SCHUMPETERIAN CREATIVE DESTRUCTION AND THE GROWTH OF CHINESE ENTERPRISES

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ABSTRACT: This paper simulates Schumpeterian Creative Destruction to study the potential impact of bankruptcy on Chinese economic growth. When the least efficient firms in each period are shut down, technological progress occurs by selection, yet a portion of the economy's productive potential is destroyed. As a result, industries without shutdown, such as those found in China's socialist economy, attain faster initial growth rates. Upon reaching maturity, however, these industries are outperformed by those with shutdown. The relative performance of socialist versus market industries depends, of course, on many factors. These include the number of firms closed, the dispersion of technology, depreciation and savings rates, the degree of diminishing returns, the method of allocating investment, and the scrap value of existing capital stock. The effect of these factors is estimated with a Monte Carlo response function. Creative Destruction can help explain the high growth of China's rural township and village enterprises, as compared to more mature state-owned enterprises. Immature industries grow faster because relatively inefficient firms remain small. In mature industries, however, inefficient firms may be quite large due to past performance, and diminishing returns to investment increase the relative importance of technological progress. If rural enterprises remain socialist enterprises protected from shutdown, growth will eventually slow as well. JEL Classification Numbers: C15, P27, P31.

1. INTRODUCTION

As China continues to adopt market mechanisms of price, profit, and competition in order to improve prospects for sustained growth, bankruptcy is once again being considered. The first bankruptcy of a state enterprise occurred in 1986, and the current bankruptcy law has been in place since 1988 (Liu, 1989), though rarely used until recently. There is today, however, a serious debate about shutting down inefficient state-owned firms; anecdotal evidence and newspaper reports both suggest that some small state-owned enterprises are in fact going bankrupt, being shut down or sold off in spite of political and ideological resistance.

There are several reasons for using bankruptcy as a tool to improve economic efficiency. Since the beginning of economic reform, the Chinese have recognized the need for reward and punishment in economic performance. The phrase is "You Sheng Lie Tai"—the good succeed and the weak are discarded. Enforcement of Chinese bankruptcy laws is seen as a way to harden the enterprise's budget constraint, to make examples of poorly managed enterprises in order to improve overall managerial performance. Underlying the Chinese
view is the belief that managers could be efficient if only they had the proper incentive and institutional arrangements.

Bankruptcy also helps to stem the hemorrhage of public funds into subsidizing money-losing firms. Prior to the dismemberment of the state sector’s industrial monopoly, enterprise profits were the primary revenue source for the state budget (Naughton, 1992). However, allowing competition has reduced profits and constrained government income even as the economy has expanded, a problem only compounded by policies allowing profit retention in order to improve managerial and worker incentive. Many once profitable enterprises have become drains on the state budget, either directly through subsidies or investment allocations, or indirectly through bank loans that are not paid back.

There is an additional but often ignored effect of bankruptcy, the effect of Schumpeterian “creative destruction.” Though bankruptcy is a threat to managers who fail to manage responsibly, it also serves as a means of correcting decisions made under uncertainty that turn out wrong. Since efficient institutions, resources, and technologies are often not identifiable until after the fact, a selection method such as bankruptcy improves average efficiency by destroying relatively inefficient arrangements. However, this has led to Marxist criticisms of capitalism regarding the waste caused by competition, part of which results from the firms and factories that must close their doors. Bankruptcy destroys a portion of society’s accumulated capital stock, and so the net effect of creative destruction is ambiguous.

This paper explains both the current and potential growth of Chinese enterprises with creative destruction. When bankruptcy is absent, as is the case in the socialist economy, new industries may grow faster than when it is present; older industries, however, will grow more slowly. The relative performance of state-owned and rural enterprises depends not only on differences in incentives and institutional arrangements, but also on their stage of growth. This is the primary conclusion of this paper, but it is affected by a number of factors. The efficiency of investment is crucial in determining the relative weight given bankruptcy’s creative and destructive sides, as is the presence of diminishing returns to investment.

This paper begins by first examining the performance of Chinese enterprises, particularly the differences between state-owned and rural township-village enterprises. While there are a number of explanatory factors for their different performance, neither sector currently has a working shutdown mechanism for large inefficient firms. The maturity of each sector may be an important factor, and this implies that growth in rural enterprises will also slow unless policies change. In the section following this discussion, the effect of creative destruction on growth is reviewed.

Next, this paper builds a simple model of creative destruction to show the effects of bankruptcy on economic growth. This model is then simulated using Monte Carlo methods, and several response functions are estimated to test the determining factors. The model predicts, first, that shutting inefficient firms down leads to faster technological progress. Second, creative destruction leads to slower economic growth in the short-run, but faster growth in the long-run, particularly when diminishing returns to investment are present. Because of this, the absence of creative destruction is a contributory explanation for the fast initial growth of state enterprises (and the centrally planned economies in general) in the past, as well as a contributory explanation for the rapid growth of Chinese rural enterprises; however, this absence also helps to explain the weakening relative performance of state firms at present. Creative destruction also has a lower negative tradeoff
when relatively efficient firms receive relatively more investment, suggesting an alternative strategy for avoiding large scale bankruptcies of state firms. Finally, the implications of the simulation are discussed in the final section.

II. THE PERFORMANCE OF CHINESE ENTERPRISES

In 1978, when economic reforms began in China, State-owned Enterprises (SOEs) dominated the industrial landscape, producing 76 percent of China’s nominal gross value of industrial output and employing 59 percent of all nonagricultural workers. Fifteen years later, the SOE’s share of nonagricultural employment slipped to 41 percent in spite of a doubling of state employees in government and education, and the SOE’s share of nominal gross industrial output fell to 43 percent in spite of average output prices that grew twice as fast as those outside the state sector. This change is one of the most striking characteristics of China’s emerging “Socialist Market Economy.” The plummeting share of the formal state-owned sector has occurred in spite of improvements in technical efficiency since reform began, and in spite of government intentions to the contrary. In early 1994, according to China’s State Statistical Bureau, almost half of China’s state enterprises were losing money, and state industrial output growth had slowed to zero. Economic reforms designed to force the SOEs to be responsible for their losses appear to be slowing as the costs of shutting firms down becomes apparent.

As production by SOEs has stagnated and their profits have fallen, output from other types of enterprises has grown rapidly. Urban collective enterprises grew rapidly through the mid-1980s before losing ground, and China’s new rural Township and Village Enterprises (TVEs) have expanded beyond all expectations. In 1980, TVEs and urban collectives combined accounted for 23 percent of gross industrial output; by 1993, this share rose to over 38 percent. Meanwhile, private firms, joint ventures, and foreign enterprises, along with the so-called individually-owned enterprises, have increased their combined gross output from less than one percent of the total to almost 19 percent. These other enterprises, particularly the rural TVEs, have helped to create a competitive atmosphere in which many state firms are unable to compete effectively.

