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Knowledge Driven Decentralization

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Abstract

This paper explores the paradigm shift from centralized, command-and-control systems to decentralized, knowledge-driven structures across economic, organizational, technological, and social domains. The inefficiencies and lack of innovation in centrally planned systems stem largely from informational constraints—particularly the inability to effectively gather, process, and utilize dispersed, local, and tacit knowledge. Decentralization enables autonomous agents to leverage their own knowledge, fostering experimentation, innovation, and adaptability. Through a series of examples—including economic markets, firms, states, environmental systems, communications networks, and educational models—the paper illustrates how decentralization replaces vertical, hierarchical communication with horizontal, networked interactions. The transition is characterized by the central authority relinquishing direct control in favor of setting rules of interaction, thereby mitigating principal-agent problems and enhancing system robustness. The analysis extends to social learning, contrasting passive, top-down education with active, dialogical learning, and highlights the importance of intellectual freedom and experimentation in organizations and societies. The overall conclusion is that successful decentralization depends on well-designed rules that maximize autonomy and spontaneous activity, consistent with the broader goal of compossible freedom for all agents.

Keywords: Decentralization, Knowledge, Market Restructuring, Environmental

1. Introduction

The major institutional transformation of our time is the transition from socialist systems of central planning and state ownership to private property market economies. The failure of the socialist economies to operate efficiently and to innovate can be traced in large part to informational considerations. Indeed, the plan-to-market restructuring can be seen as the paradigmatic example of the information-driven decentralization that is taking place in many spheres of life. We will describe many different examples of this restructuring towards decentralization, and we will draw out the common informational factors driving these transformations.

1.1. The Standard Example of Plan to Market Restructuring

The pattern of restructuring will be described by considering the two extremes or "ideal types": the centralized form and the decentralized form. Actual examples will exhibit various mixtures of these two extremes. In the plan-to-market example, the "plan" is a classic command economy where a central authority issues orders to the various economic agents (producers and consumers). The principal channels of information flow are vertical, between the center and the agents. Coordination is through the center. At the other extreme is a system of decentralized agents regulated by certain rules of interaction (the "market"). The agents are autonomous and self-directed although they need to obey the "rule of law" expressed in the interaction rules between the agents. The central body enforces these rules of interaction. Coordination takes place through the horizontal links between agents. What is the role of knowledge and information? Knowledge about beliefs, preferences, technology, and local conditions is available but is dispersed between the economic agents. Centralized mechanisms for gathering, processing, and transmitting this information deteriorate as the informational messages grow more complex (as is illustrated by the children's game of transmitting a piece of information or a story around a circle). The problems would be compounded by the difficulties of eliciting and transmitting knowledge that is tacit or implicit in behavior (like knowing how to skillfully operate a machine). Centralized attempts to reduce "wasteful" duplication of experiments would ultimately stifle innovation. Centralized structures might work only for relatively short spans of historical time, e.g., a war effort or a big technology project. Attempts to "command" decentralized behavior in a centralized framework face severe motivational and principal-agent problem, and lack the credible commitment that the "decentralized" decisions will be respected and sustained by the central authorities.

The available but dispersed, local, and tacit knowledge would be used by the agents if they were acting on their own behalf in a decentralized and competitive market process. Instead of postulating some unrealistically ideal information transfer to and from central planners as well as some idealized central information processing capacity, the plan-to-market type of restructuring allows the available knowledge to be locally utilized by the decentralized agents. The separate agents would also perform many local experiments (which might "wastefully" duplicate one another) to discover new knowledge. Prices would evolve to reflect the relative scarcity of resources and to align subjective expectations with the factual state of affairs.

1.2. The Standard Model

We will give more examples of the centralized and decentralized structures so that the commonalties can be better discerned and the restructuring from one structure towards the other can be better understood. We will use a simple abstract "standard model" of each structure. There is a central body and there are numerous agents. In the centralized structure, there is a hierarchical command relationship and vertical communication links between the central body and the agents. In the decentralized type of structure, the central body gives up direct commands and only sets the "rules of the game" between the autonomous agents who in turn establish horizontal "network" ties or relationships with one another as illustrated in Figure 1.

