let $\Omega$ be the set of enterprises that the minister expects, at time $j$, to be active at time $t$ with $E_j[x_{it}] < x$. Define the marginal enterprise $m$ at time $t$, evaluated at time $j$, as $m: E_j[\phi_{mt}] \geq E_j[\phi_{it}]$ for every $i \in \Omega$, except for $m$.

We note that, with the exception of the marginal enterprise, all enterprises will be operating at either the maximum or minimum scales of production. Specifically, enterprises with $E_j[\phi_{it}] < E_j[\phi_{mt}]$ will be expected to produce $x$ at time $t$ and enterprises with $E_j[\phi_{it}] > E_j[\phi_{mt}]$ will be expected to produce $x$. This feature is a consequence of the linearity of the cost function. In a more general model, however, we would anticipate the size distribution of enterprises to be more diffuse.

Note that when an enterprise enters, the output levels of some other enterprises are changed. To calculate the effects we need to specify how large is the marginal enterprise relative to the minimum production scale. It turns out that it is easiest to state the next two propositions for the case when the marginal enterprise produces at least twice as much as $x$ at time $j$. We then discuss what happens when this is not true.

Proposition 6: Assume that $k$ is sufficiently high to preclude exit and that $Q_t$ is constant for all $t$. Assume that, in the absence of new entry, the marginal enterprise will produce at least twice the minimum scale of production in time $j$. Then, the minister will create a new enterprise in period $j$ if and only if $E_j[\phi_{mj}] > \mu_\Omega$.

Proof: Let $\Gamma$ be the set of active enterprises at time $t$. Let $\Gamma^*$ include all the enterprises in $\Gamma$, plus one newly created enterprise. Then, the minister will create the new enterprise if and only if:

$$\sum_{i \in \Gamma^*} \sum_{t=j}^{T} E_j[c_{it}] < \sum_{i \in \Gamma} \sum_{t=j}^{T} E_j[c_{it}]$$

Now, $Q_t$ is constant over time. Also, $E_j[c_{jj}] = E_j[c_{j,j+1}] = \ldots = E_j[c_{jT}]$. Therefore, the optimal static decision in period $j$ is also the optimal decision for all later periods.

Consequently, the minister's decision simplifies to a comparison of production costs in period $j$. 

14 Or enterprises, if more than one enterprise has the marginal level of productivity $\phi_{mt}$. 

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Entry Without Exit

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...j only with and without the creation of a new enterprise. That is, the minister will create a new enterprise if and only if:

$$\sum_{i \in \Gamma} E_j[c_{ij}] < \sum_{i \in \Gamma} E_j[c_{ij}]$$  \hspace{1cm} (10)

Now, partition \( \Gamma \) into \( \Gamma_1 \) and \( \Gamma_2 \), where \( \Gamma_1 \) contains all enterprises producing \( \bar{x} \) and \( \Gamma_2 \) contains all enterprises producing \( \bar{x} \). Then,

$$\sum_{i \in \Gamma} E_j[c_{ij}] = \sum_{i \in \Gamma_1} E_j[\bar{x} \phi_{ij}] + \sum_{i \in \Gamma_2} E_j[\bar{x} \phi_{ij}] + E_j[x_{mj} \phi_{mj}]$$  \hspace{1cm} (11)

Similarly,

$$\sum_{i \in \Gamma} E_j[c_{ij}] = \sum_{i \in \Gamma_1} E_j[\bar{x} \phi_{ij}] + \sum_{i \in \Gamma_2} E_j[\bar{x} \phi_{ij}] + E_j[(x_{mj} - x) \phi_{ij}]$$  \hspace{1cm} (12)

where the subscript \( e \) indicates the new entrant. Then, substituting equations (11) and (12) into (10), we find that the minister will create a new enterprise if and only if:

$$E_j[(x_{mj} - x) \phi_{mj}] > E_j[(x_{mj} - x) \phi_{ej}]$$  \hspace{1cm} (13)

Equation (13) states that the minister will create a new enterprise if and only if the savings in costs from lowering the level of production of the marginal enterprise to minimum scale is greater than the addition in cost of setting the production of the new enterprise to the level of production that enterprise \( m \) would produce in the absence of new entry less the level it produces with entry. The output differences in (13) are constants, and hence they can be taken outside the expectations operator. Given that \( E_j[\phi_{ej}] = \mu_\Theta \), (13) can be simplified to yield \( E_j[\phi_{mj}] > \mu_\Theta \).