TVEs have quickly grown from small rural sidelines into China’s second-largest industrial sector, and have improved productivity at a far faster pace than state enterprises. In contrast to state firms, where wage discipline has been lax, TVE productivity growth has exceeded the growth rate of wages. The superior performance of these rural enterprises is what Weitzman & Xu (1994) call the paradox of China’s township-village enterprises. The majority of these rural enterprises are quasi-state firms, and are still characterized by poorly-defined property rights of state firms, yet they are competing successfully. For political reasons (especially in the lower Yangzi basin, which is a major source of state industrial revenue), most rural enterprises operate like “vaguely defined cooperatives,” with no identifiable owner, no residual claimant, and no transferability of ownership rights by workers.

Sources such as the Asian Development Bank (1993, p. 221) and Lin (1990, p. 185), have contended that rural private enterprises often disguise themselves as collective enterprises to receive favorable treatment, to turn in part of their profit, pay administrative fees, or offer shares to the township and village governments to receive the protection of cooperative or collective production. But these firms are certainly in the minority. Rural enter-
prises in southern Jiangsu province, for example, are largely owned and tightly controlled by township and village governments. Enterprise managers simultaneously wear the hats of local party and state leaders, and make decisions about such things as new products, worker allocation, investment plans, and shutdowns without clearly segregated lines of responsibility and authority. Oi (1992, p. 100) describes this as "local state corporatism," a new institution between state and private ownership, in which "local governments have taken on many characteristics of a business corporation, with officials acting as the equivalent of a board of directors."

How is it possible that state enterprises are doing so poorly in China's growing economy, while quasi-state rural enterprises are doing so well? Aren't clear property rights essential? Weitzman & Xu (1994) argue that the paradox is resolved by a "cooperative culture" of rural people with strong long-term relationships and implicitly communal property rights. Another argument is that state ownership can be made more efficient by institutional changes promoting decentralization, autonomy, a harder budget constraint, and market competition.2

Both rural and urban collectives usually lack the state-owned enterprise's access to the state's deep pockets, and so may differ significantly in behavior due to the harder budget constraint. Rural enterprises have been "gap fillers," largely growing according to market opportunities without significant reliance on the state plan for guidance and resources. "The only people who support [the collective] are the customers," Stepanek (1991, p. 446) said, and even before the reform era urban collectives were often formed without governmental assistance to fill the gap left by state firms, and responsible for their own financial performance (Tang & Ma, 1985, p. 639). This lack of state guidance also means that the non-state firm was better able to find high-profit opportunities while the state firm usually faced pressure to continue to produce low-profit items.

TVEs, along with urban collective enterprises and foreign joint-ventures with state enterprises, are much more "entrepreneurial," according to Lardy (1992), since they pay a price for capital and inputs much closer to market-clearing levels, they pay wages based more on profitability, and they sell most of their output on the market rather than to the state-run commercial network. Furthermore, the rural township-village enterprises generally face a much clearer and consistent set of objectives than state enterprises, while state enterprises are often saddled with significantly higher social overhead costs in the form of housing, medical care, and numerous subsidies. The relatively poor performance of the formal state sector may be explained by unfavorable historically-based institutions, a soft budget constraint, and a lack of market discipline even as competition has intensified. The impressive growth of Chinese TVEs, on the other hand, suggests the benefits of decentralized market competition even when private property incentives are not in place.

There is another possible explanation, one that contributes to rather than replaces the effect of different incentives and institutional arrangements. The relative performance of SOEs and TVEs depends on the maturity of the enterprises, on their stage of growth, and this depends critically on the absence of bankruptcy. Historically, the centrally planned economics based on state-owned enterprises performed impressively in their early years. In almost all of these economies, however, star performers eventually turned into basket cases. In part, these economies reached the limit of easily-exploitable resources, incentive and motivation flagged, and the complexity of the economy eventually overwhelmed the ability to central planners to direct it. But there may also be significant effects resulting from simply the lack of free entry and exit. This paper will explore these effects.
Reforms in China have attempted to improve the efficiency of management in the SOE, so that it may keep up with the TVE. In the mid-1980s, these reforms focused on increasing enterprise autonomy, improving the manager’s concern for profits, allowing competition and the development of markets, reducing the role of the central plan, encouraging foreign trade, and rationalizing prices. Current reforms aim at weaning the SOE from the state by treating investment as a banking decision rather than a subsidization, and by transforming the management structure to make managers more accountable for their performance. Many Chinese reformers argue that these reforms will enable the SOE to survive and prosper. These reforms, however, are not enough.

III. CREATIVE DESTRUCTION AND GROWTH

The view that efficient management will result from proper incentives oversimplifies the production process. Rather than making clear moves toward a known technological frontier, a firm’s managers try new methods and machinery, as well as new products, market strategies, managerial methods, and employees. In a dynamic economy, risky decisions are made which may or may not turn out for the good of the firm. Good decisions are not known until after the fact, and while proper incentive may increase a manager’s probability of making good decisions, incentives alone do not explain economic growth. In a market economy, some firms fail. These bankruptcies lead to “industrial mutation,” says Schumpeter (1942/1950, pp. 83-85), an incessant revolution from within. The Schumpeterian concept of creative destruction may be described by the metaphor of evolution and the need for a selection device, in which “progress” occurs because the “least fit” are destroyed.3

Schumpeter used creative destruction as a critique of antitrust policies, arguing that perfect competition is inconsistent with technological innovation (Kirzner, 1973, p. 125). Monopolies are created out of competition, by “. . . the new commodity, the new technology, the new source of supply, the new type of organization” (Schumpeter, 1942/1950, p. 84). Romer (1990, p. S72) has used this approach to endogenize technological change in models of growth, on the premise that “technological change—improvement in the instructions for mixing together raw materials—lies at the heart of economic growth.” In Reinganum (1985), a single firm enjoys monopoly power in the short-run, but is eventually overthrown by another firm with a new innovation, while Geroski (1990) counters that monopolies stifle current innovation more than they act as a reward for past innovation. At equilibrium, as the growth model of Aghion & Howitt (1992) shows, the prospect of future research does discourage current research. Other aspects of the Schumpeterian logic include the view that recessions serve to destroy older, inefficient technologies (Cabellero & Hammour, 1994), that innovations create entrepreneurial waves leading to business cycles (Cheng & Dinopoulous, 1992) as well as product life cycles (Segerstrom, Anant, & Dinopoulous, 1990), and that the development of financial markets is a fundamental condition for sustained economic growth (King & Levine, 1993).