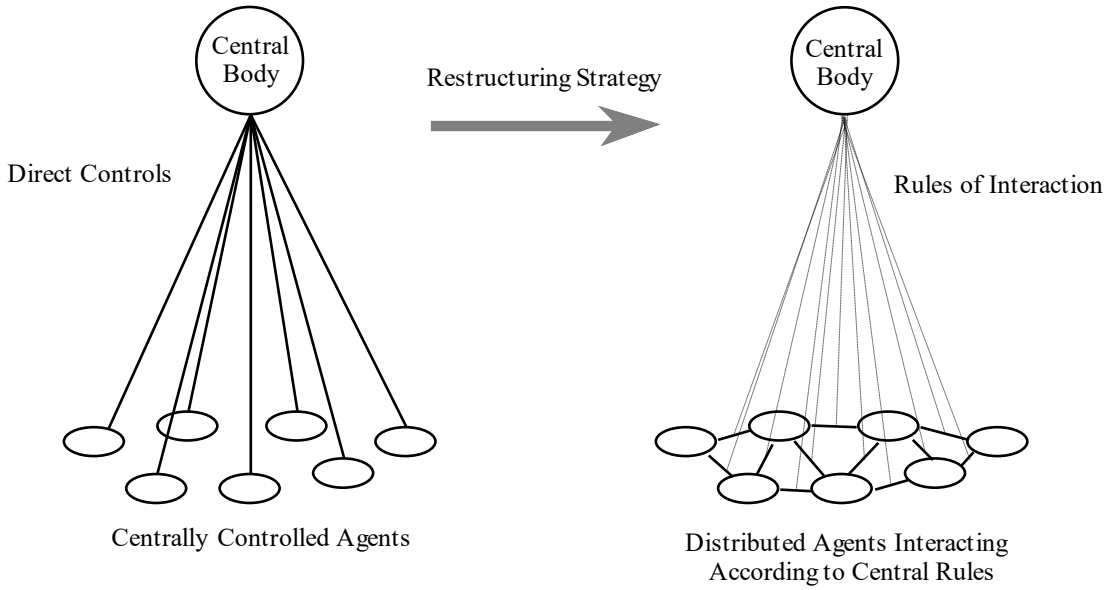

Figure 1: Restructuring Strategy

The informational requirements of the two models are quite different. In the centralized structure, the relevant information has to be communicated along the "long lines" to the central authority. Moreover, the central authority has to be able to process all the information from the agents to make effective decisions and then to retransmit the commands back to the agents. Coordination takes place through the central authority. In general, there will be significant principal-agent problems between the central authority and the agents. In the decentralized model, the communication lines are the "short" horizontal links between the agents. Each agent only has to communicate with its neighbors, not necessarily with all agents in the network. The network is "distributed" in the sense that there is no central "root" node through which all information must pass. Since each agent has some decentralized autonomy (not under direct command of central body), the agent can use its dispersed local and tacit knowledge to make decisions. That information does not have to be transmitted to the central body in order to be used in decision-making. This degree of local autonomy also mitigates the principal-agent problem (since the agent and principal are in part unified). Since each agent is only solving a local problem, there are reduced demands on information processing power. In short, the system is much more robust.

Box 1 Paving the Paths

A number of office buildings were built in the middle of a large field. Where should the sidewalks be? A central planner would design the sidewalks to "address human needs," specify where the sidewalks should be built, and prescribe penalties for "walking on the grass." But the planner would have little way to elicit the desires and forecast the decisions of the many users. Instead the area could be filled with grass for several months. By that time, paths would have been worn in the grass by the self-directed activities of the users of the buildings. The paths could then pave to create a system of sidewalks that responded to the knowledge revealed by the spontaneous activities of the users [1].

