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Allocation of Economic Competence in Teams: A Comparative Institutional Analysis

by

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Abstract: Attention is called to a little explored scarce resource, termed 'economic competence,' which combines features of human capital and bounded rationality, and causes a singularity in resource-allocation in society. The performance of each economy is shown to strongly depend on how this resource is allocated, which in turn strongly depends upon the economy's institutions ('rules of the game'). Two stylized institutional variants of market selection and one of government selection are compared for their short-term and long-term effects upon the output and growth of a perfect team economy. The results are exemplified by throwing new light on the social value of financial markets and the limitations of industrial policies.

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1 Introduction

The study of the use of scarce resources in society often advanced when more resources were recognized scarce and important than previously admitted. Well-known examples are information and human capital, recognized to be such resources first in the second half of this century. This paper argues that human capital and bounded rationality overlap in form of another such resource that has not yet been properly taken into account by theory. Naming it 'economic competence,' I define it as the *non-transferable* abilities of economic agents to understand and use available *transferable* information for taking decisions about the use of scarce resources, *including economic competence itself*.

Taking this resource into account is of particular importance in assessing the merits and demerits of alternative institutions.[1] The reason is that the performance of each economy strongly depends upon how economically competent, or incompetent, agents have been selected for key decision tasks — such as organizing and managing of firms, large-scale investing, and government policy-making — and how difficult, and thus competence demanding, these tasks have been designed.[2] And in turn, both the task design and task assignment strongly depend upon the prevailing institutions: for example, market competition and selection typically lead to different solutions than democratic elections or procedures of government administration. Studying how scarce economic competence is used and allocated in society thus promises to enrich comparative institutional analysis by new interesting results, which may help societies to choose efficient institutions, or at least avoid the most inefficient ones.

Perhaps the most important works that deal with this resource are Manne (1965) and Lucas (1978), who studied the allocation of managerial talent, Sah and Stiglitz (1991), who examined the quality of managers selected by other managers, and Murphy et al. (1991), who compared the use of talent in entrepreneurship with that in rent-seeking. But all these works are limited in two respects: they consider only special forms of economic competence, and they do

[1]Throughout the paper, the term 'institutions' is used in the sense of 'constraints upon decision spaces,' or 'rules of the game' — such as law and custom — common in neo-institutional economics (see, e.g., North, 1990:3). The institutions examined in this paper are more precisely defined in Section 5.

[2]The relationship between the competence of an agent and the difficulty of her task was studied by Heiner (1983), who coined the term 'competence-difficulty gap.'

not consider its kinship with bounded rationality.

To venture beyond these limits was the objective of several of my previous studies (Pelikan 1988, 1989, 1992, 1993). I defined there economic competence as a scarce resource which is needed for all economic decisions and which all economic agents must possess in some quantities and qualities, and thus had to recognize in it features of both human capital and bounded rationality. This lead me to discovering that resource-allocation in society contains a singularity with elements of self-reference: as scarce economic competence must be used in deciding about the use of all scarce resources, it must also be used in deciding about the use of itself. Although I was unable to deal with this singularity very precisely, a simple qualitative discussion allowed me to uncover some previously neglected merits and demerits of certain institutions — in particular national planning, industrial policies, markets for corporate control, and forms of ownership of firms.

The purpose of this paper is to expose this singularity with more precision and to illustrate some of its consequences by an elementary mathematical model.[3] To do so, I find it necessary to strongly simplify three aspects of the resource-allocation problem with scarce economic competence: (i) economic competence itself, whose many interesting properties are neglected, in order to focus on its role in the allocation of economic competence, the key to modeling the above-mentioned self-reference; (ii) the economy where the resource-allocation problem is studied, which is assumed to be a perfect team with negligible communication costs, in order to avoid all problems of effort, incentives, income distribution, and information asymmetries, and thus fully concentrate on the scarcity and asymmetries of economic competence; and (iii) the institutions which govern the allocation of economic competence, of which only two highly stylized variants of market selection and one of government selection are examined. Moreover, the model is limited to the productive sector of the economy, leaving aside the economic competence relevant to final consumption.

In spite of all these simplifications, however, some of the results of the model appear to make reasonably good sense in the real world. They appear to help to explain some so far

[3]The model is elementary indeed and the illustration it offers is only very rough; hopefully better models will be possible to build in the future. Right now, however, this is the best model I am able to offer. I can think of mathematically more complex models, but none of them would illustrate the singularity of economic competence any better than the present one.

poorly understood intricacies in the observed development of institutionally different economies — such as the waning success of the Japanese economy, the J-form growth trajectory of post-socialist economies after privatization, and the differences in growth and wealth distribution between market economies with developed financial markets and those where these markets are underdeveloped or absent.

The paper is organized as follows. The problem of resource-allocation with scarce economic competence is first exposed in general terms: Section 2 identifies economic competence as a property of individual agents, and Section 3 explains why it causes a singularity in resource-allocation in society. The elementary mathematical illustration begins in Section 4 with a stylized model of the use of economic competence for selecting economic competence, and continues in Section 5 with a corresponding model of allocation of economic competence in a perfect team, which compares the effects of the three stylized institutional variants upon the team's output and growth, in the short run and in the long run. The last two sections consider dropping some of the simplifying assumptions of this model. Section 6 drops the assumption of a perfect team and discusses the problems of agency and income distribution. Section 7 discusses more realistic institutional variants, in which the stylized variants are mixed in different proportions, and concludes by examples of policy implications concerning the roles of financial markets and industrial policies.

2 Identifying Economic Competence

As an overlap of bounded rationality and human capital, economic competence has features of both. Much like her bounded rationality, an agent's economic competence determines her more or less limited abilities to conduct economic calculus, solve economic problems, and take decisions about the use of scarce resources. And much like her human capital, an agent's economic competence is a non-transferable scarce resource which she may obtain only from two sources: her initial endowment or her own learning. While teachers may help by providing suitable verbal or non-verbal inputs, they cannot directly transfer the competence itself.

The bounded rationality features imply that an agent's economic decisions depend, in addition to her preferences (utility function), also on her economic competence. Thus, in the same decision task under the same external constraints, two agents who have the same preferences may nevertheless take different decisions, and thus obtain different outcomes, if they differ in economic competence.

Whether or not the differences in the outcomes are significant, however, depends on the difficulty of the task. For a given population of agents with a given distribution of economic competence, decision tasks can be divided into three broad categories: 'easy,' in which even the least competent agents can obtain optimal outcomes; 'too difficult,' in which even the most competent agents cannot avoid grossly failing; and 'difficult,' defined precisely as those tasks in which differently competent agents can obtain significantly different outcomes.

An obvious qualification is that in a risky or uncertain world, some differences in outcomes may also be due to chance. A more competent agent may have bad luck, and thus obtain a worse outcome than a less competent agent who had better luck. But it is often possible to assume — as the present model will also do — that effects of chance upon outcomes, while possibly large in the short run, cancel each other out in the long run. We only need to keep in mind that because of such effects, to infer an agent's economic competence from observations of her outcomes may be a difficult task by itself: from the same observations, less competent agents may learn less about others' competence than more competent agents.

The human capital features imply that economic competence is included among the scarce resources whose allocation in an economy matters for the economy's performance. To be precise, this implication is limited to economies where efficiency requires at least some decision tasks to be difficult. Clearly, if an economy could be efficient while keeping all of its decision tasks easy, economic competence would be a free resource and its allocation would not matter. But, as no real economy meets this condition — for example, the tasks of entrepreneurs, investors, and policy-makers can nowhere be considered easy — this limitation is of little practical interest.[4]

But economic competence is a very special kind of human capital, which profoundly

[4]Standard theories of resource-allocation, which assume that all decision tasks are performed optimally, can be interpreted in two ways: either as limited to unreal economies where all decision tasks are easy, or as limited to an advanced stage of resource-allocation, while presupposing that economic competence was efficiently allocated during a previous stage, which they do not comprehend. A classical example of the latter interpretation is in Friedman (1953). In present terms, his suggestion was to regard the theories which assumed all firms to maximize expected returns as presupposing that during an unexamined previous stage, market selection had eliminated all the less competent firms which failed to do so, and thus allowed only firms with the right economic competence to be still around during the stage under examination.

differs from all the other kinds. This difference stems from the difference between the roles of people *as factors of production*, corresponding to arguments in production functions, and their roles *as economic agents*, or *homines economici*, meaning their ways of conducting economic calculus and taking economic decisions — such as maximizing, or satisficing, under constraints. It is in the former roles that people employ the other kinds of human capital, and in the latter, their economic competence.

That the two roles are difficult to mix can be seen if we try to include economic competence in standard human capital theory. As this theory assumes that all agents optimally invest in their learning of human capital, it admits scarcity of this capital in nearly all walks of life, but just not in economic calculus. For example, an imperfect engineer must be a perfect investor to optimally invest in further studies of engineering and thus comply with the theory. In contrast, an imperfect investor who wants to invest in studies of economics of investment cannot do so optimally, for she would need the economic competence that she is only considering to learn already now, for this very consideration. Economic competence thus turns out to be a singular resource, whose scarcity cannot be admitted without causing inconsistency of the theory: it is indeed by assuming away the scarcity of human capital for economic calculus, and thus making itself incomplete, that the theory saves itself from being inconsistent.[5]

One consequence is that learning of economic competence has a particular feedback structure. To see it, consider that all learning of human capital uses inputs of transferable information ('learning stimuli') — such as observations from own and others' experience, or instructions from teachers — which, however, are never the capital itself. This must be produced by internal learning processes, for which the inputs are only raw materials. What human capital increases, if any, will be produced from such inputs depends upon the learning competence ('talent') with which these processes are conducted, and with which the learning agent must thus have been previously endowed.[6] The particularity of economic competence is

[5] I began to note this incompleteness of human capital theory in Pelikan (1989, 1993). The trade-off between completeness and consistency suggests a relation to Gödel's Incompleteness Theorem, which formally proves that no axiomatic system can be both complete and consistent (for an intuitively clear explanation, see Hofstadter, 1979). This result deserves to be carefully examined in methodology of economics, as it puts in question the currently prevailing research program to build theoretical economics as a complete system of formally provable theorems.

[6] Economic models of learning often limit attention to the amount of learning stimuli — such as the length of experience or education — while ignoring the constraint of pre-existing talent. To clearly see the existence and

that also the competence for learning it ('economic talent') is included in it. As using scarce learning stimuli to produce scarce economic competence is only a special case of use of scarce resources, the competence employed, by definition, is also economic competence.

This implies that economic competence cannot be learned from zero ('tabula rasa'), but some of it must be initially available, to allow the first learning stimuli to be effectively used. Although subsequently, with continuing supply of learning stimuli, all types of economic competence, including the learning competence itself, may grow, the initial endowment remains crucial, as it never stops constraining this growth.[7] Thus, if several agents can benefit from the same learning stimuli, their ranking according to the competence learned will remain identical to their ranking according to the initial endowment. We need to keep this implication in mind, as it will help us to justify one strong simplification of the following model.

In spite of all the differences, however, to see economic competence as a kind of human capital is important. First, this will remind us that economic competence is only one of many valuable human abilities, which different persons may posses in different quantities and qualities. For example, persons of low economic competence may be outstanding musicians, writers, athletes, or even theoretical economists, whereas persons of high economic competence may not be outstanding at anything else. Not to misunderstand the intentions of the present argument, it should be carefully noted that economic competence is not claimed to be the only, nor the most valuable, ability that people may have.

Second, and more fundamentally, the human capital features are what distinguishes economic competence from what is usually studied as bounded rationality. Namely, none of the usual definitions of bounded rationality gives it the meaning of a scarce and unequally

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severity of this constraint, perhaps the best way is to try to model learning on a computer. The starting point is an imperfect problem-solving program, which is to be improved by learning from data about the not quite satisfactory results of its applications. Clearly, there is no direct way from the data to improvements of the program: how to translate the former into the latter is precisely the crux of the model. To make such translation possible, the computer must also be endowed with a sophisticated learning program — the computer model of 'talent' — upon which the results of the learning will crucially depend.

