THE INCENTIVES APPROACH TO THE DESIGN AND DOWNFALL OF THE PLANNED ECONOMY

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> "Never has the plan of alteration been more imperfectly thought out. ... Not for one day could the economic state of the future be administered according to any such reading of value." (Wieser, 1893, p. 65).

Institutional System: Efficiency versus Stability

Despite Wieser's dictum, the former Soviet Union was administered according to the socialist theory of the planned economy for 74 years. Moreover, together with its East European allies, it was the only country in history which attempted to seriously challenge the economic superiority of property rights enforcement based on private ownership and monetary exchange and has attained the goal of industrialization and building up a military machine which was rivaled only by that of the United States. As will presently be shown, to a large extent the performance of the planned economy was assisted by the parallel functioning within it of another system based on incentives and implicit exercise of property rights which were totally different from what was officially envisaged. However the formal system of property rights of the socialist state had remained in force right until

the collapse of communism.

In this system, property rights for plants, machines and equipment ("means of production" in Marxist jargon) were alienated from individuals and "collectivized". Private transactions in means of production naturally had to be prohibited, severely restricting the domain of free exchange and the use of money. Control over means of production and production itself "was firmly vested with the central authority" (Schumpeter, 1987, p. 167).

The conventional view of "collective ownership" over means of production interprets the resulting property rights as diffused to the point of being very hard to enforce (see, for example, Demsetz, 1995, p. 50). That was undoubtedly true of the late stages of the planned economy when its incentive mechanisms, as argued below, were already to a great extent destroyed (and it is also true of the present-day transition economy). However, the early stages of the planned economy when the system operated in full strength present a rather different picture. "Collective ownership" of the type which could be observed, for instance, in the former Soviet Union under the rule of Stalin exemplifies not extreme egalitarianism, but quite the opposite situation of extreme concentration of wealth. In the theoretical model below this essence of the institutional organization of the planned economy is captured by specifying the initial distribution of assets under which only one agent (the dictator) owns everything while no other agent owns any single productive asset of the economy (see also the evidence discussed after the presentation of the model).[2]

The "collective" (dictatorial) property rights were not just well

delineated formally. They were also very stringently enforced, in fact much more stringently than private property rights are usually enforced in non-totalitarian economies. For example, there are records of court cases in the Soviet Union in 1930s in which peasants at collective farms or workers at industrial plants were sentenced to years of hard labor for stealing literally a handful of crops from the "collective" field, or for leaving their workplaces for a couple of minutes. Thus anybody who was caught trying to appropriate his or her part of "collective" ownership without due sanction was very severely punished.[3]

It does not require proof nowadays that such a control by the central authority is inefficient (from the conventional viewpoint of consumers' welfare) as compared to the decentralized market economy, at least for the current state of technology. However, relative inefficiency of an institutional system would not necessarily cause its instability let alone breakup (North, 1990, pp. 92-93). If the institutional system of the planned economy is considered as relatively autonomous, with high transaction costs involved in "exiting" from it (those costs were being consciously inflated by the authorities by limiting the exchange of goods, people, and information with the rest of the world), the well-known factors of path-dependence and lock-in (North, 1990, p. 94) can be brought up to argue that the system will be stable unless we can find disruptive factors within its own incentives mechanism. Accordingly, we must be interested not so much in relative inefficiency of the planned economy in comparison to a market economy, but in discerning those elements within the former's own system of incentives which have led it to an ultimate collapse.

Moreover, the discussion above suggests that the very meaning of "efficiency" is different between the planned economy and a conventional market economy. In the theoretical planned economy all assets are owned by one agent, the dictator. Thus the planned economy might be thought of as functioning "efficiently" when it functions strictly in accordance with the plan set up by this dictator (by the planning authorities). Now this is precisely the situation which a conventional economist, trained to look at things from the consumers' welfare point of view, would be tempted to brand "inefficient". The key observation bridging the gulf between the two concepts of efficiency is that in a conventional market economy, too, not all preferences of the consumers, but only that part of those which is backed by effective demand matters. The allocation of resources should then be considered to be "Pareto-optimal" in the theoretical planned economy as well, in the sense that any departure from it would necessarily hurt the dictator.[4]

The above argument should by no means be interpreted as a "justification" of the planned economy. "If preventing the burning of Rome would have made Emperor Nero feel worse off, then letting him burn Rome would have been Pareto-optimal. ... A society or an economy can be Pareto-optimal and still be perfectly disgusting." (Sen, 1970, p. 22) The system of the totalitarian economy in the former Soviet Union indeed represented one of the most disgusting systems ever created on our planet. Still more interesting is the insight obtained from the analysis below. That is, regardless of any considerations with respect to consumer welfare (or human rights) taken from other more palatable

economic and social systems, *the totalitarian economy contained the seeds of self-destruction within its own incentives mechanism.* In other words, even if tremendous economic inefficiencies (from the conventional viewpoint) are directly incorporated into the "social welfare function" of the socialist economy as determined by the preferences of its dictator (whatever reservations one may have against defining such a "social welfare function" in the first place), the inner logic of development will inevitably bring it to a stage at which it starts malfunctioning with respect to its own purpose (the conventionally defined efficiency, on the other hand, may in some cases be improving as a result of this).

Before turning to this crucial theme of our analysis, however, we must take a closer look at the similarities and differences between the institutional mechanisms of enforcement of private and "collective" property rights and the implications for incentives.

I. SOME INTRODUCTORY DISCUSSION

Property Rights and Firms Governance in the Planned Economy and in a Market Economy

Private property over means of production is theoretically well defined and can always be exercised by selling the asset in question.[5] Money in its function as the store of value represents the social institution which makes those property rights visible and exercisable. Protection and enforcement of property rights is a function of "the third party", the state, which uses coercion if necessary to ensure adherence to the prevailing institutional rules of the game. However it is generally not the threat of sanctions which makes economic agents

obey the constitutional order. "Ultimately ... authority is viable to the extent that it is the focus of convergent expectations. An individual obeys authority because he expects that others will obey it." (Arrow, 1974, p. 72) This is particularly evident in the institution of fiat money, which serves not only as the medium of exchange of goods between consumers but also as a measure of claims on social assets.

The system of property rights enforcement and the exchange of asset claims in the case of "collective ownership" also has the social contract (an evolutionary stable equilibrium of the social game) underlying its basic institutional features. Although, as we will immediately see, the parallel cannot be pushed too far, there are striking similarities between the role which the institution of money plays in an economy based on private property and the role performed by hierarchical (*nomenklatura*) order in the totalitarian state. The desire to rise higher in the hierarchy, which entitles the successful agent to a larger share of "residual control rights" over social assets is the main incentive which replaces, under the planned economy, the desire to increase one's money holdings. At least when the system functions efficiently, "the Party ensures that the "implicit contract" of reward for loyal performance is kept, that is, that superiors within the government, ministry, or Party hierarchies do not renege on implicit promises to subordinates. In this way, the Communist party takes the place of enforceable property rights to solve the problem of mutual cheating characteristic of exchange when law-based property rights are absent." (Wintrobe, 1990, p. 866)

This vision of the planned economy as a means to provide

incentives to economic agents to act in the interests of the ultimate "owner" (the totalitarian dictator) is what underlies the theoretical model in the next section. This incentives mechanism will be discussed in more detail there. Here, in the preliminary discussion part, I would highlight the differences between the two mutually exclusive incentive systems, furnishing thereby a clue to understanding the process of demise of the planned economy.

One of the key differences between the system of incentives based on the institution of money and that of hierarchical order is that one's place in the hierarchy does not amount to formal ownership rights but only to the residual rights of control. Although it is currently widely believed that ownership is residual control rights, in an "efficient" (in the sense referred to above) totalitarian economy, like that which prevailed in the former Soviet Union during Stalin years, the position of *nomenklatura* managers of assets was much less secure than the position of shareholders or even the employed managers of capitalistic firms (indeed, as shown in the theoretical model below, this insecurity was the condition sine qua non for the "efficient" functioning of the planned economy).

Another crucial distinction is that the planned economy generally has to rely much more on repressive sanctions for its institutional stability than a market economy based on private property. Although redistributive activities (for example, by rent-seeking groups or by gangs) might be potentially as profitable under the system of private property as "privatizing" collective property is under the socialist state or even more, the expected strength of resistance faced by any group

aiming at redistribution will be quite different in those two cases. In the system based on private property successful redistribution as a result of lobbying by one pressure group will meet effective resistance from other pressure groups who find their property rights endangered. Unless one of the pressure groups is much more effective in producing influence than its opponents, some "tyranny of status-quo" (Becker, 1983, p. 382) can be expected to prevail. An even more important factor perhaps is high opportunity cost involved in abandoning wealth enhancement by means of production and replacing that with redistribution activity. This opportunity cost will dilute incentives to engage in unproductive conflict activities even under a low level of third-party sanctions.[6]

Under socialism there will be only one economic agent (the dictator) suffering from the activity of the coalition determined to privatize some of the ownership rights to means of production. Obviously his motivation to impose harsh sanctions will be much stronger; however, since all other agents will for most part be indifferent to the outcome of this struggle between the state and a particular pressure group, the system will be much harder to maintain without strong penal sanctions. The Soviet government under the leadership of Mikhail Gorbachev has discovered the force of this logic in practice.[7]

Passing from the issue of ownership to the issues of firm governance, it should be noted that the *nomenklatura* system was different from employed management system in market economies in one more important respect. In the latter, theoretically at least, perfect

capital markets compel the managers to act in the best interests of shareholders, while perfect labor markets guarantee that efficient managers will be competitively rewarded by the owners. The latent conflict of interests is thus resolved, or at least largely mitigated, by the impersonal market mechanism.

Under the *nomenklatura* system no such impersonal mechanism for the resolution of the conflict of interests between the owners and the employed management exists. In its early stage the conflict was resolved simply by the overwhelming power of the dictator which did not tolerate a slightest disobedience. However, as pointed out in (Demsetz, 1995), this mechanism is not viable in the long run, in particular due to mounting informational difficulties and increased complexity of planning as the economy grows. Thus for its later stage of existence, the *nomenklatura* system had developed a way of resolving the conflict of interests between the owners and the management by resorting to idiosyncratic bargaining between the planning authorities and the management of state-owned enterprises. In the process of this bargaining ex post firm-specific "corrections" of the planned targets became wide-spread. The assessment of an "effective manager" and his reward thus became largely dependent not on his true "efficiency" (in terms of actually fulfilling the plan), but on the degree of "special relationship" which he was able to establish with his supervisors. The owner-manager relations effectively became split into relatively independent enclaves, lacking a common yardstick to measure performance.

The Presence of Money and the Absence of a Self-Correcting Mechanism

The hierarchical order and the institution of money thus represent two competing forms of social contract. While there always are elements of both incentive systems present within each existing economic society, one of it inevitably dominates the other, save for exceptional cases of systemic transformation. For example, when Schumpeter expressed concern about the prospects for the survival of capitalism, he made the point that too large a scale of collectivist elements in a market economy will dilute incentives and threaten the efficiency of the institutional system based on private property (the position in the state and/or political hierarchy would become a surer way of acquiring property, or at least temporary residual control rights over assets than possessing large amounts of money; see Dixit and Londregan, 1995 for a recent model of this type).