2. Examples of Restructuring Towards Decentralization

2.1. From the Knowledge-Using Company to the Learning Company

One important restructuring example is provided by the firm: the transformation from a hierarchical command-and-control knowledge-using firm to a decentralized horizontally-coordinated active learning firm [2,3]. In this case, agents could be taken as semi-autonomous work teams operating within the rules of interaction supplied by management.

2.2. From Hayekian Organization ("Taxis") to Spontaneous Order ("Kosmos")

Many of the examples are variations on the basic plan-to-market theme. At the level of the state, the restructuring would move from a centralized authoritarian state model to a state model emphasizing coordination under the rule of law between semi-autonomous organizations, associations, and individuals. Friedrich Hayek generalized the paradigmatic plan-to-market example to a more general juxtaposition of an organization ("taxis") designed to promote one overarching end (e.g., the "Good") versus the classical liberal vision of a spontaneous order ("kosmos") consisting of autonomous agents seeking their own diverse ends interacting according to certain impersonal laws [4,5].

2.3. From Command and Control to Decentralized Environmental Systems

There are several decentralizing approaches that might improve on the classical command and control approach to environmental control. Taxes, tradable permits, and deposit-refund systems can bring market pressures to bear on pollution problems. Overcoming market failures in credit and insurance markets can promote the use of high fixed cost but environmentally friendly technologies by households and businesses. Another type of decentralization is the devolution of the government's role from central to local governments. The municipal or other local governments are closer to the monitoring information, know better the local adaptations needed to apply solutions, and have less turnaround time in updating actions with feedback on their effects. Another approach is to develop local property rights and businesses that will overcome the tragedy of the commons, e.g., tourism based on local natural habitats.

2.4. From State Monopolies to Regulated De-Monopolized Private Enterprises

An example of the plan-to-market type of restructuring of particular concern to the World Bank is the example of utilities being restructured from state-owned monopolies (where "regulation" was part of the operational commands) to a system of privatized or semi-autonomous corporatized public enterprises operating within a regulatory framework. In the case of the network utilities, this is the switch from the traditional model of vertically integrated monopolies (e.g., the old AT&T monopoly) to a system of network pluralism with multiple operators using uniform interconnection standards to have access to the network (e.g., the "Baby Bells" after the split-up of AT&T into regional phone companies).

2.5. From Central Traffic Control to Regulated Self-Directed Traffic on Networks

Not only the economics but also the technology of networks is moving towards more decentralization. For transportation networks, a centralized model is used for rail traffic and air traffic where there is centralized scheduling and coordination by traffic controllers. A decentralized model is used for road traffic where autonomous cars and trucks interact according to the rules of the road (e.g., driving conventions, stop signs, traffic lights, and speed limits).

2.6. From Centralized to Diversified Channels of Project Selection

Economic and political institutions powerfully affect which ideas, innovations, or projects are selected to be financed and implemented. There are two opposing extremes: a hierarchical system where a proposal must pass a series of hurdles to be accepted, or a decentralized system of alternative decision centers where a proposal can be accepted by any one of them (and can get a second chance if turned down). The hierarchical system would tend to err on the side of rejecting many good projects, while the decentralized system would err on the side of accepting many bad projects. The advisability of the two systems would depend on the relative cost of accepting a project that turns out to be bad versus the opportunity cost of rejecting a project that turned out to be good.

Box 2: Columbus and Zheng He

The political fragmentation of Europe gave it more dynamism than the centralized structure of China. Columbus was turned down by the King of Portugal and two Spanish dukes before submitting his proposal to Ferdinand and Isabella. After a four year wait, he was again turned down, but the decision was reversed two years later in 1492. After the spectacular voyages of the Chinese fleet under Zheng He to Africa in the early 1400's, the Ming Dynasty had by Columbus' time made a centralized decision to give up sea expeditions and stop producing sea-going vessels.