[7]Strictly speaking, this is not true about learning the competence for simple tasks, which can be perfectly mastered by virtually everyone — such as the competence for playing tic-tack-toe or solving linear equations. In such cases, differences in initial talent may only influence the time of attaining the perfect mastery and then lose importance. But, to recall, the tasks considered here are difficult — such as managing a firm, estimating economic value of new products or technologies, or assessing the competence of others. For them perfect mastery can hardly be attained and the constraint of initial talent thus remains binding.

distributed resource, whose allocation in society would matter for social efficiency.[8]

Nevertheless, economic competence has enough common features with bounded rationality to be drawn with it into the not yet fully clarified conflict with the standard optimization postulate.[9] Its own relation to this postulate thus calls for explanation. That this relation may not be easy is hinted by the above-mentioned conflict with human capital theory. But a limited compromise can be reached. The first necessary step is to clearly distinguish between one-agent and multi-agent settings (much confusion in the conflict is indeed due to the absence of this distinction). If only one agent is considered, no distinction between transferable and non-transferable resources need be made. Then, scarce economic competence can be seen as an additional resource constraint, under which the agent can be said to optimize *in a subjective sense* — in other words, to do *her* best, under the constraint of her economic competence, in however short supply this might be. In such a case Boland (1981) is right that all criticism of the postulate would be futile. But in a multipersonal economy, where 'optimization' has *the objective meaning* of providing for socially efficient actions — such as maximizing the expected returns of investment — scarcity of economic competence cannot but exclude the postulate. Not all agents, if any at all, can optimize in such an objective sense. And if they lack economic competence, no reallocation of transferable resources, including information and information technology, can supply it to them. While each of them can still be credited with doing *her subjective best*, this may be quite different from *the objective best*, as determined by the requirement of social efficiency. The difference is the greater, the more difficult her decision task and the lower her economic competence.

That scarcity of economic competence cannot be reduced to scarcity of data or computational capacities need no longer be dwelled upon. In the old days, when the possibilities and limitations of information technology were little known, such reduction was often seen as a way to save the optimization postulate in face of the obvious fact that people often fail to take optimal decisions. The idea was that if data and computational capacities were

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[8]In principle, of course, definitions can always be enlarged. But the difficulty is that giving old established terms new meanings often leads to misunderstanding. Moreover, it sounds more natural (and nicer) to speak of economic agents as more or less economically competent, than to say that their rationality is more or less bounded.

[9]Perhaps the most instructive view of this conflict remains to be Simon (1978).

abundant, suboptimal decisions would disappear. Today, however, it is quite obvious that even the most extensive data bases and the most powerful computers do not suffice: the competence with which they are used clearly remains of prime importance. In fact, this importance is often the greater, the more data there are to consider and the more powerful computers can be used. Information technology thus turns out to be a demanding complement, rather than a substitute, of economic competence, whose relative scarcity consequently increases, rather than decreases.

3 Resource-Allocation with Scarce Economic Competence

What makes economic competence a singular resource in resource-allocation is that its scarcity destroys the traditional separation between an *object sphere*, consisting of the scarce resources allocated (into which modern economics includes information and human capital), and a *control sphere*, consisting of economic agents and their economic competence, with which they use the information, conduct economic calculus, and decide on the allocation. This separation is a direct consequence of the standard optimization postulate: if all agents perfectly optimize (in the objective sense), economic competence must be abundant, and scarcity is thus strictly limited to the object sphere. In contrast, when also economic competence is scarce, the control sphere collapses into the object sphere, and the structure of the resource-allocation problem is profoundly changed.[10]

Note that the traditional structure can be maintained as long as *some* separate control sphere, however small, is assumed to exists. Some recent theories reduce indeed this sphere by admitting scarcity of competence for agents that older theories assumed to perfectly optimize, which moves such agents from the control sphere to the object sphere. For example, the theory of credit rationing do so for borrowers, and several theories do so for managers of firms. The crucial point is that this is not done with *all* agents: some of them still remain in a separate control sphere, assumed to optimally deal with the situation — such as banks which optimally allocate credits, or owners of firms who optimally shop on the market for managers. In contrast, if scarcity is admitted for all economic competence, no separate control sphere is left. The

[10]This change may be compared to changing the usual chess game, in which the players are well separated from the pieces and keep sitting on in advance given places outside the chessboard, into a curious game where the players are included among the pieces on the chessboard, and thus both move pieces and are moved themselves, with changes in their possibilities to move pieces and each other.

competence of all agents — and thus even banks and owners — must be put in question and included among the scarce resources of the object sphere.

Allocation of the economic competence available in a given population involves two problems: (i) the design of decision tasks as points of demand, and (ii) the assignment of these tasks to specific members of the population as sources of supply.

One difficulty is that the two problems must be solved in mutual adjustment to each other. To be socially efficient, the design must include all the difficult tasks from which the economy may benefit — such as management of large firms, large-scale investment in technologies and firms, and coordination of industrial strategies — but not more difficult than what the competence of the agents assigned to them can safely handle without committing errors whose social costs would outweigh the benefits. The economic competence available in the population and the feasible ways of selecting agents and assigning them to these tasks thus impose a constraint on how difficult the designed tasks can be. In other words, social efficiency requires that the design and the assignment *together* avoid all socially costly competence-difficulty gaps. An additional difficulty is that both problems must be solved endogenously, by some of the members, without any in advance given perfectly competent task-designers or assigners. This makes the tasks of solving these problems part of these very problems, and thus also subject to the constraint of the economic competence available.[11]

For a theorist, the first question is, how to deal with these difficulties in a clear operational way. One rough and tentative answer will be offered by the following model. Before presenting it, however, some general observations are in order. First, if all tasks in an economy must be designed and assigned endogenously, then at least some of them must include task designing and assigning, while also these tasks must be endogenously designed and assigned. This suggests that all the tasks may be ordered into chains or trees according to their descent from other tasks, although possibly with loops, as some tasks may be partially or

[11] Although in the literature, both task-design and task-assignment have been amply studied, these studies are of little help here. The reason is that the two problems have never been studied at the same time. Task design (sometimes named 'mechanism design') has been studied under the standard assumption that all agents are equally perfect optimizers, which avoids the problem of task-assignment and moreover allows the task designed to be arbitrarily difficult. And assignment of tasks to agents of unequal abilities (sometimes referred to as 'job assignment' or 'matching') has been studied under the assumption that all the tasks are already designed and, moreover, that the top task of assigning these tasks is already assigned to a perfectly optimizing task-assigner, and thus excluded from the problem studied.

entirely self-designed or self-assigned. Some of them may thus be identified as key tasks, in the sense that an entire chain or tree of task designing and assigning can unfold from their design and assignment. To model allocation of economic competence, it suffices, at least in a first approximation, to consider only such key tasks. They are the ones that raise most of the novel questions, and it is from the qualities of their design and assignment that most of the qualities of the design and assignment of all other tasks follow.

For the productive sector of an economy, to which the model is limited, the most important results appear possible to obtain by considering only the tasks of entrepreneurs and the ones of investors, understood as follows. Entrepreneurs bear projects, which they seek to implement. Their tasks are self-designed and include the designing and assigning of the tasks of managers for the implementation. These tasks in turn may include the designing and assigning of many other tasks, and possibly also contributing to their own design. However, as managers need for all this at least a tacit agreement of their entrepreneurs, on whom they also ultimately depend for their jobs, it is entrepreneurs' tasks that are the true key tasks.

Investors allocate capital to entrepreneurs, and thus effectively assign the latter's tasks: an entrepreneur is effectively assigned to the task she has designed for herself only if some investor(s) supply her with necessary capital. The tasks of investors are also self-designed, but constrained by the investment opportunities offered by the entrepreneurs and by the capital available. The supply of capital is thus the effective means of assigning also these tasks. However, in contrast to the supply of capital to entrepreneurs, which, by definition, is always determined by investors, investors may obtain capital from a variety of sources — such as own or others' savings, previous capital gains, or government budget. The sources actually used depend on the prevailing institutions, on which more will be said below. Right now, the main observation is that the tasks of entrepreneurs and investors are indeed the key tasks with which the allocation of economic competence within the productive sector must begin. It is from their design and assignment that the design and assignment of all the other tasks within this sector unfold.

To avoid misunderstanding, note well the difference between tasks and agents, and thus the possibility that one agent may be assigned to more than one task. For example, the same agent may be an entrepreneur, the manager of her enterprise, and the investor who supplies it with capital. It is indeed important to admit that an agent whose current task includes the assigning of another task may choose to assign this task to herself. This also means that the use of economic competence for assessing economic competence may include assessing one's own economic competence, in comparison with the economic competence of others.[12]

When considering how allocation of economic competence can start, it is important to realize that in the beginning no decision task can be relied upon to be of the right design and assigned to the right agent. What the agents can initially know is that they are of unequal economic competence, and that social efficiency requires certain top tasks to be as difficult as the most competent among them can safely handle and to be also assigned to such agents. But they do not know very well what their competencies are, how they compare with each other, and how difficult tasks they are able to handle. In consequence, they do not know very well who the most competent agents are and how difficult the top tasks can be allowed to be. More precisely, the most competent agents know it better than the others, but this only begs the same question of who they are.

That there are no a priori known agents of adequate competence for difficult tasks deserves emphasis, as the standard optimization postulate implies the opposite. To recognize the absence of such agents has far-reaching consequences for standard analysis and some of its policy implications. Namely, in the study of resource-allocation mechanisms with difficult tasks for central policy-makers or planners, the postulate allows all such tasks to be assumed immediately assigned to adequately competent agents. Many such mechanisms can thus be proved efficient, with the implication that they contain promising solutions to real policy problems.[13] In contrast, the present implication is that most of these mechanisms would be scourged by competence-difficulty gaps causing enormous social losses. While some members

[12]That assessing one's own economic competence is a non-trivial task which also requires economic competence should be carefully noted. The reason is that economists have often assumed the opposite: in theories which consider agents of different abilities, the usual assumption has been that only the abilities of others are difficult to assess, but everyone knows perfectly well one's own. Yet in philosophy, knowledge of oneself is often considered the most difficult to acquire. And in practice, it is not unusual to meet persons of low competence which makes them unable to see how low their competence is.

[13]Classical examples of such proofs are in the well-known models of optimal socialist planning, elaborated by some of the most respected economists of their time (for an interesting survey, see Heal, 1973). This assumption is still used in formal models of optimal government (see, e.g., Tirole, 1994).

of the population are likely to have much higher economic competence for large-scale resource-allocation than others, they are unknown to any majority. To identify them and select them for correspondingly difficult tasks — such as management of large firms, large-scale investing, or planning of industrial strategies — is an integral part of the resource-allocation problem for which solution is sought; therefore, they cannot be assumed initially known. In other words, some large-scale planning may very well be part of an efficient resource-allocation mechanism, but the problem is not only *how* to conduct it, but also, and first of all, *who* is competent enough to conduct it and *by what selection process* he or she can be found and effectively assigned to it.

The absence of generally known agents of guaranteed high economic competence is also the reason why efficient resource-allocation must begin with a choice of institutions. When agents of high economic competence are both scarce and poorly known, the only promising way is to choose institutions ('rules of the game') under which at least some of them could be discovered and promoted to correspondingly difficult tasks. As opposed to the inevitably scarce and unequally distributed knowledge about the competence of specific agents, sufficient knowledge about institutions to make this choice reasonably rational appears possible to obtain by means of suitably oriented theoretical research.[14]

4 Modeling Economic Competence for Selecting Economic Competence

As all key decision tasks include designing and assigning of other decision tasks, they must include assessing the economic competence of other agents, and possibly also, as noted, one's own. Thus, entrepreneurs must assess the economic competence of the candidates among whom they choose their managers, and investors must assess the economic competence of the entrepreneurs who compete for their capital.