Now, suppose, in the absence of entry, that the marginal enterprise would produce less than twice the minimum scale of production at time \( j \). In this case, the entry condition is a bit more complex. To illustrate, consider the following example. Suppose, in the absence of entry, the
marginal enterprise would produce $1.5x$. Now, consider the entry of a new enterprise $e$. The savings in costs from lowering the level of production of the marginal enterprise to minimum scale is $E_j[0.5x\phi_{mj}]$. The addition in cost of adding the new enterprise is not $E_j[0.5x\mu_\Theta]$. Rather, it is $E_j[x\mu_\Theta]$, given that the new enterprise must produce at least at minimum scale. If $E_j[0.5x\phi_{mj}] > E_j[x\mu_\Theta]$, then a new enterprise will be created. If not, then the minister has to determine whether downsizing the next to marginal enterprise will provide sufficient additional cost savings to warrant entry. This process continues until the sum of the reductions in the volume of production of the set of marginal enterprises is at least as great as the minimum scale of production. While the entry condition under these circumstances can be derived, it adds no depth to our analysis. Therefore, we do not include it here.

Our next proposition describes the distribution of enterprises by size that our model predicts. We present three concepts to facilitate the exposition.

**Definition 5:** An enterprise $i$ is mature at time $j$ if and only if $E_j[\phi_{it}] = \theta_i$ for $t=j,...,T$.

**Definition 6:** An industry is mature at time $j$ if and only if $E_j[\phi_{it}] = \theta_i$ for every enterprise $i$ and $t=j,...,T$.

**Definition 7:** An industry is large at time $j$ if and only if the distribution of the $E_j[\phi_{it}]$ is $N(\mu_\Theta, \sigma_\Theta^2)$ for $t=j,...,T$.

We now are able to state the key proposition of the paper, which describes what happens to the size distribution of enterprises over time.

**Proposition 7 (Bi-modality):** Assume that $k$ is sufficiently high to preclude exit and that $Q_t$ is constant for all $t$. Assume that, in the absence of new entry, the marginal enterprise will produce at least twice the minimum scale of production in time $j$. Then, in a large and mature industry, one-half of the enterprises will operate at minimum scale and one-half will operate at maximum scale.

**Proof:** We know from Proposition 1 that, under the circumstances of this proposition, the minister will create a new enterprise in period $j$ if and only if $E_j[\phi_{mj}] \geq \mu_\Theta$. Thus, entry
will continue until the time at which \( E_j[\phi_{mj}] \) falls below \( \mu_0 \). From definition 5,

\[ E_j[\phi_{mj}] = \theta_m. \]

Because the \( \theta_i \) are drawn from a normal distribution and the industry is large, one-half of the enterprises will possess a \( \theta_i \) greater than \( \mu_0 \) and one-half of the enterprises will possess a \( \theta_i \) less than \( \mu_0 \). Given that enterprises with \( E_j[\phi_{ij}] < E_j[\phi_{mj}] \) will produce \( \bar{x} \) at time \( j \) and enterprises with \( E_j[\phi_{it}] > E_j[\phi_{mt}] \) will produce \( \underline{x} \), the proposition follows.

Proposition 7 states that the observed distribution of enterprises by size will have a bi-modal character. That is, productive enterprises will agglomerate at the right mode of the size distribution and less productive enterprises will agglomerate at the left mode. In an industry that is either smaller or younger, we anticipate the this bi-modal feature will persist, although the division of enterprises between the modes is unlikely to be equal.

The literature on selection under capitalism focusses on the evolution of industry over time (i.e., industrial dynamics). In particular, it examines issues of growth and its relation to an enterprise's characteristics, such as its age and present size. In the Jovanovic model, for example, the variance of the growth rates of enterprises declines with age, as more is learned about the underlying productivity of enterprises. We would like to offer similar analyses for our model. Unfortunately, the simple cost function that we use in this analysis limits our ability to do so, since almost all enterprises (i.e., all but the marginal) produce at either \( x \) or \( \bar{x} \). Nonetheless, some inferences are possible. Below, we list a series of related propositions. Note that, in these propositions, we equate the size of an enterprise with the size of its output target.

Our previous analysis shows that a minister will allocate a higher target to enterprises that are observed to have lower costs. Of course, the minister does not know \( \theta_i \). The minister only observes \( \phi_{it} \). Clearly, however, enterprises with higher real productivity are more likely to display lower costs. Hence, we obtain the following proposition.