This was also perfectly understood by the founding fathers of the socialist state. As late as in early 1920s, amidst "new economic policy" which basically revived many elements of a market economy, Lenin insisted, in a series of key-note speeches, that in the long run commodity-money relations should be prohibited altogether if the socialist system is to become stable and viable. What neither Lenin nor Stalin who embarked upon rebuilding the totalitarian economic machine in 1930s could do, however, was to devise an effective alternative system of incentives for ordinary workers which would keep the economy from total collapse of output in the absence of money. Such an alternative system is probably impossible to devise outside a primitive

tribe. Money was thus grudgingly allowed to survive in the personal consumption sector, but we can witness the remains of the doctrine of eliminating commodity-money relations in all text-books on "Scientific Communism" employed in the former Soviet Union right until it finally collapsed.

Limited as its use was, the monetary unit thus competed with the place in the hierarchy as a means of legitimate claims to part of ownership rights. Since money was necessary to increase personal consumption, a natural symbiosis developed between communist party mandarins and those economic agents who managed to accumulate large money funds. "Connections" (*svyazi*) was the single most important asset which economic agents needed both for personal consumption and for a career in the hierarchy, and those connections were often lubricated by outright bribery as well as by other forms of money transfer. As long as the basis for ownership claims remained different from that of an economy based on private property, no "convergence" between the two systems, as envisaged, for example by (Galbraith, 1978) could of course occur. The superficial analogy between the increased role of political influence and redistribution under private property and the increased role of money under the planned economy should not blind us to the fundamental difference which consists of the fact that in the end, the calculus of ownership claims was made in totally different units. However, the hierarchical "*nomenklatura*" system proved to be much more vulnerable to the penetration of the rival incentive mechanism than its market-based counterpart.

One very important reason is the absence of the mechanism of

self-correction provided in a market economy by the system of democratic elections.[8] Under collectivist state and the planned economy free democratic elections are impossible to begin with. Although this may seem obvious to a modern reader, it is in fact not so and requires proof.[9] In a slight digression from the main theme, we offer here a theorem establishing incompatibility between the totalitarian economic order and political democracy. The proof of the theorem presented employs an incentives-based line of reasoning in accordance with the general spirit of the analysis in this paper.

"First Incompatibility Theorem": *Hierarchical ownership is incentive-incompatible with free democratic elections.*

Proof. Collective ownership is vested with the communist party hierarchy, and each member of the hierarchy is performing under an implicit contract with his or her superiors described above. If free democratic elections are allowed (even limited to the ranks of the communist party itself), there is a risk that the hierarchical order might be completely reshuffled at any moment. It would then be impossible for superior hierarchs to keep promises of reward for loyal performance to subordinates. In other words, the existing implicit exchange contract may be invalidated at any moment, which destroys individual incentives to comply with it. Something similar would happen to incentives to acquire large share-holding positions in companies if it were decided that shareholders' meetings should employ one-person-one-vote democratic principle. In a market economy ownership rights of shareholders are by and large independent from the political system,

but under the planned economy political system directly determines ownership rights and this makes democratic change of government a test which such an economy cannot endure (end of the proof).[10]

This incentive argument calls for a stable totalitarian hierarchical order, and for harsh sanctions against anyone who challenges it. Since in addition the enforcing hierarchs own all major assets on which people's living depends, participating in a pro-democracy movement becomes extremely costly so that only a few exceptionally courageous people ("*dissidents*") dare to speak out against totalitarianism. Elections, even if held, serve only for camouflage, and the planned economy becomes inseparable from the totalitarian social order.

But without a self-adjusting mechanism provided by democracy and free elections, the planned system cannot hope to react with due flexibility to the loss of efficiency caused, among other things, by the intrusion of money into its system of incentives. "The use of reason" in the process of institutional adjustment is precluded or severely hampered. The situation develops into a so-called "antagonistic contradiction", one of Marxists' favorite topics, a contradiction which cannot be resolved without self-destruction.

II. THE TOTALITARIAN STATE AND THE INNOVATIVE GROWTH

Why Planned Economy?

Why did the totalitarian principal in the Soviet Union and other

Soviet-type economies organize the economy based not on market mechanism but on centralized planning? Why have all attempts at introducing elements of market into a socialist economy invariably failed? What was called the "first incompatibility theorem" showing that hierarchical ownership of assets was incentive-incompatible with democratic free elections was presented in the previous section. The "second incompatibility theorem" will be established here which argues that the market mechanism is also incentive-incompatible with the hierarchical ownership rights.

While the "first incompatibility theorem" seems to enjoy wide support, at least on the intuitive level, the proposed "second incompatibility theorem" continues to be a subject of some controversy. It has been disputed by the proponents of so-called "market socialism" in the former Soviet Union and Eastern Europe. More significantly, it is currently being disputed by those who find that China is becoming the first country to successfully combine socialist order with a market-oriented economy.[11]

The planned economy which had been employed in the former Soviet Union and its East European allies obviously entailed high deadweight costs. Those costs go far beyond what seems to be needed to assure an effective monitoring by the principal of the economic activity conducted by other agents. The problem of effective monitoring is both theoretically and practically different from the problem of effective planning.[12] By resorting to a market mechanism instead of planning in resource allocation, the communist regime could avoid the dissipation of a large part of its rent. This simple truth has led many

authors to conclude that the whole set-up of the planned economy was "irrational" and could be explained only through ideological factors (see for example Katz, 1972). The "second incompatibility theorem" argues that in the environment of innovative industrial growth, the planned economy might have not been as irrational as it seems, when viewed from the communist principal's side.

The Bench-Mark Model

A very simple bench-mark model designed to capture some basic features of innovation and growth in a market economy is presented first. The approach stems from Schumpeter's "Theory of Economic Development" (Schumpeter, 1934). In contrast to recent models of innovation-led growth (see for example Grossman and Helpman, 1991), it is assumed that innovation arrives not as a deterministic function of investment in R&D and not even as a stochastic function of such an investment (with a well-defined probability distribution), but as a totally unpredictable "industrial mutation". Thus, as far as innovation is concerned, its timing and scale cannot be predicted at all, even as expectation, so we find ourselves in the world of uncertainty in the sense of Knight (see the discussion in Demsetz, 1995). This is important for the following argument because it makes the social planner unable to predict the occurrence of innovation by simply monitoring R&D expenditure.

In what follows the economic environment is kept as simple as possible in order to concentrate on the main task of comparing the effects of innovative growth under private and totalitarian ownership.

In particular, the consumer analysis is suppressed, treating the consumption-saving decision as given exogenously and independent of the interest rate.

Economic environment

Consider an economy populated by a finite number N of infinitely-lived initially identical utility-maximizing agents. Assume that the number of agents N is large enough so that the conditions of perfect competition are satisfied. Time is discrete and at the beginning of each period an agent is inelastically endowed with 1 unit of labor (and/or some other primary resource lumped together). Apart from this labor and/or primary resource, at the start of each period there exists in the economy a stock of the produced capital good, which can be employed in production. The total stock of this capital good is denoted by X_t, where t is the time subscript, and its initial distribution will be specified in a moment. The production is carried out by individual agents separately and independently by combining their endowments of a primary resource (labor) with the stock of the produced good which they own, according to a common production function $y=a(x)$, where x is the amount of the produced good invested in production and we have suppressed the second argument identically equal to 1 by the assumption above. To avoid potential complications caused by the need to consider discount factors and interest rates it is assumed that investment bears fruit instantaneously, and the resulting output y is a certain mix of the consumption good consumed immediately and the capital good which is carried over to the next period. The exact

mechanism by which agents arrive at their consumption-saving decision is not important here. The production function $y = a(x)$ is assumed to satisfy all the standard properties, including second-order differentiability and the Inada condition ($a(0)=0$, $\partial a/\partial x>0$, $\partial^2 a(x)/\partial x^2<0$, $\partial a(0)/\partial x=\infty$, $\partial a(\infty)/\partial x=0$).

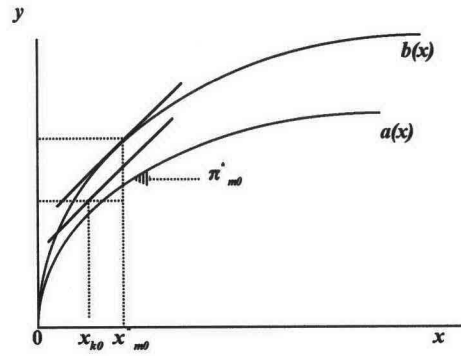
In the bench-mark model, at the starting period 0 each agent owns an equal share of the total stock of the produced good, X_0. Thus each agent k owns $x_{k0}=X_0/N$, $k=1,...,N$.[13] Of course, the capital good is freely tradeable on the market, but since all agents are assumed to be identical, there will be no trade in the capital good, so x_{k0} will also represent the amount each agent invests into production. It is possible of course that the initial stock of the capital good does not correspond to the most preferred division between consumption and investment, so that the agents would like to change the mix represented by output y at the end of the period.[14] However, with identical agents this will be a once-and-for-all proportional adjustment, so by abusing the notation slightly we will continue to denote by x_{k0} also the equilibrium amount of investment, given the production function $y = a(x)$.[15] Since no discounting of future consumption and no change in the production function is assumed to take place at this stage, the situation will then exactly repeat itself at the start of each subsequent period, corresponding to what Schumpeter called "the circular flow" (Schumpeter, 1934, chapter 1).

Innovations are introduced into this economy in the following way. First at a time t a certain agent (labeled m) "mutates", that is, costlessly discovers a new technology embodied in a new production

function $b(x)$, satisfying the same assumptions as $a(x)$ and more productive both totally and at the margin for the whole range of investment of the capital good.[16] Formally, $b(x) > a(x)$ and $\partial b(x)/\partial x > \partial a(x)\partial x$ for all x other than zero and infinity. In particular, the marginal rate of transformation for agent m at the level of investment $x_{m0} = X_0/N$ will become greater than for other agents: $\partial b(x_{m0})/\partial x_{m0} > \partial a(x_{k0})/\partial x_{k0}$, $k \neq m$.

Agent m, in possession of a superior technology, would now want to acquire additional capital goods,[17] and he can do it instantaneously without altering his own personal mix of output (which, moreover, can be employed in production only in the next period) by procuring capital goods from the market, provided that the price he has to pay (in terms of the final output mix y) is below the marginal productivity of his investment.[18] Competition between other owner-agents will drive the price that the innovator has to pay down to just

Figure 1.



$\partial a(x_{k0})/\partial x_{k0}$. Thus agent m's new level of investment x^*_{m0} will be determined implicitly by the following equation (see Figure 1):

$$\partial b(x^*m_0)/\partial x_{m0} = \partial a(x_{k0})/\partial x_{k0}.^{19} \quad (1)$$

Note that since the innovation is caused by mutation, there is no free entry into the innovative activity in this model. Accordingly, agent m will earn inframarginal returns on his investment (denoted by π^*_{m0} in Figure 1). These inframarginal returns will increase both the current consumption and the stock of the capital good owned by agent m at the start of the next period, breaking up the initial equality of the communal equilibrium. It is this increased consumption and increased command over the capital good which represent what Schumpeter called "the big prize" accruing to the innovator, and it is this prize, observed by other agents, which creates incentives to emulate the innovator's technology.

