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**THE RISE AND DECLINE OF THE  
EAST GERMAN ECONOMY, 1949-1989**

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## RÉSUMÉ

Pourquoi certaines organisations entrent-elles en déclin tandis que d'autres continuent de fleurir? Afin d'étudier cette question, nous introduisons le changement technologique dans une théorie de l'agence proposée par Laffont et Tirole. Nous démontrons que la forme optimale de l'organisation pour la production dépend de l'importance des économies d'échelle et du coût de la surveillance des employés. Quand l'écart entre les formes idéale et véritable devient trop grand, l'existence même de l'organisation est menacée. Nous vérifions cette hypothèse structuraliste pour l'Allemagne de l'Est et de l'Ouest sur la période 1949-1989. Le déclin relatif de l'Allemagne de l'Est s'explique par une structure institutionnelle qui s'est avérée incompatible avec le progrès technique qui favorise des organisations plus petites et plus plates.

Mots clés : organisation, risque moral, Allemagne de l'Est

## ABSTRACT

Why do some organizations decline while others do not? To study this issue, we introduce technological change into a theory of agency proposed by Laffont and Tirole. We show that the optimal organizational form for production depends on the extent of scale economies and on the cost of monitoring workers. When the discrepancy between ideal and actual forms becomes too great, an organization's viability is threatened. We test this structuralist hypothesis for East and West Germany over the 1949-1989 period. East Germany's relative decline is explained by an institutional structure that proved incompatible with technological change favoring smaller, flatter organizations.

Key words : organization, moral hazard, East Germany



## I. INTRODUCTION

During the first years after the fall of the Berlin Wall in 1989, there was considerable optimism that changes in economic policies would be sufficient to start the depressed economies of Eastern Europe along the path to economic prosperity (Sachs, 1991). In the light of disappointing growth and high unemployment, this initial policy optimism now seems to be giving way to what might be termed institutional pessimism. According to recent writings, the economies of the former Soviet bloc are weighed down by decades, if not centuries, of history inimical to rapid progress (Easterly and Fischer, 1994; Murrell, 1995). Such a position is consistent with the difficulties that most of these economies have experienced in the transition years. Yet it overlooks the high rates of growth obtained in East Germany during the first postwar decades.

The economic miracle of postwar West Germany is common knowledge: between 1950 and 1975, production rose at an average annual rate of 6.7 percent in real terms. Less well known is the economic miracle that occurred in the neighboring centrally planned economy to the east of the Elbe River. Over the same period, real output in East Germany increased by an average of 7.4 percent a year.<sup>1</sup> Then, beginning in the mid-1970s, the motor of East German growth stalled and the economy entered into a prolonged tailspin, as displayed in Figure 1. The imminence of a severe economic crash was one of the principal factors that brought about the fall of the state's regime in the autumn of 1989.<sup>2</sup> Subsequently, from mid-1990 to early 1993, total output fell by approximately 40 percent. Overall the combined record of both rapid growth and decline suggests that something may be missing from previous accounts that have focussed on economic policy and social institutions.

**[Insert Figure 1 about here.]**

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<sup>1</sup> Because of differences between the material product system of the East and the national accounts system of the West, these rates are not strictly comparable.

<sup>2</sup> For the details of East German economic policy and its effects during this period, see Dennis (1993).

How can the rise and fall of the post-war East German economy be explained? The question is important because this country offers one of the few well-documented cases of a complete cycle of growth, stagnation, and collapse in a national economy. A theory of economic growth should be able to explain not only the cases of success but also the instances of failure. The aggregate data presented in Figure 1 therefore provide an opportunity to test the robustness of existing theories of economic growth under an unusually complete set of conditions.

One possible starting point for an answer to this question is the neoclassical theory of economic growth. As proposed by Solow (1956, 1957), this theory permits an economy's total output growth to be broken down into components explained by the changes in each aggregate factor of production, along with an unexplained residual. Further research by Lucas (1988), Romer (1986, 1990), and Barro (1991) suggests that the key to decomposing the residual is to take account of changes in accumulated knowledge, many of which are incorporated into human capital. Over time, the neoclassical approach predicts convergence to a steady-state growth path, as Barro and Sala-I-Martin (1992, 1995) have demonstrated. How, then, may a sustained period of divergence such as that experienced by East Germany in the 1970s and 1980s be explained?

Implicit in the neoclassical approach is the hypothesis that the society's institutions remain unchanged. If this theory's predictive power is to be improved, it is therefore natural to ask what happens when the set of rules under which resources are allocated (constitutions, laws, and regulations) and the institutional forms within which economic agents interact (associations, partnerships, firms and markets) are modified. The theory of the firm of Coase (1937) and Williamson (1985) and the theory of institutions proposed by North (1981, 1990), suggest that resource allocation may be very sensitive to the transaction costs of measuring and enforcing.<sup>3</sup> Progress occurs when institutions evolve in a direction that reduces transaction costs through a succession of small changes. In the case of postwar eastern

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<sup>3</sup> Richter (1992) compares these new institutional theories with those proposed by earlier generations of economists.

Europe, transactions-costs theorists would argue, institutional decline occurred because the degree of competition was too low to assure the selection of an efficient path (North, 1990, 95, 110). The difficulty in applying this approach to East Germany, however, is that during the first three postwar decades the path chosen by the socialist government was very successful in generating economic growth. What happened after 1970?