**Proposition 8:** Consider two active enterprises of the same age, but with different \( \theta_i \)'s. The probability, \( p \), that the enterprise with the lower \( \theta_i \) is at least as large as the other enterprise is greater than one half. As the enterprises age, this probability increases.

**Proof:** We know that \( \mu_0, \sigma_\theta^2 \), and \( \sigma_\epsilon^2 \) are identical for the two enterprises. From equation (3) the only cause of a difference in expected costs is a difference in the sample mean, \( \hat{\mu}_{it} \). To show that the enterprise with lower \( \theta_i \) has lower \( \hat{\mu}_{it} \) with \( p > 1/2 \), let \( \theta_1 \) and \( \theta_2 \) be the
true productivities of the high and low productivity enterprises ($\theta_h < \theta_l$), respectively. Let $
abla = \theta_l - \theta_h$. Then, $\mu_l < \mu_h$ if and only if $\varepsilon_h - \varepsilon_l > \nabla$. But the probability that $\varepsilon_h - \varepsilon_l > \nabla$ is less than 1/2. Since the minister will never assign a higher target to a higher-cost enterprise, the first part of the proposition follows.

As the enterprises age, the precision of the measurement of their sample means increases. Thus, the second part of the proposition follows.

The reader may wonder why the more productive enterprise does not always produce more than the less productive one, and why $p$ does not go to unity as $t$ increases in Proposition 8.16 The reason is that the low and high cost enterprises may end up producing the same level of output. This is a consequence of the linearity of the cost function. Notice that, if we dropped this assumption, then we could state a stronger version of proposition 8, where for very large $T$, $p$ goes to one as $t$ increases.

**Proposition 9:** Consider two active enterprises with same $\theta_i$, but of different ages. If $\theta_i < \mu_\Theta$, then the probability, $p$, that the older enterprise is at least as large as the younger enterprise is greater than one-half. If $\theta_i > \mu_\Theta$, then the probability that the older enterprise is no larger than the younger enterprise is greater than one-half. As the difference in the ages becomes larger these probabilities increase.

**Proof:** From equation (4), the expected value of the sample mean, $\mu_{it}$, for both enterprises is $\theta_i$. $\sigma_\Theta^2$ and $\sigma_\varepsilon^2$ are also equal for both enterprises. Consider first the case where $\theta_i < \mu_\Theta$. Denote the enterprises o and y for old and young. If the enterprises were of the same age, the weights on the sample mean and the prior in equation (3) would be the same for both enterprises. Hence, the probability that $E_j[\phi_{oj}] > E_j[\phi_{yj}]$ would equal 1/2. But $\rho_o > \rho_y$, so the weight on the sample mean is greater for the older enterprise. Since $\theta_i < \mu_\Theta$, the expected value of $\mu_{it}$ is greater than $\mu_\Theta$. Hence, the probability that $E_j[\phi_{oj}] > E_j[\phi_{yj}] > 1/2$. Since the minister never assigns a lower output target to the enterprise with higher expected costs we have the result. The converse case immediately follows.

As the difference in the ages increases, so does the precision with which the expected

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16Of course, one reason why $p$ does not go to unity is that we have a finite number of periods. But, as we note in the text, there is a more fundamental reason.
marginal cost of the older enterprise is measured. Hence the \( p \) must increase.

As with Proposition 8, the linearity of the cost function weakens our statement of Proposition 9. Were we to relax this assumption, as the minister gained more precise estimates of relative costs, output targets would be adjusted so that the lowest cost enterprises had the highest targets. Linearity forces enterprises to produce at either the upper or lower levels of \( x \). Dropping linearity would lead to choices of \( x_{it} \) throughout the interval \([x, \bar{x}]\). In that case, the relationship between costs and size would be strengthened.

The previous two propositions imply that the growth of an enterprise tends to be largest when it is young. This follows, because the impact of an additional observation of performance on the minister’s evaluation of its likely productivity is greater the fewer the number of past observations. In other words, current performance has a greater effect on the minister’s posterior’s for younger enterprises. Hence, the minister will be more likely to revise the output targets for young enterprises.

In our simple model, only rarely will enterprises operate at levels other than their maximum and minimum capacities. One exception to this is the case in which an enterprise is the marginal productive enterprise and demand is insufficient to warrant its operating at capacity. Thus, the greatest opportunity for growth for a productive enterprise is in the first periods following its creation. Dropping the assumption of linearity would only strengthen this result, however, as in that case enterprises would not jump to either the upper or lower limit of the range of feasible outputs. Rather there would be a range of potential output values, and the number of enterprises that change size, at any age, would increase.