Innovation: the Propagating Mechanism and the Question of Institutional Stability

Continuing to follow the spirit of the original Schumpeter's model and in anticipation of the model of the planned economy to be developed in a moment, the mechanism by which a successful innovation is propagated is specified in the following way. A topology is introduced on the set of agents N in the form of a distance function d, and it is assumed that the new technology becomes in period $t+1$ observable only to agents belonging to a certain neighborhood of an innovating agent m.[20] Formally, denoting the diameter of the set N by D, agents who are located at a distance $d_0(m) \leq D$ from m form his

neighborhood, $S(m)$ contained in (and possibly equal to) N. All agents in this neighborhood can costlessly learn the innovative technology discovered by agent m in period $t+1$. Thus, in $t+1$[21], those agents would also want to buy some additional amount of the capital good to implement innovation. Depending on the size of $S(m)$, this may or may not affect the market price. If the market price of the capital stock is not yet affected, then we can substitute $S(m)$ for m in the previous analysis and carry it over to the next period, $t+2$, in which a larger number of agents, specifically all those in $S[S(m)] \supseteq S(m)$ will learn the new technology and would want to increase their investment. It is clear from the construction that if the set N cannot be partitioned into two or more sets the distance between which is greater than the maximum distance which is required for the new technology to be observed, sooner or later the new technology will become observable to all agents populating the economy. In the ultimate new steady state, there will again be no trading in the capital good, and all the increase in productivity will be translated into increased consumer surplus.[22]

A few further facts about this process of innovation and dynamic adjustment under a market economy and private property rights should be noted here for the purpose of comparison with the subsequent model of the planned economy.

It is obvious that the initial equal distribution of the capital stock will not be maintained beyond the first wave of innovative activity; instead some agents will greatly increase their share of social assets while other agents (most distant from the innovator) will find their share reduced, or will even join the ranks of the proletariat.

Those results will depend on the specification of the distance function and the production function, as well as, of course, on differences in the consumption-saving decision which were suppressed in the model. However, in absolute terms all agents ultimately benefit from the innovation, as it increases the output mix available for consumption and accumulation to everybody. Thus, by eventually becoming accessible to all agents, the innovations raise the overall welfare of the society, so that the inequality will be only relative against the background of every member of the society growing absolutely richer. Since the stability of the institutional framework of a perfectly competitive capitalistic environment does not depend on relative equality of distribution, nothing in the mechanism of Schumpeterian growth poses a threat to the underlying institutional system.

A Model of Innovation-Led Growth in a Totalitarian State

We now turn to the totalitarian (hierarchical) state and to the "second incompatibility theorem".

Economic environment

The set-up of the model remains the same, but now only one agent, agent 1, or "Stalin", initially owns the whole stock of the capital good, X_0. This represents the simplest way to formalize the notion of the planned economy at its early stage, as discussed above. What this assumption is actually designed to capture is that no agent besides the dictator can invest in production. The following analysis is not affected if agents other than 1 to are allowed to have access to some minimum

amount of the consumption good needed for survival, or even a larger amount of consumption goods provided they cannot invest but can only consume.

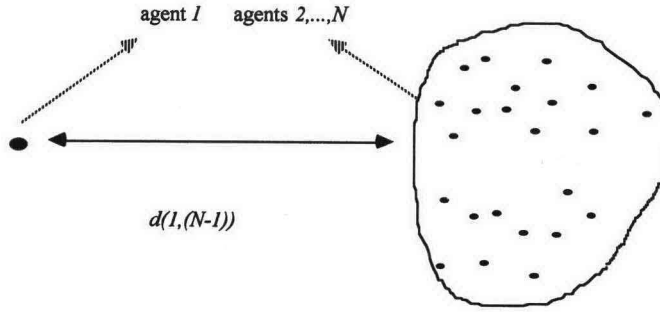
The stability of the totalitarian social order depends on the relative power of the dictator versus other agents. In other words, and in contrast to the bench-mark model of a post-constitutional state, property rights in a totalitarian state arise solely from power. However, the power is not given exogenously. The crucial assumption is that the only source of power in a social state is economic power represented by the amount of the capital good owned.[23] For example, any owner of a certain amount of the capital good may employ it to produce armaments, and/or additional consumption good to pay (or bribe) the police, the armed forces, hire private enforcement teams, etc. If there are competing owners, the highest bidder will be able to hire (bribe) a stronger enforcement team and emerge as a winner in the contest for power. To focus on the main theme we again do not model explicitly the mechanism by which an owner of the stock of capital decides on its use (there are three alternative uses now: personal consumption, accumulation, and investment in power - a directly unproductive (DUP) activity).[24] The important thing is that in order to maintain the social order of the totalitarian state, the dictator must always make it sure that no other agent or coalition of agents in the economy acquire more of the capital good than he does.

Innovative growth and economic power

Let us now introduce a topology on the set of agents of the

totalitarian state. As in the bench-mark model, the "distance" between agents determines the speed at which they can, in particular, learn about new technologies introduced by one of them. The distance here is interpreted as representing mostly the social distance. Under this interpretation, "Stalin" (the dictator) can be heuristically described as an "isolated agent" in the set N of the total population, meaning that the distance between him and any other agent is larger than the largest distance between any of the remaining N-1 agents.[25] That is, without taking some additional measures "Stalin" will be the last agent to learn what is happening in any neighborhood $S(m)$ contained in $(N\text{-}1)$. Formally (see Figure 2),

Figure 2.



$$d(1,(N\text{-}1)) > D(N\text{-}1), \tag{2}$$

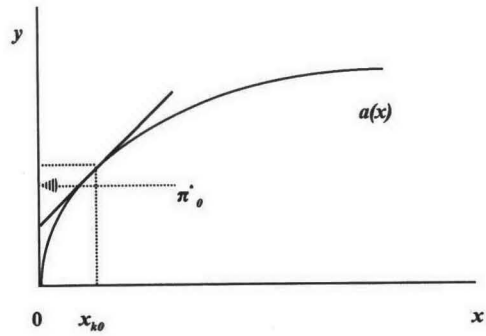
where $D(N\text{-}1)$ denotes the diameter of the set of all agents other than the dictator.

Note that assumption (2) does not imply that the dictator cannot devise an effective monitoring mechanism to discover innovations (one

such mechanism is constructed immediately below). All what it asserts is that the enforcement of the dictator's property rights (through police and armed forces) is effective only with respect to that amount of the capital good which can be detected and monitored. Without a special monitoring system, the dictator, however powerful, will not learn about an innovation until everybody else has already done so.[26] And for a monitoring system to allow "Stalin" to know what is happening in small neighborhoods surrounding economic agents, the monitors must be given incentives to monitor and report.

Under these assumptions, suppose first that Stalin decides to employ a market mechanism of resource allocation. With a common production function $a(x)$, the dictator will be able to copy the resource allocation of the bench-mark model even if he does not know the exact form of the production function. In particular, if he were to employ the procedure of competitive bidding for renting contracts for the capital good, he would be able to collect inframarginal returns π^*_0 in the form of rent (see figure 3).

Figure 3.



There is no need for the dictator, however, to be as benevolent as to stop at the competitive bidding procedure and to be content with receiving just inframarginal returns. Moreover, as suggested by the last condition mentioned in the previous paragraph, such a procedure may be incompatible with his long-term goal of maintaining the whole of the capital good stock in the economy under his ownership. Instead the following "totalitarian mechanism of market allocation" is feasible for him. The simplest game consisting of just 2 more agents apart from the dictator is considered below. It generalizes to N-1 agents in an obvious fashion.

At the first stage of this market allocation game the dictator asks the agents to present competitive bids for different amounts of the stock of the capital good that he owns. He will thus learn the equilibrium level of investment, x_{10} and x_{20} for both agents where $x_{10}+x_{20}$ just exhausts the stock of the capital good offered for rent (in case the agents are identical $x_{10}=x_{20}$, of course). This is guaranteed by the concavity property of the production function a(x): if for example agent 1 bids for a higher than equilibrium among of the capital good, agent 2 will offer to pay the dictator more rent for an additional unit of the capital good reallocated to him than agent 1 will offer to prevent such a reallocation. Neither of the two agents can bribe the other into cooperation against the dictator's interests.

At the second stage of the game Stalin requests a fixed payment ("operation licence fee") from each agent presenting them with the "take it or leave it offer", which in this case is represented by the condition that all the stock of the capital good will be taken away from the

agent who pays less and reallocated to the agent who offers a higher fixed payment. For identical agents with the reservation utility level zero (no production is possible without the capital good rented from the dictator), it is obvious that both will offer to pay an operation licence fee which will be equal (in the limit) to the total amount of the output y produced from x_{i0}, $i=1,2$.[27] The result that the dictator captures the whole social product in this setting is formally the same as the well-known result that a perfectly discriminating monopolist captures the whole consumers' surplus (see Tirole, 1988, chapter 4).

Thus the dictator, by using his power, can extract the whole social product $(N\text{-}1)y=(N\text{-}1)a(x_{k0})$ from other agents, and not just the rent $\pi^{*}{}_{0}$ (it is sufficient that he leaves at the disposal of other agents some amount of consumer good marginally above zero). By doing so he will also guarantee himself from any potential menace resulting from possible accumulation by other agents of some capital stock of their own. Note *that if the production function undergoes no change*, the "market allocation game" described above will have to be played just once, at the beginning of period 0, after which Stalin will be able to repeat the optimal allocation at the start of each new period by simply fixing the amount of the capital good each agent is allocated at $x_{kt}=x_{k0}$, and the "operation licence fee" equal to $y=a(xx_{k0})$ for all $t=1,2,...$, and $k\in(N\text{-}1)$.

The situation changes dramatically when the production function undergoes changes caused by sudden mutations of some agents. That is the claim of the

"Second Incompatibility Theorem": *Hierarchical ownership in an innovating economy with an "isolated dictator" is incentive-incompatible with a market allocation of the capital good.*

The outline of the proof. The theorem can be proved by contradiction. First assume that the dictator employs the market allocation mechanism of the type described immediately above and arrive at the result that sooner or later some other agent may come to possess a larger amount of the capital good than the dictator. This agent will then be in the position to overtake the dictator. It can then be concluded that a rational dictator will never resort to a market mechanism in the first place.

Suppose that in the situation as described above innovative growth by industrial mutation of the bench-mark model type takes place. At date t agent m discovers a technology $b(x) > a(x)$ and $\partial b(x)/\partial x > \partial a(x)\partial x$ for all x other than zero and infinity. The assumption about the distance between the dictator (agent 1) and all other agents implies that in the absence of an effective monitoring scheme, the propagation process of the innovation will be exactly the same as in the bench-mark model within the framework of N-1 private agents (the dictator excluded). In particular, agent m and then other agents who learn the new technology at early stages would again be able to bid away some capital good from other agents by offering them marginal returns above those on their own investment and thus enabling themselves and others to enjoy a surplus over the fixed fee equal to $a(x_{k0})$ which they have to pay to the dictator. In the notation of figure 1 above, the inframarginal returns π^*_{m0} represent a pool of consumer's

and capital good which will be retained by private agents.