The dynamic theory of interest-group formation proposed by Olson (1982, 1995) offers a possible answer to this question. Given enough time, he suggests, there will form within any organization coalitions whose object is to divert the organization's resources to their own particular ends. As these groups become more powerful, the organization weakens and finally collapses. However, virtually all organizations have internal mechanisms such as auditors and performance-review procedures to defend themselves against such internal predation. Under what circumstances do these internal defences break down? In terms of the approach of Wintrobe and Breton (1986), when does efficient vertical exchange within an organization become unable to control inefficient horizontal exchange? More specifically, why was the West Germany economy able to become a dominant force on world markets while its twin in the east collapsed?

To explain these sharply different case histories, this paper proposes a structuralist theory of institutional change in which technical progress plays a major role.<sup>4</sup> It opens two of the black boxes that economists have found convenient for compressing complicated interactions into simple formulas. One of these boxes is that of the firm, or rather the choice of organizational form for production. Tirole (1986), and Laffont and Tirole (1991, 1993) have modeled decision-making by individuals within hierarchical structures. Using multi-level principal-agent models, they demonstrate that standard rules of efficiency must be compromised in order to correct for information asymmetries. However, they do not examine how an entrepreneur selects the most appropriate organizational form.

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<sup>4</sup> For a review of structuralist explanations of productivity change, see Lipsey and Bekar (1995).

Section II below addresses this problem. It proposes three polar forms of productive organization: the vertical firm, the atomistic competition, and the horizontal firm. The choice depends on two technological parameters: first, the extent of potential scale economies and second, the probability of being able to monitor workers' effort. If scale economies and monitoring probability are both low, atomistic competition will be favored. If scale economies then rise, large, vertically structured organizations with multiple decision-making levels become efficient. Paradoxically, however, an increase in the probability of monitoring does not lead to still further increases in the steepness of organizations. Because the costs of correcting for information asymmetries rise, it becomes cheaper for the principal to monitor the agent directly rather than to hire an intermediary to do so. Flatter firm structures will therefore be favored.

The second black box to be opened is that of technological change. Rosenberg (1982), Mokyr (1990) and others have studied in detail the conditions under which new product and process innovations occur and are disseminated. To date, however, there has been little systematic application of the hypothesis of Innis (1951) that communications technology is the key to explaining relationships within an organization. Yet the historical evidence of Chandler (1977) suggests that such technologies are crucial to the choice of organizational form for production.<sup>5</sup>

In Section III, following Innis, we distinguish two dimensions of information processing; namely, transmission and storage. We argue that a decrease in information transmission costs, with storage costs remaining high, will create important scale economies in organizations. It will become efficient to concentrate information storage at a central point where decision-making will be located. Orders will then be issued for inexpensive transmission to lower levels in the hierarchy. We suggest that a fall in information storage costs for given transmission costs will make it cheaper for the principal to monitor the

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<sup>5</sup> In the early 1850s, for example, David McCallum of the Erie Railroad was one of the first to use the telegraph -- by means of hourly reports -- to coordinate the activities of multi-leveled, geographically dispersed agents from a central point (Chandler, 1977, 103).



performance of individual agents. Rather than delegate supervisory tasks, and install expensive incentive mechanisms to assure that managers report correctly, she will prefer to interact directly with the agents under her. Consequently, an increase in the probability of observing the agents' behavior will result in a flatter organization structure.

For a given set of technological parameters, there will be some size and structure of organizations that maximizes an economy's total output. The smaller the 'distance' of an economy's actual industrial organization from this ideal form, the greater will be total output. To date there has been no shortage of analyses of the difficulties of transition in Eastern Europe. Because of a lack of reliable data, however, few have attempted to subject their hypotheses to statistical tests. Prior to its collapse, the regime in the German Democratic Republic completed preparation of a consistent set of national and sectoral accounts covering the entire period from 1949 to 1988. In Section IV, we combine these data with those of the Federal Republic of Germany in order to test our structural hypothesis against the competing neoclassical and institutional theories of growth.

## II. THE SELECTION OF ORGANIZATIONAL FORM

In the new institutional economics of Coase (1937), Williamson (1985), and North (1981, 1990), transaction costs determine the boundary between individual producers and the firm. When such costs are low, individuals use the market to transact with one another; when these costs are high, one individual will purchase the labor services of the others and resource allocation will occur within a firm structure. However, the formation of a firm does not dispense with transaction costs: within a firm, employers must somehow provide incentives for workers to supply effort in a direction that furthers the firm's goals. What, then, determines the size of a production unit and the structure of its internal organization?<sup>6</sup>

### *Atomistic individuals*

One possible form of organization is made up of atomistic producers. Assume that each such worker receives a certain income,  $w^*$ .

### *The horizontal firm*

In another form of organization, one individual purchases the labor services of a second. Assume that there are two types of individuals; namely, a small proportion with entrepreneurial abilities who are risk-neutral and who may play the role of principal, and a larger proportion without such abilities who are risk-averse and must play the role of agent (or, in the following section, supervisor). Consider, following Tirole (1986), the problem of one such principal who attempts to maximize the expected output of a good,  $x$ . The amount produced depends on the effort,  $a$ , of an agent and on a random variable,  $v$ , which takes either the value zero or the positive value,  $\theta$ . Let the relationship take the following linear form, where  $n$  represents the state of nature:

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<sup>6</sup> The model presented in this section is based on that of Tirole (1986). For a more complete discussion of moral hazard and its implications for organizational design, see Tirole (1988, 15-60) and Milgrom and Roberts (1992, 166-247).

$$x_n = a_n + v_n, \quad v_n \in \{0, \theta\}.$$

When a principal forms a firm, there are therefore two consequences. First, her expected earnings change, due to the scale economies of joint production. Second the variance of her earnings increases. For simplicity, we capture the first of these effects in a single parameter,  $\theta$ , the upper value of the productivity shock, and the second in  $\sigma$ , the probability of this favorable value. Thus  $\theta$  may be thought of as a measure of the importance of *scale economies* -- the (uncertain) gain when the firm replaces atomistic production.