At this point, we would like to emphasize that enterprises do contract. Literature on the ratchet effect suggests that every enterprise is subject to increasing output targets over time. Here, we argue that this implication ignores constraints placed on ministers by limitations in demand and heterogeneity in enterprise productivity. Surely, an ambitious minister will attempt to maximize the performance of his and her sector, avoiding the pitfalls of creating a bottleneck in the economy or producing goods at low levels of productivity. A better expression of the implication of the ratchet effect is that it creates a tendency for tauter targets, perhaps not higher targets, at least not for every enterprise.

An interesting question that arises concerns the optimal response of the minister to observed low productivity of an enterprise. When enterprises are known to be identical, liquidation is not optimal. In this case the source of differing productivity must be the human assets of the enterprise.
If the source of low productivity is the skills and habits of enterprise employees, then destruction of the enterprise's assets might be unnecessary. A better director and set of workers might be able to employ the old enterprise's assets productively.

We emphasize that, even in cases in which the source of heterogeneity among enterprises is initially organizational, the assets of enterprises may begin to differ over time. Different management strategies lead to different levels of capital maintenance and process innovation. Under these circumstances, the effects of poor organizational structure can be so severe that the minister still chooses to close the enterprise. Note that our concern is with closing the enterprise, as opposed to bankruptcy, where only the ownership (in this case management) is changed. These considerations suggest that the absence of foreclosure in planned economies might be the result of a belief in the source of heterogeneity, rather than high exit costs.

4.0 Implications for Economic Reform

In this section, we consider the implications of our model for economic reform, in particular, in the Russian Federation. Current reform policies, such as privatization and anti-monopoly policy, are predicated on certain conventional beliefs about the structure of Russian industry. Our model of industry evolution is in stark contrast to the conventional view and, thus, has important consequences for the conduct of economic reform.

The conventional view is based on an informal model, which we refer to as the "cookie cutter" model. In this model, a Stalinist minister is assigned the responsibility of building a new industry. The minister studies the set of technologies available to produce the product to identify the efficient scale of production within a centrally planned setting. After this efficient scale is identified, the minister uses the cookie cutter to carve a set of identical factories at this scale to satisfy industrial development needs.

Clearly, the conventional model supports the view that Russian industry is very homogeneous. Each industry is populated by identical enterprises. Also, the model is often interpreted to suggest that industry is highly concentrated and dominated by very large enterprises. It is generally accepted that Stalinist ministers identified scales of production that were quite large, a phenomenon known as gigantomania. Eva Ehrlich [1985, p. 293] relates this bias quite simply, "In the socialist

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17However, much of our analysis is applicable to other formerly centrally planned economies.

18See, for example, Gregory and Stuart [1986, p. 143], Katz [1977, pp. 205-222], Woroniak [pp. 265-284].
countries, large size and economic efficiency were thought to be synonymous.\textsuperscript{19} Stalin, especially, preferred large scales of production because such enterprises stood out as impressive examples of Soviet industrialization. Moreover, by building fewer enterprises, the administrative costs of central coordination of production could be economized.\textsuperscript{19}

Our model suggests a very different picture of industrial evolution under central planning, one which emphasizes the presence of heterogeneity within an industrial sector. One way in which the two views can be distinguished is through an examination of the structure of industry under planning. The conventional view would predict that enterprises in a given sector would be of roughly the same size. Our model predicts that the variation in the size of enterprises would be quite large. Empirical analysis of the Russian case suggests that the industrial structure in Russia is, in fact, more heterogenous than the conventional wisdom would predict (Brown, Ickes, and Ryterman, 1993).

We note, however, that the industrial structure in Russia is less heterogeneous than in a market economy. Very small and very large firms account for a smaller share of total firms in Russia than in the U.S. This difference in the distribution of firms between countries appears to rest on differences in the cost of coordinating production in the two economies. Very large firms in the U.S. serve international markets. Often, they are multi-national, using advanced information technology to link firms located in different countries. In contrast, firms in Russia predominantly serve the domestic market. Under central planning, they did not have access to even the simplest information technologies, making inter-regional, let alone international, expansion difficult. Moreover, under central planning, less productive enterprises were using resources that, with exit, would have been allocated to more productive enterprises. Because the allocation of resources was sub-optimal, the ability of good firms to grow to their optimal size was constrained.