As noted, to assess economic competence, both others' and one's own, is a difficult task by itself, which makes the outcome depend on the economic competence of the assessor. There is little empirical evidence for modeling this dependence, besides the common sense principle that more competent agents assess better both others' and own competence than less competent agents. As a rough illustration of this principle, I assume that each agent safely recognizes

[14]Even Hayek (1973-1978), who is most skeptical about what humans can know about their societies, seems to believe in this possibility.

agents of lower economic competence than her own, but is unable to properly appreciate the subtleties of higher economic competence.[15] Hence she cannot correctly distinguish among agents of as high as or higher economic competence than her own, and may even mistake some higher economic competence for lower, possibly including her own. This can be stated as follows.

ASSUMPTION 1. (a) Assume a population of agents, whose economic competence *q* can be graded in an objective, but to the agents inaccessible way by integers from interval [1, *Q*], with distribution function *F(q)*, probability function *P(q)*, and expectation (average) q; *P(*1*)* and *P(Q)*, the probabilities in the distribution tails, are assumed very small.[16] (b) When trying to choose the most competent agent(s), each agent uses her subjective distribution where *q* has two values: 'eligible' and 'non-eligible.' She chooses the agent(s) by randomly drawing from the eligible ones. (c) Agent *i* of economic competence q_i considers eligible a sample of agents of $q \geq q_i$ which she selects according to an idiosyncratic criterion of hers, uncorrelated to any relevant factors (e.g., based on irrational prejudices). Hence the sample is random and the objective probability function over the eligible agents is the same as over all agents of $q \geq q_i$, which is $P(q)/[1 - F(q_i\text{-}1)]$. The probability that *i*'s choice falls on an agent of competence *q* is thus

(1)

[15]This assumption has been admitted as plausible, at least as a first rough approximation, by all the colleagues to whom I submitted it for criticism. The closest reference I found is an advertisement by Austin Reed, a London tailor, in the Financial Times: 'It takes talent to recognise excellence but mediocrity knows only itself.' The reason why relevant references are so scarce seems to be that cognitive scientists find measuring people's competence so controversial by itself that no one dares to go on and consider measuring the competence for measuring competence.

[16]Assuming a discrete distribution of *q* appears necessary (at least to me) to keep the model tractable, given the fact that it will involve distributions of truncated distributions. Among continuous distributions, the only tractable alternative seems to be the uniform one, but to use it would be to depart too far from reality: all empirical distributions of abilities in society have been found close to the normal one, with the best abilities always being much scarcer than the average. A discrete distribution easily accommodates this fact in a tractable model, and moreover facilitates the calculus of numerical examples (in the example below, the distribution will be assumed binomial as the closest approximation to normal).

Non-eligible are therefore all agents whose $q < q_i$ together with those agents of $q \geq q_i$ rejected by the idiosyncratic criterion.

In other words, i is assumed to make her selection by drawing at random — in the sense that her draws are uncorrelated to relevant factors — from left-truncated $P(q)$ where $q \geq q_i$, while never choosing any agent whose $q < q_i$. Thus, the most competent agents ($q = Q$) limit their selection to the most competent agents, whereas the least competent agents ($q = 1$) cannot recognize any differences in q; in their subjective distributions, the sets of eligible agents are random samples of the entire population.

Note well that i is *not* assumed to recognize all agents of $q \geq q_i$. If this were true, the most competent agents would be easy to find: they would simply be the ones who consider the largest number of other agents to be less competent than themselves. The point to keep in mind is that i's set of non-eligible agents, in addition to including all agents whose $q < q_i$, also includes a more or less large proportion of agents of $q \geq q_i$, namely all those who fail to pass i's idiosyncratic criterium. In other words, admitting an agent of low q eligible is an unmistakable sign of one's own low q, whereas an agent of high q may be non-eligible according to many agents of lower q — such as a genius who fails to be recognized by mediocrities.

Note also that neither the severity of i's idiosyncratic criterion nor her own ability to pass it are assumed known: the agents may differ from each other in both these respects. This formally recognizes the above-mentioned difficulty of assessing one's own q. For instance, i's criterion may refuse most agents of $q \geq q_i$, but allow herself to pass, which makes her overestimate her q in relation to them and thus be conceited. Alternatively, her criterion may admit many agents of $q \geq q_i$, but not herself, which makes her underestimate her q and thus be too modest. In the model, however, we need not specify how conceited or modest different agents are. We only assume that they use certain irrelevant criteria in order to formally explain why they cannot be relied upon to always recognize higher q, nor to correctly assess their own q.

Assumption 1 leads to two lemmas of importance (for proofs of all lemmas, see Appendix). Both concern a selection process in which all agents are candidates or, alternatively, the candidates are a random sample of the population with the same $P(q)$ and $F(q)$.

LEMMA 1: The expected q of the candidate(s) chosen (voted for) by agent i of competence q_i is

$$\bar{q}(q_i) = \frac{1}{1 - F(q_i - 1)} \sum_{q=q_i}^{Q} P(q) \bullet q \,. \qquad (2)$$

This means that the expected q is at least as high as q_i, and also at least as high as q of the population: $q(q_i) \geq q_i$ and $q(q_i) \geq q$. The former equality is true only for $q_i = Q$, and the latter, only for $q_i = 1$. In plain words, nearly all agents select (vote for) agents whose q is in average higher than their own, with the exception of the most competent ones, who cannot do better than vote for their peers. And nearly all agents vote in average for agents of an above the average q, with the exception of the least competent ones, who in average only select the average.

LEMMA 2: If all agents cast an equal number of votes, the proportion of votes that the candidates of competence q_i obtain is

$$P_S(q_i) = P(q_i) \sum_{q=1}^{q_i} \frac{P(q)}{1 - F(q - 1)} \,. \qquad (3)$$

Figure 1 illustrates both lemmas, using the numerical example from Table 2 below.[17]

(Figure 1 about here.)

$P_S(q)$ can be interpreted as the probability function with which q is distributed over an elected assembly where each competence category is represented in proportion to the votes obtained. The corresponding distribution function $F_S(q)$ and the expected (average) q_S can be calculated in the usual way. Selection by voting thus transforms $P(q)$ of the selecting agents (electorate) into $P_S(q)$ of the selected candidates (elected assembly). This transformation has the following property.

[17]The lemmas can also be illustrated by the famous refusal of Groucho Marx to become member in a club which would accept him as a member. Namely, if no one accepts to be in a club together with persons less competent than oneself, the lemmas imply that only clubs formed of persons of the same competence may exist. Then, if we kept increasing the precision of measuring competence — or, in other words, if we let the presently assumed discrete distribution of q converge towards a continuous one — the size of such clubs would converge to zero.

LEMMA 3: $P_S(q)$ is superior to $P(q)$ in that $P_S(1)<P(1)$, $P_S(Q)>P(Q)$, and $q_S>q$.

The present model will contain two examples of such selection: (i) a democratic election in which a random sample of the agents are the candidates and each agent casts an equal number of votes; and (ii) a financial market on which a random sample of the agents are potential entrepreneurs competing for capital, and each agent (or each member of a random sample of the agents) has an equal share of capital to invest.

Note that Lemma 3 provides an interesting defence of democracy against accusations of promoting the mediocre or the worst.[18] But this is a qualified defence. First, it presupposes that the competence distribution over the candidates is not worse than the competence distribution over the population, which may sometimes be put in doubt. Second, even if this is so and the competence promoted can thus be expected well above the population average, this competence is nevertheless not the best. This qualification suffices, as will become clear below, to make democratic governments unsuitable for many top economic decisions.

A strong simplification of the present model is that Assumption 1 will be maintained unchanged over time. This means that — in spite of what was said earlier about the possibilities of learning economic competence — the agents will be assumed to improve neither their own q nor their assessment of others's q. The primary reason for this simplification is that it appears prohibitively difficult (at least to me) to superpose the complex dynamics of individual learning (and possibly also forgetting) upon the allocation of economic competence in society, which, as will become clear below, has a complex dynamics of its own. But there are also two good reasons to believe that however strong this simplification might be, it will not affect the direction of the main results of the model.

First, as q also includes the abilities to learn more q, if we admitted that agents can increase their q by learning, we would also have to admit that agents of higher q will learn more than agents of lower q. Their relative comparative advantages and disadvantages in q, which are what will matter most for the direction of the results, would thus be fully preserved. Maintaining Assumption 1 over time may thus also be understood as measuring q in *relative* units which learning in the homogenous learning conditions of the model leaves unchanged.

Second, the assumption that agents do not improve their assessment of others' q, even

[18]An example of such accusation is in Hayek (1944).

when past outcomes become observable, may to a large extent be justified by referring to the effects of chance. Because of them, to recall, inferring agents' q from such observations is a difficult task by itself, which makes the inferences depend on the observer's q.[19] Thus, even if in the long run the real effects of chance cancel each other out, this may not help. Namely, differences in q must be expected to imply differences in memory and in abilities to use large amounts of data, which means that agents of lower q will be able to infer less from whatever observations may become available than agents of higher q. In consequence, agents of different q can be expected to converge to correspondingly different assessment of others' q, which further supply of observable data will leave unchanged.[20]

5 Allocation of Economic Competence in a Perfect Team

As noted, the present model is limited to the economy of a perfect team, where all agents share a common objective function, and which thus excludes all problems of effort, incentives, and income distribution. The strategy of assuming a perfect team to fully concentrate upon a new problem is due to Marschak and Radner (1972), for whom the new problem was costly communication. For the present purposes, however, we need a somewhat different team from theirs. Namely, they maintained the standard optimization postulate in the objective form, assuming that each member of the team always makes an objectively optimal use of any information available to her. As noted in Section 2, this implies abundance of economic competence, and thus excludes our problem.[21] Therefore we cannot follow Marschak and

[19]A firm whose performance has declined provides an instructive example. To decide whether the manager lacks competence or only had a bad luck is then indeed a difficult task for the owner(s). Keeping the manager in the former case or dismissing her in the latter case are two very costly errors to be avoided. Note that in standard analysis based on the objective form of the optimization postulate, chance is the only explanation why identically motivated agents in identical decision tasks (including identical access to information) may obtain different outcomes.

[20]A less realistic but formally simpler way to avoid the complication that agents may learn from past data is to assume that they only assess future projects and/or other agents' assessment of future projects, without keeping any track of past events at all. This assumption was suggested to me by Thomas Brenner.

[21]Some writers consider bounded rationality equivalent to imperfect information (see, e.g., Williamson, 1985). Let me therefore make it explicit that here, in agreement with Marschak and Radner, available transferable information, which may be more or less imperfect, is strictly distinguished from the non-transferable competence with which it is used. Only the competence is understood equivalent to 'rationality.' Thus, even an imperfectly informed agent may, at least conceivably, be perfectly rational, and thus of abundant economic competence, if she

Radner in maintaining this assumption, but may instead assume negligible communication costs, and thus exclude their problem. In other words, instead of assuming, as they did, that the members of the team are unequal in the access to transferable information but equal in the competence for using it, we assume them equal in the access but unequal in the competence.[22]

Such an economy may be visualized as a very large idealized kibbutz, equipped at negligible costs with extensive and continuously updated data bases, an abundant software library, a highly developed internet, and the most powerful computers in every home and work place. The only differences among its members are in their abilities to use the cheaply and equally accessible information and information technology for deciding about the use of the team's scarce resources, including the use of these very abilities.

ASSUMPTION 2: (a) The team has q distributed with $P(q)$ and $F(q)$ from Assumption 1. (b) It forms a productive economy whose output Y in period t is a linear function of its capital stock K in that period (constant returns). The units of measurement are chosen so that $Y(t) = K(t)$, and $K(0) = Y(0) = 1$. (c) In each t, $Y(t)$ is divided in a constant proportion between final consumption and gross investment (constant investment ratio). This results in $K(t+1)$, which yields $Y(t+1)$. (d) All agents have an identical utility function, preferring more Y to less Y in all t; their common discount rate corresponds to the constant investment ratio.