By the time the dictator observes the new technology and has a chance to raise the rent payment (operation fee) on the capital stock, substantial inframarginal returns will have already accrued to all other agents.[28] Of course, those returns will be the highest for the initial agent m and those in his immediate neighborhood, who will now presumably possess a considerable independence from the dictator in terms of capital stock ownership and a reservation level of utility much higher than zero. A secondary market for the capital good would come to existence and proliferate, and the dictator can no longer devise a simple game which ensures that no single agent ever accumulates more capital stock than he has under his command. Under the interpretation of power employed here, rich private agents will establish their own property rights by recruiting private enforcement teams and will grow richer. Hence, sooner or later the dictator will have to face an immediate threat to his grip on power. Indeed, it would be enough to remember the example of the rapid decline in the economic and political power of old aristocracy as capitalistic, that is innovating, way of production developed in Europe and Japan. Thus, a market economy is indeed incompatible with totalitarianism if it is to be based on innovative growth, which establishes the "second incompatibility theorem".[29]

These considerations suggest that a rational dictator (a "Stalin") who wants to enjoy the benefits of innovative growth while avoiding any potential threat to his power, will try to attain the following two basic goals. First, he must construct an effective monitoring system

compensating for the distance between himself and other agents. He must be able to detect any innovation as soon as it occurs so as not to allow any private accumulation of Schumpeterian big prizes accruing to innovators. Second, he must construct a mechanism which would at least partially replace private incentives in the process of propagating an innovation. This will be necessary to ensure that his revenues are always maximized given the state of the art technology. In the next subsection it is shown that the combination of these goals requires (a) *the police state*; (b) a strict ban on capital good trading and especially on *private hiring of labor*; (c) *economic planning* in the sense of assigning direct tasks to producers. Those features combined with their by-products (such as the inevitable emphasis on egalitarianism among ordinary people) constitute what is commonly described as the planned economy.

The Puzzle Resolved: the Incentives Structure of the Planned Economy

Monitoring

We will first consider the necessary conditions for an effective monitoring system, that is, a system under which agents have incentives to report to Stalin promptly about any innovation which occurs in the economy. Those conditions do not in themselves constitute a planned economy, but they represent its major part and have special relevance to the police nature of Stalin's state.

In the simplest case the dictator can ensure that he learns about the innovation in period $t+1$ (that is, the first period when it becomes

observable to some other agent apart from the initial innovating agent m) by forcing agents in $S(m)$ to play the following version of the "prisoner's dilemma" game.

Specifically, if the innovation is revealed at $t+1$, that is if all agents in $S(m)$ report it to the dictator, surrendering their inframarginal returns to him and not trying to secretly profit from hidden knowledge, they face no consequences. However, if some agents in $S(m)$ try to conceal the innovation while some report on it, then those who fail to report are severely penalized (say, sent to jail or even executed) while those who report receive a reward. The resulting payoff matrix may in the case of two agents look as follows.

Table 1

Strategy	Hide	Reveal
Hide	(π^*_{m0}, π^*_{m0})	$(-\infty, r\pi^*_{m0})$
Reveal	$(r\pi^*_{m0}, -\infty)$	(0, 0)

In table 1 we have assumed that the set $S(m)$ consists of only two agents, agent m himself and one more agent. Both have two strategies: to hide the new technology in which case each can enjoy inframarginal returns equal to π^*_{m0} if the other agent also sticks to the "hide" strategy, but which entails a payoff equal to minus infinity if the other agent reports. The strategy of revealing the new technology yields $r\pi^*_{m0}(r>1)$ in case the other agent hides it and nothing in case the other also reports. It is obvious that "reveal" strongly dominates "hide" in this game, and the dictator will learn the new technology in

period $t+1$ without having to pay any reward. The only inframarginal returns that will escape his capture would thus be the inframarginal returns earned by agent m in period t, but that can for most part be ignored.

The monitoring mechanism described in table 1 is a very simple application of a Nash equilibrium in a one-off game. However, the story is actually more complicated than that. In particular, there is no reason why the agents should perceive the game as a one-off one and why they should perceive it as a non-cooperative one. We are thus led to consider the structure of the game in more detail.

Once we depart from the simplest one-off interpretation of the game, the dictator will need much more than the simple mutual monitoring of the "prisoner's dilemma" type. With the time dimension added the agents will weigh the sum of all future inframarginal returns that they can earn against the dictator's reward offer. There is no reason why transfers among the agents should not be possible in the model presented, so the agents who have already learned the innovation can offer bribes to those who have just got access to it. It is easy to see that in the limiting case Stalin would have to offer a prospective reporter a reward exceeding the sum of all future inframarginal returns accruing to him for the whole period before the innovation reaches the last agent in the economy - but having to pay such a reward to the reporter will make monitoring itself quite meaningless for the dictator. In other words, Stalin cannot hope to always be able to provide incentives for revealing the technology, if the agents perceive the game they play as a repeated cooperative game.

There is a strong countervailing force, however. So far we have implicitly assumed that private agents were either risk-neutral or at least not too much risk-averse. If the dictator can impose a very harsh penalty (like death sentence) on the agent who is reported to him as having being guilty of playing "hide" (this is represented in table 1 by setting the payoff in this case equal to minus infinity), that might be enough to effectively deter cooperation. Faced with the prospect of being executed, no agent would risk adopting the "hide" strategy given even a relatively small probability that someone else may play "reveal" (for example, due to a simple mistake or some non-economic factor). In other words, the cooperative equilibrium will fail the test of the "trembling-hand perfect equilibrium" (Kreps, 1990, pp. 437-443).[30]

If the penalty is not that extreme, or the probability of detection is very low, the cooperative mode of behavior may easily prevail especially at earlier stages of the innovation when it is limited to a relatively compact neighborhood of agents. The harsher the penalty, the larger the probability of detection, and the higher the degree of risk-aversion, the sooner will the cooperative behavior break down. Stalin's ruthless purges, his utter disrespect for human rights and human lives were thus the major factors which deterred agents from cooperating in hiding from him some important information. Under less ruthless regimes, the greatly reduced cost of the punishment can be expected to make the "hide" strategy quite attractive with the passage of time.

The Ban on Trading in the Capital Good and on Hired Labor

The inherent imperfectness of monitoring was one of the major

reasons which led the communist principal in the Soviet-type economy to adopt a much more sophisticated economic system than just an ordinary police state. The communist mandarins did not know game theory, but they knew only too well that economic incentives will ultimately prevail over even most ruthless police state if not complemented by other social institutions.

One very important measure which was introduced early in the history of the planned economy was a total ban on trading (re-renting) the capital good and on hiring labor (establishing private firms). This was largely attributed to ideological factors, but the analysis presented here suggests that there were also serious economic reasons behind this measure.

In the bench-mark model agents introducing an innovation were able to procure additional capital good from the market. This trade in the capital good allowed them to reap even larger inframarginal returns than would be possible otherwise. By outlawing such a market (and by making the ban effective through offering a prize to anyone who reported on capital good trading even without the accompanying report on an innovation) Stalin and his successors effectively limited the pool of the capital good available to innovators who might decide to play "hide" after all.[31] The cooperating innovators were thus confined in their deals to a small inner circle and had to work each with the stock of the capital good provided to them by Stalin. This diluted incentives to play "hide", and also made the "hide" strategy less of a threat to Stalin.[32]

The Role and Costs of Economic Planning

The core of the planned economy is constituted by large-scale state-owned enterprises (SOEs) and not by small independent producers. No doubt, one of the major reasons for that was Stalin's desire to establish stricter control over the production process and to monitor industrial mutations more effectively. But there was also another, and perhaps more important reason for the industrial organization relying on large-scale SOEs. Stalin needed a mechanism which would speedily propagate an innovation in the economy lacking private incentives. To this effect the dictator had to present to the economic agents a clear production assignment in the form of a plan.

In a highly "stylized" explanation adopted here, the plan assigned by Stalin to SOEs consists of a fixed amount of output which each SOE had to hand over to him in exchange for being supplied with the capital good. As we have shown before, this amount of output would theoretically be equal to the total product $a(x_{k0})$ which can be produced by each SOE working with the stock of the capital good x_{k0}. When Stalin received a report on an innovation, he had to process that information, issue instructions on the employment of the new technology and also change the plan assignment for all SOEs from $a(x_{k0})$ to $b(x_{k0})$. The optimal balance of consumption and investment for him could also change as a result of the innovation, in which case he had in addition to calculate the new optimal amount of investment, x_{k1}, and make it sure that SOEs adhere to the corresponding output mix when producing y. The costs of this planning and plan enforcement procedure are separate from the costs of monitoring (the police state) and represent

what we referred to in the introductory discussion as additional deadweight costs of the planned economy. This insight is formalized below using the framework of the model developed so far. It is assumed that the cost of economic planning (the cost of centralized propagation of the innovation which has already occurred, by the method of assigning and enforcing a new plan), denoted by c, is an increasing and convex function of the diameter of the set of productive agents. In the context of homogeneous state-owned enterprises, this diameter is trivially related to their number. Thus the "cost of the planning" function can be denoted by just $c(N\text{-}1)$ with $c'(N\text{-}1) > 0$, $c''(N\text{-}1) > 0$.

Extending slightly the earlier model, denote the expected frequency of industrial mutation by f, and assume that it is an increasing concave function of the number of SOEs: $f(N\text{-}1)$ with $f'(N\text{-}1) > 0$, $f''(N\text{-}1) < 0$. That is, the assumption for the planned economy is that when individual agents are assembled in SOEs, mutations can occur only at the SOE as a whole and not at the level of an individual employee.[33] A smaller set of SOEs would thus result in less frequent mutation (industrial innovation). The dictator can then solve for the optimal number of producers (state-owned enterprises) from the following reduced-form implicit equation:

$$B'f'[D(N\text{-}1)] = c'[D(N\text{-}1)], \tag{3}$$

where $B' > 0$ with $B'' < 0$ measures marginal benefit accruing to Stalin from a marginal increase in the frequency of industrial mutation caused by a larger number of independent SOEs. Equation (3) means that Stalin trades the benefits of a higher frequency of innovations

sustained by a larger set of SOEs against the rising costs of propagating each particular innovation because of higher deadweight costs of planning.

Monitoring Once Again

With the tasks of the planning mechanism set up as above, what would the characteristic features of the system of SOEs acting in the planned economy be? One thing which stands out clearly is that the SOEs will be much more rigid than their counterparts from the bench-mark model. They will all be more or less equal in size (since there is no market mechanism which favors agents more receptive to a given innovation).[34] Ideally, they would all have identical performances for all periods except those in which a mutation has just occurred at one of them. Thus, in contrast to the bench-mark model, the topology of the set of economic agents has no analytical role in the planned economy, and all SOEs should be considered as basically "isolated" agents. This consideration, in particular, casts even more serious doubts on the effectiveness of the mutual monitoring mechanism as a means of revealing an industrial mutation to Stalin.