Creative destruction describes more than a process by which monopoly profits encourage innovation. It also describes a mechanism of economic evolution, in which the best technologies are chosen through a selection process. In his classic paper, Alchian (1950) argued that profit maximizing behavior in a market economy is ensured through this selection, since a lack of profit threatens a firm’s survival. In a socialist economy that has had a long period of development with such a selection device conspicuously absent, genetic
defects survive. Poznanski (1993) has applied a similar argument to the collapse of the socialist economies of Eastern Europe. As he explains,

This substandard dynamic efficiency [of Eastern European economies] can be attributed to the replacement of market coordination with a bureaucratic one, in particular with the substitution of an easy exit (i.e., bankruptcy) and easy entry mechanism with one that precludes the timely termination and formation of enterprises. The easy exit/entry is critical for technological progress since changes in production typically assume the form of "creative destruction," where innovations give rise to new entities that put out of business those using older techniques. (p. 10)

Many SOEs are characterized by inefficient and inappropriate technology, work habits, and institutions, as well as by products maladapted to market circumstances. Sufficient improvement in these existing firms is of small probability; major reorganization is necessary, and this may entail large scale layoffs and the closing of many plants even if the firm itself somehow survives in name. Rather than being a one-time event, this process will need to be ongoing. This metaphor also implies that some enterprises will survive and prosper, but indications are that the number of firms currently in trouble is dauntingly high.

To describe why Chinese SOEs are losing ground to the TVEs, this paper uses Schumpeterian creative destruction as an evolutionary fable in which competitive markets act as a device for natural selection, and by which technological progress results from random mutations. The Darwinian tone of this fable is only proper, for Schumpeter was an open admirer of Darwin (Jones, 1989). The problem with such a fable is that enterprises may be "genetically programmed" in a metaphor, but they are not in fact. John R. Commons substituted the term "artificial selection" for this process, as Atkinson & Oleson (1994, p. 979) point out, because humans can change both their conditions and their institutions. Unlike an organism, enterprises may be able to "rewrite their DNA" within their lifetime. It is possible that current managerial reforms may ultimately lead to a greater portion of state enterprises surviving than now seems likely.

Still, creative destruction offers some explanations for the performance of Chinese enterprises, and some predictions. As the simulation in the following sections will show, an economy without a selection mechanism will initially grow more rapidly. This is consistent with evidence in China and the Soviet Union that initial growth was quite rapid under central planning. As firms become increasingly differentiated over time, however, and as their capital-output ratio rises, growth will slow; this is consistent with slowing growth in Socialist economies before economic reform, and also consistent with the stubborn resistance of SOE performance to dramatic changes.

IV. A SIMPLE MODEL OF CREATIVE DESTRUCTION

Without a selection mechanism, firms become more heterogeneous over time. In this section, a simple model is defined in which \( n \) initially identical firms become unequal through random changes over time to their methods of production. This model illustrates the process of creative destruction when some number of the least efficient firms are closed in each period. In a real economy, these firms could be independent firms, and shutdown would be equivalent to bankruptcy; or they could be parts of a larger firm, resulting in plant closings or the dissolution of a subsidiary. This model describes shutdown's effects on technological growth and capital accumulation: for reasons of clarity its effect on managerial incentives is ignored, as is the interaction between monopoly and innovation.
The Production Function:

I define the basic model for the time path of growth by a simple production function, where output $Q$ for firm $i$ at time $t$ is a Cobb-Douglas function of efficiency $\eta$, labor $L$, and capital stock $K$:

$$Q_{it} = \eta_{it}K_{it}^{\alpha}L_{it}^{1-\alpha}, \ 0 < \alpha < 1.$$  \hspace{1cm} (1)

For simplicity's sake, labor is assumed fixed and set to unity in each firm, so that this production function can be rewritten as:

$$Q_{it} = \eta_{it}K_{it}^{\alpha}.$$ \hspace{1cm} (2)

Output is therefore a positive but diminishing function of the capital stock, where $\alpha$ is a returns to scale parameter. Additions to the aggregate capital stock come from savings $S$, which is a share $\zeta$ of the previous period's total output:

$$S_t = \zeta Q_t, \text{ where } Q_t = \sum_{i=1}^{n} Q_{it}.$$ \hspace{1cm} (3)

The savings share $\zeta$ is assumed to be positive, but less than one.

Efficiency and Creative Destruction

Suppose that firm efficiency $\eta$ depends on a variety of firm-specific events. These may include new products, technologies, managers, methods, worker characteristics, and institutional arrangements, as well as changing environmental and demand factors which affect the market value of the good being produced. I assume that these innovations and events occur randomly, like genetic mutation, and that this mutation affects efficiency multiplicatively rather than additively. In each period, the firm's efficiency depends on past efficiency in addition to new (normally distributed) random events that affect the firm proportionally, so that the firm's efficiency over time is a random walk in logs:

$$\Delta \ln \eta_{it} = \epsilon_{it}, \text{ where } \epsilon_{it} \sim N(\mu, \sigma^2).$$ \hspace{1cm} (4)

The process of creative destruction begins when the least efficient firms shut down. Suppose that in each of $t = 1$ to $T$ periods, $x$ firms close.\textsuperscript{6} These individual firms do not necessarily produce the same goods, so I may assume that there are a constant number of firms, and ignore the life cycle of specific products. When old firms shut down, a new firm picks up the fallen business license and enters the market with the previous period's average efficiency level. Assuming that firms in each period are sorted by increasing order of efficiency $\eta$, this can be written as:

$$\eta_{it} = \begin{cases} \bar{\eta}_{t-1} \exp(\epsilon_{it}), & \text{if } i \leq x \cr \bar{\eta}_{t-1} \exp(\epsilon_{it}), & \text{if } i > x \end{cases}$$ \hspace{1cm} (5)
A mean-zero normal distribution truncated on the left-hand side has a mean greater than zero, and so shutdown acts as a selection device that will lead to technological progress in excess of mean $\mu$. This technological progress depends on both the rate of shutdown ($\alpha / \eta$) and the standard deviation $\sigma$ of technological mutation. This fact is illustrated in Figure 1 showing the change in log mean efficiency for 30 identical experiments with $T = 50$ iterations each, $n = 1000$ firms, and $\mu = 0$, altering only the standard deviation and shutdown rates. Within each version $\Delta \ln \eta$ changes with $t$, but it clearly depends almost linearly on the shutdown rate and standard deviation.

If a firm is not shut down, capital stock is equal to the firm's gross investment $I$ plus the previous period's depreciated capital stock, where depreciation rate $\delta$ is positive but less than one. If a firm is shut down, the new firm which replaces it can enter with a small initial capital stock $K_0$. So the firm's capital stock is:

$$K_{it} = \begin{cases} 
K_0, & \text{if } i \leq x \\
K_{i-1}(1 - \delta) + I_t, & \text{if } i > x 
\end{cases}$$

(6)

The new firm has equal access to investment, but the capital stock of the firm it replaced ($K_{it} - K_0$) is lost unless it is mobile, and can be used by more efficient firms. Since the value of scrapped inputs (which could include human capital) is presumably affected by the development of financial and labor markets, the proportion of scrap value is also included in the model as an exogenous variable. Scrapped (or mobile) capital $M$ is assumed to have a non-negative value for other firms equal to a proportion $\nu$ of shutdown capital stock:

$$M_t = \nu \sum_{i=1}^{x} (K_{it} - K_0).$$

(7)

This scrap value re-enters the economy, and total gross investment is defined as the sum of both the previous period's savings and the scrap value of mobile shutdown capital:

$$I_t = \sum_{i=1}^{n} I_{it} = S_{t-1} + M_{t-1}$$

(8)

Assuming that it continues to survive, the logarithmic rate of output growth $g$ for the individual firm is equal to the rate of change in efficiency plus a function of the rate of net investment:

$$g_{it} \equiv \Delta \ln Q_{it} = \Delta \ln \eta_{it} + \alpha \ln (1 - \delta + \zeta I_{it}/K_{it-1}).$$

(9)

If $\delta = 0$, $\alpha = 1$, $\Delta \ln \eta_{it} = 0$, and $I_{it} = \zeta Q_{it-1}$, this rate of growth is approximately equal to the Harrod-Domar growth equation. Decreasing returns to scale, however, implies a rising capital-output ratio and a decreasing rate of growth over time.