LEMMA 4: The growth of K is identical to the growth of Y; hence the gross rate of growth $R(t) = K(t+1)/K(t) = Y(t+1)/Y(t)$.

The output and growth are obtained by putting the available capital under the control of entrepreneurs, who use it for implementing their productive projects (which, as noted, is also the origin of the designing and assigning of tasks for other agents). Entrepreneur i is assumed to contribute as follows.

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can make an optimal use of her imperfect information — e.g., by following an advanced textbook on optimizing under risk or uncertainty.

[22]While a perfect team is never a very realistic picture of a real economy, the present one, given the development of information technology since 1972, appears somewhat less unrealistic than the one assumed by Marschak and Radner. Indeed, the costs of collecting and communicating *transferable* information are now so much lower that they hardly constitute a binding constraint upon any economic activity. Instead, it is the availability of *non-transferable* competence ('tacit knowledge'), needed for making sense out of the enormous amount of information which modern technology can so cheaply and rapidly process and communicate that constitutes an increasingly binding constraint.

ASSUMPTION 3: (a) For all t, i's output $y_i(t)$ is nominally equal to the capital under her control $k_i(t)$. (b) The main indicator of i's performance is the gross rate of growth, π_i, that i obtains for k_i, and thus also for y_i ($\pi_i>1$ means positive growth, $\pi_i=1$ zero growth, and $\pi_i<1$ negative growth). (c) π_i is an increasing function of i's competence q_i: $\pi_i = \pi(q_i)$; $\Delta\pi(q_i)/\Delta q_i>0$.[23] (d) π_i does not depend on the size of k_i (constant individual returns), nor the performance of other entrepreneurs (absence of spillover effects).

3(a) is a simple extension of 2(b) to the microlevel. 3(c) together with 3(a) means that the influence of q_i is assumed limited to the depreciation of k_i: while producing the same y from the same k, an entrepreneur of a low q causes a higher depreciation of this k than an entrepreneur of a higher q. This is why, with a constant investment ratio, the capital used by the latter, and thus also her output, grow faster.

LEMMA 5: The sum of the outputs produced by all entrepreneurs of competence q_i depends upon the sum of the capital they use, but not upon their number. Hence the team's expected output at time t is

$$Y(t) = \sum_{q=1}^{Q} y(q,t)\,, \tag{4}$$

where $y(q,t)$ is the sum of the outputs produced by entrepreneurs of competence q at time t.

As follows from their common preferences, it is in the interest of all agents to put the team's capital under the control of the most competent entrepreneurs among them. Ideally, if they knew right in the beginning how to allocate the capital only to entrepreneurs of $q = Q$, the team would maximize both $Y(t)$ and $R(t)$ for all t under the constraint of $K(0)$. But the point is precisely that they do not know it. What nearly all of them know is that they are of unequal q, and therefore also of unequal beliefs about how unequal their q is. Exceptions can only be

[23]This is what implies that all real effects of individual chance of entrepreneurs are assumed to cancel each other out. It may, however, be claimed that the performance of entrepreneurs must also depend on exogenous conditions of the entire economy, such as the state of nature and world markets — in other words, a collective chance. For the present comparative purposes, however, we need not consider such conditions explicitly; all we need is to implicitly assume that they influence the performance of all entrepreneurs homogeneously so that only the team's global output and growth are affected, while the relative contributions of individual entrepreneurs are left unchanged. This allows us to rank institutional alternatives according to how well they select entrepreneurs without taking such exogenous conditions into account.

found in the small minority whose $q = 1$, the only agents who might possibly believe that all agents are of the same q.[24] Some agents may also claim to be the most competent ones, but only few of them can be expected to be right, and there is no reliable way to tell which ones. A large majority therefore recognizes that the search for the most competent entrepreneurs is a problem whose solution must begin by a choice of institutions, as explained in Section 3 above.

To be precise, two types of institutions must be chosen: (i) those for guiding the search for entrepreneurs, suitably denoted as 'economic'; and (ii) those for guiding the choice of (i) — thus to be chosen first — suitably denoted as 'political.' Here, however, we examine only the choice of economic institutions, while assuming that the political institutions have already been chosen and are of the democratic type: we simply assume the team to adopt the economic institutions supported by a majority. Note that in a perfect team, technical details about the size of this majority are of limited importance: if the members had a good knowledge of the effects of different economic institutions, they would unanimously vote for those that have the best effects in terms of their common objective function. The present model can be seen as a contribution to their search for such knowledge.

As noted, the model is limited to three highly stylized variants of economic institutions. Their common feature is that they all provide for markets for goods and labor; in other words, the economies they generate can all be denoted as 'market economies,' with no centralized planning or rationing of inputs and outputs. The only significant differences among them are in the ways in which entrepreneurs are selected and entrusted with the control of the team's capital. The variants are: **1M**, meaning 'simple market selection'; **2M**, meaning 'double market selection'; and **RG**, meaning 'representative government.' To compare them on an equal footing, they will all be put to work in the same initial situation in which the influence over the use of $K(0)$ is distributed equally, in the corresponding institutional form, among all members of the team, or among a random sample of the members. The initial influence of the category of members of competence q will thus always be proportional to $P(q)$. Let me now define these variants and examine their effects upon the team's Y and R.

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[24]This follows from Assumption 1. Note that not all agents of $q = 1$ need share this belief; some of them may be conceited and believe themselves superior to many others. But whoever shares this belief must also have $q = 1$, for all those with a higher q are bound to see some true differences in q. Note also the teasing implication for those theoretical economists who believe that everyone's rationality is equally perfect or equally bounded.

1M generates a stylized form of a primitive market economy without financial markets: entrepreneurs are there also their own investors, and are selected only according to their performance on product markets.[25] Thus *K(*0*)* is distributed directly to entrepreneurs, initially a random sample of the population. The equality of initial distribution means that the share of *K(*0*)* controlled by entrepreneurs of competence *q* is $k(q, 0) = P(q)$, for all *q*. Following 4(a), this is also their initial output: $y(q, 0) = P(q)$. One period later, both the capital and the output will be multiplied by $\pi(q)$. Hence the team's output in the first period, and thus also the initial rate of growth, is

$$Y_{1M}(1) = R_{1M}(0) = \sum_{q=1}^{Q} P(q) \bullet \pi(q) . \tag{5}$$

At time *t*, the output of entrepreneurs of competence *q* will grow (decrease) to

$$y(q,t) = P(q) \bullet [\, \pi(q) \,]^t . \tag{6}$$

Summing up for all competence categories, the team's output will be

$$Y_{1M}(t) = \sum_{q=1}^{Q} P(q) \bullet [\, \pi(q) \,]^t , \tag{7}$$

and the growth rate

$$R_{1M}(t) = \frac{\sum_{q=1}^{Q} P(q) \bullet [\, \pi(q) \,]^{t+1}}{\sum_{q=1}^{Q} P(q) \bullet [\, \pi(q) \,]^t} . \tag{8}$$

2M generates a stylized form of a more developed market economy which contains both product and financial markets: entrepreneurs need not be the same persons as investors and

[25]It is to this simple form that most existing analysis of market selection has been limited. In particular, this is the case of the analysis pioneered by Alchian (1950) and Winter (1971). The present analysis of **1M** can be seen as parallel to theirs.

market selection works on both. More precisely, entrepreneurs are selected by investors, while investors are selected according to the performance of the entrepreneurs they select. Initially, both the set of investors and the set of entrepreneurs are random samples (possibly overlapping) of the population. $K(0)$ is distributed equally among the investors, who make their initial investment choices, and thus determine the allocation of $K(0)$ among the entrepreneurs.[26]

The performance of investor j is expressed by the gross rate of growth of her portfolio. Given $P(q)$ and the corresponding $P[\pi(q)]$ over the set of entrepreneurs, this rate depends on q_j, the competence with which j selects the entrepreneurs for her investment. But there is a complication. Whereas entrepreneurs' $\pi(q)$ remain constant, the growth rate of j's portfolio may change in time, and moreover depend on the frequency of j's investment decisions (j's 'diligence').[27]

Let the expected growth rate for the first period after her investment decision be $\rho_j = \rho(q_j)$. As j selects entrepreneurs for her portfolio according to Assumption 1, and ρ_j is the expected π of these entrepreneurs, the same line of reasoning which deduced Lemma 1 also deduces this growth rate:

$$\rho(q_j) = \frac{1}{1 - F(q_j - 1)} \sum_{q=q_j}^{Q} P(q) \bullet \pi(q). \tag{9}$$

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[26]To avoid misunderstanding, it should be realized that financial markets are modeled here in different conditions and with a different purpose than in standard theory. This typically assumes that all investors are perfect optimizers, and thus models these markets in a fully developed form, when market selection has already done its job and made all less competent investors insignificant. Here, in contrast, we consider this selection from the very beginning, when investors of all competence categories still try their chance. Moreover, whereas the purpose of standard theory is to determine how developed financial markets allocate investment in an absolute sense, the present purpose is purely comparative: we only wish to identify the main differences between economies where they can work and *eventually* develop, and economies where they cannot. The present model converges to compatibility with standard models *in the limit*, when only investors of $q = Q$ remain significant.

[27]An implicit assumption is that the economic competence of investors is of the same kind, graded by the same q, as the one of entrepreneurs. To make this assumption intuitively appealing, we may conceptually separate, in the activities of entrepreneurs, design of tentative projects from economic evaluation of the projects designed. The specialty of entrepreneurs can then be seen in the design, for which the abilities required may be described as 'creativeness' or 'inventiveness,' and the use of their economic competence can thus be limited to the economic evaluation. As this is in essence what also investors do, we may indeed see both to use the same kind of competence. A possible difference is that entrepreneurs typically handle more technical details, whereas investors put more weight on the competence of the entrepreneurs with which they expect all relevant details to be handled. But this does not change the common 'economic' nature of their respective decision problems.

Namely, as Lemma 1 shows the expected q selected with competence q_i, we only need to substitute $\pi(q)$ for q and q_j for q_i to obtain the expected $\pi(q)$ selected with competence q_j.

The complication appears in the following periods. The further growth of j's portfolio depends on whether she takes a new investment decision after each period or leaves her initial investment unchanged. Let $\kappa(q_j , t)$ be the cumulative growth after t periods in the former case ('short-term investing') and $\lambda(q_j , t)$ in the latter case ('long-term investing'). In the case of short-term investing, j takes a series of t investment decisions, each of which makes her portfolio grow by the same ratio $\rho(q_j)$. Thus, following from (9),

$$\kappa(q_j,t) = [\,\rho(q_j)\,]^t = [\,\frac{1}{1-F(q_j-1)}\sum_{q=q_j}^{Q} P(q)\bullet\,\pi(q)\,]^t\,. \qquad (10)$$

For the long-term investing, the cumulative growth is determined by the performance of the initially selected entrepreneurs, who make their respective investment shares grow (decrease) exponentially, according to their respective $\pi(q)$. Thus, again from (9),

$$\lambda(q_j,t) = \frac{1}{1-F(q_j-1)}\sum_{q=q_i}^{Q} P(q)\bullet[\,\pi(q)\,]^t\,. \qquad (11)$$

The interesting result is

LEMMA 6:

$$[\,\pi(q)\,]^t < \kappa(q,t) < \lambda(q,t), \;\; \forall\, t > 1 \wedge \forall\, q < Q\,. \qquad (12)$$

In plain words, nearly all agents, with the exception of the most competent ones, can make their capital grow faster (decrease slower) as investors than as entrepreneurs, and the more so, the less diligent they are and the longer they leave their portfolios unchanged.[28] The

[28]Lemma 6 thus recognizes in theory what has for a long time been known in practice: *without sufficient competence, less effort may often be both individually and socially superior to more effort*. At first sight, however, the validity of this lemma may appear limited by the present artificial assumption that no one learns from observations of past performance. But this is not quite so. The lemma remains valid, with the exception of an initial learning period, also under the more realistic assumption that low q implies poor learning abilities, which prevent

exception can be seen by setting $q_j = Q$ in (9), (10), and (11), which yields

$$[\pi(Q)]^t = \kappa(Q,t) = \lambda(Q,t)\,, \quad \forall t\,. \tag{13}$$

After the initial investment decisions, the continuation will thus depend on how diligent the investors of $q < Q$ happen to be. The team's $Y(t)$ and $R(t)$ may thus follow many different trajectories, depending on which proportion of such investors take new investment decisions and how often they do so. But all these trajectories must be contained between two limits: κ-limit, in which all investors of $q < Q$ take new investment decisions after each period; and λ-limit, in which all such investors leave their initial investment unchanged. For determining these limits, recall Assumptions 4(b) and 5(a): they imply that $Y(t)$, besides being the sum of the outputs realized by all entrepreneurs, is also the sum of the capital allocated by all investors:

$$Y(t) = \sum_{q=1}^{Q} y(q,t) = \sum_{q=1}^{Q} k(q,t)\,, \tag{14}$$

where $k(q,t)$ is the capital invested by all the investors of competence q at time t.