The hierarchical system would be best for a decision where accepting a bad project might be fatal–as in the decision to go to war. But where accepted bad projects are not fatal and only waste resources, the clear verdict of history is in favor of a more decentralized system of diverse political or economic units. In a decentralized system, decision-makers compete against one another to find good projects. With centralized or monopoly project selection, there is no fear that a rejected innovation will be adopted by a competitor and an accepted innovation might have an uncertain effect on the monopoly. Thus, hierarchical centralization has been a recipe for uniform and essentially static societies from ancient Egypt

to the Soviet Union.

2.7. From Macro-Machines to Complexes of Micro-Machines

By way of analogy, we might consider a few examples of technological decentralization or decomposition of systems. An example (with a ring of science fiction to it) is the transition from a system of command and control of a macro-machine like a car or plane to a decentralized system of automata or micro-machines which is controlled by setting the rules of interaction. In the former case, we use the laws of physics and chemistry to get the direct effects of the macro-machine that are desired. In the latter case, the automata obey the laws of physics and chemistry at the micro-level but the desired effects for the human user only emerge at the macro-level. The new science of complexity tries to find the laws of "scaling up" so we will understand the connection between the rules of micro-interaction set by the human user and the emergent macro-effects from the multitude of interacting "organisms."

2.8. From Central Switching to Packet Switching in Communications Networks

The centralized-to-decentralized restructuring can be applied to different types of communications networks. The best known decentralized distributed network (aside from the brain) is the Internet. The corresponding centralized structure would-be long-distance telephone operating through central switches, one for each locale or city. Each call goes through the central switch to a party or "node" in the same locale or to the central switch in another locale. If a line is damaged, one or more nodes are cut off the system as seen from Figure 2.

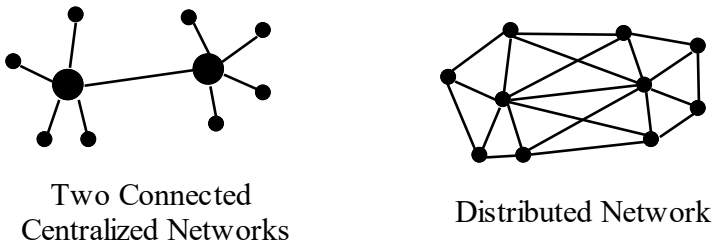

Figure 2: Comparison of Networks

There are many paths between two given nodes in a distributed network, so some lines can be damaged and a node can still be connected. Also, the messages are "distributed" on the Internet. In telephony, a line is dedicated to the conversation between two nodes. In the Internet, a message is broken down into many packets each of which wends its way through the network to the given destination where they are reassembled to give the original message. With "packet switching" there is no central plan for the packet routing. Each node has a computer that keeps track of the relevant information about neighboring nodes (which are open for more packets and which are full) so decentralized decisions are made about the best next step in the "adaptive" route without having to transmit that information to a central hub. The "rules of interaction" are embodied in the programming of the computers at the nodes.

2.9. From Batch Processing to Time Sharing on a Computer

During the 1950s, a similar temporal restructuring took place in the change from the batch processing mode of using a mainframe computer with centralized prioritizing of batches to the time-sharing system. Instead of a conversation taking a dedicated line in a telephone network, a batch (actually a stack of computer cards, each containing a line of program) would have the dedicated use of the computer with central control by the system administrator. With time-sharing, a person's use of the computer was broken up into small parts (like packets) and parts from different users were run in rapid sequence so each user seemed to be using the computer alone.

Box 3: Robustness of Distributed Networks

In 1960, Paul Baran of the RAND Corporation developed the idea (but not the name) of packet switching in a distributed network in order to increase robustness. Conventional telephone networks with a hub, say, in Omaha were too vulnerable to a nuclear attack. The distributed networks had redundant routes so some links could be lost and still the message could get through.

The idea (and the name) of packet switching was also developed a few years later by Donald Davies of the British National Physical Laboratory using the analogy with time-sharing [6].