The principal is assumed to be able to observe the level of output but not necessarily the agent's effort,  $a$ , or the productivity shock,  $v$ . If  $\sigma$  is the probability of the favorable state, and  $\rho$  is the probability that the agent's effort is observed, there are four possible states of nature, with probabilities represented by  $p_n$ ,  $n=1, \dots, 4$ .

State ( $n$ )	Probability ( $p$ )	Productivity shock ( $v$ )	Information of principal
1	$(1-\sigma)\rho$	0	0
2	$(1-\sigma)(1-\rho)$	0	?
3	$\sigma(1-\rho)$	$\theta$	?
4	$\sigma\rho$	$\theta$	$\theta$

Note that  $\sigma = p_3 + p_4$  and  $\rho = p_1 + p_4$ .

The problem the principal faces is to determine the levels of the agent's effort,  $a_n$ , and his salary,  $w_n$ , that maximize the expected net value of output,

$$E(x) = \sum_n p_n [a_n + v_n - w_n], \quad (1)$$

subject to the behavior of the agent. Let the disutility of effort to the latter be a strictly-convex increasing function,  $g(a)$ , of the effort he makes. The agent must be at least as well off as in his next best alternative occupation, where he would obtain the utility associated with the certain wage,  $w^*$ :

$$\sum_n p_n U[w_n - g(a_n)] \geq U(w^*). \quad (2)$$

If the principal were perfectly informed concerning the agent's effort, she would require him to work in each state until the marginal disutility of that effort were equal to its marginal product. Let the optimal level of effort be  $a^*$  and the salary required to induce that effort be  $w^*$ . Now consider the possibility of slacking.

In state three, when the productivity shock is positive and the agent is not observed, the latter has an incentive to lie about the state of nature. By asserting that the true state was state two, he can reduce his effort by the amount of the shock. In order to remove this incentive to distort information, the agent's wage net of effort when he tells the truth must be at least as great as when he lies:

$$w_3 - g(a_3) \geq w_2 - g(a_2 - \theta). \quad (3)$$

As Tirole has shown, the solution to this revised problem calls for a reduction in the state-two wage and an increase in the state-three wage until the incentive to slack has just disappeared:

$$w_2 < w_1 = w_4 = w^* < w_3. \quad (4)$$

However, because of the additional constraint, (3), the efficiency of the system is reduced. The agent supplies the first-best level of effort in all but the second state, where he now makes a reduced effort:

$$a_2 < a^* = a_1 = a_3 = a_4. \quad (5)$$

Note that if the agent lies in state three, declaring that the technology shock was

unfavourable, he has nothing to gain. For not pulling his weight, he is penalized by being deprived of part of the lost output. If he tells the truth, however, he receives as a bonus a portion of the extra production.

In the *size* decision, the principal must decide whether to set up this firm organization or remain a self-employed worker and earn the certain wage,  $w^*$ . For the organization of a firm to be worthwhile for the principal, it must provide an expected income,  $\pi_H$ , at least as great as her opportunity cost as an atomistic producer:

$$\pi_H \equiv \sum_n p_n (v_n + a_n - w_n) \geq w^* \quad (6)$$

Assume that when the principal reduces the state-two wage, she cuts the effort required from the agent by the same amount; that is,  $w^* - w_2 = a^* - a_2$ .<sup>7</sup> Then inequality (6) may be written:

$$a^* - w^* + \sigma[\theta - \delta_w + \rho\delta_w] \geq w^* \quad (7)$$

where  $\delta_w \equiv w_3 - w^*$  is the wage premium given to the agent in state 3.

Allow  $\theta$  and  $\rho$  to vary and consider the cases where the two types of organization are equally profitable. From (7), we have:

$$d\theta/d\rho = -\delta_w < 0. \quad (8)$$

In Figure 2, the horizontal axis measures the probability,  $\rho$ , that the agent's productivity is observed while the vertical axis shows the importance of scale economies,  $\theta$ . Equation (8) then takes the form of the negatively sloped line, *GB*. For a given level of the observation-

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<sup>7</sup> Because the agent's income now varies across states of nature, his expected wage net of effort must rise if his expected utility is to remain equal to the reserve level. By allowing utility in state two to fall by less than the wage, this assumption allows the necessary risk premium to be distributed between states two and three.

probability parameter, an increase in the scale-economies parameter increases the efficiency of the firm compared to atomistic producers. Similarly, for a given level of scale economies, an increase in the probability of observing the agent increases the profitability of the firm relative to the atomistic individual.

**[Insert Figure 2 about here.]**

### *The vertical firm*

Given the choice of firm as production unit, will a flat structure such as that of the horizontal firm described above be optimal?<sup>8</sup> Suppose that if the principal is freed from supervisory work to concentrate on other activities (for example, marketing the product), the scale economies arising from the firm structure increase from  $\theta$  to  $(1+\lambda)\theta$ , where  $\lambda > 0$ . She may then decide to hire a (risk-averse) supervisor to monitor the agent's effort in her place, offering to pay the supervisor a salary,  $s_n$ , that depends on the state of nature.