For the κ-limit, the outcomes can best be deduced from the performance of investors. Investors of competence q are initially endowed with $P(q)$ of capital, which they make grow (decrease) by $\rho(q)$ per period. Recalling that $Y(t) = K(t)$, we can deduce

$$Y_{2M\kappa}(t) = \sum_{q=1}^{Q} P(q) \bullet [\,\rho(q)\,]^t \tag{15}$$

and

$$R_{2M\kappa}(t) = \frac{\sum_{q=1}^{Q} P(q) \bullet [\,\rho(q)\,]^{t+1}}{\sum_{q=1}^{Q} P(q) \bullet [\,\rho(q)\,]^t}\,. \tag{16}$$

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little competent investors from further improving their assessment of entrepreneurs' q after that period (cf. the last paragraph of the previous section).

For the λ-limit, the outcomes can best be deduced from the performance of entrepreneurs. After their initial investment decisions, the investors leave the entrepreneurs undisturbed during all the t periods considered — with the possible exception of investors of $q = Q$, who however keep their investment limited to entrepreneurs of $q = Q$. As the investors make their choices according to Assumption 1, the initial capital is distributed among the entrepreneurs according to Lemma 2: the share of entrepreneurs of competence q is thus $P_S(q)$. This share then keeps growing (decreasing) by $\pi(q)$ per period. In consequence,

$$Y_{2M\lambda}(t) = \sum_{q=1}^{Q} P_S(q) \bullet [\pi(q)]^t \tag{17}$$

and

$$R_{2M\lambda}(t) = \frac{\sum_{q=1}^{Q} P_S(q) \bullet [\pi(q)]^{t+1}}{\sum_{q=1}^{Q} P_S(q) \bullet [\pi(q)]^t} \,. \tag{18}$$

RG extends political democracy from the choice of economic institutions to the selection of investors and entrepreneurs, and thus generates a stylized market economy in which enterprises are owned and productive investment is directed by government. A full-fledged theoretical example of such an economy is the market socialism proposed by Bardham and Roemer (1992) and partial practical examples can be found in market economies with state-owned enterprises and state investment banks.

More specifically, **RG** is defined to prescribe elections of two levels. At the first level, all agents elect an Assembly of Investors. The equality of the initial situation means that all the agents are given an equal number of votes, and a random sample of them are the candidates. At the second level, the Assembly elects within itself a Committee of Entrepreneurs. The control of the team's capital is divided among the members of the Committee in proportion to the votes obtained in the second election, so that the share of the capital used with competence q is equal to the share of the votes obtained by the Committee members of this competence. In consequence, the team's output in the first period, and thus also the initial rate of growth, is

$$Y_{RG}(1) = R_{RG}(0) = \sum_{q=1}^{Q} P_C(q) \bullet \pi(q)\ , \tag{19}$$

where $P_C(q)$ is the probability function with which q is distributed over the Committee. This function follows from two applications of Lemma 2: the first shows the distribution of q over the Assembly and, as this becomes both the electorate and the set of candidates in the second election, the second application shows the distribution of q over the Committee. The expected share of entrepreneurs of $q = q_i$ is thus

$$P_C(q_i) = P_{SS}(q_i) = P_S(q_i) \sum_{q=1}^{q_i} \frac{P_S(q)}{1 - F_S(q-1)}\ . \tag{20}$$

The double S in the subscript is meant to suggest that this is the result of a double selection. The corresponding distribution function $F_{SS}(q)$ and expected (average) q_{SS} can be calculated in the usual way.

The strong side of **RG** can thus immediately be seen: Lemma 3 implies that the Assembly has a higher q than the population and the Committee has a higher q than the Assembly. The weak side, however, is that regardless of the frequency of elections, the distribution of q over both the Assembly and the Committee cannot be expected to further improve. The reason is that, regardless of their q, all members of the population maintain, as political democracy requires, the same number of votes in all future elections. Hence new elections, although they can change persons, cannot significantly change the distribution of q over the Assembly and, consequently, nor over the Committee.

At first sight, this conclusion might be contested by suggesting that entrepreneurship be decentralized to individual members of the Committee in such a way that those of a high q would keep growing their enterprises, while those of a low q would be demoted by capital losses and eventually bankruptcies. But this would mean effective privatization of the government enterprises, and thus transformation of **RG** into **1M**. To maintain **RG**, the Assembly cannot leave the task of selecting entrepreneurs to the market.

It might also be objected that there is no need to limit elections to two levels. Another level — such as the Committee electing a Presidium — would further improve the average *q* of the effective entrepreneurs, pushing it even higher above the population's q than q_{SS}. But this would not change the main point: **RG** can rapidly find entrepreneurs of a significantly higher average *q* than the population's q, but, for any reasonable number of election levels, this average remains far from *Q* and does not further improve.

The limitation of the Assembly is worth spelling out. The main problem is that only a very small minority of its members can ever be expected to be of $q = Q$. Although Lemma 3 implies that this minority is somewhat larger than $P(Q)$, if this is very small, as is reasonable to expect, $P_S(Q)$ is only marginally higher. A vast majority of the Assembly will thus keep misjudging entrepreneurs by confusing some of their high *q* with good luck and some of their low *q* with bad luck. As a result — which appears to agree with observations of governments dealing with state-owned enterprises — a significant part of the team's capital will keep being wasted on subsidies to entrepreneurs of low *q*, mistakenly believed to be future champions in temporary difficulties.

The team's output in the first period, and thus also its initial rate of growth, can now be determined:

$$Y_{RG}(1) = R_{RG}(0) = \sum_{q=1}^{Q} P_{SS}(q) \bullet \pi(q) \,. \tag{21}$$

As the distribution of *q* over the entrepreneurs is stationary, the rate of growth remains constant:

$$R_{RG}(t) = R_{RG}(0) \quad for\ \forall\, t \,, \tag{22}$$

which makes it unnecessary to mention time. The output at time *t* can thus be written

$$Y_{RG}(t) = [\, R_{RG} \,]^{t} \,. \tag{23}$$

The institutional variants examined can now be ranked. As their effects are functions of time, also their rankings may be functions of time. While these entire functions are illustrated by the artificial numerical example below, the algebraic comparison is here limited to two points: the initial growth *R*(0), and thus also output *Y*(1), which indicate the short run tendencies, and the limits for $t \rightarrow \infty$, to which *R(t)* and *Y(t)* converge in the long run. As growth directly depends upon entrepreneurs' *q*, the rankings according to *R* are also the rankings according to the performance in the selection of entrepreneurs. Writing '≈' for equivalence, '_' for superiority, and '__' for very large superiority, Proposition 1 states the results for the short run and Proposition 2 for the long run.

PROPOSITION 1:

RG _ **2Mλ** ≈ **2Mκ** _ **1M** according to *R*(0) and *Y*(1).

PROPOSITION 2:

2Mλ ≈ **2Mκ** ≈ **1M** _ **RG** according to *R(∞)*,

2Mλ _ **2Mκ** ≈ **1M** __ **RG** according to *Y(∞)*.

In plain words, **RG** starts best, but finishes far worst. **1M** starts worst, but eventually outclasses **RG**. **2M** starts from a middle position and finishes best, especially in its λ-variant. To understand the rise and fall of **RG**, recall that it starts with above the average investors and thus even more above the average entrepreneurs, while **2M** starts with only random selected investors and **1M** with only random selected entrepreneurs. But thanks to market selection, the competence of entrepreneurs under both **1M** and **2M** keeps improving and converging to the best available, while the competence of entrepreneurs under **RG** remains stationary. Thus, after a more or less long taking-off of **1M** and **2M** — during which the growth under them may even be negative — both of them first catch up with and then outclass **RG**.

Comparing the market variants among themselves, **2M** has, as noted, an initial advantage: random selected investors provide for a better start than random selected entrepreneurs. Nevertheless, **1M** eventually catches up with **2M** in growth. As to output, however, much depends on investors of low *q*. If they keep quiet, **2M** never loses its initial advantage. But if they are diligent, they slow its growth so much that **1M** catches up with **2M** also in output. Thus, counted in long-term effects upon output, what entrepreneurs of low *q* waste rapidly under **1M** is equivalent to what investors of low *q*, if they are diligent, waste slowly under **2Mκ**. To be precise, however, this is not waste, but the price of finding such agents and demoting them from tasks that surpass their competence. **RG** avoids paying this price, but subsequently pays a much higher price in terms of foregone output and growth over the entire future. The price, however, is somewhat negotiable. **1M** never catches **2M**$_{\mathbf{K}}$ in the sum of output over time, however discounted: there is a certain initial period during which the economy is poorer under **1M** than under **2M**$_{\mathbf{K}}$, and this difference is never compensated. The total price is therefore always lower under **2M** than under **1M**, however diligent investors of low *q* might be.

All these results are illustrated by the following artificial example. Let *P(q)* be binomial and $\pi(q)$ linear:

$$\pi(q) = \pi(\bar{q}) + \alpha(q - \bar{q}) \tag{24}$$

with $Q = 7$, $\pi(q) = \pi(4) = 0.98$, and $\alpha = 0.05$.[29] Tables 1 to 4 and Figure 2 show the results.

(Tables 1, 2, 3, 4, and Figure 2 around here.)

Recall now the initial problem of how the team can best select its entrepreneurs and thus maximize its output and growth. The model implies a simple policy advice: unless the team's members had a very high discount rate, in which case their best choice would be **RG**, they should opt for the immediately less visible but in the long run decisive advantages of **2M**.

An evolutionary economist may add that in a world where many teams are competing with each other and their long-term economic performance is the decisive selection criterion, the freedom to choose the discount rate is limited. There, high discount rates and **RG** are not evolutionarily stable; a low discount rate, and thus the choice of **2M** or at least **1M**, are necessary for protecting the team from demise. In other words, an effective internal selection, which allows the team to identify and efficiently employ its most competent members, is the only way in which the team can endure such an external selection.[30]

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[29]Among the values of $\pi(q)$ and α with which I experimented, and which of course all agreed with the above results, these appear to provide for a particularly clear illustration. To avoid misunderstanding, let me emphasize that the illustration is purely comparative and is not meant to approximate any real absolute values, either in the performance indicators or in the time scale.

[30]Evolutionary constraints upon institutional choices are discussed more extensively in Pelikan (1995).

It may not be easy, however, to convince the team's members that **2M** is their best choice, even if they can observe and compare the working of the three variants in other teams. As there are important differences in entrepreneurs' q which most members cannot see, a majority cannot properly appreciate the selective advantages of this variant. In particular, only a minority can see the crucial difference between q_{SS}, the stationary average competence of entrepreneurs under **RG**, and Q, to which the competence of entrepreneurs converges under **1M** and **2M**. More precisely, only the minority whose $q > q_{SS}$ can see some of this difference, and only the very few whose $q = Q$ can see it in its entirety. For the remaining majority, the poor long-term performance of **RG** comes as an inexplicable surprise. In contrast, the short-term superiority of **RG** is easier to see: one only needs $q > q_S$ to perceive that entrepreneurs under **RG** are initially superior to those under **2M**. Thus, unless enlightened by the present model, many above the average members — more precisely all those whose q satisfies $q_S < q \leq q_{SS}$ — may be the most sincere advocates of **RG**.