2.10. From Fordism to Toyotism

The transformation from a hierarchical firm to a more decentralized and participatory firm also has implications for the use of fixed assets. The technological time-sharing example also allows us to understand part of the human-systems transition from mass production or Fordism to

Toyotism or lean production. Mass production is based on dedicated use of the dies and machinery to produce one model with fixed characteristics–like the dedicated use of a mainframe computer by running a batch program with fixed program lines on the computer cards. The development of rapid die changes and just-in-time (JIT) inventories in Toyota allowed the company to intersperse the production of many different models with characteristics that could be specified almost in real time, like operating a mainframe from a terminal in a time-sharing system.

2.11. From a Closed Society to an Open Society

At the level of social discourse and the flow of information, Karl Popper has emphasized the juxtaposition of a closed society which typically has government control of the information media and government co-option of organizations versus the open society of free and independent information media together with a civil society populated by non-governmental organizations and associations all sustained by "interaction rules" of tolerance and rational debate [7]. Closed societies are often based on some assumption that the central authority has the "Truth" that is coupled with "Virtue" to rationalize authority over the agents (e.g., Plato's Republic). The move towards an open society is based on the sobering recognition that in this imperfect world, society is better based on the more robust assumption that the knowledge and virtue of the central authorities will fall short of perfection. The restructuring relinquishes the idea of a closed society that "knows the Truth" in favor of an open society that "knows it does not know the Truth."

2.12. From Authoritarian Dogma to the Scientific Method

One of the most remarkable historical examples of the movement from a closed society to an open society is the intellectual transition from the Church-dominated world-view of medieval Europe to modern science that grew out of the Renaissance, Reformation, and Enlightenment. The Reformation provided the archetype of this type of transformation: from the centralized Church to the radically decentralized "universal priesthood of man." In the general model of authoritarian "truth," there is a central repository and arbiter of "truth"; agreement with the official dogmas of the church, party, or bureaucracy is the touchstone of "true knowledge." Science differs in the methodology used to sustain or overturn the hypotheses. In mathematics, it is proof, not authority, that is the basis for theorems. In the empirical sciences, hypotheses are developed on the basis of intellectual coherence and factual cues, and are then openly subjected to experiments that can be intersubjectively verified and reproduced. It is a decentralized affair. In the tradition of Galileo, the humblest experiment or proof by an unknown scientist or mathematician can overturn the most exalted "authority."

A social innovation benefits many even though it may have been developed by only a few. There is no patent on new institutions so social innovation and organization may be seen as a public good that tends to be undersupplied. There is scope for government intervention to alleviate this market failure by promoting local experimentation. Societies that do not experiment can be historical deadends like the closed and static feudal manors of medieval Europe. Modern Europe evolved from the towns which grew up in the "cracks" of an otherwise closed medieval society and which functioned as "special zones" where new forms of economic and social organization could be tested. Experimentation often requires first breaking out of a closed belief system that resists learning. Some beliefs are of a metaphysical nature about "another world" and thus cannot be falsified. Most long-standing belief systems have built-in "antibodies" that attack invading ideas. Intellectual defense mechanisms are usually accompanied by social reinforcement to maintain the beliefs. These intellectually closed or unfalsifiable belief systems provide strong obstacles to learning and might function as self-sustaining "belief traps" providing the intellectual component of poverty traps. The closed belief system of medieval Europe was but one of many examples.

Box 4: Experiments Give Feedback from Reality

Some assumptions can be falsified by simple experiments. In the Middle Ages, it was debated why putting a dead fish into a pot filled with water to the brim would cause the water to overflow while putting a live fish in the water would not cause an overflow. Finally, a budding "Galileo" resolved the matter by putting it to an empirical test; the water overflowed in both cases.

In more general terms, how is knowledge separated from "knoise" (noise posing as knowledge) such as biased opinion, self-serving misinformation, hyperbole, propaganda, ideology, and cult-like beliefs? How is knowledge corroborated? How was astronomy separated from astrology, and chemistry from alchemy? In general, there are two methods of "corroboration": (1) approval or disapproval from a social reference group or (2) objective experimentation. The former gives a socially approved norm or custom which may in the past have encapsulated the best practices in another environment. But times change, knowledge progresses, and new opportunities arise. It is the "feedback loop" with the objective world that provides the ultimate test for corroboration of knowledge, not congruence with social customs or ideology. The color of the cats doesn't matter just so long as they catch the mice.