Shutdown raises growth rates because it culls out low-efficiency firms, but lowers growth rates because it destroys capital stock. Figure 2 shows the growth rates from a typical exper-
Figure 1
Effect of Shutdown on Efficiency Growth
iment in which only shutdown rates vary and the scrap value of shutdown capital equals zero. In this experiment, \( T = 50, n = 1000, \zeta = 0.20, \delta = 0.15, \alpha = 0.50, \mu = 0, \sigma = 0.02, \nu = 0 \), investment is allocated according to the firm's share of output, and the same \( t \)-specific vector of random shocks to \( \eta \) is used for all five versions.

It is clear from Figure 2 that in this case higher rates of shutdown lead to lower initial growth and faster, if variable, long-run growth. In fact, a shutdown rate of one percent in this case not only results in faster growth by Period 18 but also a greater level of output by Period 38, the "crossover point." A five percent shutdown rate leads to faster growth by Period 19, and by the three final periods of the experiment this growth averages 0.7 percent higher per year, though total output has not yet “crossed over.” By Period 50, a five percent shutdown rate also leads to a 21 percent higher efficiency level.

Why does shutdown lead to slower growth in immature sectors and greater growth in mature sectors? First, when a particular sector (organized by institutional structure, not product market) is immature, the less efficient firms are likely to be smaller; in a mature industry inefficient firms have a history, and may have been efficient once and therefore may still be large. This would be affected, of course, by how firms grow. Second, diminishing returns to investment imply a larger weight for efficiency gains as the capital-output ratio increases. Many growth studies support this hypothesis, since capital investment consistently accounts for more than half of growth in capital-poor countries, yet less than half of growth in capital-abundant economies. Finally, it is also worth noticing that the different time paths are identical to those of “gradual” vs. “big bang” economic restructuring (Lin, Fang, & Zhou, 1994).

The Method of Investment

In Figure 2, investment was allocated based on output share. This method uses both past history (as embedded in the undepreciated capital stock) and present efficiency to determine the share of investment. Two other possible alternatives are considered: the first uses each firm's marginal product of capital to determine the market-clearing shadow price of investment, then allocates non-negative levels of investment accordingly; the last allocates investment on an equal share basis, to represent investment by planners when performance is not a factor. These methods allocate investment according to the following three formulae, where \( M1 \) is the marginal product method, \( M2 \) is the output share method, and \( M3 \) is the equal share method:

\[
M1) \quad I_{it} = \left( 1 - \delta \right) \sum_{j=1}^{n} K_{jt-1} + I_t \left[ \eta_{it-1} \left( \frac{1}{1-\alpha} \right) \sum_{j=1}^{n} \eta_{jt-1} \left( \frac{1}{1-\alpha} \right) \right]^{-1} - (1 - \delta)K_{it-1};
\]

\[
M2) \quad I_{it} = Q_{it-1} \left[ \sum_{j=1}^{n} Q_{jt-1} \right]^{-1} I_t;
\]

\[
M3) \quad I_{it} = \frac{I_t}{n}.
\]
Figure 2
Effect of Shutdown on Growth Rates

Change in log
It is important to note that at a given point in time, the aggregate level of investment is determined by equation (8) and is unaffected by the investment method. When firms are shut down, their current-period investment is reallocated to other firms (proportional to their current investment), as is the scrap value of capital from the shutdown firms.

Figure 3 illustrates the typical effect of the three methods of allocating investment on output growth. In these experiments, $\zeta = 0.15$, $\delta = 0.10$, $\alpha = 0.95$, and $x/n = 0.01$. Other variables are equal to those used in Figure 2. It is clear from Figure 3 that in the context of the above-described model, an allocation method which is at least partially determined by efficiency yields greater growth rates.

V. A SIMULATION OF THE MODEL

This section attempts a more systematic exploration of the costs and benefits of creative destruction in shutting down existing inefficient enterprises. This is done through a Monte Carlo simulation, in which multiple trials of randomly generated data are processed through the model described in the previous section. Several results are then regressed against explanatory variables to estimate response functions. With results that confirm the logic of creative destruction as well as the interplay of the underlying economic characteristics, this simulation further suggests the degree of magnitude of the offsetting effects.

Each experiment begins with a single set of basic parameters randomly chosen within reasonable ranges, and after $T = 50$ successive periods, generates six trial observations: three trials in which investment methods differ but there is no shutdown ($x = 0$), and three more trials in which methods differ and shutdown exceeds zero. For each period, one vector of $n$ normal random adjustments to efficiency are generated (see Equation 4), and this is used in all six trials for that period.

There are in all cases $n = 1000$ different firms. The basic parameters [and their ranges] are the shutdown number $x$ [1-50], the standard deviation $\sigma$ of the log-normal change in firm efficiency [0-0.05], the depreciation rate $\delta$ [0-0.25], the aggregate savings rate $\zeta$ [0.01-0.10], the elasticity of scale $\alpha$ [0.01-0.99], and the share of scrap value recovered $\beta$ [0-1]. The mean $\mu$ of a priori efficiency change is set to zero. There are 1250 experiments, for a total of 7500 observations. At the end of 50 periods for each observation, several results are generated. These include average growth, crossover period, shutdown size, and average efficiency.

These results can help to answer four questions relevant to Chinese industry.

1. What effect does the shutdown rate have on long-run growth rates, and how is this relationship affected by factors such as the investment method and others described above?
2. Since shutdown leads to lower initial growth, how long does it take an industry with shutdown to overtake one without it?
3. What are the effects of the underlying factors on the size of firms in trouble?
4. How is efficiency affected by the shutdown rate relative to other factors?