However, under an industrial organization based on SOEs and planning Stalin can easily construct an alternative monitoring mechanism. He assigns to each SOE a supervising agent (we denote such an agent by s and we imply mostly SOE managers, or "red executives") who is made responsible both for carrying out the production plan and for observing an industrial mutation and reporting on its inframarginal returns to the dictator.[35] To avoid potential hazards

caused by the possibility of cooperative behavior in a repeated game, each agent s is rotated frequently from one SOE to another.[36] An agent s who discovers and reveals a mutation in his SOE is rewarded by the full amount of inframarginal returns, and is subsequently promoted to a higher supervising position in a more important SOE or even to a position in the elite Stalin's enforcement team.[37] Of course, he will be severely penalized if someone else reports on a mutation which he failed to reveal. Agents s who are the elite of the planned economy and the rest of the working force work together for a very limited period of time at each particular SOE, and even when they do, there is a huge social gap between them. This makes collusive behavior extremely difficult, at least as long as the system functions effectively.

To conclude: the role of SOEs and plan targets in a Soviet-type economy was double-fold. First it presented a mechanism of implementation of an innovation caused by industrial mutation which replaced private incentives. Second, it assigned supervisors constituting a closed shop (the nomenklatura) divorced from the production teams in order to construct an even more reliable mechanism of monitoring and reporting innovations. Both tasks are obviously closely intermingled in practice though they can be separated for the purpose of theoretical analysis. Stalin would not be able to both maintain innovative-led growth and to preserve his grip on power without creating an industrial organization based on SOEs and without assigning plans to them. *State-owned enterprises and the cumbersome procedure of planning were thus basically not irrational at all.* The logic of hierarchical property rights required not only the totalitarian political order but

also the planned economy despite all its well-known deadweight costs if the hierarchical state was to generate industrial innovation and compete with its rivals based on private property and market mechanism.

Some Comparisons with a Market Economy

It is instructive to draw some comparisons between innovative processes in the planned economy and in a market economy at this stage.

(1) Incentives to innovate are much lower in the planned economy, since the innovator himself receives nothing for his innovation. However, if "mutation" is considered to be at least partly a spontaneous act and not a rational investment act by the innovator (which is the view adopted here), it will still occur, albeit at a reduced rate.

(2) The propagation of a given innovation which takes the form of a plan assigned to all SOEs simultaneously, might in some cases take place more rapidly in the planned economy than in a market economy, and without generating a business cycle. This constitutes what was widely regarded as "advantages of the planned economy" at least at early stages of industrialization. However, it should also be clearly understood that even if the incentives system of the planned economy works effectively, its advantages can be realized only in a very limited context of propagating an innovation the characteristics of which have already been tested somewhere outside the planned economy. In other words, the economy of resources and time through the introduction of a centralized decision-making, if any, presupposes the existence of a

previous stage of the game at which the market mechanism selects a viable innovation from a number of alternative ones. The planned economy might thus possess some advantages at the stage of catch-up industrialization, but not in a developed economy having to generate and test its own innovations.[38]

(3) The number of productive units (SOEs) is limited by deadweight costs of planning which have no parallel in a market economy. Thus the number of independent units will tend to be less in the planned economy than would be required from the viewpoint of "pure" economic efficiency (that is, disregarding constraints imposed by the need to maintain the hierarchical property rights). SOEs are likely to be overmanned and have low labor productivity as compared to their counterparts in a market economy because of rent dissipation caused by the cost of planning. Needless to say, this is justified from Stalin's point of view since he is still better off in the long run compared to the situation in which he risks being displaced.

(4) Finally, there is a divergence between the true social rate of transformation of the capital good x and the output mix y (which is equal to the marginal product $\partial a(x_{k0})/\partial x_{k0}$) and the rate of transformation demanded by the dictator (which is equal to the average product $a(x_{k0})/x_{k0}$). If the dictator does not fully perceive this difference so as to take account of it in his plan assignments, this is likely to result in overinvestment, creating incentives to reallocate the capital good to the "parallel economy".

III. SOME STYLIZED FACTS ABOUT THE RISE AND FALL OF THE PLANNED ECONOMY IN THE FORMER SOVIET UNION

The Early Stage - Full Domination by the Principal

The early stage of the planned economy in the former Soviet Union corresponds to the pure form of the social game described in the model immediately above. In late 1910s one single and rather small group of individuals initially seized control over virtually all assets in the Russian economy (or rather of what was left of those after 8 years of warfare). By late 1920s- early 1930s, i. e. by the time the true history of the Soviet-type planned economy begins, virtually all productive assets were firmly under the ownership of the highest ranks of the communist party apparatus, or even just under the ownership of a single person, First Secretary of the Communist Party and later also Premier and Generalissimos Joseph Vissarionovich Dzhugashvili (Stalin) with absolute and unlimited powers.

Stalin's ownership was exercised not only with respect to tangible assets, but also extended to much of the labor force. Recent studies have revealed secret documents of the Politburo of the time which make it clear that concentration camps were not just means of repression against political dissidents, but also important elements of economic planning. Slave labor force digging for gold in Magadan, procuring wood in the Siberian taiga, constructing roads, railroads and channels, etc. was not just taken account of in five-year and annual plans; it was planned in its size and output. It is believed that approximately 10-11 million people (6-7% of the total population) were continuously held in labor camps, and since the death rate given harsh

working conditions and malnutrition was exceptionally high,[39] new "enemies of the people" had to be detected at a constant *planned* rate. Hard as it is to imagine, all regional branches of *NKVD* (the People's Commissariat of the Interior, the antecedent of the notorious *KGB*) were given targets as to how many "dissidents" they should detect and send to labor camps; and if those *normas* were underfulfilled the local *NKVD* chief could easily go to the labor camp himself. No wonder that people were arrested and sentenced to hard labor on most bizarre pretexts; in the present context the main implication is that this amounted to an almost undisguised slavery and showed better than anything else how far Stalin's ownership of the planned economy's assets stretched.

Even apart from these more than 10 million constantly and deliberately reproduced slaves, Stalin owned much of the remaining labor force, too. Peasants in collective farms were not allowed to move outside the villages in which they lived and often worked just for the provision of basic necessities in kind (not much different from slave peasants in the 17th-18th centuries!). Even workers and engineers in large cities experienced strict restrictions on their freedom of movement represented by the notorious institution of *propiska*.[40]

Those strict regulations with regard to how individuals could use such an inalienable productive asset as their own labor force suggest how strict "public ownership" of all assets was implemented. All unauthorized transactions in resources, raw materials, finished or unfinished products, machines and equipment, if discovered, were most severely punished, including a very real possibility of capital punishment.

What made this system of Stalin's ownership enforceable and operational was the initial small size of the economy (especially of its industrial sector) and the ruthlessness of the police state. The Stalinist model of industrial management was installed in the former Soviet Union over the years 1920-32. At the time there were just over 11,000 large state-owned industrial enterprises under all-union jurisdiction which accounted for 67.1% of all industrial output (USSR in Figures, 1935, p. 20-23). The number of truly large SOEs (with the number of employees over 1,000) was much less: just 1,135 firms (USSR and Foreign Countries, 1970, p. 57). Those were supervised initially by only four industrial ministries (People's Commissariats, as they were called at the time). To compare: by 1964 when Kosygin and Brezhnev embarked upon a far-reaching industrial reform, the total number of large state-owned enterprises had more than doubled and there were at the time already 3,334 SOEs with the number of employees exceeding 1,000 people producing 58.6% of all industrial output. In particular, the number of SOEs which employed more than 10,000 people had tripled from 1933 to 1964, and the number of those which employed between 5,000 and 9,999 people had quadrupled (*idid.*). Those were being supervised by more than 20 industrial ministries. And in 1980s, despite extensive mergers in a desperate attempt to control the number of economic units, there were already more than 45,000 large-scale enterprises and associations in Soviet industry supervised by more than 50 industrial branch ministries.

This growth in the size of the industry and the complexity of the system of industrial management was accompanied also by the

process of spatial growth. The industrial sector of the Soviet economy has expanded from the old industrial regions in its European part to the Ural mountains (especially during World War II) and then to Siberia, the republics of Central Asia and to the Far East. Naturally, this process also made the task of effective economic planning from Moscow much more difficult.

The ruthless police state was the second element essential for the "effective" functioning of the planned economy. The communist party rule under Stalin was exercised through an elaborate system of control over the management of state-owned enterprises. Especially characteristic of those years was the strength and pervasiveness of secret police control. By employing an extensive network of open and secret agents the *NKVD* was able to keep track of all activity which was going on within each local or industrial entity. Moreover, the *NKVD* was independent from both the industrial and local authorities and controlled directly by Stalin himself. This furnished the dictator with a most powerful system of monitoring the professional management of state-owned enterprises (SOEs) and punishing those agents who tried to pursue their own goals and not those of Stalin.

There is evidence which appears to contradict the view adopted here that during the Stalin years the owners' control over means of production was almost unchallenged. For example, in one of the most authoritative English accounts of the Soviet economic system of the time (Berliner, 1957) presents a picture of the functioning of the planned economy even in Stalin years in which the management of SOEs, often with implicit cooperation from supervising authorities (which just chose

to "look the other way"), were engaged in all sorts of practices going against the (apparent) intents of the owners - from hoarding materials to illegal exchange transactions. Berliner finds it especially difficult to understand why those practices were being tolerated by the secret police. His conclusion is that although "the real answer can be little more than wondered about", there were forces "at work in the system which, quite apart from technical matters, motivate[d] control officials to refrain from carrying out in full measure the control functions with which they [were] charged by the state." (Berliner, *op. cit.*, p. 231); "a conscious awareness that cracking down too hard on the unlawful practices of management would cause the system to be so rigid that it would freeze up and stop producing" might have played a significant role (*idid.*, p. 293).

We tend to agree with this latter view. While it is no doubt true that illicit practices listed by Berliner (which will play such an important role in the collapse of the planning system later) did exist already under very early stages of the planned economy, we should be cautious in drawing the conclusion that the agency problem had plagued the planned economy from its very beginning. The tolerance of "the unlawful practices of management" was produced by the desire to alleviate the problem of poor governance by owners themselves, resulting from an extreme concentration of wealth.

As pointed out in a much more general context by (Demsetz, 1995), when wealth is extremely concentrated, the few wealthy people have to take governing positions in many large firms, and their control of the professional management of those firms "is compromised by their

time and knowledge limitations." (p. 45). In the case of Stalinist planning this limitation manifested itself not so much in the failure of monitoring as in the failure of task assignment. Stalin and his planning authorities could perhaps effectively monitor most of the economic activity, but that did not mean that they could also govern it in the sense of coming up with a mutually coherent and effective system of plan targets for individual enterprises. The enterprise managers were nevertheless obliged to fulfil the plan targets created in this manner, and strict adherence to regulation would in all probability make achieving that goal impossible.