The ability of the principal to obtain the optimal effort at the optimal wage in the fourth state (when productivity is both high and observed) requires that the supervisor truthfully report what he sees. It is therefore in the agent's interest to persuade the supervisor not to reveal this information, for then the agent will receive the higher state-three salary.<sup>9</sup> Two other constraints must therefore be added. Together, the agent and supervisor must not receive a higher combined salary in state three, when the supervisor has no information, than in state four when he is able to observe the state of nature:

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<sup>8</sup> The distinction between vertical and horizontal coordination structures plays an important part in Aoki's (1986, 1990) comparisons of American and Japanese firms. Whereas Aoki uses the concept of bounded rationality, the model presented here assumes information asymmetries among fully rational agents.

<sup>9</sup> A typical form of collusion between supervisor and agent in centrally planned economies was for the former to set 'soft' targets that could be exceeded by the latter without undue effort.

$$s_4 + w_4 - g(a_4) \geq s_3 + w_3 - g(a_3). \quad (9)$$

In addition, it cannot be in the two employees' combined interest to claim state two when state three occurs:

$$s_3 + w_3 - g(a_3) \geq s_2 + w_2 - g(a_2 - \theta). \quad (10)$$

When (1) is maximized subject to (2), (3), (9) and (10), the following solution is obtained:

$$\begin{aligned} s_2 &= s_3 < s_1 < s_4 \\ w_2 - g(a_2) &< w_1 - g(a_1) < w_3 - g(a_3) < w_4 - g(a_4) \\ s_4 + w_4 &= s_3 + w_3 \\ a_2 &< a_1 = a_3 = a_4. \end{aligned}$$

It will be assumed that the supervisor and agent decide separately how to divide the amount  $s_n + w_n$  between them.

Is it worth the principal's effort to operate within this vertical firm structure? Once again, she must ask whether to set up her own firm or to be a self-employed worker and earn the certain wage,  $w^*$ . For the firm to be worthwhile, her expected income,  $\pi_v$ , from this vertical firm must be at least as great as her opportunity cost as an atomistic individual.

$$\pi_v \equiv \sum_n p_n (v_n + a_n - w_n - s_n) \geq w^* \quad (11)$$

Let  $s_1 = s^*$ ,  $s_2 = s_3 = 0$ , and  $\delta_s \equiv s_4 - s_1$ . She is therefore indifferent between the two forms of organization when:

$$a^* - w^* - \rho s^* + \sigma[(1+\lambda)\theta - \delta_w + \rho(\delta_w - \delta_s)] = w^* \quad (12)$$

The combinations of  $\theta$  and  $\rho$  that leave the principal indifferent between the vertical firm and individual employment are given by:

$$\frac{d\theta}{d\rho} = -\frac{\delta_w - (s^*/\sigma + \delta_s)}{1+\lambda} < 0. \quad (13)$$

In Figure 2, equation (13) is represented by the negatively sloped line,  $CD$ . As before, for a given level of the observation-probability parameter,  $\rho$ , an increase in scale economies,  $\theta$ , raises the efficiency of the vertical firm relative to atomistic individuals. However, a comparison of equations (8) and (13) reveals that the boundary between firm and individual organizations is less steeply sloped than in the case of the horizontal firm. Due to the slippage from providing an incentive to the supervisor to tell the truth in state four, a change in the probability of observing the agent has less impact on the outcome than it did in the case of the horizontal firm, where the principal herself did the monitoring. From inequalities (8) and (13), we have the following proposition.

**PROPOSITION 1.** The efficiency of the firm relative to atomistic producers increases with (a) the extent of scale economies, and (b) the probability of observing the agent.

To determine which type of firm is more appropriate, the left side of (12) must be compared to the left side of (7). The principal will be indifferent between the two firm structures for combinations of  $\rho$  and  $\theta$  that satisfy:

$$\sigma[\theta - \delta_w + \rho\delta_w] = \sigma[(1+\lambda)\theta - \delta_w + \rho(\delta_w - \delta_s)] - \rho s^* \quad (14)$$

The slope of the boundary  $EF$  between the vertical- and horizontal-firm zones in Figure 2 is therefore

$$\frac{d\theta}{d\rho} = \frac{(s^*/\sigma) + \delta_s}{\lambda} > 0. \quad (15)$$

This line is positively sloped. A rise in the productivity shock favors the vertical firm because of its greater productivity. To maintain equality (14), one must make it easier for the principal in a horizontal structure to keep watch over the agent. From inequality (15), we



have a second proposition.

**PROPOSITION 2.** The efficiency of a vertical relative to a horizontal firm structure: (a) increases with the extent of scale economies, and (b) decreases with the probability of observing the agent.

The second part of this proposition seems somewhat paradoxical. One might have expected that the greater the ease of monitoring, the more an entrepreneur would prefer a hierarchical structure, because of a diminution of the loss of information between levels of the organization. However, we must ask what the principal gains if the agent's effort can be observed more easily. Under a horizontal firm structure, as the right side of (8) indicates, if the agent's effort can be observed, the principal avoids paying a premium of  $\delta_u$  to the agent, when the productivity shock is favorable, in order to prevent the latter from slacking. Under a vertical structure, as the right side of (13) shows, this gain is offset by the premium of  $\delta_s$  that must be paid to the supervisor, when the latter observes the true state of nature, in order to prevent him from colluding with the agent. In short, the flatter the organization, the more the principal benefits from increases in the probability of observing the agent.

Thus the choice of organizational form for production depends on two technological parameters. First is the scale-economies parameter ( $\theta$ ), a measure of the importance of the expected productivity gain when workers come together to form larger units of production. Second is the monitoring-ease parameter ( $\rho$ ), the probability that agent's effort level may be accurately recorded. When both of these measures are low, atomistic production will be chosen. When scale economies are high but agents are difficult to monitor, a vertical firm structure will be selected. And when scale economies are low but agents are easy to monitor, a horizontal firm structure will be preferred.