Box 5: Scientific Method in Tokugawa Japanese Farming
An eighteenth-century Japanese peasant put down his agronomic observations in an unsigned and untitled work perhaps for the benefit of his son. In the words of a modern scholar:
"For those who would farm intelligently [this peasant] had a single admonition which he repeated tirelessly: study and learn! Study and learn from personal experience and from that of others. How? One way he recommended was to keep a record of one's farming–of seeds, plants, soils, fertilizers, harvest and planting dates–so that the 'turning of the front wheels may warn the rear.' Then, for instance, if one variety did better than another in a particular soil, one knew it immediately, whereas one might not otherwise discover the fact until too late. It was also possible to learn from others by cross-examining and badgering peasants who excelled at farming until at last they revealed the secrets of their superiority [8]."

The systematic pursuit of feedback from the objective world is the scientific method, the application of critical reason coupled with openness, pragmatism, and impartial experimentation. The scientific method begins with the knowledge that we do not have perfect, ideal, or ultimate knowledge. There is always more to be gained from open experimentation–"Crossing the river by feeling for the stones"–and from following Kant's dictum to "Have the courage to use one's own reason."

2.13. From Bureaucratic Truth to Intellectual Freedom in an Organization

Organizations are structured rather differently depending on whether they take the arbiter of knowledge to be a given "authority" or to be reason and experiment that is open to all. The international society of science is a remarkable "organization" that operates without any central authority as the touchstone of truth. Through the horizontal interaction of scientists and the methodology of repeatable experiments, a rough moving consensus nevertheless tends to emerge as to the best current theories. Another example of an organization that promotes intellectual freedom and the "collision of adverse opinions" is the university that emerged after the Middle Ages. The central authority in a university is only an administrative authority, not an intellectual authority. The university departments and professors are intellectually autonomous subject to certain rules of reason, fair play, and tolerance.

Box 6: Basis of Knowledge Determines Nature of Learning
"Obviously a man can 'learn' languages, mathematics, science, history, literature, even philosophy, no matter how servile his mind. But what exactly does it mean to say that he has 'learned'? Does it mean merely that he can repeat some proposition, answer questions about it, get it right on an examination? If so, then knowledge has nothing to do with freedom. Or does it mean that he can give *reasons* for what he believes, that he can himself see the merits of those reasons, and that he stands ready to withhold or change his beliefs whenever he judges it right to do so? If *that* is what 'learning' means, then authority and education are polar opposites. Authority says, Do this, believe this, because I say so! Education says, Here are reasons for doing, for believing--reflect on them and see whether you yourself judge them to be good reasons [9]."

2.14. From Passive to Active Learning

We might juxtapose two different types of educational philosophies or pedagogies [see Box "Basis of Knowledge Determines Nature of Learning"]. One pedagogy regards education as analogous to pouring a liquid into a passive container or to putting money into a bank to be later withdrawn. The structure is top-down, the teacher is the central authority pouring the information into the passive students who absorb the information and reproduce it (e.g., the Tayloristic approach to workplace learning). The other theory ("active learning") interprets learning as an active project of the learners (as autonomous agents) with the teacher playing a more Socratic role of questioning and guiding the learners in their process of educational discovery [10]. Much relevant knowledge is local and tacit which places more emphasis on "horizontal" learning (e.g., dialogue, apprenticeships, or twinning arrangements) from those who have already acquired the knowledge.