If we consider this serious dilemma facing both Stalin and the management of his enterprises, there is a striking similarity to the case of corporate governance in a market economy analyzed by Demsetz. Demsetz first observes that not all on-the-job consumption would probably be eliminated even if owners could perfectly monitor the management. There could still be some on-the-job consumption agreed upon in advance, which would represent not shirking but "only an efficient form of compensation." (Demsetz, 1995, p. 25). The choice of on-the-job consumption as a form of managerial compensation reflects the fact that the manager is better off consuming on the job than taking money to consume at home and to eliminate it a higher money compensation should be paid. Thus, "this type of on-the-job consumption, should it be allowed, actually lowers the firm's cost of production." (*idid.*) In the context of the Stalinist planned economy, illicit practices tolerated by authorities also in effect represented a mechanism actually lowering the cost of planning for the principal.

There was not much on-the-job consumption (that was strictly regulated by one's place in the hierarchy and was relatively independent of industrial activity), but the principal apparently found it less costly to leave some room for maneuvering to managers of SOEs rather than undergo the costs of devising more realistic plan targets.

The analogy with the on-the-job consumption argument is in fact very important. In the case studied by Demsetz, when monitoring becomes imperfect, on-the-job consumption tends to rise beyond the level agreed upon in advance and becomes a source of inefficiency. And in the planned economy, as we shall see, imperfect monitoring at its later stages greatly extended the initially rather narrow room for maneuvering and the implicit compensation mechanism began to increase rather than decrease the costs of planning for the principal.

Our view that under Stalin's police state some managerial "slack" was deliberately tolerated as part of implicit contracting can also be substantiated by referring to the otherwise hardly explicable recurring most ruthless purges. Occasionally, during especially hard times, Stalin had to resort to private incentives more than was allowed by the blueprint of his totalitarian system. For example, immediately after the end of the Second World War the regime found it necessary to employ some elements of private property for the purpose of speedy reconstruction of the consumer goods industry. Workers' cooperatives (*artyels*) were organized which were very similar to small private businesses. However, once the situation with the production of consumer goods had somewhat stabilized a few years later, those cooperatives were abolished and many of their members sent to jail. Given the fact

that respect for human rights and even for human life apparently commanded a zero value on his scale of preferences, Stalin has constructed the "cheapest" mechanism of economic planning conceivable: very harsh and often apparently "irrational" plan targets which kept agents under constant pressure,[42] a tacit agreement giving them some space to breathe and a glimmer of hope, and finally large-scale purges which occurred with remarkable periodicity.[43] Those purges, apart from their psychological effects, also effectively reshuffled the hierarchy so that no stable lower-tier hierarchical structures could be formed and assume too much real power. The system resembles the rotation system still employed by firms and government agencies in Japan to prevent corruption, but being "rotated" often meant a death sentence under Stalin's regime. Without markets and high-level incentive provided by those, the only ultimate enforcement mechanism which could be trusted by the planners was the state of permanent mortal fear for all agents. Thus, the relentless oppressive machine was an indispensable part of the mechanism of the planned economy and once the fear of purges was removed, it would not (and actually did not) take the agents and intermediate level controllers much time to discover that they could engage in mutually beneficial slack not only to fulfill the plan, but also for their own private benefit.

System's Growing complexity - the Demise of Monitoring and Planning

Khrushchev's decision to abolish most horrible of the Stalinist practices was probably due more to non-economic rather than direct

economic factors. However, interesting insights emerge from following the economic logic present in his and subsequent reform measures as well. The main elements of this economic logic came from the growing complexity of the economic system and a sharp increase in the costs of economic planning and monitoring. It was frequently stated that the mature planned economy of the Soviet Union produced about 24 million products. The task to coordinate the production of those 24 million products inevitably implied very serious compromises. In fact the compromises were as serious as to prompt some economists to compare planning to a "rational ritual" that conveys "the illusion that the chaos we see around us is in fact part of a rational order." (M. Ellman, quoted in Hewett, 1988, p. 184) Although such an assessment of the planning system is perhaps too extreme, it does contain a seed of truth in it, especially for later decades of the existence of the planned economy.

One rather obvious result of the increased complexity of both the planning procedure and of the game which it involved was a reduction in the number of commodities directly controlled by the central planning bodies. All reforms of the planned economy introduced since the first such attempts by Khrushchev amounted to giving some limited autonomy to local leadership and to the management of SOEs over planning decisions. In 1953 (the year when Stalin died) the production and materials-allocation sections of the national economic plan contained twice as many specific items as in 1940. This tendency was reversed in 1954: the decree of the Central Committee of the Communist Party and the USSR Council of Ministers abolished a large

number of ministerial departments, and the number of plan targets contained in the annual plan was reduced by 46%. The number of parameters of performance to be reported to the state and to the ministries by SOEs (which, although not being formally the subject of planning, in effect performed the functions of centralized monitoring) was reduced to 1/3 (The History of the Socialist Economy in the USSR, Vol. 6, 1980, p. 286). Especially important, from the point of view of the analysis here, was the decree giving SOEs a larger role of in developing blueprints for annual plans (*idid.*, p. 287).

The bureaucratic dialogue between SOEs and the government hierarchy, involving also the party hierarchy, elements of which, no doubt, had already been present in Stalin years, assumed much more elaborated forms as a result of those reforms. Hewett notes that the mere passage of time makes such a bureaucratic game "infinitely more complex and interesting than it otherwise would be. Year after year the two sides engage in the game, using the information they have accumulated in an effort to gain an advantage for the future. The past is the major source of information available to the center in its effort to verify independently the current flow of information coming from individual economic units. ... Enterprise managers know this and therefore try as best as they can not to take actions which will reveal too much and cause them difficulties in future years. The center knows they know that and is doing its best to draw them out. In the midst of all this stand the ministries, which are also seeking to draw information out of enterprises and control them while dealing with the center on behalf of those units." (Hewett, 1988, p. 137-138).

It is well known from game theory that such strategic games involving "I know that he knows that I know..." can be very rich in outcomes which cannot be easily tracked analytically. The fact that what we are dealing with is not a one-shot game but rather a supergame, and that it involves not two but at least three independent parties (the center, the ministry and the SOE) make the analysis more complicated still. However, the basic tendency of the evolution stands out quite clearly.

Faced with mounting information problems and with the increased possibility of moral hazard, the planning authorities had gradually abandoned (over mid-1950s-late 1960s) most aspects of rigid top-down planning with respect to each individual SOE. The number of parameters set in the plan was greatly reduced and setting up of most of specific targets was relegated to the management of SOEs. The authorities also gave up the practice of assigning the SOEs plans itemized by individual workshops. Instead they tried to control the industrial activity by more indirect means by making greater use of volume of sales and profits targets. With centralized prices, this did not introduce any fundamental changes from the point of view of conventional economic efficiency. However, the consequences of these changes in terms of incentives faced by managers of SOEs proved to be detrimental to the totalitarian planned economy.

As shown above, the primary target of the cumbersome and costly economic planning system was to promote innovations coming in the form of industrial mutations. Bonuses and penalties under the Stalinist system of planning were linked to success or failure in

achieving very detalized output targets and in implementing particular technological processes assigned by the authorities. Once, in response to growing size of the economy and complexity of planning, the plans became less detalized and technology-specific, the control over the most essential aspect of the economic planning system was lost. Instead, the planning system was leaning more and more heavily towards planning on the margin, or "planning from the achieved level."[44] Such planning from the achieved level could not of course distinguish between innovative and routine activity, thus the incentives for technological progress, not too strong to begin with, became completely diluted.[45] By introducing a rougher and more general planning procedure the authorities may have succeeded in containing the costs of planning somewhat for themselves and also in mitigating to some extent the moral hazard involved in individualized plans, but the changes have at the same given rise to another and potentially even more serious set of problems.

The nature of the new moral hazard can be most clearly seen in the practice of extensive *ex prst* "corrections" of the plans. These corrections became more and more wide-spread over 1970s and 1980s, as SOEs presented the planning authorities with the prospect of not fulfilling the original plans and thus destroying the propaganda myth of the ever-growing socialist economy. Deprived of reliable source of information concerning each individual enterprise, the central planning authorities found it increasingly difficult to resist the pressure for such ex post corrections when it came jointly from several major enterprises in the industry backed by its ministry.[46] But if a plan becomes a

subject of such *ex post* corrections, bonuses can be obtained and penalties avoided by means other than striving to fulfill the assigned production task. The whole incentive scheme of the first aspect of planning breaks down.

This was further aggravated by the fact that the more complex the plans were, the more inconsistent they became, so that even managers who were prepared to be "honest" were forced to choose which parts of the plan to fulfill and which to violate. The process of planning was again turning idiosyncratic, but in contrast to earlier stages of the planned economy, it was the SOE which often took the lead in idiosyncratic bargaining this time.[47]

New impetus to the ultimate decline of the planned economy was given to the system when Brezhnev and Kosygin introduced "planning according to orders" or "direct contacts" among SOEs (see, for example, Katz, 1972 for an English description of this system). Firm and legal horizontal links between SOEs, the links which previously were just marginally tolerated under the Stalin compensation mechanism, were now officially approved of. The planned economy started following its own logic of development largely from that time on; it is no coincidence that (with the time lag of a few years) the tendency had set in to underfulfil the five-year and even annual plan targets, and that plan targets themselves started to follow actual performance rather than try to keep the high pace of economic growth (Hewett, 1988, pp. 50-78). Industrial ministries became more and more the instruments of lobbying the interests of their industries against the highest authorities in the land, not the means of transferring orders from the top to the

enterprise level and monitoring the managers. In this function they, together with large SOEs under their jurisdiction, formed powerful industrial pressure groups, the key driving force in the decay and collapse of the communist system.

Reversal of Power and Systemic Collapse

It has frequently been pointed out that many of the measures envisaged by the reforms of 1950s, 1960s and 1970s were never really implemented. However, they at least became important bargaining chips for SOE management in what was becoming a more and more individualized relationship with the ministry and other supervising authorities, and they gave the management opportunities to use the already existing system of the "shadow economy" not just to compensate for the rigidity of planning but also increasingly to promote their own private interests.

But perhaps of even greater importance from the point of view of changing the system of incentives of the planned economy was the relaxation of the political terror. Although the Soviet Union retained many features of a police state right until its collapse in 1991, it had been considerably relaxed since mid-1950s, both with respect to basic human rights (the abuses of those rights in Khruschev and Brezhnev years, to say nothing of Gorbachev, cannot be even compared with the horrors of the past) and, more significantly from the point of view of the analysis here, with respect to monitoring the unofficial activity of SOEs and their management.

The relaxation of terror coupled with the changes in the

mechanics of planning itself caused the following changes in the game between the dictator (the highest authorities of the planned economy) and the economic agents (SOEs) described in the previous section.

The assignment of plan targets mainly "from the achieved level" and lowering the level of sanctions which any manager of SOE had to face when caught cheating has profoundly changed the incentives faced by those managers. The basic reason can be found in the fact that the margin which is obtained by an agent of type s by bargaining with the authorities is different in principle from that which he obtains from reporting an innovative mutation. A mutation is idiosyncratic to a particular agent m (the production team of a particular SOE), thus agent s cannot count on continuing to enjoy it when rotated (transferred to another SOE).