## II. THE IMPACT OF INFORMATION TECHNOLOGY INNOVATIONS

In the preceding section, it was shown that production can occur under three different institutional forms: atomistic competition, the horizontal firm and the vertical firm. The choice depended on two parameters, the first a measure of scale economies, and the second a measure of monitoring ease. However, this formulation only begs a further question: what determines the values of these two parameters?

A firm may be viewed as an information system in which individuals participate in order to overcome the limits of their own capacity to process information. Such a system requires two basic elements. First, it needs a way of *storing* information; that is, a means of codifying that information in storable form, of maintaining the resulting records over time, and of retrieving them for later use. From the first states in antiquity to the corporations of the late nineteenth century, hand-written records were the dominant form of permanent information storage. Over the past century, typed records, punched cards, and more recently, magnetic tape, silicon wafers and laser disks have transformed information storage technology. Second, a firm must have a means of *transmitting* information effectively. Since antiquity, couriers have been used to relay written messages at the speed of a person walking or on horseback. However, over the past century and a half, the railroad, telegraph, telephone, radio, airplane, television, and microwaves have each permitted an acceleration in transmission speeds. At any one time, the size and structure of an organization will tend to be shaped by the relative costs of these two dimensions of information handling.

Let us now examine how information costs might affect the two key parameters of the organizational-choice model of the previous section. Consider first the scale-economies parameter,  $\theta$ . For given production technology, the potential scale economies from the formation of a firm will be determined by the cost of transmitting information from management to workers. A reduction in transmission costs, other things being equal, will make it more efficient for an entrepreneur to send out directives to her employees and to receive feedback on their activities. Accordingly,  $\theta$  will be a decreasing function of the cost,

$t$ , of transmitting a unit of information.

$$\theta = f(t), \quad f' < 0. \quad (16)$$

Turn next to the monitoring-ease parameter,  $\rho$ . Management control (monitoring) involves (i) the setting of standards, (ii) the measurement of performance (iii) the evaluation of that performance relative to the standards. Information storage costs are important in all three areas: (i) the setting of standards requires a knowledge of past performance; (ii) the precision of the measurement depends on storage costs; (iii) evaluation requires comparison of two sets of stored information. A fall in the cost of storing information will therefore increase the probability that the principal will be accurately informed of the agent's effort when the time comes to evaluate the latter's performance. Therefore, the probability of observing the agent will be a decreasing function of unit storage costs.

$$\rho = h(s), \quad h' < 0. \quad (17)$$

Equations (16) and (17) enable us to predict the impact of innovations in information technology on the choice of organizational form. Assume that initially information storage and transmission costs are both high. In Figure 2, we are in the zone of the atomistic producer. If transmission costs fall leaving storage costs unchanged, it will become more profitable to organize large-scale production units. As a result, there will be an upward movement in Figure 2 from the zone of atomistic production to the zone of the vertical firm. Information will be stored centrally and directives issued to workers. Assume, now, that information storage costs fall, leaving transmission costs unchanged. As the cost of monitoring decreases, entrepreneurs will find that they can do away with intermediate levels whose main role was to monitor those who produce. Organizations will be flatter, with more direct contact between top management and workers. In Figure 2, we move from the area of the vertical firm to that of the horizontal firm.<sup>10</sup>

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<sup>10</sup> If both scale economies and the ease of monitoring are high (in the region of point F in Figure 2), one would expect that both forms of firm structure would be able to compete with

The theoretical model of Figure 2 suggests that at any one time there is an *ideal* organizational form that may be indicated by a point such as *I*. Now at any given moment because of delays in adjustment to changes in information transmission and storage costs, the *actual* form of the organization may be at some position other than the ideal point. Let the actual organizational characteristics be represented by the point *A*. Then the distance, *d*, between the ideal at *I* and the actual at *A* is a measure of the extent to which the organization has lagged in adopting a form appropriate to information handling. The greater this distance, the lower the rate of growth in productivity will therefore tend to be.

Let us admit, then, that the performance of an economy will tend to decrease with the 'distance' of its industrial organization from an ideal organization that minimizes information-processing costs. How might this distance be calculated in practice? First, we must determine the ideal state. In the case of East Germany, we have an obvious benchmark in the economy of the West Germany. Let us then define the production organization of West Germany as the ideal and inquire how it was affected by technological change. We can then compare the East German situation with this reference point.

How has information technology changed in the last few decades? During the nineteenth century and the first half of the twentieth, the most important innovations in information processing involved improvements in the *transmission* of information. The steamship, the railroad, the telegraph, the telephone, the automobile and the airplane all reduced the cost of sending information over space. Because of the falling cost of transmission and continuing high cost of storage, it was efficient to collect information at a central point, transform it, and then redistribute the result at a very low marginal cost. Equation (16) allows us to predict that such a fall in information transmission costs would raise the scale-economies parameter,  $\theta$ . In Figure 2, we will therefore have an increase in the size of the representative productive unit.

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each another. In West Germany in the 1970s, highly centralized firms such as Volkswagen and AEG coexisted with flatter organizations such as AUDI and Siemens-Bosch.

What actually happened? Figure 3 catches the last decades of this trend, showing that average firm size in West German manufacturing did increase during the 1950s and 1960s. In East Germany, individual firms were not autonomous: most of the economy was run as a state holding company. Therefore the corresponding measure is the share of workers in socialist industry; that is, the relative size of the state-owned part of industrial production. This measure too increased throughout the 1950s and 1960s.

**[Insert Figure 3 about here.]**

Although the replacement of small firms by large corporations had permitted great gains in productivity over the period from the middle of the nineteenth century to the middle of the twentieth, by the late 1960s, the transformation was virtually complete. If further growth were to occur, it would be necessary to reduce the cost of information storage, which had remained virtually unchanged since the introduction of paper in the late middle ages.