Box 7: Freire, Cudworth, and Socrates
Paulo Freire juxtaposed his active dialogical theory of learning to a "banking" theory which pictured training like depositing knowledge into a bank–to be later drawn upon [11]. The active model has its roots in the Socratic Method and was quite explicit in the Cambridge Platonist Ralph Cudworth writing in the late 1600's: "knowledge was not to be poured into the soul like liquor, but rather to be invited and gently drawn forth from it; nor the mind so much to be filled therewith from without, like a vessel, as to be kindled and awakened." [1996, 78] Cudworth also saw clearly the active nature of learning [12]: "knowledge is an inward and active energy of the mind itself, and the displaying of its own innate vigour from within, whereby it doth conquer, master, and command its objects...." [73]

The aim of the active learning approach is not information transfer but the transformation of the student into an active and autonomous constructor and appropriator of knowledge. The ancient model is the Socratic method of dialogue exemplified in the Meno where Socrates by his questioning led a slave boy to discover some truths of geometry. How can the teacher be the "midwife" in the process of active learning on the part of the students? Students do not construct knowledge in a void. Learning is contextual; it builds upon the context of previous knowledge, experience, and problems. For the teacher to guide and assist in the process, the teacher must first learn to see the world through the eyes of the student–to see the student's context. Hence Freire's emphasis on dialogue as the prelude to as well as the means of learning. The cases, examples, and questions can be couched in terms that make sense from the student's viewpoint and are relevant to the student's interests. With this preparation, the student can take responsibility for actively reconstructing and appropriating knowledge with occasional prodding and questioning from the teacher as midwife. Knowledge obtained in this active way is truly the student's own; it is neither a gift nor an imposition. However, the real product of this active learning process is not the immediate knowledge thereby gained but the capacity to learn, to exercise judgment, and to think for oneself which might continue long after the end of the formal educational encounter [13].

3. Review of Examples

These examples can now be summarized in Table 1.

Example	Centralized Structure	Regulated Decentralized Structure
Economic resource allocation system	Central planning system ("Plan").	Decentralized market system ("Market").
Firm	Hierarchical Tayloristic command and control system.	Decentralized teams coordinating between themselves according to management guidelines.
State	Central government commands subordinate agents.	Central government set coordination guidelines for network of semi-autonomous agents.
Social Order	Designed order of an organization ("*taxis*") serving some overarching end.	Spontaneous order ("*kosmos*") of autonomous agents serving own ends and interacting according to impersonal laws.
Environmental Systems	Command and control by central government.	Market, local government, or community based systems.
Information and other utilities infrastructure	Traditional paradigm of vertically integrated monopolies. Operation and regulation often combined.	Emerging paradigm of multiple operators and suppliers with network pluralism enforced by interconnection standards. Separate regulation.
Transportation network	Rail and air traffic governed by centralized traffic controllers.	Road traffic of self-directed cars and trucks interacting according to rules of the road.
Project Selection	Many stages of approval in centralized process. Ancient China. Modern communism.	Diverse channels for approving and financing projects. Patrons, independent banks, venture capitalists.
Machines	Direct control of macro-machine as one system. Effects directly determined by laws of physics and chemistry.	Rule-setting for complex of micro-agents. Micro-behavior of agents scales up to macro-effects.
Communications network	Dedicated connections through central switch. Voice telephone.	Packet-switching through distributed network. Internet.
Use of mainframe computer	Dedicated batch processing with batch priorities determined by system administrator.	Time-sharing with multiple users connected through terminals.
Production system.	Mass production or Fordism. Long production runs with fixed tooling and buffer inventories.	Lean production or Toyotism. Short production runs with flexible tooling and JIT inventories.
Civil Society and Public Life	Closed society. Government controlled media carrying public discussion. Organizations co-opted by state.	Open society. Free press, non-governmental organizations and associations using tolerance and rules of public debate.
Basis of Knowledge	Agreement with Central Authority. Political or religious dogma.	Corroborated by experience and reason. Empirical science and mathematics.
"Received Truth" in Organizations	Central authority determines "received truth."	Intellectual freedom reflected in organizational autonomy. Universities and community of scientists.
Education	Top-down transmission of information from teacher to passive students.	Active learning by semi-autonomous learners guided by teacher.