These questions will all be addressed using response functions which enable us to estimate both the magnitude and significance of the effects.
Figure 3
Effect of Investment Method on Growth Rate
Growth

The first result is the 50-year average growth rate of the average firm:

\[ G = \frac{\ln Q_{50} - \ln Q_0}{50} \]  

(11)

Following the approach of Parker (1994), this result is assumed to be a hedonic second-order function of the basic parameters \( (x, \sigma, \delta, \zeta, \alpha, \nu) \), as well as two dummy variables \( (M1, M2) \) representing investment Methods 1 (the marginal product method) and 2 (the output share method) relative to 3 (the equal share method). This second-order estimating equation is:

\[
G = \gamma_0 + \sum_{k=1}^{6} \gamma_k V_k + \sum_{k=1}^{2} \gamma_{Mk} M_k + \frac{1}{2} \sum_{k=1,j=1}^{6} \gamma_{kj} V_k V_j + \sum_{k=1,j=1}^{2} \gamma_{Mkj} V_k M_j.
\]  

(12)

where \( \gamma_{kj} = \gamma_{jk} \) for all \( k \) and \( j \), and the second order cross terms \( \gamma_{Mkj} \) for dummy variables are not estimable. This response function is estimated using ordinary least squares, and the results are shown in Table 1, which includes the mean coefficient estimates, coefficient standard errors, the mean of the dependent variable \( \mu_Y \), the standard error of the regression \( \sigma_Y \), the adjusted \( R^2 \) statistic, and the number of observations in the estimate.

As expected, the second-order interactive coefficients indicate that higher shutdown rates are more likely to improve growth rates the greater the dispersion of efficiency change \( (\gamma_{\sigma x} > 0) \), the greater the depreciation rate \( (\gamma_{x\delta} > 0) \), the greater the degree of diminishing returns \( (\gamma_{x\alpha} < 0) \), and the greater the share of scrap value recovered \( (\gamma_{x\nu} > 0) \). Shutdown is less effective when the output share investment method is used. A higher dispersion of efficiency change is also more likely to improve growth when depreciation is high, savings are low, the degree of diminishing returns is low, or either the marginal product or output share investment method is used.

The effect of returns to scale on growth is very significant as well. A low degree of diminishing returns (meaning \( \alpha \) is high) leads to higher growth when dispersion is high, the shutdown rate is low, the depreciation rate is low, the savings rate is high, or the scrap rate is high. Greater (that is, less diminishing) returns to scale also has more impact when the marginal product investment method is used or, to a lesser but still significant degree, when the output share method is used. The hypothesis that savings and depreciation have identical effects (with reversed signs) is tested, and with a \( \chi^2 \) statistic of 687.3 (with nine degrees of freedom), the hypothesis is rejected.

Care must be taken in interpreting coefficients in a quadratic expression, since the sign of the intercept is not inherently meaningful. Table 2 makes this interpretation possible through two methods. First, a first-order equation is estimated which imposes the restriction \( \gamma_{kj} = 0 \) and \( \gamma_{Mkj} = 0 \) for all \( k \) and \( j \). Second, the first partial derivatives are calculated for each observation using mean coefficient estimates from the original second-order response function, and the means are shown. For each basic parameter in the response function, two hypotheses are tested. The first joint hypothesis is that all coefficients in the partial derivative equal zero; the second applies this hypothesis to all but the first-order
Table 1
50-Year Average Growth Rate Response Function

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Coefficient</th>
<th>Estimate</th>
<th>Standard Error</th>
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<td>$\gamma_0$</td>
<td>-0.4847</td>
<td>(0.0356)**</td>
<td>$\gamma_3$</td>
<td>-0.0002</td>
<td>(0.0000)**</td>
</tr>
<tr>
<td>$\gamma_6$</td>
<td>-0.0340</td>
<td>(0.0178)*</td>
<td>$\gamma_c$</td>
<td>0.0089</td>
<td>(0.0178)</td>
</tr>
<tr>
<td>$\gamma_\alpha$</td>
<td>-0.1119</td>
<td>(0.0018)**</td>
<td>$\gamma_0$</td>
<td>0.0025</td>
<td>(0.0017)</td>
</tr>
<tr>
<td>$\gamma_M$</td>
<td>-0.0104</td>
<td>(0.0009)**</td>
<td>$\gamma_M$</td>
<td>-0.0041</td>
<td>(0.0009)**</td>
</tr>
<tr>
<td>$\gamma_{\sigma}$</td>
<td>3.5719</td>
<td>(0.5176)**</td>
<td>$\gamma_{\sigma}$</td>
<td>0.0068</td>
<td>(0.0004)**</td>
</tr>
<tr>
<td>$\gamma_6$</td>
<td>1.1632</td>
<td>(0.2394)**</td>
<td>$\gamma_{\sigma}$</td>
<td>-0.6222</td>
<td>(0.2275)**</td>
</tr>
<tr>
<td>$\gamma_{\sigma}$</td>
<td>0.7119</td>
<td>(0.0234)**</td>
<td>$\gamma_{\sigma}$</td>
<td>-0.0167</td>
<td>(0.0224)</td>
</tr>
<tr>
<td>$\gamma_{M1}$</td>
<td>0.2043</td>
<td>(0.0160)**</td>
<td>$\gamma_{M2}$</td>
<td>0.0881</td>
<td>(0.0160)**</td>
</tr>
<tr>
<td>$\gamma_X$</td>
<td>-1.99 $10^{-6}$</td>
<td>(5.12 $10^{-7}$)**</td>
<td>$\gamma_8$</td>
<td>0.0007</td>
<td>(0.0002)**</td>
</tr>
<tr>
<td>$\gamma_C$</td>
<td>0.0003</td>
<td>(0.0002)</td>
<td>$\gamma_{\sigma}$</td>
<td>-0.0001</td>
<td>(2.06 $10^{-5}$)**</td>
</tr>
<tr>
<td>$\gamma_{XU}$</td>
<td>0.0002</td>
<td>(2.00 $10^{-5}$)**</td>
<td>$\gamma_{M1}$</td>
<td>-1.01 $10^{-5}$</td>
<td>(1.44 $10^{-5}$)</td>
</tr>
<tr>
<td>$\gamma_{M2}$</td>
<td>-0.0001</td>
<td>(1.44 $10^{-5}$)**</td>
<td>$\gamma_8$</td>
<td>0.3323</td>
<td>(0.1302)**</td>
</tr>
<tr>
<td>$\gamma_{M2}$</td>
<td>0.1222</td>
<td>(0.2472)</td>
<td>$\gamma_{M1}$</td>
<td>-0.7084</td>
<td>(0.0120)**</td>
</tr>
<tr>
<td>$\gamma_B$</td>
<td>0.0135</td>
<td>(0.0116)</td>
<td>$\gamma_{M1}$</td>
<td>0.0110</td>
<td>(0.0083)</td>
</tr>
<tr>
<td>$\gamma_{M2}$</td>
<td>0.0083</td>
<td>(0.0083)</td>
<td>$\gamma_8$</td>
<td>-0.3969</td>
<td>(0.1227)**</td>
</tr>
<tr>
<td>$\delta^2$</td>
<td>0.7313</td>
<td>(0.0113)**</td>
<td>$\gamma_8$</td>
<td>-0.0416</td>
<td>(0.0109)**</td>
</tr>
<tr>
<td>$\gamma_{M1}$</td>
<td>0.0008</td>
<td>(0.0078)</td>
<td>$\gamma_{M2}$</td>
<td>0.0024</td>
<td>(0.0078)</td>
</tr>
<tr>
<td>$\gamma_{\alpha}$</td>
<td>0.0906</td>
<td>(0.0013)**</td>
<td>$\gamma_{M1}$</td>
<td>0.0057</td>
<td>(0.0011)**</td>
</tr>
<tr>
<td>$\gamma_{M1}$</td>
<td>0.0188</td>
<td>(0.0008)**</td>
<td>$\gamma_{M2}$</td>
<td>0.0052</td>
<td>(0.0008)**</td>
</tr>
<tr>
<td>$\gamma_0$</td>
<td>0.0009</td>
<td>(0.0012)</td>
<td>$\gamma_{M1}$</td>
<td>-0.0027</td>
<td>(0.0008)**</td>
</tr>
<tr>
<td>$\gamma_{M2}$</td>
<td>0.0008</td>
<td>(0.0008)</td>
<td>$\gamma_0$</td>
<td>0.0249</td>
<td>(0.0013)**</td>
</tr>
<tr>
<td>$\mu_Y$</td>
<td>0.0150</td>
<td>Obs. 7500.0</td>
<td>$\sigma_Y$</td>
<td>0.0080</td>
<td>Adj. R$^2$ 0.8289</td>
</tr>
</tbody>
</table>