One step toward a solution came in 1959, when researchers at Fairchild Semiconductor and Texas Instruments succeeded in combining two existing technologies. The planar process for printing electronic circuits onto a wafer of silicon was combined with the transistor (developed at Bell Labs in 1948) to yield the integrated circuit. A second step came in 1971, when engineers at Intel combined the integrated circuit with the electronic computer, designing a single chip that would contain the entire central processing unit of a simple computer.<sup>11</sup> After 1973, the cost of integrated circuits fell by an average of 30 percent per year (Forester, 1987, 27). With the development of increasingly powerful and rugged mini-computers able to survive even on the shop floor, it became possible for management to monitor virtually all aspects of a firm's activities electronically (Athey and Zmud, 1988, A-9). The new technologies were quickly transferred to Eastern Europe. Indeed, in the 1980s, East Germany became the COMECON's second most important producer of electronic circuits after the U.S.S.R.. The giant *Kombinate* -- Zeiss, Jena and Robotron -- were the

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<sup>11</sup> For a more detailed description of these innovations and their effects on organizations, see Dudley (1991, ch. 8).

eastern bloc's principal suppliers of mid-sized and microcomputers. Robotron typewriters were even able to compete successfully in markets in the West.

How did these developments affect the organization of the corporate sector in the two Germanies? The structural parameter used in the theoretical model -- the probability that the agent's effort can be observed -- cannot be measured easily. Nevertheless, there is a proxy that might be used. The new information technologies generate productivity gains by allowing firm managers to replace expensive human supervisors with cheaper electronic monitoring systems. Because the expertise involved in the new technologies tends to be general rather than firm-specific, the most efficient way to do so is to purchase inputs for the monitoring process from providers of business services outside the firm. Examples of such outsourcing are for accounting, computer programming, communications, management consulting, legal and financial services. If this argument is correct, then the change in the share of the labor force in private services relative to a base period provides an approximate measure of the ease with which firm managers can monitor their workers directly.

As shown in Figure 4, the private service sector in West Germany grew extremely rapidly after 1970. From about one-fifth of the labor force in the 1960s, it climbed to about one-third in the mid-1980s. Over this period, there was no corresponding shift in the East German economy. Private services remained confined to about one-tenth of the labor force. In terms of the internal structure of the corporation, then, the distance between West and East widened sharply after 1970.

**[Insert Figure 4 about here.]**

The developments in microelectronics also have implications for firm size. As mentioned above, in adopting flatter structures, firms are in essence replacing human supervisors with computerized information systems.<sup>12</sup> As a result, the number of employees per firm could be

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<sup>12</sup> An example of simultaneous outsourcing and downsizing is the spinning off by Daimler-Benz of all its internal consulting activities into a separate firm, DEBIS.

expected to fall. From the early 1970s on, Figure 3 shows, the average size of firms in West Germany fell (with cyclical fluctuations), as large firms began to downsize and small firms absorbed most of the new entrants to the industrial labor force. However, no such development occurred in the East. Far from releasing its grip on the economy, the state sector in East Germany economy actually continued to expand in terms of its share of total workers. During the 1970s and 1980s, the last independent firms were incorporated into the giant state *Kombinate*.

The question that must now be asked is whether these growing discrepancies in organizational structure and size between East and West Germany help explain the increasing divergence in economic performance between the two economies that began in the mid-1970s.

## IV. AN EMPIRICAL TEST

To assess the structuralist explanation of East Germany's economic decline presented in the preceding section, its implications for economic growth must be tested against the principal competing theories. Define the following variables:

$y$  = growth rate of real product

$I$  = investment

$Y$  = real product

$n$  = growth rate of labor force

$K$  = capital stock

$S$  = production subsidies

$d_{\text{SIZE}}$  = absolute difference between actual and ideal organizational size

$d_{\text{STRUC}}$  = absolute difference between actual and ideal organizational structure

$e$  = random disturbance

In his neoclassical growth theory, Solow (1957) proposes the following specification, where both coefficients are expected to be positive:

$$y = \beta_1 I/Y + \beta_2 n + e \quad (18)$$

Endogenous growth models of Lucas (1988) and Romer (1986, 1990) suggest that the rate of productivity growth rises with the accumulation of human capital. Assume that for given investment, such human capital may be represented by cumulative past investment experience.<sup>13</sup> We then have:

$$y = \beta_1 I/Y + \beta_2 n + \beta_3 K/Y + e, \quad (19)$$

where  $\beta_3$  is expected to be positive. Kornai (1980, 1982) has noted that because of the soft

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<sup>13</sup> An alternative measure of human capital based on educational levels, often used for intercountry comparisons, was not appropriate for East Germany, since the country's already high educational levels changed little over the period.



budget constraints, firms in centrally planned economies tend to hoard labor (along with raw materials) as an insurance against possible future shortages. The sign of  $\beta_2$  is therefore ambiguous.