Under the later system, however, the process of bargaining over planned targets becomes common to all SOEs, which makes periodic rotations of agents s irrelevant, at least if enough time is allowed for all of them to develop the common understanding of the new situation facing them as a social entity. Sooner or later this process results in accumulation of inframarginal returns that are not revealed and handed over to the dictator, and that develops far in excess of a simple precaution against failures of the planning mechanism (the "shadow economy" implicitly tolerated by the principal). A full-scale parallel economy, exchanging and profiting from those inframarginal returns starts to develop, and it bridges the distance between SOEs reintroducing some elements of topology characteristic of a market economy though in a highly distorted way due to the need to maintain

secrecy. The following English description of the fashion in which this parallel economy emerges belongs to (Hewett, 1988).

Because consumers have money that they are willing to spend on ... goods and services in short supply, there are substantial profits to be made for any individual willing to violate the laws on private economic activity or for any enterprise willing to engage in private economic activity on the side. The result is ... the "second economy," that being the sum of production and exchange that is directly for private gain or in known contravention of existing laws. Several types of activity are involved here: work by single artisans operating without the legally required license; use of the "putting-out" system to produce illegal products; private production on the job (for example, an employee in a state garage repairs a car for a fee); parallel production in a plant, using extra materials to produce unreported output distributed through the system using bribes; private, organized production in a state enterprise or collective farm; private underground manufacturing; construction by private teams (*shabashniki*); and brokering and information selling.

The important distinction between the second and shadow economies is that the former is based on the search for private gain. The shadow economy evolves from the enterprise director's search for ways to meet their plan; it is the consequence of an effort to achieve the most important targets set in the formal system, at the cost of less important targets and norms. In the second economy the motivation is to make money. Enterprises are simply making goods on the side, outside the planning system, which they sell for profit." (Hewett, 1988,

p. 179-180).

The important thing here is that with the development of full-scale parallel economy (the shadow economy *plus* the second economy) the first elements of private accumulation of wealth, which is not monitored by the dictator appear and become common-spread, so that wealthy agents can start buying and selling resources in the parallel economy without the risk of detection (the one-off prize for reporting on those activities offered by the principal become unattractive and the economic basis for the police state collapses).

In the new circumstances, even though there may still be "irrational" agents s (or some other members of production teams) who would nevertheless act vigorously to promote a new innovation or to propagate an existing one, this is no longer a decisive factor for other agents. The death penalty (the possibility of infinite loss in the "prisoner's dilemma game above) is no longer a credible threat; thus the cooperative outcome of the repeated game can be enjoyed without too much risk. Moreover, as time passes by and the understanding of common interest develops further between the members of the *nomenklatura*, a whole system of organized cheating of the principal develops within particular segments of that closed shop, and any "mutant" immediately becomes an outcast in the system fearing the ratchet effect on the inframarginal returns that others have come to enjoy. The late planned system, in contrast to earlier times when there were no substantial inframarginal returns to be appropriated by managers and when they were under constant relentless pressure from Stalin in any case, definitely embodies very serious disincentives for

discovering and introducing innovations.

Ultimately, the result at which the planned economy arrives is similar to that which is encountered by the totalitarian economy renting out the capital stock owned by the dictator. The mechanism of planning, although an ingenious incentives device, cannot survive long after the economy becomes too complex and the state of terror is abolished.

It is important to note, however, that there is no complete parallel with a competitive market economy here. Specifically, the difference is that inframarginal returns are retained by agents s (managers of SOEs and other members of middle-rank *nomenklatura*) for an indefinite period of time while in a competitive capitalistic environment they are completely dissipated into increased consumer surplus after the innovation propagation cycle is over. They also have no parallel in the strictly dictatorial social state of our earlier model. The agents retaining inframarginal returns from innovations[48] become the kernels of clusters of economic power, and it is from their ranks that the main force had arisen that overthrew the communist system.

Large evidence as to the extent of this reversal of power was uncovered by the Soviet press and prosecution reports during the years of "glasnost" and "perestroyka" under the last communist leader president Gorbachev. Cases of organized total corruption were uncovered in late 1970s in the republics of Uzbekistan, Kazakhstan, Tadjikistan, Turkmen republic, three Caucasian republics, Moldavia, Krasnodar region, Moscow, and various other places. In each case, the top *nomenklatura* leaders of the regions or large SOEs in question were

either themselves leaders of informal power structures, or were just marionettes screening the real power of such leaders. Members of the family of the General Secretary Brezhnev himself run one of the most powerful rings of smugglers. In some places, corruption went as far as making nomenklatura posts themselves subject of trade in terms of a bribe which had to be offered to superior authority responsible for promotion.

There is some analogy between this evolution of the planned economy in the USSR and the arrival of managerial (corporate) capitalism in the West (and this analogy served as a basis for various "convergence theories" in 1960s and 1970s - see for example Galbraith, 1978). In both cases individual owners could no longer perform managing and monitoring services themselves due to increased scale and complexity of the economy. However, there is a danger of carrying the analogy too far which was not realized by the proponents of convergence theory. The Western capitalist society has been able to adapt to changes by introducing some important qualitative adjustments to the institutions of a market economy the details of which need not concern us here. In contrast, the process of separation of formal ownership and control under the industrialized planned economy could not find a peaceful institutional resolution. The supreme authorities in the former Soviet Union had to insist on maintaining the hierarchical order as the only legitimate form of asset ownership, while the de facto system was being increasingly run on entirely different principles. Gorbachev's attempts at introducing a limited private sector and his final abolishment of terror only precipitated the collapse. The power of

money came out into the open, and the clash between it and the hierarchical order culminated in the dramatic events which swept away the communist regimes in Europe almost overnight.

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Notes

1 Yokohama City University, Japan. This paper draws on the first part of (Braguinsky and Yavlinsky, 1999) . However, Yavlinsky does not bear responsibility for any errors contained in this paper.

2 It is interesting to note that this change of the basic viewpoint from which we look upon the planned economy reverses many conventional-wisdom dictums pronounced about it, as well as about the current trend of transition to a market economy. For example, much concern has been expressed about "progressing inequality of distribution" due to the introduction of the elements of a market economy. While it is true that wealth is still extremely unevenly concentrated in present-day Russia, it is in fact now being shared among a much larger number of individuals than under the planned dictatorship! The subsequent analysis should convince the reader that we are not trying just to sound paradoxical for its own sake.

3 The former Soviet Union was probably the only industrialized nation with capital punishment applied for some cases of economic crimes. This provision in its criminal code was briefly abolished under Khrushchev's thaw in late 1950s only to be reintroduced a few years later. In 1962-63, that is in the midst of more liberal post-Stalinist policies, 163 people were sentenced to death for various economic offenses. This provision in the criminal code survived till the very end of communism.

4 It might seem that the concept of "efficiency" of the planned economy proposed in the text would fail if productive resources could be combined so as to increase the total social output and thus make it possible to raise the welfare of all other consumers without decreasing the amount of

consumption of the dictator. However, the "onsumption" of the dictator includes his absolute power. As shown in the theoretical model below, an improvement in the well-being of other agents erodes this power, so it is not Pareto-improving. Compare the quotation from Sen immediately below in the text.

5 Of course, taxes have to be paid, and other legal constraints as well as contract obligations have to be satisfied, so what we are talking about here are the "residual rights of control" (see Grossman and Hart, 1986).

6 See, for example, (Skaperdas, 1992; Neary, 1997). If and when an economy attains a high general level of labor productivity, this seriously changes the incentives faced especially by the agents with entrepreneurial talent. Thus economic development itself has an effect of limiting the amount of time and effort devoted to conflict, rent seeking and other unproductive activities which begin to entail very high opportunity costs.

7 One may wish to consider the fact that rational agents are likely to perceive the fact that successful "privatization" of collective property by a particular pressure group may leave them less well off. However, the effect is indirect, and if the feeling is strong enough that the dictator is using collective property in his own interests, not in the interests of the society as a whole, then what may be called an "indifference theorem" will hold with fully rational economic agents.

8 "Democracy ... provides the institutional framework for the reform of political institutions. It makes possible the reform of institutions without using violence, and thereby the use of reason in the designing of new institutions and the adjusting of old ones." (Popper, 1966, p. 126)

9 "Nothing is so treacherous as the obvious" writes Schumpeter in this context, "until about 1916... it would hardly have occurred to anyone to dispute the socialists' claim to membership in the democratic club." (Schumpeter, 1987, p. 235) More generally, "Asociety may be fully and

truly socialist and yet ... be organized in the most democratic of all possible ways ... Paradoxical as it sounds, individualism and socialism are not necessarily opposites." (*ibid.*, pp. 170-171) The argument in the text attempts to show that Schumpeter might have got his point wrong, after all.

10 Technically, the theorem holds on the assumption of "infinite risk aversion" (Tirole, 1988, pp. 41-42), that is, when each agent is interested only in his utility in the worst possible state of nature. This assumption is justified in our context by the fact that implicit claims under a hierarchical contract (just as company shares) are totally without any value outside a given hierarchical structure (as when the firm goes bankrupt), and, in contrast to share-holding, it is impossible to hedge the risk by diversification either. Even if risk aversion is finite, a high enough probability of a change in the government combined with a slow pace of advancement in the hierarchical structure should produce the same result. It is perhaps no accident that hierarchical structures facing serious threats to their existence greatly increase the speed of promotion within their ranks in an effort to maintain incentives. It is also perhaps no accident that this usually does not help them.

11 This is not meant to deny the spectacular success that the Chinese reform has enjoyed so far, nor is there any need to invoke the argument to the effect that we haven's seen the end of the experiment yet. Instead , it is sufficient to point out that the introduction of market principles has led to disastrous consequences for China's SOEs in the industrial sector which are not that much different from what happened in Russia and other countries. Emphasis on industrial innovation and competition against industrialized Western nations plays a crucial role in the proof of the "second incompatibility theorem" below. The Chinese experience just shows that partial reform can have a different overall effect in the economic environment characterized by a large and all-important rural population, a

point which is irrelevant to our theme.

12 I am indebted to Harold Demsetz for this comment.

13 This corresponds to what is called the "communal equilibrium" in the literature on conflict and power (see Neary, 1997). However, in what follows it is assumed that after the initial equality breaks down, a market economy instantaneously finds a coordinated way of transition to the post-constitutional state with perfect and costless protection of property rights. This is an obvious simplification, but the mechanism of transition to a post-constitutional state (Leviathan) in a market economy does not concern us here.

14 For example, this will always be the case if the initial capital stock is too large in the sense that the marginal rate of transformation is less or equal to 1. For any rational consumption-saving decision, the marginal rate of transformation rate between x and y should exceed 1. In what follows it is assumed that this condition is satisfied throughout.

15 If the primary resource (labor) endowment is very large relative to the stock of the produced good carried over from the previous period, it may be less than fully employed. In what follows we ignore this difficulty by redefining, if necessary, the labor/primary resource endowment to cover only that part of it which is actually combined with the produced good in the production process. The rest will be just costlessly disposed of.