Notes: ** Significant at 5 percent
* Significant at 10 percent

coefficient. Table 2 shows the Likelihood Ratio $\chi^2$ statistic as well as the degrees of freedom for each hypothesis.

The two sets of results in Table 2 are consistent and comparable. On average, over the 50 period span of this simulation, a higher shutdown rate leads to faster growth. This effect is statistically significant, though at the mean of the data the elasticity of $G$ with respect to $x$ is only +0.08. The effect of the dispersion of efficiency change is also positive, with an elasticity of +0.40 at the mean, as is the effect of increasing the scrap recovery rate, with an elasticity of +0.04. These effects are dwarfed in magnitude, however, by the elasticities of growth with respect to the savings rate (+2.47), the depreciation rate (-2.27), and the returns to scale coefficient (+1.51). There is also a significant impact on growth from using either the marginal product or output share investment methods; the first investment method alone yields a 0.4 percent higher average increase in output annually over the equal share method, while the output share method yields a gain of about 0.1 percent. While some individual terms in Table 1 are statistically insignificant, the joint hypothesis tests show that none of the explanatory variables may be either safely eliminated or restricted to a linear impact.
Table 2  
Impact of Variables on 50-Year Average Growth Rate

<table>
<thead>
<tr>
<th>Variable</th>
<th>Linear (First-Order) Regression</th>
<th>Mean of Calculated Partial Derivative</th>
<th>Significance of Partial Derivative</th>
<th>Significance of Second-Order Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Std. Err.</td>
<td>$\chi^2$</td>
<td>d.o.f.</td>
</tr>
<tr>
<td>$\gamma_0$</td>
<td>0.2471</td>
<td>(0.0104)**</td>
<td>0.25649</td>
<td>2554.9**</td>
</tr>
<tr>
<td>$\gamma_1$</td>
<td>0.0001</td>
<td>(9.36 \times 10^{-6})**</td>
<td>0.00010</td>
<td>757.9**</td>
</tr>
<tr>
<td>$\gamma_2$</td>
<td>-0.2232</td>
<td>(0.0054)**</td>
<td>-0.23391</td>
<td>5688.5**</td>
</tr>
<tr>
<td>$\gamma_3$</td>
<td>0.2117</td>
<td>(0.0051)**</td>
<td>0.21998</td>
<td>6038.5**</td>
</tr>
<tr>
<td>$\gamma_4$</td>
<td>0.0452</td>
<td>(0.0005)**</td>
<td>0.04578</td>
<td>11933.0**</td>
</tr>
<tr>
<td>$\gamma_5$</td>
<td>0.0013</td>
<td>(0.0005)**</td>
<td>0.00185</td>
<td>250.7**</td>
</tr>
<tr>
<td>$\gamma_6$</td>
<td>0.0041</td>
<td>(0.0004)**</td>
<td>0.00408</td>
<td>1001.3**</td>
</tr>
<tr>
<td>$\gamma_7$</td>
<td>0.0010</td>
<td>(0.0004)**</td>
<td>0.00103</td>
<td>231.5**</td>
</tr>
<tr>
<td>$\gamma_8$</td>
<td>-0.0262</td>
<td>(0.0006)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\mu_Y$</td>
<td>0.0150</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_Y$</td>
<td>0.0128</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adj. $R^2$ 0.5639

Note: ** Significant at 5 percent

How did shutdown affect growth rates in the long-run? An alternative specification of this restricted response function, which is not reported, used the average growth rate of only the final 10 years of the period as an indicator of growth rates once the short-run effects of shutdown are felt. With the exception of the scrap rate, which became insignificant, the results were consistent with the fifty year average.

Crossover

The results above conclude that higher rates of shutdown on average lead to higher growth over the 50 periods of this model, and shutdown also invariably leads to higher long-term growth rates once an industry has matured. What are the characteristics of those cases in which this faster long-run growth due to creative destruction catches up?

The second result of the simulation is the crossover point $C$, in which aggregate output with shutdown finally exceeds aggregate output without shutdown. If at the end of 50 periods the crossover has not yet occurred, then $C = 51$. Using a simple linear model and the Tobit method of estimation, the following equation is estimated for those observations in which $x > 0$, a restriction that cuts the sample size exactly in half:

\[
C = \tau_0 + \sum_{k=1}^{6} \tau_k V_k + \sum_{k=1}^{2} \tau_{Mk} M_k. \tag{13}
\]

The results, which should complement the above discussion on growth rates, are shown in Table 3. Consistent with the results for 50-year average growth rates, a quicker crossover occurs the higher the dispersion $\sigma$ (which affects the creation of technological progress), and a quicker crossover also occurs the higher depreciation $\delta$, sav-
Table 3
Crossover Year Tobit Response Function

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Asymptotic Standard Error</th>
<th>Coefficient</th>
<th>Estimate</th>
<th>Asymptotic Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tau_0$</td>
<td>-63.4190</td>
<td>(1.4140)**</td>
<td>$\tau_X$</td>
<td>0.0140</td>
<td>(0.0012)**</td>
</tr>
<tr>
<td>$\tau_0$</td>
<td>-3.4062</td>
<td>(0.5862)**</td>
<td>$\tau_\phi$</td>
<td>-7.0420</td>
<td>(0.6275)**</td>
</tr>
<tr>
<td>$\tau_0$</td>
<td>2.5212</td>
<td>(0.0675)**</td>
<td>$\tau_0$</td>
<td>-2.8833</td>
<td>(0.0680)**</td>
</tr>
<tr>
<td>$\tau_{M1}$</td>
<td>-0.4802</td>
<td>(0.0419)**</td>
<td>$\tau_{M2}$</td>
<td>0.3969</td>
<td>(0.0425)**</td>
</tr>
<tr>
<td>$\tau_0$</td>
<td>4.9179</td>
<td>(0.0973)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_Y$</td>
<td>11.9900</td>
<td>Obs. 3750.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Squared Correlation between Observed and Expected Values: 0.7127
Percent of Observations below Limit = 51: 77.2 percent

Notes: ** Significant at 5 percent
* Significant at 10 percent

ings \(\zeta\) or scrap rate \(\psi\) (all of which minimize the destruction of capital from shutdown). Crossover takes longer when shutdown \(x\) is higher or when \(\alpha\) is higher (that is, when returns to scale are less diminishing). Crossover takes less time when the marginal product investment method is used, but more time when the output share method is used. This is perhaps because allocating investment according to marginal product does not reward large, inefficient firms.