If transactions costs are the key to long-run growth as North (1981, 1990) has argued, and if the evolution of the institutions that determine such costs is highly path-dependent, one would expect to find high autocorrelation in the residuals. If rent-seeking is the problem, as in Olson (1982, 1995), then the level of subsidies with respect to income should have a negative impact on growth rates. In the following equation, therefore,  $\beta_4$  is expected to be negative.

$$y = \beta_1 I/Y + \beta_2 n + \beta_4 S/Y + e . \quad (20)$$

A final specification is compatible with the structuralist model of the preceding section, in which productivity growth is a decreasing function of the distance between ideal and actual organizational forms. The firm-size dimension,  $d_{\text{SIZE}}$ , is measured by the absolute difference between East-German and West-German organizational-size indices.<sup>14</sup> As for firm structure,  $d_{\text{STRUC}}$ , it is captured by the absolute difference between the shares of total employment in private services in the two economies. Each of the distance coefficients has a negative expected sign:

$$y = \beta_1 I/Y + \beta_2 n + \beta_5 d_{\text{SIZE}} + \beta_6 d_{\text{STRUC}} + e . \quad (21)$$

We estimated these models in nested form for the period from 1949 to 1988. The East German series that make up the greatest part of our data set were taken from the *Statistical Yearbook* of the German Democratic Republic of 1989. West German data to calculate the distance variables came from several editions of the *Statistical Yearbook* of the German Federal Republic. We also added a dummy variable, *CAT*, to take account of the three years of major disturbances (catastrophes) to the East German economy. In 1953, production was

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<sup>14</sup> For East Germany, we used the share of total workers in socialist industries; for West Germany, the average number of employees per firm.

disrupted when workers in East Berlin took to the streets. In 1961, there was a major exodus of skilled workers until the construction of the Berlin wall stemmed the outflow. Finally, in 1982, the East German economy suffered a major balance of payments crisis when the prices of raw materials it imported from the Soviet Union were sharply increased.

The results for the basic neoclassical model are presented column (1) of Table 1. They indicate that the investment had a significant impact but that output changes were unrelated to employment growth, as Kornai's hoarding hypothesis predicts. Evidence of high first-order autocorrelation is compatible with the path-dependency that characterizes the transaction-costs approach. When the experience variable is added in column (2), all three neoclassical variables become insignificant. It is the autocorrelation coefficient that carries the day. This picture persists in column (3) when the rent-seeking variable, the share of subsidies in total income, is included. Neither it nor any of the other economically meaningful variables is significant.

**[Insert Table 1 about here.]**

Column (4) adds the two variables chosen to measure the 'distance' between the production organizations of East and West Germany. It may be seen that differences in firm size and structure between the two economies have a significant negative impact on the rate of growth in total factor productivity. Not only do these new variables have a significant negative effect on growth, as the structuralist model predicts, but also their inclusion eliminates the evidence of significant autocorrelation. In addition, the experience variable,  $K/Y$ , becomes highly significant while the rent-seeking variable,  $S/Y$ , appears to also play some role (it is significant at the 10 percent level). These results suggest that although new technologies were rapidly diffused in East Germany in the 1970s and 1980s, insufficient attention was given to their efficient application. Finally, in column (5), when the autocorrelation correction is dropped, the estimates remain essentially unchanged.

These results help us to understand the steady fall in East Germany's economic growth

rate after the mid-1970s. They indicate that the most important determinants of this decline were neither slower growth of factors of production nor a lack of human capital, as suggested by the revised neoclassical model. The decline in growth rates occurred despite substantial investments, rapid labor force growth, and continued accumulation of investment experience. Nor did the problem lie in the internal decay of the society's institutions, whether due to incremental evolution in a direction unfavourable to progress or to cumulative rent-seeking over time. Over the first three postwar decades, the economy performed remarkably well.

Why, then, did the East-German economy gradually collapse after 1975 while its West German twin continued to prosper? The crucial factor, these results suggest, was a shift in the direction of technological change that proved incompatible with the steeply hierarchical organizational structure that had been chosen by the East German authorities. By relentlessly reducing the cost of storing information, the development of successive generations of integrated circuits dictated a shift to simpler and shallower decision-making structures. While the institutions set up in West German after the Second World War successfully made the transition to the 'information society', the East-German economy remained committed to top-heavy monoliths making increasingly obsolete industrial products.

## V. CONCLUSION

How can the rise and decline of the post-war East German economy be explained? Why, after a remarkable performance in the first two post-war decades, did its rate of growth fall precipitously from the mid-1970s on, while its twin in the West continued to expand? It was our hope that in attempting to answer these questions we could shed light on the more general issue, raised by Olson (1982), of why organizations decline. We have therefore proceeded to open two of the traditional black boxes of economic theory and then subject the resulting conjectures to an empirical test.

The first black box to be opened was that of the firm. Applying the agency model of Tirole (1986) and Laffont and Tirole (1991, 1993), we were able to identify three polar forms of productive organization: the vertical firm, atomistic competition, and the horizontal firm. The choice depends on two technological parameters: first, the extent of potential scale economies and second, the probability of being able to adequately monitor workers' effort.

The second black box was that of technological change. Following the theory of communications proposed by Harold Innis (1951), we focussed on information technology, distinguishing two dimensions of information processing -- transmission, and storage. We argued that innovations in each dimension favor a particular type of organization. Innovations in information transmission encourage the emission of directives from a centralized command point in a vertical structure, while improvements in information storage favor a flat firm with decentralized decision centers. For given inputs and a given set of technology parameters, there will be some form of firm organization that maximizes production. The shorter the 'distance' of an economy's actual structure from this ideal structure, the greater will be total output.

We then tested the model's predictions with data from the German Democratic Republic over the period 1949-1988. The steady decline of this country's growth rate after 1975 is not well explained by either neoclassical or institutional models. Rather, a structuralist

explanation that takes account of the nature of technological change seems necessary. During the first part of post-war period, the existing information technology favored centralized decision-making (the vertical firm). Thus the centrally planned institutions set up by the East German authorities were able to generate rapid growth. During the 1970s and 1980s, however, there was a profound shift in the direction of technological change that favored smaller and less centralized production units (the horizontal firm). Unwilling or unable to adjust to the requirements of the new information technologies, the East-German regime could no longer generate the surplus it required to survive.