6 When Income Distribution and Agency Problems Cannot Be Neglected

With attention still limited to the three stylized variants, consider now a more realistic economy with individual incomes and asymmetric information, which raises the problems of income distribution and agency relations. The question is, which parts of the above results may hold also there.

In income distribution, less inequality is typically preferred to more, and thus the above rankings could be reversed if the institutions found superior in economic performance caused unacceptably larger income inequalities. This calls for two inquiries: (i) into the possibility of separating the control over capital in production from income for final consumption; and (ii) into the income inequalities caused by alternatives.

The purpose of the first inquiry is to determine how much we need to worry about income distribution when searching for institutions that maximize economic performance. If the separation could be made perfect, we need not worry at all. Income for final consumption could then be redistributed ad libitum, without affecting the distribution of the control over capital in production, and thus without distorting the search for the most competent investors and entrepreneurs. The above results would then hold in their entirety.

That control over capital in production and income for final consumption are two different things calls for emphasis, as this difference usually passes unnoticed in debates on inequality and social justice. An instructive example is Roemer (1987), who addresses the issue of talents, recognizes their unequal distribution, and finds this inequality unjust. He therefore demands that all the unfortunate persons who were too poorly endowed by nature be compensated by society. What he omits to note is precisely the importance of limiting any such compensation to income for final consumption. To let untalented persons gain control over capital in production would ruin the economy, leaving there little to be redistributed.

In spite of the difference, however, separating the income from the control is not easy, and perfect separation is probably impossible. But there are interesting ways in which the links between the two can be weakened. The weaker these links, the more robust the above results, and thus also the better the chances of protecting economic performance in face of preferences for limited income inequalities. Without discussing these ways in detail, let me only mention that they also involve institutional design, and above all the design of taxes. A progressive consumption tax, which limits the tax base to the effectively consumed part of income, appears to weaken the links the most.[31] Progressive income taxes are clearly inferior, and taxes on capital are by far the worst.

How much the links can actually be weakened, however, also depends upon the utility functions of the most competent agents, and in particular upon the consumption incentives needed to make such agents use their high competence in socially efficient ways. If these incentives were high, then even the purest consumption tax, which leaves all working capital intact, would make such agents substantially reduce their investing and enterprising activities, to the detriment of the entire economy. As utility functions are mostly determined by psychological and cultural factors, economists can only make superficial conjectures about them. Mine is that in favorable cultural conditions, these incentives need not be extremely high: showing and using high competence usually yields high personal utility by itself, and moreover the best entrepreneurs and investors often care more for hard work than for luxurious

[31]More precisely, the base of consumption tax is defined as the sum of income plus disinvestment minus investment. For a more extensive discussion and advocacy of this tax, see Pechman (1990). The present analysis brings additional support to Pechman's argument.

consumption. But, as noted, this is only a superficial and possibly also overoptimistic conjecture, on which I do not wish to build the present argument.

Instead, let me pessimistically assume that the links cannot but remain strong. This makes the second inquiry central. To compare institutions for the inequalities caused, consider first the market variants. It is easy to see that the ranking **2Mλ _ 2Mκ _ 1M** implied by Propositions 1 and 2 holds fully. While the tiny minority of agents of $q = Q$ will always acquire the same enormous wealth, inequality is the highest under **1M** and the lowest under **2Mλ**. Namely, all the agents whose q implies $\pi(q) < 1$ will eventually lose all their capital under **1M**. **2Mκ** improves the situation of the least competent agents by making them as well off as the average ones under **1M**. Moreover, if $\pi(q) > 1$, then $\rho(1) > 1$, which means that even the least competent agents, instead of losing their capital, make it grow. Under **2Mλ**, the growth of their capital is higher and eventually always positive, although possibly after a limited initial decline: in fact, this growth is equal to the growth of the entire economy under **1M**, while the capital of all other agents grows even more. Algebraically, these results follow from (6), (10), and (11). Numerical illustrations from the above example are in Table 5.

(Table 5 about here.)

Recall that in this example $\pi(q) < 1$, which means, as shown by the values of $\kappa(q, t)$, that agents of $q < q$ keep losing their capital also under **2Mκ**, although not as rapidly as under **1M**. The contrast with the long-term growth of their capital under **2Mλ** is striking: the losses caused by diligence combined with low competence may be high indeed.

In consequence, only the ranking of **RG** may need revision. At first sight, **RG** may appear promising, as it seems able to meet any preferences for low income inequalities. Upon a closer look, however, two problems emerge. First, whatever equality **RG** might achieve, in the long run this can only be equality in relative poverty, which in other than ideal exogenous conditions can become absolute. Second, the equality itself is uncertain, as much depends on the share in final consumption that the Assembly and the Committee accord to themselves. Under the present assumption that the use of high q requires high consumption incentives, this share must be expected large, with most of it going to agents whose q is not even particularly high. Thus, the likely result is the situation well-known from the history of all forms of real socialism: a high inequality between material comfort of an only modestly competent nomenclatura and penury for all the others.

These problems, however, may not suffice to discourage agents of low q from preferring **RG** over both **1M** and **2Mκ**. Under **1M** they would eventually be reduced to complete destitution. Under **2Mκ** they could avoid this fate only if $\pi(q) > 1$. But even then, agents of low q can still be made better off under **RG** if the nomenclatura does not exaggerate the tax rate for its privileges.

Only **2Mλ** remains the best choice for everyone — at least with not too high discount rates and not too high consumption externalities ('envy'). Considering $t = 100$ in Table 5, the income of agents of $q = 1$ would at best (with zero tax for the nomenclatura) grow 132 times under **RG**, but more than 3300 times under **2Mλ**. Thus, even the least competent agents would eventually be much better off under **2M** than under **RG**, provided they are not too diligent as investors. In other words, **2Mλ** yields the best results in terms of the popular welfare criterion which ranks economies according to the well-being of their poorest members.

But a problem with **2M** is that diligence of investors of low q may not be easy to restrain. That institutions hindering investment changes would be the wrong solution can be seen as soon as we (realistically) admit frequent changes of exogenous conditions: then, frequent reallocation of capital is often the only efficient answer. Ideally, of course, only investors of high q should be allowed to conduct the reallocation, but such investors cannot be distinguished in advance by any institutional rules. As will be discussed in the following section, there is a promising institutional variant by which this problem can be alleviated. But not even this variant can guarantee that agents of low q will not impoverish themselves and the economy by their investment diligence. Thus, if **2M** cannot be guaranteed to become **2Mλ** rather than **2Mκ**, only a suitable income redistribution can make **RG** unattractive also to them. In the long run, considering how much richer agents of high q become under both **2M** and **1M** than under **RG**, such a redistribution should be easy to agree upon: for these agents this is a relatively low price to pay for keeping **RG** at bay. In the short run, however, before any large wealth can be created and while **RG** is still outperforming all the market variants, this price may appear high and preferences for **RG** may be difficult to neutralize.

Consider now the problems of agency caused by asymmetric information. Note first that the seriousness of these problems depends upon the culturally given degree of opportunistic behavior and rent-seeking, or, viewed in the opposite direction, the expected level of loyalty and trust. If this level is sufficiently high, agency problems are not very serious, and asymmetric information leaves the above results unchanged. Otherwise, however, many of these results must be put in doubt, to begin with the ranking **2M _ 1M**. The reason is that agency problems are particularly devastating for the working of financial markets. High risks for investors of being victims to rent-seeking of opportunistic entrepreneurs create the well-known incentives for inefficient investment behavior, which may substantially downgrade the performance of **2M**. In contrast, the rigid intrapersonal links between investors and entrepreneurs under **1M**, which were found to handicap competence selection and cause the greatest inequalities, must now be valued as the safest defence against such risks.

The crucial question is, whether **2M** may be downgraded so much that its ranking falls under **1M**. The answer appears to be yes: in cultures where the promises traded on financial markets would seldom be properly honored, these markets would select more for high dishonesty than for high economic competence, which could hardly be socially efficient. In other words, without a certain minimum level of loyalty and trust, **2M** cannot keep its top position.

But neither **RG** escapes unharmed. When agency problems are serious, **RG** must be expected downgraded no less than **2M**: in cultures where it is difficult to defend investors against opportunism of entrepreneurs, it is typically even more difficult to defend voters against opportunism of elected politicians. The former opportunism can to some degree be counteracted by institutional design which improves upon the competitiveness and transparency of financial markets, and thus increases investors' information, strengthens their voice, and diminishes their costs of exit. In contrast, the possibilities of counteracting the opportunism of politicians appear more limited. The irremediably dispersed voices of voters are more difficult to strengthen and their only possible exit is costly emigration. **RG** thus safely preserves its lowest ranking in the long run, and may moreover lose its leading position in the short run. With widespread opportunism and rent-seeking among the political elite, **RG** may be the worst variant right from the beginning.

7 Possible Implications for Real Economies

In addition to considering a more realistic economy than a perfect team, consider now also more realistic institutional variants than the three stylized ones. In the real world, obviously, none of these exist in a pure form: government plays an important role in all real market economies, many entrepreneurs must be their own investors even in the presence of the most developed financial markets, and some private entrepreneurship can be found even in the most government controlled economy. Rather than choosing only one of the stylized variants, at the exclusion of all the others, real institutional choices are about transforming one of their mixtures into another mixture. This last section discusses possible relevance of the present model to such choices.

Relevance of models to reality can only be shown by means of corroborating empirical evidence. For this model, however, collecting such evidence is hindered by two obstacles. One is the impossibility to measure economic competence objectively, independently of the observer's own economic competence, which precludes direct empirical tests. In consequence, the only evidence that can be collected is indirect, in form of events observed in the development of real economies which the model can plausibly explain. Such evidence is particularly corroborating, if the events cannot be explained equally well by any other known theory.

The second obstacle is the above-mentioned impurity of real economic institutions. As **1M**, **2M**, and **RG** cannot be observed in pure forms, the only promising strategy seems to be to compare otherwise not too dissimilar economies where these ingredients are mixed in significantly different proportions.[32] However, to apply this strategy in any systematic way requires an extensive and sophisticated empirical research, for which precise relevant data appear difficult to obtain. Let me therefore only illustrate such comparison by a few cursory examples.

EXAMPLE 1: The extensive intervention of the Ministry of International Trade and

[32] In such comparison, RG can be seen to refer to any political form of government which intervenes in allocation of productive investment and ownership of enterprises, and not only representative democracy. Namely, it appears reasonable, in relation to *economic* competence, to see the subset of the population that selects a non-democratic government — such as the military or a unique ruling party — as a random sample. This allows all the formal results about RG to be maintained.

Industry in the development of Japanese economy indicates that the **RG** ingredient has been significantly larger in Japan than in the USA. For a long time, this intervention appeared to help Japan to achieve a much higher economic growth. But during the last years, while the US economy has been gaining in strength, the Japanese economic performance has dramatically declined.[33]

EXAMPLE 2: A large **RG** ingredient was also used in many South American and African economies, but at what appears to be a lower level of loyalty and trust than in Japan. In these economies, as long as this ingredient remained large, no period of successful development could be observed.

EXAMPLE 3: Financial markets have been more important and could more develop in the economies of North American and Northern Europe than in the most developed market economies of South America and Southern Europe. The former can thus be seen to contain larger ingredients of **2M**, and the latter, of **1M**. While successful economic development can now be observed in both, the latter needed for it more time and concentrated its benefits to a smaller part of the population than the former.