### Size

The superiority of allocating resources according to marginal product does not have to be argued, but one of the reasons the marginal product investment method is so successful is that when inefficient firms are closed down, not much capital stock is lost. This effect should be offset significantly when returns to scale are especially low for the bigger firms, and either higher depreciation rates or higher savings rates should make the inefficient firms relatively smaller more quickly. A high dispersion of efficiency should make the shut down firms smaller, while high shutdown rates should increase the relative size since more firms are included.

The third result of the simulation is the average size \(Z\) of the firms being shut down at \(t = 50\), as measured by capital stock, relative to the average size of firms not being shut down. Using ordinary least squares for a sample limited to \(x > 0\), the following equation is estimated:

\[
Z = \lambda_0 + \sum_{k=1}^{6} \lambda_k V_k + \sum_{k=1}^{2} \lambda_{Mk} M_k. \tag{14}
\]

Results for this estimation are shown in Table 4, and the results are consistent with those predicted above. The relative size of the shut down firms is smaller when \(\sigma, \zeta\) or \(\alpha\) is high, or when \(x\) is low. The marginal product method leads to a smaller relative shutdown size, since it reallocates investment to more efficient firms, while the output share method also leads to a smaller shutdown size (at half the magnitude of the first method, since the reallocation relies on efficiency more than the equal share method but to a lesser extent than the marginal product method). The effect of either \(\delta\) or \(\psi\) is insignificant.
### Table 4
Relative Shutdown Firm Size Response Function

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Coefficient</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda_\sigma$</td>
<td>-5.1879</td>
<td>(0.1743)**</td>
<td>$\lambda_\gamma$</td>
<td>0.0035</td>
<td>(0.0002)**</td>
</tr>
<tr>
<td>$\lambda_\delta$</td>
<td>-0.0309</td>
<td>(0.0850)</td>
<td>$\lambda_\beta$</td>
<td>-0.3048</td>
<td>(0.0904)**</td>
</tr>
<tr>
<td>$\lambda_\alpha$</td>
<td>-0.3106</td>
<td>(0.0088)**</td>
<td>$\lambda_0$</td>
<td>0.0077</td>
<td>(0.0085)</td>
</tr>
<tr>
<td>$\lambda_{M1}$</td>
<td>-0.3924</td>
<td>(0.0061)**</td>
<td>$\lambda_{M2}$</td>
<td>-0.1849</td>
<td>(0.0061)**</td>
</tr>
<tr>
<td>$\lambda_0$</td>
<td>1.3046</td>
<td>(0.0112)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\mu_Y$</td>
<td>0.8759</td>
<td></td>
<td>Obs.</td>
<td>3750.0</td>
<td></td>
</tr>
<tr>
<td>$\sigma_Y$</td>
<td>0.1520</td>
<td></td>
<td>Adj. $R^2$</td>
<td>0.6464</td>
<td></td>
</tr>
</tbody>
</table>

*Note: **Significant at 5 percent*

### Efficiency

The fourth result of the simulation is the average unweighted firm efficiency at $t = 50$. This average efficiency is defined as:

$$E = \frac{1}{n} \sum_{i=1}^{n} \eta_{i50}. \quad (15)$$

Since the efficiency index changes according to shutdown rates, but not according to investment method, only the observations of one method (both with and without shutdown) are used. The equation:

$$E = \beta_0 + \sum_{i=1}^{n} \beta_k V_k \quad (16)$$

is regressed on the basic parameters using ordinary least squares, and the results are shown in Table 5. These results show that a higher shutdown rate, together with a greater dispersion of efficiency changes, causes technological progress. In the long-run, this progress comes to dominate growth rates as the creative effect of shutdown overtakes the destructive effects.

### The Effect of Industrial Maturity on Creative Destruction

Results from the four response functions estimated above confirm a simple argument. Shutting inefficient firms down leads to faster technological progress, but this creative effect is dominated in an immature industry by the destructive effects of removing resources from use. In the long-run, this creative destruction leads to faster growth rates that will eventually surpass the output path of an industry that does not remove inefficient firms from production. This first result is a possible contributory explanation for the fast initial growth of the socialist centrally planned economies, as observed in the Soviet Union and elsewhere, and the eventual stagnation also observed: it is an explanation...
consistent with the limits of extensive growth in an economy unable to marshall significant gains in intensive use of resources. It also helps to explain why a new industry in a socialist economy might perform well even if it still suffers from the same fundamental institutional problems.

Creative destruction has costs and benefits, and creative destruction has a lower tradeoff when efficiency affects investment, or when scrapped capital stock can be reallocated. In addition to the natural efficiencies of using marginal product to allocate resources, the inefficient firms that are shut down are relatively smaller, since their investment is rationed long before they are closed. Though investment method does not affect average efficiency, it does change weighted efficiency since the efficient producers have more capital.

In an immature industry, the difference between inefficient and efficient enterprises is small, but over time inefficiencies can accumulate and this cumulative dispersion can become quite large. A policy of shutting down inefficient firms will in time destroy a relatively smaller section of potential output, since the inefficiencies have not accumulated. One strategy for rapid growth, therefore, is to use low rates of shutdown in an immature industry, and then increase this shutdown rate over time—a process mimicked by competitive markets as the product life cycle progresses.

**VI. IMPLICATIONS FOR CHINESE ENTERPRISES**

Fire is necessary to a healthy forest, to destroy dead wood and make room for new growth; some species even require fire to regenerate. In Yellowstone National Park, fires had been prevented for almost a century in spite of an "... ecological precedent—even an imperative—for mammoth fires" (Pyne, 1989, p. 45). Beginning in 1967, the U.S. National Park Service encouraged accommodation of naturally-caused fires. As the 1988 conflagration demonstrated, however, the philosophy that espoused an easy restoration of natural processes was overly naive.8

For almost half a century, China has been building an industrial structure for which the state is primarily responsible, and as in public sectors elsewhere, China's mature industries over time have become characterized by a wide dispersion of efficiency. Because the state sector lags behind both the growing private sector and the rural township-village enterprises, and because their continued subsidization is leading to severe macroeconomic costs, the Chinese government is facing the prospect of state firm layoffs and bankruptcies.