The absence of very small firms in Russia is not surprising, given the high cost of coordinating such firms centrally.\textsuperscript{20} This is also consistent with our model of industrial evolution, because of the nature of the entry process. Unlike a market economy, where entering firms are typically small, the entry process under planning is controlled by the minister. Enterprises become small when they are observed to be unproductive. In a market economy most of the small enterprises are transient; most will either grow into larger firms, or exit. Only a relatively small number stay

\textsuperscript{19}Fewer enterprises makes it easier to construct the plan and also reduces the costs of monitoring its implementation.

\textsuperscript{20}In our model, the assumption of a lower bound to the feasible size of the enterprise guarantees this result.
small. In our model there is less entry and no exit; the only source of small enterprises are entrants who have been observed to be relatively unproductive.

The industrial structure inherited from the period of central planning provides the initial conditions for the transition. According to the conventional wisdom, enterprises are homogeneous. Therefore, the conventional view suggests that the essence of the restructuring problem is the reallocation of resources between sectors towards comparative advantage, with ownership changes to improve internal efficiency. This is, no doubt, an important element of restructuring, but our model suggests that there may more to this problem than the conventional model suggests.

Our model of industry evolution suggests that productivity differences within sectors can be as important as differences between sectors. Productivity differences, in the absence of exit, led to a bi-modal size distribution of enterprises. Thus, there was a set of relatively small, high cost-enterprises that was operating at the onset of reform. Our model predicts that many of these enterprises were redundant, but continued to operate because exit costs were high.

This feature of the industrial structure suggests that intra-sectoral reallocation may be an important part of the process of economic reform. If the enterprises that are operating at the "absorbing barrier" are kept open, then the viability of the other enterprises and new private enterprises will be jeopardized. Less productive enterprises will compete for resources, including the limited pool of private savings. If the budget constraints of enterprises remain soft, then they might be able to compete quite successfully with more productive enterprises, jeopardizing the success of the transition. Thus, the viability of some enterprises may require that others be shut down.

This feature suggests that the historical performance (at least using conventional measures) of enterprises under planning may not be a proper guide to performance under the market because ministers operated enterprises at inefficient levels. If our model of industry dynamics is correct, the size distribution may reveal important information about the inherent productivity of enterprises.

Note that our model predicts that the best and most productive enterprises will tend to be the largest. This factor might have adverse consequences for competition. But, with reform, barriers to entry will be reduced, especially if capital markets are developed quickly. Hence, we argue that static competitive considerations ought not be given undue emphasis in the transition to markets.

5.0 Conclusion

Our model of industrial evolution under socialism is designed to capture the important features of economic selection under socialism in a simple and transparent way. As a consequence,
we have ignored several features of the planning environment that may have had an impact on the characteristics of some industries. To conclude this paper and motivate other research, we present a discussion of two of these features.

First, our model ignores issues of political economy that might be important. For example, suppose a mature sector experiences a technological shock, such as the discovery of a new, more efficient production process. If diffusion of this technology is difficult, particularly in large complex enterprises, then large enterprises that were efficient *ex ante* might become inefficient *ex post*. If these large enterprises are able to garner political support,\(^\text{21}\) then they might be able to undermine economic forces pushing for their contraction. However, it is unlikely that, in the future, they will be able to attract allocations of resources above current levels. Thus, over time, new and smaller enterprises will grow and eventually overtake these large enterprises in size.

Second, the industrial minister might not know the distribution of true productivities across potential enterprises. Thus, early in the planning horizon, the minister might be unable to determine whether a particular enterprise that is unproductive relative to existing enterprises can be expected to be unproductive relative to a new enterprise. Without knowledge of this distribution, the minister cannot evaluate whether the sector is a beneficiary of the "luck of the draw" or is performing at a more average level. Only by observing the performance of many enterprises over an extended period will the minister be able to estimate the characteristics of the productivity distribution. The minister might wish to speed up this process of discovery by creating more enterprises early in the planning horizon, thereby generating more knowledge about this important distribution at an earlier point in time. While this strategy might appear costly, possession of distributional information will improve the efficiency of decision-making over time.

\(^{21}\text{Large enterprises might be able to capture political support for two reasons. First, large enterprises tend to be older and, so, have had a greater opportunity to develop political connections they can use in times of distress. Second, large enterprises employ many workers. Political authorities might fear social unrest if the size of the enterprise is reduced.}\)
References