EXAMPLE 4: The formerly socialist economies of Central and Eastern Europe — where **RG** used to be dominant, **1M** strongly limited and **2M** non-existent — differ in the speed with which **RG** was replaced by ingredients of **1M** and **2M**. The economies where this speed was relatively high ('shock therapy') suffered from a much larger initial drop in output than those where **RG** was reformed but mostly maintained. A few years later, however, the former economies began to prosper while the latter still continued to decline.

These examples can be seen to illustrate the following implications of the model.

IMPLICATION 1: Above the average economic competence can be found more rapidly by government selection than by market selection. But after a finite, although possibly costly, initial search period, a substantially higher economic competence begins to be selected by markets, which in the long run converge to finding the extremely small minority of the best economic competence available.

This directly follows from comparing the growth rate of **RG** in expression (19) with the

[33] Allow me to note that a prediction of such a decline appeared as what was then a difficult to believe result in one of my earlier attempts to analyze allocation of economic competence (Pelikan, 1992: 55).

growth rates of **1M** and **2M** in expressions (8), (16), and (18). Namely, the weighted average of *q* of the effectively selected entrepreneurs at time *t* is, under Assumptions 2 and 3, directly proportional to the growth rate at that time. The curves illustrating the differences in *r(t)* in Figure 2 can thus also be seen to illustrate the differences in the weighted average of *q* of the effectively selected entrepreneurs.

IMPLICATION 2: Only economies with a high level of loyalty and trust can turn the temporary advantage of rapid government selection into effective economic growth.

This directly follows from the consequences of dropping the perfect team assumption, discussed in Section 6 above.

IMPLICATION 3: Market economies can successfully develop both with and without financial markets, but without these markets, the development is slower in coming and more unequal in wealth distribution.

That all market economies can successfully develop, but those without financial markets need a longer time, follows from Proposition 2, and can be seen illustrated by the *Y(t)* part of Figure 2. That the gains of the development without financial markets are more unequally distributed follows from comparing **1M** with **2M** for their impact upon the distribution of individual control over capital, as implied by expressions (6), (10) and (11), and illustrated by Table 5.

Examples 1 and 4 can be seen to illustrate Implication 1; Example 2, Implication 2; and Example 3, Implication 3.[34]

Implications 1 and 3 appear to be of particular importance for policy analysis, where they qualify, and in some cases reverse, known results. Implication 3 does so by pointing out two so far poorly understood and often neglected merits of financial markets: (i) even in a perfect team, where no one uses them to seek personal gains, they accelerate economic growth; (ii) in economies with individual wealth distribution, they broaden the part of the population over which the benefits of the growth are spread.

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[34]Conclusion 3 and Example 3 can also be seen to qualify the much discussed Fukuyama's (1994) argument that trust is a prerequisite for economic development. Here, trust is shown necessary only for benefiting from the advantages of **2M**, but it is fully admitted, in good agreement with economic history, that market economies can also develop with a low level of trust. What is found out is that such economies must take the slower, socially costlier, and less equitable road of **1M**.

This can be contrasted with some recent theories which still view financial markets as little more than places of arbitrary wealth-redistribution and unproductive rent-seeking.[35] While the possibility of rent-seeking is here admitted (cf. Section 6 above), even a financial market on which some rent-seeking takes place is recognized socially efficient (Pareto-improving), if entrepreneurs extract lower rents from less competent investors than what these gain, according to Lemma 6, from having their capital fructified with higher economic competence than their own (although from the equity viewpoint, we may dislike that highly competent but opportunistic agents extract rents from trusting less competent fellows).

In consequence, Implication 3 brings support to policies that protect the selection of economic competence by financial markets from agents that risk losing in this selection, or are external to it. Thus, in reforms of the market for corporate control, support is given to institutional choices that protect shareholders' rights to transfer this control against obstacles set up by incumbent managers. And in reforms of bankruptcy procedures, support is given to institutions that give the right to select the managers of defaulting enterprises to creditors. As these are the ones whose capital holdings, and thus the weight in deciding over the future uses of capital in society, will be affected by the quality of this selection, to make them bear the responsibility for it is the right way to test *their* competence and expose it to relevant selection of its own.[36]

As an interesting extension, the analysis that produced Implication 3 can also throw light upon the rapid growth of mutual investment funds, which are now increasingly replacing direct links between investors and entrepreneurs. Whereas many theorists view this growth with suspicion, finding its social value difficult to identify, this analysis can show it to be a socially efficient response to the need of little competent investors to restrain their diligence together with the need of a modern economy to have its allocation of investment frequently revised in face of evolving technologies and changing markets. Such funds can simply be seen to build an

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[35]Examples of such views can be found in Murphy et al. (1991) and Shleifer and Vishny (1995).

[36]This appears to be a fruitful basis for exposing the weak points of the US bankruptcy law (Chapter 11). While protection of defaulting enterprises against too rapid liquidation can be admitted, protection of incumbent managers, whose economic competence is a prime suspect among possible causes of the default, and intervention in the management by judges, whose economic competence is neither the result nor the object of any relevant selection, are definitely opposed.

additional selection level, and thus transform **2M** into a kind of **3M**, which improves the results of **2M** much like **2M** improves the results of **1M**. Although it may again take time before funds managed with low economic competence lose importance, the selection of competent entrepreneurs can thus be accelerated and, as little competent investors are offered better opportunities to keep quiet, they can become richer, while the economy can be growing closer to the most favorable λ-limit from expression (18).

Implication 1 is of relevance to the entire economic agenda of government. The traditional argument used to be that this agenda should include all allocation problems which could not be solved optimally by decentralized decisions of market participants ('market failures') and for which government could potentially obtain socially superior solutions. This argument was later put in question by public choice theory, which showed that government agents would often lack the right incentives to actually choose and implement such solutions. Implication 1 now moreover shows that even if government agents were offered the right incentives, they might be unable to find such solutions for lack of sufficient competence.

More precisely, Implication 1 teaches two policy-relevant lessons: (i) in the division of economic decision tasks between the market sector and the government sector, an important factor is the economic competence which these sectors can effectively select for the tasks entrusted to them; (ii) after an initial search period, markets can select substantially higher economic competence for entrepreneurship and productive investment than governments.

These lessons can be translated into the following policy advice. Before moving any task from inefficiently working markets to the government agenda, test whether the lower expected economic competence of government agents would not cause even more inefficiency. Then consider moving only those tasks in which government can decrease the inefficiency of the best feasible market alternative by assigning them to standard experts of above the average competence (possibly signalled by appropriate diplomas), without requiring the top economic competence that only continuing market selection can obtain and maintain.[37]

This advice needs no sophisticated analysis to clearly exclude several important tasks

[37] The objection that in the real world, government could transcend this limitation by recruiting its experts among the market champions is easily refuted by considering that on markets, much like in sports, no champion has a tenure, but is continuously challenged by new emerging talents. Once recruited by government, old champions would not only escape the challenge of new talents, but could even prevent them from emerging.

from the government agenda, and thus reverse some known results of formally impeccable theories in which the scarcity of economic competence was ignored. Perhaps the easiest to exclude are all forms of national planning of production and/or productive investment.[38] Government ownership of firms is also easily excluded: there is no market inefficiency alleviated by it, and it soon leads to much lower expected competence of entrepreneurs, and therefore substantially less well organized and managed firms, than private ownership.[39]

Tasks that call for a finer analysis can be found among less radical industrial policies — such as investment banking, setting of technical standards, and subsidies to research and development. Without entering into detail, let me only indicate the most important points. Government investment banking is usually intended to alleviate inefficiencies of financial markets, which do not always provide sufficient capital to promising enterprises, especially the small and beginning ones. The main point here is that in the long and perhaps already medium run, the relevant competence of government selected bankers must be expected significantly lower than the competence of private investors selected by markets. Thus, while the market inefficiencies must often be recognized real, the search for remedies is directed to other solutions — such as tax incentives (or just abolishment of tax disincentives) for private risk capital, and improvements of the institutional framework of markets for risk capital. And although government participation in joint ventures may be considered as a remedy of last resort, it is accompanied by the warning that the apparent advantage of government free-riding on the higher competence of private investors may be spoiled by double rent-seeking at the tax-payers' expenses: opportunistic private investors may extract rents just thanks to the lower expected competence of the public investors, who may moreover engage in rent-seeking of their own.

Government setting of technical standards is usually intended to alleviate market

[38]The competence arguments against national planning were presented in Pelikan (1988, 1989), but the entire issue lost most of its interest after 1990. That national planning is no longer interesting even for advocates of socialism is illustrated by Bardham and Roemer (1992), whose socialist blueprint makes a maximum use of markets, while limiting socialism to ownership of firms and investment banks.

[39]The market inefficiency that government ownership is sometimes claimed to alleviate is monopoly. But there are numerous examples of government monopoly being at least as harmful as the private one. Moreover, there are other, more promising ways to combat monopoly than through ownership. A more extensive (although not formalized) discussion of forms of ownership of firms is in Pelikan (1993).

inefficiencies of two kinds: suboptimal coordination of private producers, which results in excessive variety of technical parameters of products, and path-dependence, which may lock these parameters in suboptimal states.[40] The present advice admits government to alleviate the former inefficiencies, if it is more important that *some* common standards are chosen than *which ones* they are. But warning is issued against government attempts to alleviate the latter inefficiencies: if also the contents matter, government cannot be expected to have the best competence for making such standards optimal.[41]

Among government subsidies to R & D, the advice favors subsidizing basic research, but not applied development. This is not due to a higher difficulty of the latter — they are both highly difficult and government agents must be expected to suffer from large competence-difficulty gaps in both of them — but to a relatively higher inefficiency of the least inefficient market alternative to the former. In other words, market alternatives that are less inefficient than government subsidies are often feasible for applied development, but not for basic research. Thus, although government cannot be expected to have very high competence for selecting the right recipients, nor for selecting the right experts for selecting the right recipients, subsidies to basic research still appear to be the best feasible policy. While a large share is thus likely to go to second-rate researchers of high political competence, rather than to true scientific innovators discovering the most valuable pieces of new knowledge, even the dissatisfied innovators will probably admit that from the point of view of development of sciences, this is a better state of affairs than no government subsidies at all.

In sum, the advice substantially reduces the repertory of promising industrial policies. But this does not mean that analysis of economic competence is hostile to all government intervention in economic affairs. In the productive sector, it implies that government should play an important role in providing markets with a suitable institutional framework, within which they could best develop their potential for solving the society's allocation problems, including the one of allocation of economic competence. And in final consumption, it may even

[40]A well-known example is the QWERTY keyboard on typewriters and computers, pointed out by David (1985).

[41]Let it also be noted, although this is not a direct lesson of the present model, that if such standards are set by government, they are likely to become even more rigid, and thus cause even more serious lock-in problems, than technical standards set by private firms in a competitive industry.

provide government intervention with additional support: if economic competence is scarce, the very principle of consumer sovereignty is put in question and the expected above-the-average competence of government selected experts may suffice to justify government intervention in several competence requiring consumer demands. But this is another story which remains to be explored.

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Appendix

Proof of Lemma 1. The definition of expected values in discrete distributions implies that the expected $\bar{q}(q_i)$ is the weighted sum of q from q_i to Q, in which the weights are the probabilities defined by Assumption 1. Q.E.D.

Proof of Lemma 2. According to Assumption 1, candidates of competence q_i can obtain votes only from agents whose $q \leq q_i$. Agents of competence q spread their votes randomly over candidates of the same or higher competence, among whom the relative frequency of candidates of competence q_i is $P(q_i)/[1 - F(q-1)]$. Summing up for all $q \leq q_i$ while factoring out $P(q_i)$ yields equation (3). Q.E.D.