---

**Table 5**

Average Efficiency Response Function

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>Coefficient</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_\sigma$</td>
<td>4.7857</td>
<td>(0.0868)**</td>
<td>$\beta_k$</td>
<td>0.0061</td>
<td>(0.0010)**</td>
</tr>
<tr>
<td>$\beta_\delta$</td>
<td>0.0220</td>
<td>(0.0423)</td>
<td>$\beta_T$</td>
<td>-0.0391</td>
<td>(0.0450)</td>
</tr>
<tr>
<td>$\beta_\alpha$</td>
<td>0.0042</td>
<td>(0.0044)</td>
<td>$\beta_0$</td>
<td>0.0034</td>
<td>(0.0042)</td>
</tr>
<tr>
<td>$\beta_0$</td>
<td>0.9065</td>
<td>(0.0050)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\mu_Y$</td>
<td>1.1024</td>
<td>Obs.</td>
<td>2500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sigma_Y$</td>
<td>0.0618</td>
<td>Adj. $R^2$</td>
<td>0.7875</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: ** Significant at five percent*
Like the U.S. National Park Service, China faces the restoration of policies accommodating creative destruction with some trepidation, especially considering the political impact of high unemployment among former state employees in the absence of a workable social safety net. The argument and simulation made in this paper have several implications for the content of these policies.

1. The issue of bankruptcy will not simply disappear over time if left unaddressed. On the contrary, bankruptcy as a selection device will only become more important as China continues to develop, due to diminishing returns for capital and the increasing heterogeneity of Chinese firms. Managerial and financial reforms currently on the table are intended to make state firms act more like private ones, and bankruptcy is seen as a way of hardening the state firm's budget constraint and threatening managers who don't perform. The results here suggest that bankruptcies would still be inevitable in a more market-oriented economy even if all managers acted efficiently, since the future ideal technology and strategy depends on an uncertain environment. At a minimum, efficient enterprises must constantly face the need to shut down less efficient subsidiaries and operations. Shutdown as a selection device will lead to more rapid technological progress, and technological progress is more important than capital investment in the more developed economies. The effect of bankruptcy or shutdown is likely even understated in this paper, since the ability of potential shutdown to improve managerial performance has been ignored in the simulation.

2. It is possible to minimize the potential conflagration of widespread bankruptcy with an alternative strategy of gradual shutdown, one that keeps inefficient enterprises temporarily afloat but allocates additional investment towards more efficient firms. The simulation above suggests that investment method is almost as important as shutdown in the short-run, and a strategy of changing the investment method lacks the shutdown strategy's negative impact. Inefficient firms should shrink due to a lack of capital investment, reallocating resources toward the more efficient sectors, even if current expenditures are subsidized to prevent bankruptcy. Allocating capital according to its marginal product will alone improve growth, by about one-half percent per year in this simulation, and when bankruptcy does occur the shutdown firms will each be relatively small.

3. Another strategy to reduce the harmful impact of bankruptcy is to improve capital mobility so that the capital of shutdown firms has a greater scrap value. Not all inefficient arrangements are embodied in physical capital; encouraging firms to buy and sell capital from each other may ameliorate the reduction in capital stock that comes from bankruptcy. The key role Schumpeter gave to the development of financial markets for economic growth is justified, and China's financial reforms should be given priority. More effort should be made to develop institutions which encourage labor mobility, so that human capital is not entirely scrapped when state enterprises close.

4. The view that the rapidly-growing rural enterprise sector will turn out differently may be short-sighted. This simulation suggests that the TVEs will follow the SOEs into decline if local governments become unwilling to allow bankruptcies in the larger enterprises. In rural areas, local governments and enterprises are intertwined. Firms do go out of business, it appears, but the process takes into account much more than the economic viability of the business. Small firms are more often shut down than large ones, since their labor and other resources can be relatively easily reallocated to other firms. Rural governments do intervene in troubled enterprises to prevent their bankruptcy, a habit that will only become more entrenched as rural firms grow larger.
Superior relative performance of rural collective firms does not mean that these firms are efficient. More than one manager of a model TVE has expressed to me considerably more anxiety about increased competition from the small but growing and more efficient private sector than about the possible intervention of the less efficient but politically powerful formal state-owned sector. There is good reason for this anxiety, for in spite of their market-orientation it is likely that TVEs will become more like the SOEs as they mature.

When these rural enterprises accumulate history, and a portion of initially-efficient firms grows inefficient, creative destruction will become more necessary even as it becomes less likely. Large enterprises are often protected out of fear for high social costs, especially when the government is deemed responsible. Nor is the problem limited to socialist countries, since in both market economies and lesser developed economies the efficiency of public firms is much more widely dispersed between best and worst practice. Once efficient large firms may become inefficient, but still receive investment allocations or direct subsidization for current costs, as the current crisis in Chinese state-owned enterprises shows.

ACKNOWLEDGMENTS

The author wishes to thank Jeanne Wendel, Peter Brussard, Glendel Atkinson, and Ted Olesen for helpful comments, though they are in no way responsible for any remaining errors.

NOTES

1. In Wuhan, for example, five SOEs went bankrupt in 1993 (Tyler, May 6, 1994).
2. There is, however, very little evidence that local governments are significantly more willing to allow inefficient TVEs to shut down, particularly if they are large. The author's interviews found that local officials are loathe to allow significant numbers of workers to become unemployed, and bankruptcy is rarely used except for new, and small, enterprises.
3. The reader should be aware that this evolutionary metaphor is not intended to reflect Spencerian "social Darwinism," by which existing socioeconomic outcomes were ad hoc justified. The characteristics of fitness are not known a priori, but rather reflect the adaptive ability of a technological mutation to help the firm find a niche and survive.
4. In October, 1994, Vice-Minister of Trade Chen Qingtai admitted that SOEs would need to reduce employment by at least 20 percent in order to survive.
5. While poor production decisions are not immediately reversible, people can learn from experience and firms can change. Organisms, however, can only rewrite their DNA by the accumulation of genetic differences over many lifetimes.
6. In order to determine the effect of shutdown, this assumption makes shutdown exogenous. Alternatively, shutdown might be endogenous to the stage of growth or to the dispersion of inefficiency.
7. See Nafziger (1990, pp. 256-259) for a review of this literature.
8. The Tahoe Basin of the Sierra Nevada mountains may be a better, if less dramatic, example of the cumulative impact of fire prevention. Because of past suppression of fires which were generally not intense enough to kill large trees, fuel has built up and there is now severe danger from crown fires that can be fatal to the forest (Smith & Adams, 1991). Yellowstone, instead, has had mammoth fires every century for the past 3,500 years (Meyer, Wells, Balling, & Jull, 1992), so suppression may have made very little difference.
9. Of course, this intervention may occur regardless of formal ownership, as the U.S. government's Chrysler loan guarantees proved, but if local governments are also the managers of large inefficient enterprises, intervention is more likely.


REFERENCES


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Schumpeterian Creative Destruction and the Growth of Chinese Enterprises