Table 1: Summary of Examples

Many of the common themes of the restructuring towards more decentralized systems can be seen by reading down the right-hand column. Informational complexity pushes towards decentralized, devolved, or distributed systems with shorter horizontal links of communications and interaction between agents. In each case, a central body gives up or let's loose of some authority over the agents. Instead of direct commands, more weight is put on the incentives embodied in the structure of the decentralized system. With the right incentives and rules of the game, a robust system of decentralized agents will be led "as if by an invisible hand" towards the desired overall effects.

3.1. General Policy Implications

3.1.1. Common Themes

There is a common pattern in the various examples of information-driven devolution, decentralization, and marketization–and that means we can distill some common policy themes. The policy implications are primarily relevant for the cases where the systems being restructured are human organizations, not for the cases of "decentralization" in technological systems which were included as interesting analogies (e.g., micro-machines, packet-switching, and time-sharing).

3.1.2. Relaxing Centralized Command and Control

The most important and difficult part of the decentralizing restructuring is the central authority giving up its powers of direct command and control over the agents. Central control has its many perquisites that rebound to the personal welfare of the holders of central power. They are understandably reluctant to release that personal power ("Rule of Man") in the interest of the greater effectiveness and efficiency of a system of semi-autonomous agents constrained by an impersonal regulatory framework ("Rule of Law"). Every argument and stratagem will be deployed to sustain central control. After decentralization, every crisis will be probed as an opportunity for recentralization. In the cases where the activities of the decentralized agents were purely intellectual (e.g., scientific reasoning or learning), a central body could not enforce assent or dissent and thus would have no residual role of enforcing the rules of interaction. In the other cases, the central body would have at least that minimal enforcement role. When the rules are ill-designed or unenforced, or there are emergencies that require quick solutions to coordination problems, then pressures will build for a recentralization of authority.

3.1.3. Preparing Decentralized Agents for Autonomy

The switchover from central control to decentralized autonomy of the agents is always a difficult and perilous transition. It is akin to kicking the young birds out of the nest; they might fly on their own or they might plummet to the ground. Quite aside from self-serving reservations, the central authorities might always worry if the agents are prepared for more self-directed activity. The switchover should be particularly gradual if failure were fatal. But where failure was not necessarily fatal or irreversible, the verdict of experience seems to be in favor of learning by doing. That is, actually trying to fly is the best method of learning to fly. Instead of maintaining the agents in perennial tutelage for fear that they might make mistakes, it seems best to promote autonomy through active "on the job" learning programs which includes the "right" to make mistakes, to pay for them, and to thereby learn lasting lessons.

Box 8: The Exercise of Freedom as the Best School for Freedom
"For nothing promotes this ripeness for freedom so much as freedom itself. This truth, perhaps, may not be acknowledged by those who have so often used this unripeness as an excuse for continuing repression. But it seems to me to follow unquestionably from the very nature of man. The incapacity for freedom can only arise from a want of moral and intellectual power; to heighten this power is the only way to supply this want; but to do this presupposes the exercise of the power, and this exercise presupposes the freedom which awakens spontaneous activity [14]."

4. Conclusion: Getting the Rules Right

Decentralization is not chaos. In each example of the decentralized structure, there are rules of interaction that govern the otherwise mostly self-directed activities of the agents. In the special case of the plan to market transition as modeled in neo-classical economics, the decentralized agents interact through the medium of market prices. With competitive prices, the agents will be led "as if by an invisible hand" to reach an allocatively efficient equilibrium. In the more realistic models of information economics, agents interact on many dimensions (e.g., with adverse selection in credit markets, lenders need to screen applicants and ration credit rather than just raise the interest rate to clear the market). The appropriate rules will vary considerably in the wide variety of decentralized structures. But the common content of the rules of interaction might be discerned from the paradigm plan-to-market example or Hayek's general scheme of "organization" to spontaneous order. Taking the unfolding of autonomy as an end-in-itself, the minimal structure is that the rules should allow a maximum of autonomy and spontaneity of each agent consistent with similar powers for the other agents–the maximum compossible freedom.

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