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Table 1:  
 Explanations of annual growth rate of real product,  
 German Democratic Republic, 1950-1988

Variable	Neo-classical growth		Rent-seeking	Structuralist	
	Exogenous	Endogenous		(4)	(5)
	(1)	(2)	(3)		
<i>I/Y</i>	0.420** (0.085)	0.549* (0.298)	0.403 (0.277)	0.205* (0.115)	0.174* (0.093)
<i>n</i>	-0.114 (0.188)	-0.100 (0.204)	-0.072 (0.213)	0.163 (0.232)	0.269 (0.223)
<i>K/Y</i>		-0.007 (0.016)	0.007 (0.015)	0.031** (0.004)	0.033** (0.003)
<i>S/Y</i>			-0.377 (0.269)	-0.239 (0.151)	-0.224 (0.153)
<i>d</i> <sub>SIZE</sub>				-0.113** (0.040)	-0.128** (0.037)
<i>d</i> <sub>STRUC</sub>				-0.132* (0.056)	-0.132** (0.048)
<i>CAT</i>	-0.020** (0.004)	-0.020** (0.004)	-0.019** (0.004)	-0.021** (0.005)	-0.022** (0.005)
RHO 1	0.813** (0.040)	0.815** (0.036)	0.762** (0.063)	0.241 (0.153)	
adj. <i>R</i> <sup>2</sup>	0.886	0.884	0.883	0.905	0.902
Log-L.	130.0	130.2	130.6	135.8	134.6

Notes: dependent variable = growth rate of real product; *I/Y* = investment as share of real product; *n* = growth rate of labor force; *K/Y* = ratio of capital stock to real product; *S/Y* = ratio of subsidies to real product; *d*<sub>SIZE</sub> = absolute difference between East and West German indices of corporate size; *d*<sub>STRUC</sub> = absolute difference between East and West German shares of employment in private services; *CAT* = 1 for crisis years 1953, 1961 and 1982, otherwise zero; standard errors in parentheses; \* significant at 5 % level; \*\* significant at 1% level.

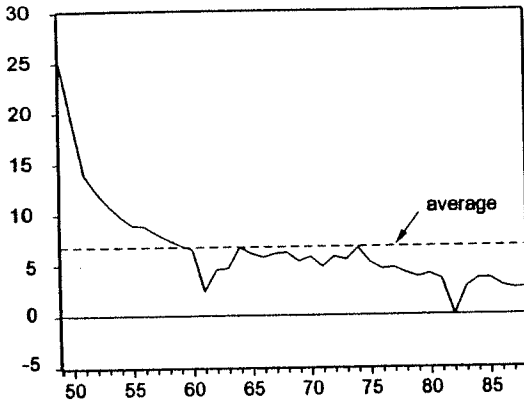


Figure 1. Percentage growth rate of real product, GDR, 1949-1988

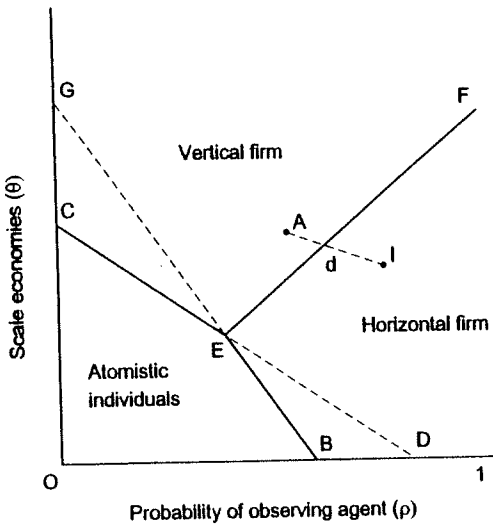


Figure 2. Three organizational structures

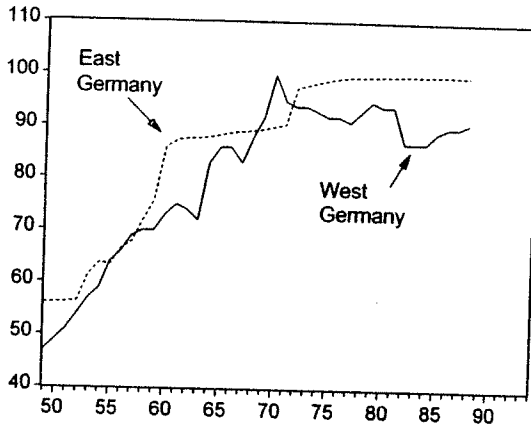


Figure 3. Firm size: indices of employment in socialist industry (East Germany) and workers per firm (West Germany), maximum = 100

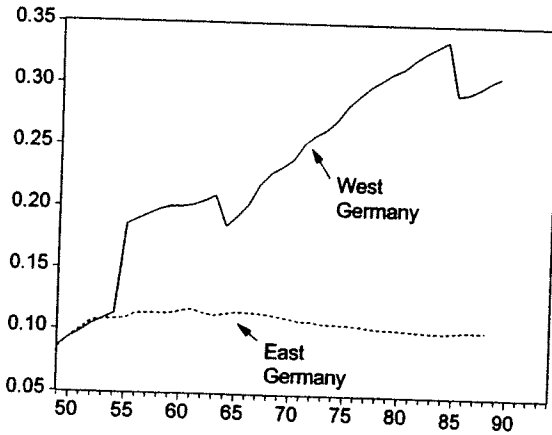


Figure 4. Firm structure: share of employment in private services, East and West Germany



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