Proof of Lemma 3. In Lemma 2, setting $q=1$ yields $P_S(1)=[P(1)]^2$; since $P(1)<1$, this implies $P_S(1)<P(1)$. Setting $q=Q$ yields

$$P_S(Q) = P(Q)\sum_{q=1}^{Q}\frac{P(q)}{1 - F(q-1)}\,,25$$

where

$$\sum_{q=1}^{Q}\frac{P(q)}{1 - F(q-1)} > \sum_{q=1}^{Q}P(q) = 1\,,26$$

which implies $P_S(Q)>P(Q)$. Now consider that the average of the votes received is equal to the average of the votes casted,

$$\bar{q}_S = \sum_{q=1}^{Q}P(q)\bullet\ \bar{q}(q)\,.27$$

Since Lemma 1 implies $\bar{q}(q)>q$ for all $q<Q$ and $\bar{q}(Q)=Q$, then

$$\bar{q}_S = \sum_{q=1}^{Q}P(q)\bullet\ \bar{q}(q) > \sum_{q=1}^{Q}P(q)\bullet q = \bar{q}\ \ .28$$

Q.E.D.

Proof of Lemma 4. This follows directly from parts (b) and (c) of Assumption 4. Q.E.D.

Proof of Lemma 5. Assumption 2(b) implies that influences of ε_i can be neglected in calculating *i*'s long-term contributions to the team's *Y* and *R*, and Assumption 5(d) implies the unimportance of the number of individual entrepreneurs, which together imply equation (4). Q.E.D.

Proof of Lemma 6. For an investor of $q<Q$, the set of eligible entrepreneurs, among whom she randomly allocates her capital, includes her own competence category plus at least one category of superior competence, q+1. If she allocated all her investment only among these two categories, the rate of growth of her portfolio in the following period could at most be $\rho(q)$:

$$\frac{P(q)\bullet\ \pi(q)+P(q+1)\bullet\ \pi(q+1)}{P(q)+P(q+1)}\leq\rho(q),\quad\forall\, q<Q\,,29$$

where the equality is true for investors of $q = Q - 1$, and the inequality for all the others, whose $\rho(q)$ is further boosted by contributions of some relatively even more competent entrepreneurs. Following Assumption 5(b), $\pi(q) < \pi(q+1)$. Hence:

$$\pi(q)=\frac{P(q)\bullet\ \pi(q)+P(q+1)\bullet\ \pi(q)}{P(q)\ +\ P(q+1)}<\frac{P(q)\bullet\ \pi(q)+P(q+1)\bullet\ \pi(q+1)}{P(q)\ +\ P(q+1)}\leq\rho(q)\,.30$$

If $\pi(q)<\rho(q)$ for $q<Q$, then also $[\pi(q)]^t < [\rho(q)]^t$ for $q<Q$ and $t>0$. As equation (10) shows $[\rho(q)]^t = \kappa(q,t)$, the Lemma's first inequality follows.

In the portfolio of an investor of $q<Q$, consider now the shares invested with entrepreneurs of competence categories $q+m$ and $q+m+n$, say $h(q+m)$ and $h(q+m+n)$, where $m\geq0$, $n\geq1$, and $(q+m+n)\leq Q$. The former share grows with the rate $\pi(q+m)$ and the latter with the rate $\pi(q+m+n)$. Since, according to Assumption 5(b), $\pi(q+m+n) > \pi(q+m)$, the growth of their sum is an increasing function of their ratio $\sigma(q,n,m) = h(q+m+n)/h(q+m)$. In the first period after each investment decision, $\sigma(q,n,m) = P(q+m+n)/P(q+m)$. For the second period, if no new investment decision is taken, this ratio is multiplied by $\pi(q+m+n)/\pi(q+m) > 1$. Thus, the sum of these shares will grow faster if no new investment decision is taken: each new investment decision diminishes this growth. As this holds for any two competence categories of the portfolio, this also holds for the entire portfolio. Since the cumulative growth of the portfolio according to $\kappa(q,t)$ is the result of more new investment decisions than the growth according to $\lambda(q,t)$, the Lemma's second inequality follows. Q.E.D.

Proof of Proposition 1. Lemma 3 and equation (20) imply

$$\sum_{q=1}^{Q} P_{SS}(q)\bullet q > \sum_{q=1}^{Q} P_S(q)\bullet q > \sum_{q=1}^{Q} P(q)\bullet q\,.31$$

Following Assumption 5(b), $\Delta\pi(q)/\Delta(q)>0$. Hence substituting $\pi(q)$ for q cannot but strengthen the inequalities:

$$\sum_{q=1}^{Q} P_{SS}(q)\bullet\ \pi(q) > \sum_{q=1}^{Q} P_S(q)\bullet\pi(q) > \sum_{q=1}^{Q} P(q)\bullet\pi(q)\,.32$$

Following equation (21) the first term equals $Y_{RG}(1)$; following equation (17) the second term equals $Y_{2M\lambda}(1)$ and, as implied by equations (14) and (15), also $Y_{2M\kappa}(1)$; following equation (7) the third term is $Y_{1M}(1)$. Hence

$$Y_{RG}(1) > Y_{2M\lambda}(1) = Y_{2M\kappa}(1) > Y_{1M}(1)\,,33$$

which implies the ranking according to $Y(1)$. Since Assumption 4(a) sets $Y(0) = 1$, this is also the ranking according to $R(0)$. Q.E.D.

Proof of Proposition 2. Following equations (8) and (18), both $R_{1M}(t)$ and $R_{2M\lambda}(t)$ tend to

$$\lim_{t\to\infty} \frac{\sum_{q=1}^{Q} P(q)\bullet[\pi(q)]^{t+1}}{\sum_{q=1}^{Q} P(q)\bullet[\pi(q)]^{t}} = \lim_{t\to\infty} \frac{\sum_{q=1}^{Q} P_S(q)\bullet[\pi(q)]^{t+1}}{\sum_{q=1}^{Q} P_S(q)\bullet[\pi(q)]^{t}} = \frac{[\pi(Q)]^{t+1}}{[\pi(Q)]^{t}} = \pi(Q)\,.34$$

Following equation (16), $R_{2M\kappa}(t)$ tends to

$$\lim_{t\to\infty} \frac{\sum_{q=1}^{Q} P(q)\bullet[\rho(q)]^{t+1}}{\sum_{q=1}^{Q} P(q)\bullet[\rho(q)]^{t}} = \frac{[\rho(Q)]^{t+1}}{[\rho(Q)]^{t}} = \rho(Q)\,.35$$

Setting $q_i=Q$ in equation (9) yields $\rho(Q) = \pi(Q)$. Hence for $t\to\infty$, $R(t)$ under all the market variants converges to $\pi(Q)$. According to equation (22), R_{RG} is time-invariant, and equation (21) implies $R_{RG} < \pi(Q)$. This establishes the ranking according to $R(\infty)$.

In the assumed stationary and favorable exogenous conditions, $Y(t)$ under all the variants grows beyond all limits, but converges to differently performing growth paths. Equation (7) implies that $Y_{1M}(t)$ converges to $P(Q)\cdot[\pi(Q)]^t$; equation (15) implies that $Y_{2M\kappa}(t)$ converges to $P(Q)\cdot[\rho(Q)]^t$; and equation (17) implies that $Y_{2M\lambda}(t)$ converges to $P_S(Q)\cdot[\rho(Q)]^t$. Following equation (23), $Y_{RG}(t)$ grows all the time according to $[R_{RG}]^t$. Since $\rho(Q)=\pi(Q)$, $P_S(Q)>P(Q)$, and $\pi(Q)>R_{RG}$, the paths ranks as follows:

$Y_{2M\lambda}(t) > Y_{2M\kappa}(t) = Y_{1M}(t) > Y_{RG}(t)$. 36

This implies the ranking according to $Y(\infty)$. The superiority of **2M$_\mathbf{K}$** and **1M** over **RG** is considered 'very large' because the ratio $Y_{1M}(t)/Y_{RG}(t)$ itself converges to an exponential growth path: $[P(Q)\cdot\pi(Q)/R_{RG}]^t$. In contrast, the ratios $Y_{2M\lambda}(t)/Y_{2M\kappa}(t)$ and $Y_{2M\lambda}(t)/Y_{1M}(t)$ converge to the constant $P_S(Q)/P(Q)$. Q.E.D.

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TABLE 1
Values of the assumed *F(q)* and *P(q)*

q	1	2	3	4	5	6	7
$F(q)$	1/64	7/64	22/64	42/64	57/64	63/64	1
$P(q)$	1/64	6/64	15/64	20/64	15/64	6/64	1/64
$P(q)$ percent	1.56	9.38	23.44	31.25	23.44	9.38	1.56

TABLE 2
Voting behavior according to Lemma 1 and Lemma 2

q	1	2	3	4	5	6	7
$\Pr(q\rightarrow 1)$	1/64	0	0	0	0	0	0
$\Pr(q\rightarrow 2)$	6/64	6/63	0	0	0	0	0
$\Pr(q\rightarrow 3)$	15/64	15/63	15/57	0	0	0	0
$\Pr(q\rightarrow 4)$	20/64	20/63	20/57	20/42	0	0	0
$\Pr(q\rightarrow 5)$	15/64	15/63	15/57	15/42	15/22	0	0
$\Pr(q\rightarrow 6)$	6/64	6/63	6/57	6/42	6/22	6/7	0
$\Pr(q\rightarrow 7)$	1/64	1/63	1/57	1/42	1/22	1/7	1
$\mathrm{q}(q)$	4	4.048	4.236	4.714	5.364	6.143	7
$P_S(q)$ percent	0.024	1.04	8.77	26.57	35.91	22.40	5.30

TABLE 3
Comparative performance of institutional alternatives

	RG		1M		2Mκ		2Mλ	
t	*Y(t)*	*r(t)*	*Y(t)*	*r(t)*	*Y(t)*	*r(t)*	*Y(t)*	*r(t)*
0	1	5	1	-2	1	2.28	1	2.28
1	1.050	5	0.980	-1.63	1.023	2.39	1.023	2.56
2	1.103	5	0.964	-1.24	1.047	2.51	1.049	2.87
5	1.276	5	0.939	-0.12	1.132	2.86	1.150	3.63
10	1.629	5	0.968	1.65	1.320	3.52	1.408	4.89
20	2.653	5	1.311	4.74	1.987	5.02	2.501	7.08
50	11.47	5	12.59	10.29	16.51	9.54	36.05	11.06
100	131.5	5	3385	12.68	3601	12.46	11258	12.78
200	17293	5	$6.454 \cdot 10^{8}$	12.996	$6.466 \cdot 10^{8}$	12.989	$2.187 \cdot 10^{9}$	12.998

NOTE: $r(t) = 100 \cdot [R(t) - 1]$

TABLE 4
Taking-off times for surpassing

type	in *Y*	in *r*
1M _ RG	48.0	21
2Mκ _ RG	39.8	20
2Mλ _ RG	22.8	10.5
1M _ 2Mκ	never	22.9

TABLE 5
Cumulative growth of individual capital

q		1	2	3	4	5	6	7
RG	$t = 1$	1.05	1.05	... 1.05	1.05	1.05	1.05	1.05
	10	1.63	1.63	1.63	1.63	1.63	1.63	1.63
	100	132	132	132	132	132	132	132
2Mλ	$t = 1$	0.98	0.98	0.99	1.02	1.05	1.09	1.13
	10	0.97	0.98	1.06	1.26	1.66	2.34	3.40
	100	3385	3439	3801	5158	9848	$3.09 \cdot 10^4$	$2.03 \cdot 10^5$
2Mκ	$t = 1$	0.98	0.98	0.99	1.02	1.05	1.09	1.13
	10	0.82	0.84	0.93	1.17	1.60	2.31	3.40
	100	0.13	0.16	0.50	4.89	109	4197	$2.03 \cdot 10^5$
1M	$t = 1$	0.83	0.88	0.93	0.98	1.03	1.08	1.13
	10	0.16	0.28	0.48	0.82	1.34	2.16	3.40
	100	0.00	0.00	0.00	0.13	19.2	2200	$2.03 \cdot 10^5$

NOTE: RG is idealized by assuming a perfectly egalitarian distribution, with no privileges for the politically selected investors and entrepreneurs.