16 "We will simply define innovation as the setting up of a new production function." (Schumpeter, 1939, p. 87) The assumption of costless innovation is less restrictive than it appears. This assumption just captures the basic Schumpeterian insight that innovators do not balance expected profits and losses in a usual sense. Innovative activity is interpreted here as an act of expressing the innovator's preferences, thus any costs which that act incurs would be taken account of in the form of his utility function.

17 "He [the entrepreneur] withdraws, by his bids for producers'goods, the

quantities of them he needs from the uses which they served before." (Schumpeter, 1939, p. 131)

18 What happens here, after the "mutation" and before the new technology becomes known to all agents, is that effectively two capital goods emerge: the capital good owned by agents in possession of the new technology is more productive (produces more of the final output mix per unit of investment) than that owned by the agents who have not learned it yet.

19 Strictly speaking, some or all other agents will now be investing not $x_{k_0} = X_0/N$, but slightly less. We are assuming a very large N, so we ignore this marginal difference.

20 "Distance" here should not necessarily imply spatial distance, it may be interpreted as the distance in terms of entrepreneurial talent or social status. Various specifications of the distance functions, including also the time distance (as with patent protection) can be employed to study how particular institutional settings affect the speed at which an innovation proliferates. One such specification is employed below to study the planned economy environment.

21 In contrast to the case of the original innovator, the assumption of costlessness here cannot be justified by invoking the "preference for innovation" argument. By assuming that only agents in a certain neighborhood can observe the new technology, we effectively do introduce a cost function in a specific step-function form, equal to zero for all $k \in S(m)$ and equal to infinity for all other agents. A more general cost function (for example, continuously increasing with the distance) will not affect the conclusion.

22 The simple model presented here can also be utilized to analyze the persistent effects caused by the dynamic adaptation process proposed by Schumpeter (1934 and 1939) . See (Braguinsky and Yavlinsky, 1999) for more details.

23 This is obviously a very crude assumption. In the real world, power in too many cases is generated by non-economic factors. However, the qualitative features of the following analysis will not be affected if the assumption is relaxed to the point where it is just asserted that, other things equal, larger wealth puts an agent in a better position to protect his property rights. As for what brought about Stalin's command over the whole existing stock of the capital good in the first place, it is assumed, following (Thompson and Faith, 1981), that a higher-order game, "a warlike affair with no higher authority" was played before history began. "War losses are strictly sunk costs once a hierarchy is established and our game is ready to be played." (*ibid.*, p. 371)

24 For models involving elements of choice between production and the generation of power see, for example, (Bush and Mayer, 1974), (Hirshleifer, 1995), (Neary, 1997). DUP activities are broadly defined as "activities that ... yield pecuniary returns but do not produce goods or services that enter a utility function directly or indirectly via increased production or availability to the economy of goods that enter a utility function." (Bhagwati, 1982, p. 989).

25 At least those which are engaged in production - we do not count members of the dictators enforcement team among the N agents at all. In this sense "Stalin" can also be interpreted as a "collective dictator" comprised of Stalin himself, his armed forces, police, etc. In topology, an "isolated point" of a set is defined as a point for which an open neighborhood not containing any other point of the set can be found. A set which contains at least one isolated point thus becomes "disconnected" In this case the set N consists of a discrete number of agents (points), so the concept is employed heuristically.

26 This assumption is actually more stringent than necessary. The following analysis will remain basically intact were we just to assume that the new

technology will have spread to a non-negligible set of agents allowing the initial innovators to earn their "big prizes" and perhaps create their own private firms before it becomes known to the dictator.

27 A similar "take it or leave it offer" for non-identical agents will require a ban on private reselling of the capital good, and thus an effective monitoring scheme (see more on this below).

28 The dictator cannot save the situation by repeating the "market allocation game" described above at the beginning of each new period. The reason is that with heterogeneous production functions, only the old (relatively inefficient) technology will be revealed to him. Both those agents who have already learned the new technology and those who have not done so yet, will find it more profitable to perform the reallocation of resources in discretion since they will then be able to retain among themselves the total amount of inframarginal returns. Moreover (and perhaps more fundamentally), if the dictator makes the "market allocation game" described above a repeated game, private agents may develop collusive behavior even in the absence of innovation, so playing a one-shot game and then fixing its results (the allocation of the capital good and the size of the fixed payment) for an indefinite period of time is essential to the long-term stability of the dictator's position.

29 It follows from this discussion that the degree of vulnerability of the social order in a totalitarian economy will increase with (1) the magnitude of the innovative process itself.; (2) the larger size of the economy. In particular, if we assume that the innovative process is positively correlated with the human capital accumulated, higher level of education will definitely pose a threat to social order. Also, with large distance among private agents more inframarginal returns will be accumulated by innovators in each round of successful innovation, so that *celeris paribus* large and/or heterogeneous sets of $(N-1)$ agents are more likely than small and/or homogenous ones to

produce out of their ranks "strongmen" who will be ready to challenge the dictator for the ultimate power. See (Braguinsky and Yavlinsky, 1999) for more on this.

30 It is a subject of some controversy whether even a very small probability of an infinite loss (like that represented by the threat of capital punishment) will be enough to deter risk-averse agents from ever playing "hide" (Kreps, 1990) contends that even generally risk-averse agents do balance finite benefits against some very low-probability infinite losses (for example, anyone does this sort of balancing when crossing a busy street on one's way to the theater). For the argument in the text to hold, the probability of being caught and executed cannot thus be perceived to be too low. In practice Stalin had to maintain a very costly and extensive net-work of *seksoty* (secret police agents) and *stukachi* (civilians paid for cooperating with the secret police) at virtually each workplace.

31 Of course, no small set of innovating agents can hope to be able to bribe the whole population to induce them not to report to the dictator on deals in the capital good (remember the perfect competition assumption).

32 Another economic reason for the ban on re-renting the capital good is the dictator's desire to effect perfect price discrimination among possibly heterogeneous producers when charging them the capital stock usage fee (see above).

33 For example we may think of a mutation as being triggered by some deviation from the established operational routine which is not tolerated with respect to individual members of a state-owned productive team.

34 The distance function and trading in the capital good have performed this selection role in the bench-mark model.

35 "Individual economic units in industry, agriculture, and other branches of the economy are charged with providing the center with the information it needs to monitor the operation of the economy and plan for its future

operation, and with fulfilling the plans coming from above." (Hewett, 1988, p. 115)

36 The average period for which a Soviet manager stayed in charge of a particular SOE was less than 2 years during the Stalin era.

37 It is essential that the supervisor is made the residual claimant since otherwise there will be an incentive for him to collude with the mutant production team and understate the true productiveness of a new technology (compare Alchian and Demsetz, 1972).

38 The post-war Japanese economy presents one example of successful utilization of the advantages of centralized coordination in the phase of catch-up growth. As the Japanese system was not based on hierarchical property rights, the combination of de facto economic planning with regard to innovative growth and the market mechanism presented no special problem, so private incentives could be employed for the propagation of the innovation. It is not surprising, however, that once Japan has reached the stage of an advanced nation, it discovered that its system started seriously malfunctioning. Note also that the former Soviet Union placed great emphasis on stealing industrial innovations from developed market economies to compensate both for the lack of incentives and of the appropriate selection mechanism within its own system.

39 According to former prisoners, in Magadan gold mines almost 1/3 of the prisoners died each year. Since the shortest sentence term was 5 years, this means that the survival expectancy was equal to zero for *all* prisoners. Magadan was feared for its exceptionally high death rates, but in other places, too, the death rate was considerable.

40 Under *propiska* urban residents were not allowed to move to another city unless they had acquired a job there; however, for most employers *propiska* in the city where it was located was an absolute precondition for hiring an employee. Anyone desiring to move was thus caught in a vicious circle

exacerbated by the draconian law according to which anyone without an official job could be sent to prison just for that (as well as for violating the propiska regulation!). Thus, in 1961 (already after Stalin's death and in the midst of Khrushchev's thaw) the future Nobel prize winning poet Joseph Brodsky was sentenced to 5 years of hard labor for not having a job. His claim that he was a poet failed to impress the judge who reportedly remarked that there was no such profession on her list of officially approved occupations (to be admitted as a poet, the person had to become a member of the official Writers" union and comply with "socialist realism".

41 According to the Soviet criteria of the time, those included all enterprises with the number of workers over 16 and at least one mechanical engine, or 30 or more workers without the aid of a mechanical engine.

42 "Perhaps the outstanding feature of the ethos within which the Soviet firm functions, the most "massive fact" about the life of the Soviet manager, is the sense of pressure from above. It is not the nature of the planning mechanism itself, but the pace at which it is kept in motion by the state, that generates this pressure. The word "tempo," one of the proudest slogans in the Bolshevik economic glossary, encapsulates for the manager all the strain and urgency that is normal to Soviet economic life." (Berliner, 1957, p. 23)

43 Since early 1930s Stalin has apparently adopted a 6-7-year cycle; the peaks of his purges arrive in 1937-38, then in 1944, and finally in 1950-51. Those peaks were preceded by relative "thaws" a new and "most democratic" Constitution was adopted in 1936, the regime seemed much more flexible in 1941-42 (due also to initial defeats in the war against Germany, of course), and there was an upsurge in the discussion of the need to change the system of economic planning in 1947-48. Raising people's hopes and then ruthlessly crushing them seems also to have been part of Stalin's political strategy.

44 Hewett, in the description of this feature of the mature Soviet planning system writes as follows. "Anyone who has read Soviet plan documents is struck by the heavy reliance on growth rates and absolute increments, but particularly growth rates, to express target. It is the growth rate of national income, investment, per capita real income, industrial production, and so on that receives attention. ... Soviet authorities have quite naturally fallen into the practice of basing plans for next year's performance on increments related to this year's performance." (Hewett, 1988, p. 186)

45 A striking example is provided by the propagation of one of the most important pioneering innovations generated by the Soviet industry in 1960s, the method of continuous iron casting. Although it was a Soviet SOE which first developed this technology, 15 years later it was introduced in just 14% of Soviet steel firms. On the other hand, the Japanese steel manufacturers, which had learned this technology from the Soviets, introduced it in more than 80% of their firms during the same period.

46 See, for example, (Hewett, 1988, p. 188).

47 As also noted in the authoritative account by Hewett, "the central planners, faced with the de-facto inconsistency of their assigned objectives and the efforts of managers to serve many motives, begin to make special deals with each enterprise, through the ministries. The resulting relationship between the state and enterprises is far more complex and individualized than the regulations would suggest. ... The successful "entrepreneur" in this system is not a person who develops new products and new technologies, but one who successfully develops a workable relationship with the government and party authorities supervising his enterprises" (Hewett, 1988, p. 198).

48 The innovations consist at this stage not so much of true innovations in the production technology (which would still be rather difficult to hide in principle) but rather of various "new combinations" of resources particularly in the field of arbitrage in the heavily distorted consumer

goods' markets as well as in rent seeking. See (Baumol, 1990) for the extension of Schumpeterian "new combinations" along these lines.